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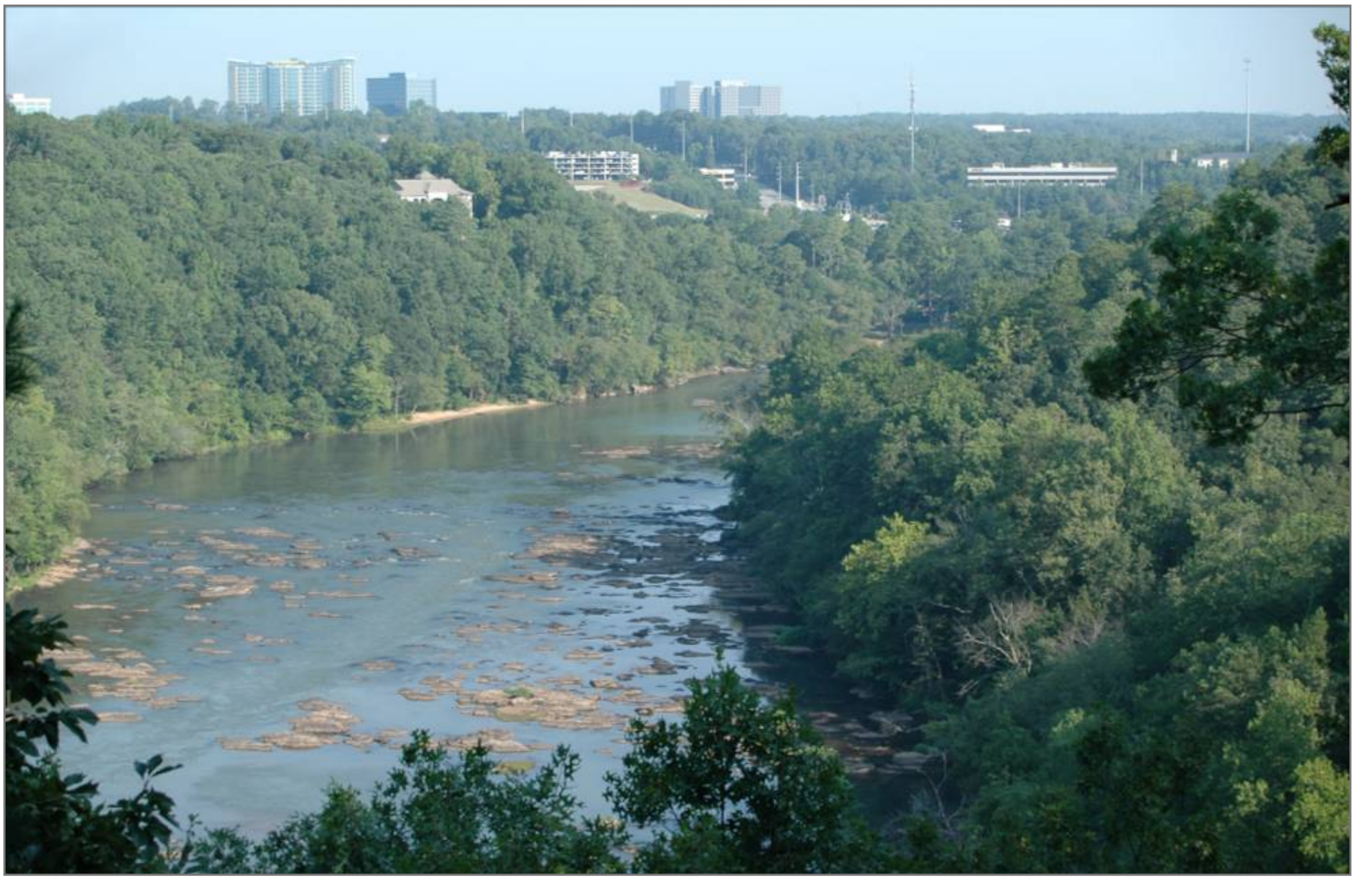
Assessment of Water Resources and Watershed Conditions in the Chattahoochee River National Recreation Area, Georgia

Natural Resource Report NPS/SECN/NRR—2010/274



ON THE COVER
City scape, Palisades Unit, Chattahoochee River National Recreation Area.
Photograph by: Eric Morris

Assessment of Water Resources and Watershed Conditions in the Chattahoochee River National Recreation Area, Georgia

Natural Resource Report NPS/SECN/NRR—2010/274

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Abbreviations

ARC – Atlanta Regional Commission
AQI – Air Quality Index (of the U.S. EPA)
brl – below reporting limit
BOD_5 – biochemical oxygen demand (five-day testing duration)
CAAE – Center for Applied Aquatic Ecology (of North Carolina State University, NCSU)
Cd - cadmium
cfs – cubic feet per second
cfu – colony-forming units
CCC – criterion continuous concentration (of the U.S. EPA)
CEC – chemical environmental contaminant
CMC – criterion maximum concentration (of the U.S. EPA)
CO_2 – carbon dioxide, a major greenhouse gas contributing to global warming
COD – chemical oxygen demand
Cr – chromium
Cu – copper
DIP – dissolved inorganic phosphorus
DO – dissolved oxygen
DOC – dissolved organic carbon
DON – dissolved organic nitrogen
DOP – dissolved organic phosphorus
DP – dissolved organic phosphorus
EC – type of culture medium used to assess fecal coliform densities with a multiple-tube procedure
ECHO ICIS – Enforcement and Compliance History Online Integrated Compliance Information System (of the U.S. EPA)
EIS – environmental impact statement
EPD – Environmental Protection Division (of GA DNR)
FC – fecal coliforms
FEMA – Federal Emergency Management Agency
FS – fecal streptococci
ft – foot or feet
GA – Georgia
GA DAA – Georgia Department of Audits and Accounts
GA DNR – Georgia Department of Natural Resources
GA DOT – Georgia Department of Transportation
GBP – Georgia Bioassessment Protocol
GIS – Geographic Information System
gm (gms) – geometric mean(s)
gpd – gallons per day
gpm – gallons per minute
Hg – mercury
IPCC – United Nations Intergovernmental Panel on Climate Change
lat. – latitude
long. – longitude

m – meter
MF – membrane filter (refers to a technique for analysis of fecal coliform densities, also using M-FC medium)
M-FC – type of culture medium for assessment of fecal coliform densities (see above)
mgd – million gallons per day
mg/L – milligrams per liter (= parts per million, ppm)
MPN – most probable number (pertaining to fecal bacteria)
MNGWPD – Metropolitan North Georgia Water Planning District
µg/L – micrograms per liter (= parts per billion, ppb)
MPN – most probable number
MS4 – municipal separate storm sewer system
N – nitrogen (nutrient; excessive enrichment can degrade water quality)
NAAQS – National Ambient Air Quality Standards
NARSAL – Natural Resources Spatial Analysis Laboratory
NH_3 – ammonia (gaseous form; can be an air or water pollutant)
NH_4^+N – ammonium (inorganic form of nitrogen, ionized from ammonia; excessive enrichment can degrade water quality
$NO_3^- + NO_2^-$ – nitrate + nitrite (inorganic forms of nitrogen; excessive enrichment can degrade water quality)
NO_x – in waters, refers to nitrate + nitrite
NO_x or NO_y – in the atmosphere, a “catch-all” term for all reactive oxides of nitrogen
NP – nonpoint
NPCA – National Parks Conservation Association
NPDES – National Pollutant Discharge Elimination System
NPS – National Park Service
NTU – nephelometric turbidity units
NWIS – National Water Information System (of the USGS)
P - phosphorus (nutrient; excessive enrichment can degrade water quality)
PAMS - Photochemical Assessment Monitoring Stations (for air quality)
park – the Chattahoochee River National Recreation Area
Pb – lead
PCS – Permit Compliance System (of the U.S. EPA)
$PM_{2.5}$ – particulate matter, diameter $\leq$ 2.5 µm (air pollutant)
PM_{10} – particulate matter, diameter $\leq$ 10 µm (air pollutant)
QA/QC – quality assurance/quality control (refers to standardized procedures for ensuring acceptable quality of data)
SECN – Southeast Coast Network of the National Park Service
SO_2 – sulfur dioxide (air pollutant)
spec. cond. – specific conductivity
SPOC – species of concern
sq. mi. – square mile(s)
SRP – soluble reactive phosphate
STORET – STOrage and RETrieval Environmental Data System (of the U.S. EPA)
strep – streptococci (type of fecal bacteria)
sv – single value

SVOC – semi-volatile organic compounds, also called polycyclic aromatic hydrocarbons (air pollutants)
TDP – total dissolved phosphorus
TDS – total dissolved solids
TKN – total Kjeldahl nitrogen
TM – trace metal
TMDL – total maximum daily load
TP – total phosphorus
TSS – total suspended solids
USACE – United States Army Corps of Engineers
USDA – United States Department of Agriculture
USDI – United States Department of the Interior
U.S. EPA – United States Environmental Protection Agency
U.S. FWS – United States Fish and Wildlife Service
USGS – United States Geological Survey
USGS NAWQA – United States Geological Survey National Water Quality Assessment Program
VOC – volatile organic compound
WC – water column
WPCP – water pollution control plant (wastewater treatment plants)
WQ – water quality
WTP – water treatment plant (drinking water)
WRD – Wildlife Resources Division (of GA DNR)
WUI – Wildland-Urban Interface

Executive Summary

The purpose of this report was to locate and assess existing information pertaining to the water quality in and around the Chattahoochee River National Recreation Area (the park), assess the present and likely future water conditions of the park, and make recommendations to fill existing information gaps. Water quality and quantity, habitat issues, the potential for invasive species, trends in park resource use, and watershed influences and other stressors were addressed insofar as possible through available data and first-hand observations.

The park is relatively large (6,500 acres, with maximum potential area of 10,000 acres depending upon land acquisitions) but highly fragmented, presently consisting of 16 non-contiguous units along a 48-mile reach of the Chattahoochee River from Buford Dam at Lake Lanier downstream to the northwestern area of the City of Atlanta, Georgia. This river park is of vital importance to the greater Atlanta metropolitan area, providing about 75% of the area's remaining green space. The river in the park area alone has more than three million visitors per year, and is the most intensely used stream segment in the state. It sustains rainbow trout and brown trout put-and-take fisheries, with a trout hatchery at the northern end of the park, and some tributaries have supported trout reproduction. The Chattahoochee River also supplies about 75% of the drinking water for the Atlanta metropolitan area.

Nevertheless, relentless increasing development characterizes the Chattahoochee River watershed including the area immediately surrounding the park. The entire corridor of this river park, and beyond it to the north surrounding Lake Lanier, is sustaining rapid growth of housing, commercial development, and roads and other infrastructure while older sewage treatment plants and sewer pipes in developed areas frequently overflow or leak. The resulting chronic water quality degradation includes high fecal coliform bacterial densities, high suspended sediment loads, high concentrations of various toxic substances (especially PCBs, lead, cadmium, copper, and zinc), and increased summer water temperatures. Lake Lanier, the source water for the Chattahoochee River segments including the park, is now a repository for treated sewage from Atlanta. Its elevated nutrient loading stimulates blooms of potentially toxic cyanobacteria. Much of the mainstem Chatthoochee River and most of its major tributaries in the park area are officially listed as impaired waters that cannot meet their designated uses for drinking water supplies, fishing and/or recreation. Yet, unchecked development continues to escalate. Not surprisingly, water supply is another major issue that is significantly affecting the park's natural resources, and is projected to more seriously affect them within the next decade.

The park's dramatically beautiful river corridor, with its rocky bluffs and wide river shoals, still has a rich flora of terrestrial, wetland and aquatic plants. However, at least ten native fish species and most shellfish species which once were abundant in park waters apparently have been extirpated, including some endangered species. In contrast, diverse exotic/invasive plant and animal species thrive in both terrestrial and aquatic/wetland habitats of the park.

The overall assessment of this Report is that the natural and resources of the park are being significantly impacted by upstream and encroaching urbanization, and by the multitude of water and air pollutants and other stressors associated with rapid human population growth, land development, and natural resource degradation and destruction in the Atlanta metropolitan area. The already-high and increasing impervious surface area in the watershed has resulted in

increased floodplain areas for some streams because of increased stormwater runoff, resulting in severe stream bank erosion, loss of land and vegetation, and other damage. Surrounded by this intensive urbanization which is actively favored by various powerful entities, the NPS has an especially difficult challenge to meet its charge of preserving and protecting this park for present and future generations. The already-formidable task is exacerbated by the inadequate approach that presently characterizes water quality monitoring of the Chattahoochee River and its tributaries in the park area. Since the turn of the century – for almost a decade, now – even the most basic monitoring efforts have been left almost entirely to the counties, along with limited sampling by the federal USGS in partnership with the state environmental agency, and extremely limited sampling by the state environmental agency itself.

The available data are compelling, nonetheless: Even piecemeal water samples taken twice per year or once per quarter show, over time, degraded conditions with a high frequency of violations of the state water quality standards or federally recommended guidelines for fecal coliform bacteria, toxic metals, nutrient enrichment, sediment loading, and biochemical oxygen demand. When *water-column* toxic metal concentrations are excessive – given that most toxic metals rapidly leave the water column and accumulate in the sediments, which have gone uncharacterized – a "flag is up" that points to serious, chronic water pollution problems.

The airshed surrounding and over the park contributes to this pervasive water pollution: It sustains among the highest CO_2, NO_x, fine particulate, and SO_2 emissions in the entire country, mostly from various coal-fired power plants including two of the largest in the world. The airshed is in violation of federal ozone and fine particulate standards, which threatens the health of park staff and frequent visitors, and the high ozone concentrations likely are damaging terrestrial and wetland foliage. The park also lies in an area that is prone to atmospheric acid deposition, and acidification, especially acid spates, likely is adversely affecting its terrestrial, wetland and aquatic resources.

Other stressors to the park's natural and historic resources are related to encroaching urbanization, including the illicit dumping of trash and other refuse, erosion/washout of hiking trails that receive heavy use, noise pollution, light pollution, the urban island heat effect of increased temperatures, and spillover crime from Atlanta.

Recommendations

The following recommendations, which can be addressed within NPS jurisdiction, address pressing needs to help restore and improve protection of the seriously degraded, ecologically and economically valuable water resources and other natural resources of this park. These major recommendations are based upon the past ca. decade of information as described in this Report. Also considered are as-yet unaddressed or only partially addressed recommendations, still highly germane, that were put forth in the Chattahoochee Water Management Plan of 2000 (Kunkle and Vana-Miller 2000) and in NPS (2004a).

- A top priority is to conduct a one-year sampling program in park surface waters including the Chattahoochee River and its major tributaries with biweekly or, at a minimum, monthly sampling frequency. At least two stations in each of the four sections of the park and at least one station on each tributary should be sampled for, at a minimum, water temperature, pH, dissolved oxygen, suspended solids, turbidity, nutrients (TN, TP, nitrate, ammonium, BOD_5), fecal coliform densities, enterococci bacteria, and chlorophyll *a* concentrations. This effort should be repeated at three-year intervals. This program should include additional monitoring of representative storm events because they are known to contribute most nonpoint source pollution from urban runoff and other sources.*

- Once per year during an appropriate seasonal timeframe, the fish and macroinvertebrates (benthic fauna, aquatic insects) should be assessed at these stations.*

- Data should be collected at least quarterly on toxic substance concentrations in *sediments* and *fish* tissues. Parameters of focus should include, at a minimum, cadmium, copper, lead, zinc, mercury, and PCBs.*

- The NPS developed a bacterial water quality monitoring program, BacteriALERT, to help safeguard human health safety in the park's recreational waters. BacteriALERT includes a system that displays water pollution and water quality information, although limited to fecal bacteria and turbidity. The program, originally with three stations, is now down to two, and three had been inadequate to accomplish the program goal. This important program needs to be expanded strategically to include additional stations in park waters.*

- As a fifth top priority, data from the above three recommendations should be used to prioritize restoration of degraded areas, and to identify the major actions that will be needed.*

- As a sixth priority, updated economic evaluation is needed of the recreational value of the park, including the economic threat of water quality degradation.*

- Some of the major existing sources of water quality impacts on the park's aquatic resources have been identified in this Report. Inventory of other major sources of water pollution, for which computerized information mostly is not available, is needed for septic tanks in large-scale subdivisions, new highway projects, numerous new shopping centers, and other sources that are being added through the rapid surrounding increase in urbanization and urban sprawl. The data should be used to create GIS maps of these sources, and these maps can be upgraded to help the NPS track pollution and its impacts in park waters.

- The NPS should confer with the USACE and other agencies to evaluate the effects of the Tri-State Water Allocation Formula, once approved and applied, to assess whether the allocated flows are sufficient to support recreation and healthy fisheries in the park.

- The NPS should also work with the USACE to address more effectively the bank sloughing problem caused by hydroelevation surge flows.

- Wetlands in each Park Unit should be more clearly delineated and described. Large-scale as well as more detailed maps are needed, and wetland vegetation should be inventoried.

- A sampling program is needed to establish present conditions and track exotic/invasive species, and assess the ongoing status of their impacts on aquatic and wetland resources in the park, so that park staff can develop active management strategies to optimize control.*

- The streams in Park Units nearest the Buford Dam (especially Bowmans Island) should be monitored for stream bank erosion from water release activities, and for tree damage.

- The NPS should assess incidence of foliar injury to park plants from ozone pollution, including common wetland bioindicator species such as yellow poplar and American elder. More generally, data are needed to assess the extent to which air pollution is affecting the park, and to forecast how increasing air pollution from the greater Atlanta metropolitan area will affect its waters and other natural resources.*

- The park should continue to work to strengthen education outreach to teach visitors about the importance of greenspaces such as this park in ecosystem sustainability.*

Park Description

Background

Location, Size, and Boundaries

The Chattahoochee River National Recreation Area (the park, ~6,500 acres, elevation 700 – 1,000 ft) is a highly fragmented park consisting of 16 non-contiguous units along a 48-mile linear corridor of the Chattahoochee River, from Buford Dam at Lake Lanier downstream to the northwestern area of the City of Atlanta (NPS 2008a; *Figures 1* and *2*). The Park Units are located in four counties (Forsyth, Fulton, Cobb, Gwinnett), along with one tributary in Dekalb County (*Figure 2*). The park is surrounded by rapidly developing urban and suburban areas (NPS 2008a), and it provides about 75% of the green space in the greater Atlanta metropolitan area (population ~4 million); another NPS park, Kennesaw Mountain National Battlefield Park, provides most of the remainder (Kunkle and Vana-Miller 2000). The Chattahoochee River and its riparian environment are the major outdoor recreation attraction in the Atlanta area, including four counties and a small portion of a fifth, for more than three million visitors per year, many of whom use the Park Units for hiking, fishing, picnicking, boating, nature study, and other outdoor activities (Kunkle and Vana-Miller 2000). In fact, the segment of the river including the park has been described as the most intensely used stream segment in Georgia (Atlanta Regional Commission 1992a). The Atlanta Regional Commission (1992b) describes the river as a "thread of nature running through a bustling, growing major metropolitan area, offering an irreplaceable asset that adds immensely to Atlanta's quality of life". The entire park area is severely affected by urban impacts and continued urban sprawl.

The primary purpose of the original park was to recognize the beautiful scenery of unique cliff features associated with the Palisades area, formed by continental drift associated with the Brevard Fault (*Plate 1*) (NPS 2008b). The park lies in an upland area of moderately strong relief. The park consists of beautiful cliffs along the river, gorges, rock outcroppings, rivers shoals, and surrounding native forested uplands. Certain cultural resources such as a major Native American rock shelter and historic industrial mill sites are also present. The 16 Park Units along the Chattahoochee are shown, together with major tributaries, in *Figures 3-6*, with information on latitudes and longitudes and access points given in *Table 1*. A recent major land acquisition, Hyde Farm (adjacent to the western boundary of Park Unit #13; see *Figure 5, Plate 2*) and the NPS' top priority for land purchase for the park, was secured in 2008 by the national conservation organization, the Trust for Public Land (135 acres in total; 40 acres acquired in 1993, and the remaining 95 acres purchased for $14.2 million in 2008). The Trust for Public Land will convey the land to Cobb County and the NPS under a joint cooperative management plan for the site. Hyde Farm is a historic working farm, one of the last remaining near Atlanta, initiated in the 1920s and including a log cabin from the Power family who settled there in the 1830s. The site is expected to be opened to the general public in late 2009.

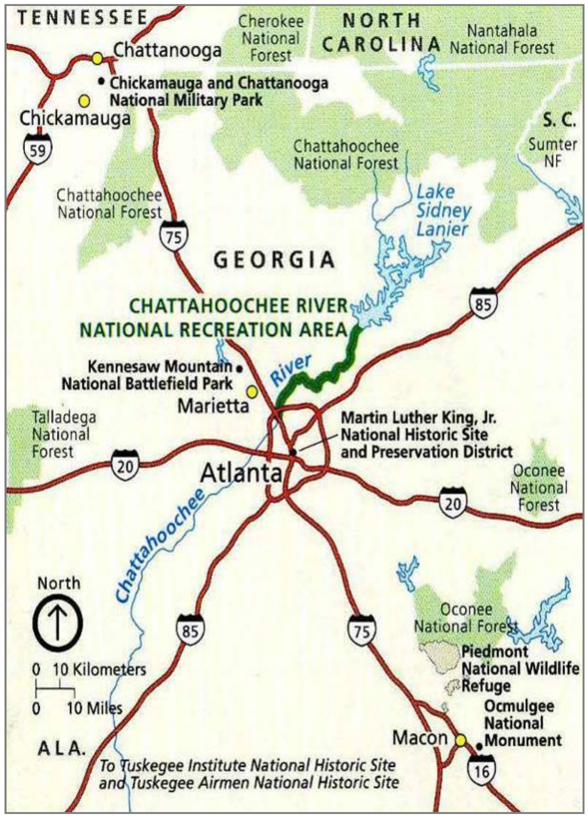


Figure 1. Map of the Atlanta area, showing the general park area (although not contiguous) as well as two other NPS entities, Kennesaw Mountain National Battlefield Park, and the Ocmulgee National Monument. From NPS (2008a).

History of the Park

The word "Chattahoochee" means painted rock in the Cherokee language (NPS 2008b). The Cherokee Indians had settlements along the Chattahoochee River for thousands of years until they were forced out in the early 1800s (NPS 2008b). In the early 1970s, a group of local citizens who understood the value of the Chattahoochee River to the state and were concerned about signs of water quality degradation, sought public protection for its preservation (Kunkle and Vana-Miller 2000). Congressional response was followed by then-President Jimmy Carter's signing of a bill to create the park in recognition of its scenic vistas, urban location, geologic features, and biodiversity. The enabling legislation (PL 95-344, HR 8336, 1978) authorized land acquisition of 6,300 acres at sites along the Chattahoochee River from the Lake Lanier dam downstream to northern Atlanta at the mouth of Peachtree Creek (Figures 2-6) (NPS 2008a). The legislation also authorized the NPS in a major role to manage the park's natural resources and "protect the river's natural, scenic, recreation, historic and other values…from development and uses which would substantially impair or destroy them" (U.S. Congress, 1978 in NPS 2008a).

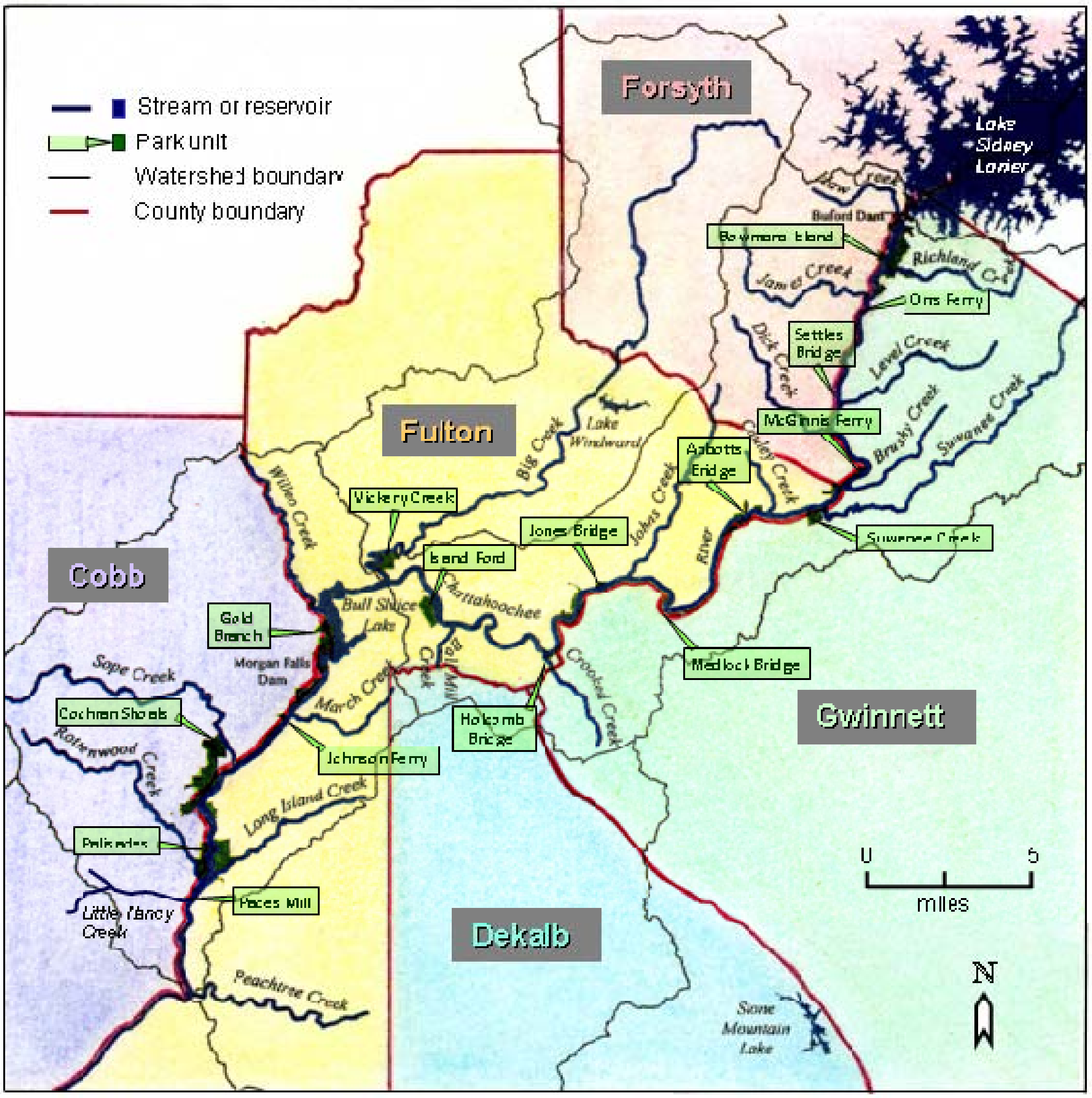


Figure 2. Overview map of the park in the five-county area (Cobb, Fulton, Forsyth, Gwinnett, and Dekalb), showing locations of the 16 present-day Park Units, Lake Lanier, the Chattahoochee River, various tributaries, and watershed boundaries. Modified from Kunkle and Vana-Miller (2000).

The park's authorized boundaries have since been expanded twice. In 1984, Public Law 98-568 was enacted to the authorized boundary to 6,800 acres (Kunkle and Vana-Miller 2000), and clarified that the park was established to "facilitate Federal technical and other support to State and local governments to assist State and local efforts to protect the scenic, recreational, and natural values of a 2,000-foot-wide corridor adjacent to each bank of the Chattahoochee River and its impoundments in the 48-mile segment." The 1984 law also declared the park to be an area of national concern. In 1999, another federal public law (PL 106-154, Sec. I, 106 Stat. 1736) enables the park's authorized boundaries to expand to 10,000 acres (NPS 2008a), if funds can be acquired for land purchase. This law recognized that the park is a nationally significant resource that has been adversely affected by land use changes inside and outside the park; and that "the population of the metropolitan Atlanta area continues to expand northward, leaving dwindling opportunities to protect the scenic, recreational, natural, and historical values of the 2,000-foot-wide corridor adjacent to each bank of the Chattahoochee River and its impoundments in the 48-mile segment known as the 'area of national concern'. Thus, *Park* technically means the waters of the Chattahoochee River, to the maximum extent of the high water mark ("bank to bank"), from Buford Dam to the confluence of the Chattahoochee River with Peachtree Creek and the land units along it as defined in the enabling legislation (NPS 1989). There remains a major difference, however, between authorization and reality: the present-day 16 Park Units, covered in this Report, extend only as far south as Little Nancy Creek, about three miles north of the confluence of the Chattahoochee River with Peachtree Creek, with a total land area of only about 6,500 acres (Kunkle and Vana-Miller 2000).

Plate 1. A beautiful public trust resource: the Chattahoochee River viewed from various Park Units.

The state of Georgia had earlier (1973) enacted the Metropolitan River Protection Act (Georgia Code 12-5-440) to ensure protection of this corridor, or the corridor located within the 100-year floodplain, whichever is larger. The 100-year floodplain corridor includes the area of national concern. The 1999 federal legislation noted that the state and political subdivisions of the state along the Chattahoochee River had "indicated willingness to join in a cooperative effort with the federal government to link existing units of the recreation area through a series of linear corridors to be established within the area of national concern and elsewhere on the river". However, expansion of the park to 10,000 acres resulted from more than 15 years of coordination by the NPS in cooperation with the Trust for Public Land and other private organizations. Non-federal land holdings within the expanded park boundary (*Figures 2-6*) can only be acquired by the NPS if the owners are "willing sellers". The NPS is under negotiation with various landowners in attempts to acquire additional parcels as funding becomes available (NPS 2008a).

Plate 2. Photos concerning Hyde Farm, the most recent land acquisition of the park: (left top) Mr. J.C. Hyde and his mule Nell, who farmed the land until Mr. Hyde's death in 2004; (left bottom) Members of the Friends of Hyde Park in 2001. This concerned citizens group, the Triangle Land Trust, the NPS, and state and federal legislators worked for many years to protect the farm from development. (right) View of the Chattahoochee River from Hyde Farm. Photos by N. Arroyo (top left) and A. Sharp (bottom left and right), with permission from the Atlanta Journal - Constitution).

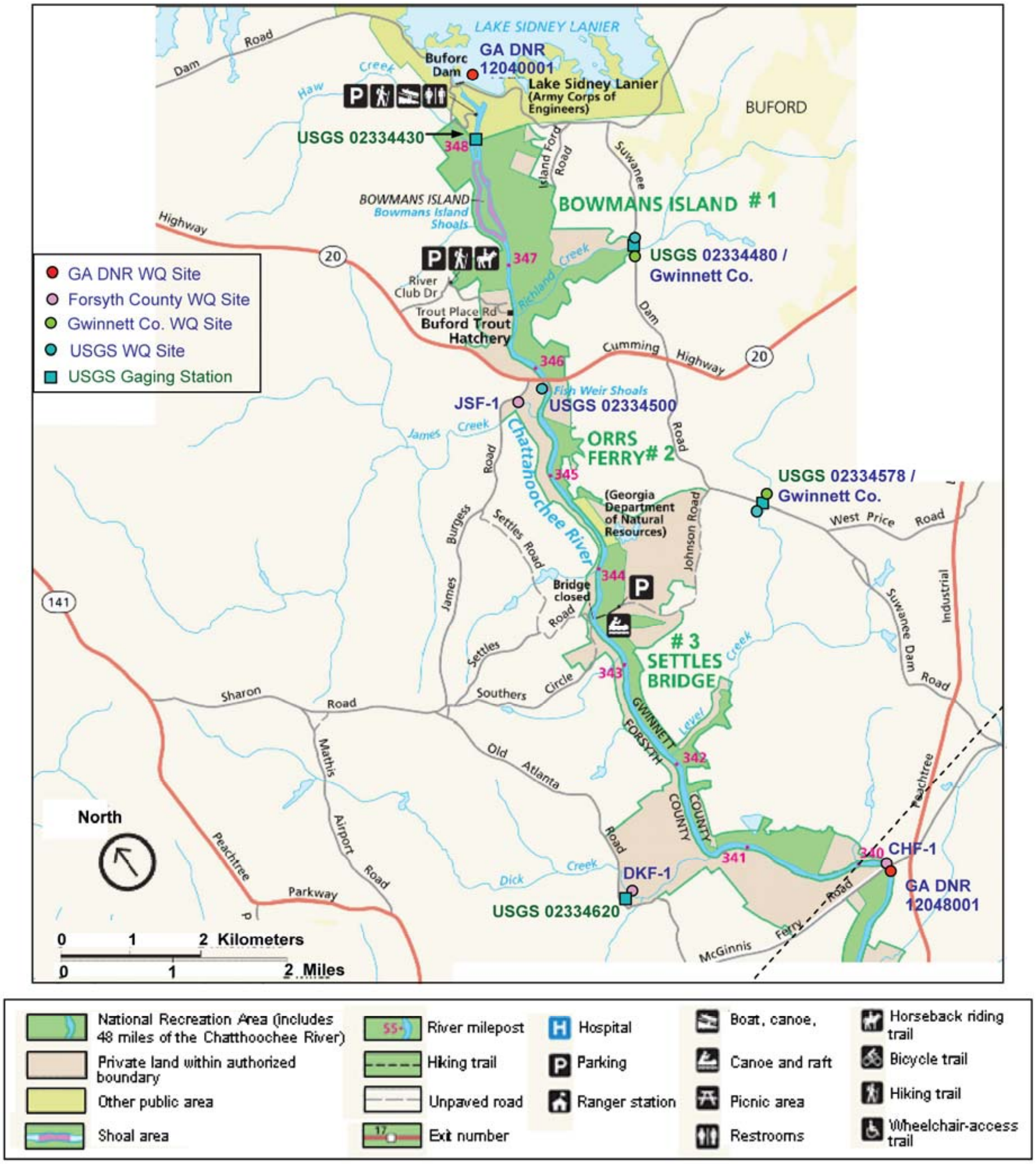


Figure 3. Section I of the park, designated for this Report – the three northernmost park Units Bowman's Island, Orrs Ferry, and Settles Bridge; the Lake Lanier source water for the mainstem Chattahoochee River in the park area; and major tributaries Haw Creek, Richland Creek, James Creek, Level Creek, and Dick Creek (note that the area south of the diagonal line is in Section II). Also shown: 1 GA DNR-EPD water quality sampling site (near the outflow of Lake Lanier), 2 Forsyth County sites, 2 Gwinnett County/USGS water quality sites, 1 USGS water quality site, and 3 USGS gaging stations. Note: In Figures 2-5, the private land within the park boundary would have to be purchased by the NPS to become part of the park. Modified from NPS (2008b); Sections I-IV (*Figures 3-6*) collectively include 48 miles of the Chattahoochee River.

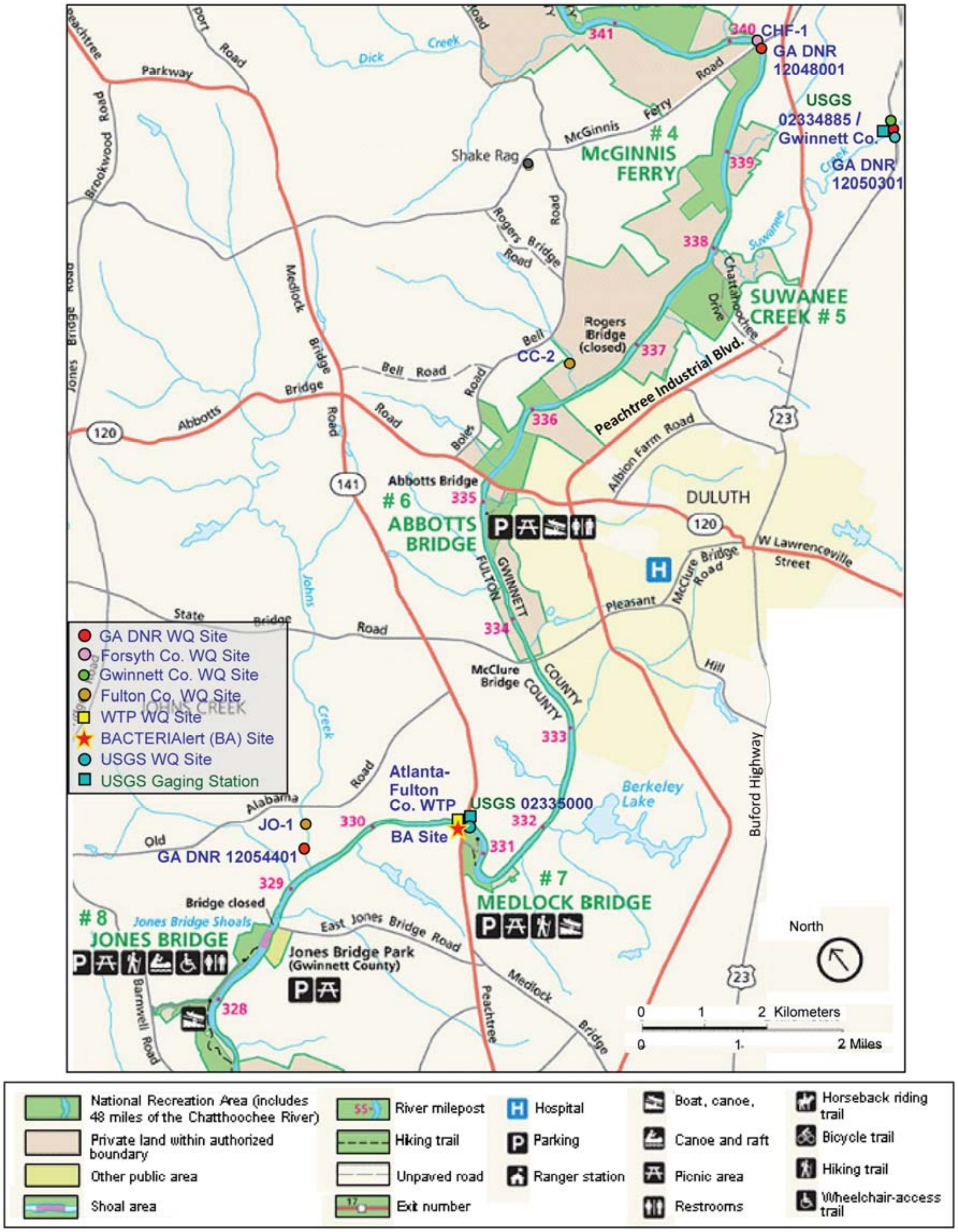


Figure 4. Section II of the park proceeding south, showing Park Units 4-7 as McGinnis Ferry, Suwanee Creek, Abbotts Bridge, Medlock Bridge, and all but the southern end of Park Unit # 8, Jones Bridge; and Chattahoochee River tributaries Suwanee Creek and Johns Creek. Also shown are 3 GA DNR-EPD water quality sampling sites, 1 Forsyth County Site, 1 Gwinnett County/USGS site, 2 Fulton County sites, 2 UGSG gaging stations, 1 water treatment plant (WTP) site, and 1 BacteriALERT site. Modified from NPS (2008b).

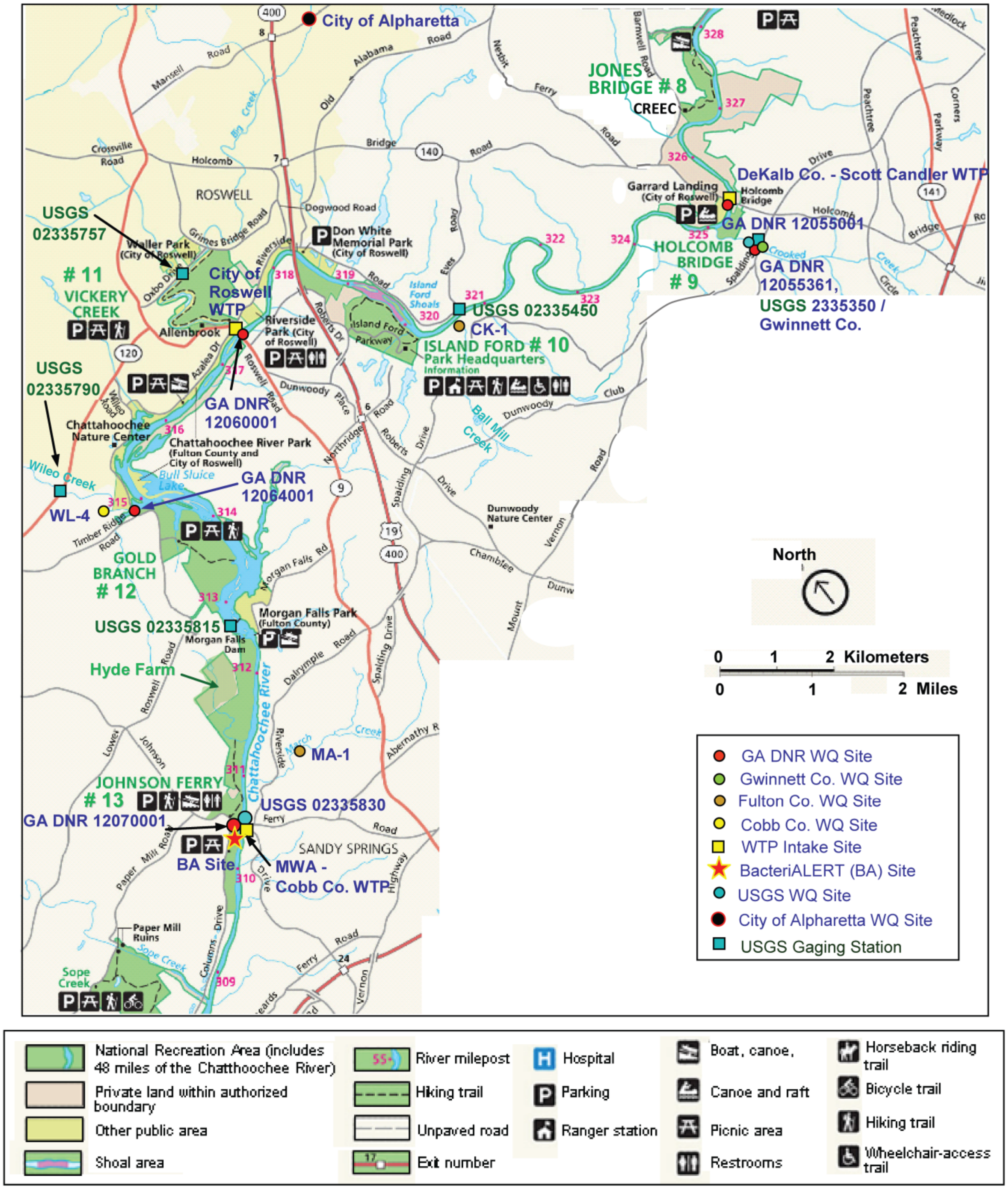


Figure 5. Section III of the park proceeding south, showing the southern end of Park Unit #8, and Units 9-13 as Holcomb Bridge, Island Ford, Vickery Creek, Gold Branch, and Johnson Ferry (the latter including Hyde Farm, acquired in 2008); the Chattahoochee River Environmental Education Center (CREEC – in the southern area of Park Unit 8); and Chattahoochee River tributaries Crooked Creek, Vickery Creek, and March Creek, as well as Bull Sluice Lake and the Morgan Falls Dam. Also shown are 5 GA DNR-EPD water quality sampling sites, 2 Fulton County sites, 1 Cobb County site, 2 USGS water quality sites (1of these also a Gwinnett County site), 4 USGS gaging stations (a fifth site, USGS 02335700, Big Creek at Alpharetta, is out of the field of view – see *Figure 19*), 1 water quality site maintained by the City of Alpharetta, 3 WTP sites, and 1 BacteriALERT site. Modified from NPS (2008b).

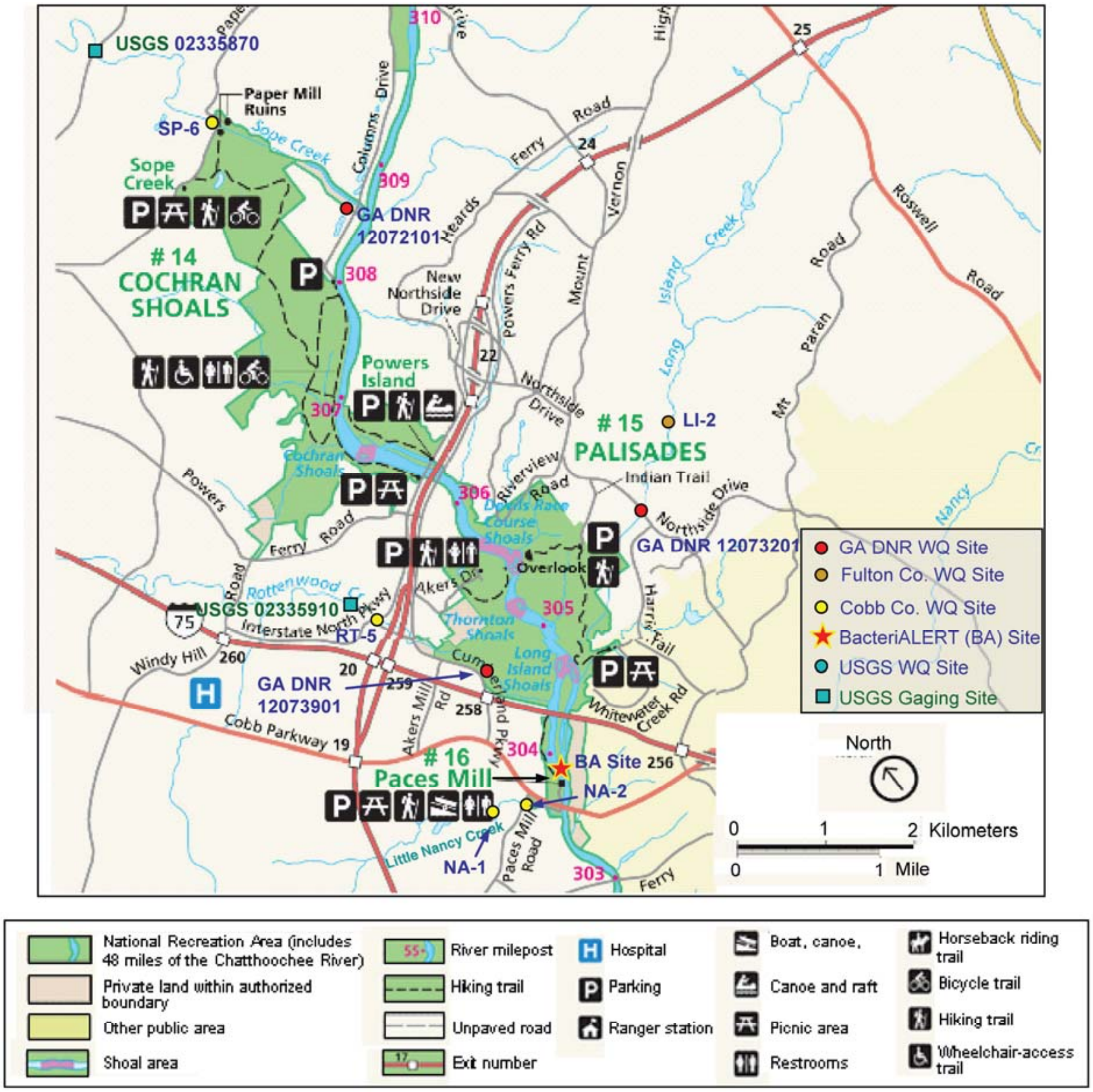


Figure 6. Section IV of the park – southernmost Park Units 14-16 as Cochran Shoals, Palisades, and Paces Mill; and Chattahoochee River tributaries Sope Creek, Long Island Creek, Rottenwood Creek, and Little Nancy Creek. Also shown are 3 GA DNR-EPD water quality sampling sites, 1 Fulton County site, 4 Cobb County sites, 1 BacteriALERT site, and 2 USGS gaging stations. Modified from NPS (2008b).

Table 1. Main street or highway access points for the 16 Park Units, listed proceeding from north to south along the Chattahoochee River (Rm = river mile; latitudes and longitudes from approximately the central portion of each Park Unit). Modified from Kunkle and Vana-Miller (2000).

Park Unit	Location	Description
Park Section I		
1) Bowman's Island	Latitude 34.1432 Longitude -84.0812 Rm ~348 - 345.8	Cumming Highway/GA 20, Suwanee Dam Road
2) Orrs Ferry	Latitude 34.1212 Longitude -84.0922 Rm ~345.6 - 343.6	From GA 20 south on Suwannee Dam Road NE, right onto Ramey Road NE, right onto Wild Timber Road NW, right onto Wild River View NW
3) Settles Bridge	Latitude 34.0988 Longitude -84.0973 Rm ~343.6 - 340.3	Suwanee Dam Road, Johnson Road (unpaved)
Park Section II		
4) McGinnis Ferry	Latitude 34.0454 Longitude -84.1087 Rm ~339.8 - 338.4	McGinnis Ferry Road
5) Suwanee Creek	Latitude 34.0279 Longitude -84.1254 Rm ~337.9 - 337.4	Peachtree Industrial Boulevard, Chattahoochee Drive (unpaved)
6) Abbotts Bridge	Latitude 34.031 Longitude -84.1662 Rm ~335.3 - 334.6	Abbotts Bridge Road, Boles Road
7) Medlock Bridge	Latitude 33.9928 Longitude -84.2054 Rm ~331.3 - 330.7	Peachtree Parkway, Medlock Bridge Road
8) Jones Bridge	Latitude 33.9958 Longitude -84.2518 Rm ~328.7 - 326.5	Holcomb Bridge Road, Jones Bridge Road, Barnwell Road
Park Section III		
9) Holcomb Bridge	Latitude 33.9707 Longitude -84.2657 Rm ~325.4 - 325.0	Holcomb Bridge Road
10) Island Ford	Latitude 33.9936 Longitude -84.3283 Rm ~320.2 - 318.3	GA 400, Northridge Road, Dunwoody Place, Roberts Drive
11) Vickery Creek	Latitude 34.0133 Longitude -84.3491 Rm ~317.4 - 317.5	Roswell Road, Azalea Drive, Riverside Road (note: most of this unit is set back from the river)
12) Gold Branch	Latitude 33.9798 Longitude -84.3807 Rm ~314.9 - 312.9	Lower Roswell Road, Timber Ridge Road
13) Johnson Ferry	Latitude 33.9463 Longitude -84.4053 Rm ~312.4 - 309.6	Johnson Ferry Road

Table 1. (continued).

Park Unit	Location	Description
Park Section IV		
14) Cochran Shoals	Latitude 33.9255 Longitude -84.4417 Rm ~308.7 - 308.6 Rm ~308.7 - 306.3	Johnson Ferry Road, Paper Mill Road, Columns Drive (including Powers Island)
15) Palisades	Latitude 33.8871 Longitude -84.4395 Rm ~306.0 - 304.5	I-285, Northside Drive, Mount Vernon Highway, Powers Ferry Road, Riverview Road
16) Paces Mill	Latitude 33.8694 Longitude -84.4534 Rm 304.4 - 303.6	I-285, I-75, Cobb Parkway

Land Use / Land Cover in the Chattahoochee Watershed

Land use characteristics of the total Chattahoochee River watershed upstream from the southern edge of the park, and of the watershed from the Lake Lanier outfall to the southern edge of the park, were determined using data layers from 2005 that were provided by the Natural Resources Spatial Analysis Laboratory at the University of Georgia, Athens, GA (*Figures 7 and 8*). Also considered here are data by Park Section (I-IV) for sub-watersheds from a few years earlier (digital images from 2000), when land use in Chattahoochee River basin watersheds was assessed as part of the process of developing TMDLs for fecal coliform densities and suspended sediments in some of the impaired waters affecting the park. Land use characteristics were determined using data from Georgia's Multiple Resolution Land Coverage, which was produced from Landsat Thematic Mapper. The land use characteristics of these sub-watersheds were determined using data from Georgia's Multiple Resolution Land Coverage (MRLC), and these land use coverage data were obtained from the Atlanta Regional Commission (*Tables 2-6*).

In the entire Chattahoochee watershed, forest still covers about half of the land, and pasture/hay and other agricultural practices cover nearly 20%, with urban land use about 14% of the total (2005 data layers, Natural Resources Spatial Analysis Laboratory, University of Georgia). However, urban development over the past 15 years has dramatically affected the portion of the watershed containing the park (*Tables 2-5, Figure 8*). The percent of impervious surface within a watershed or sub-watershed is an index of urbanization, and is significantly related to nonpoint source pollution (Mallin et al. 2001, Rothenberger et al. 2009). For perspective, watersheds with impervious surface higher than 7% typically have high fecal coliform bacterial densities from stormwater input to surface waters, so that shellfish are not safe for human consumption (Mallin et al. 2001). Schueler (1994) and Paul and Meyer (2001) inferred that healthy watershed conditions can be met if impervious surface area is maintained at or below 10%. Considering the three major urban land use categories (low-intensity residential, high-intensity residential, and high-intensity commercial-industrial-transportation), nearly one-third (32.7%) of the sub-watershed drained by the Chattahoochee River from its confluence with Jones Creek down to Morgan Falls was reported to be in urban land development (GA DNR 2007a). This situation is exacerbated for the lower park segments: the sub-watershed drained by the Chattahoochee from Morgan Falls Dam downstream past Paces Mill to Peachtree Creek was reported as 65.1% urban land development (GA DNR 2007a). Sub-watersheds drained by tributaries in the upper Park

Section I for which data were available averaged 44.3% urban land use; tributary sub-watersheds in Sections II, III, and IV averaged 57.9%, 82.7%, and 90.4% urban land use, respectively.

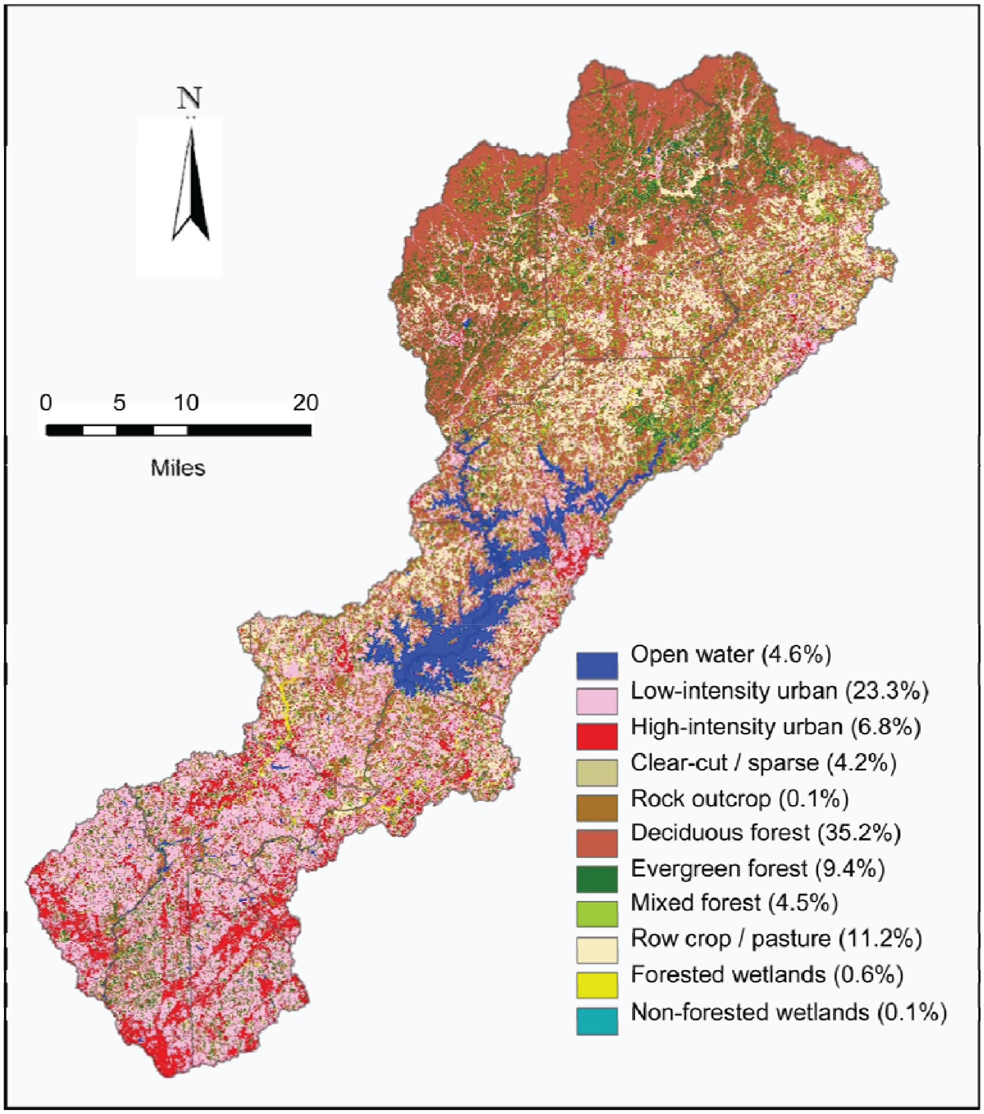


Figure 7. Land use in the Chattahoochee River watershed that lies upstream from the southernmost extension of the park, based on data layers from 2005 that were provided by the Natural Resources Spatial Analysis Laboratory at the University of Georgia. Land use percentages are indicated in parentheses after each category. As the map illustrates, most of the watershed above Lake Lanier is covered by rock outcrop, forest and cropland, whereas most land use in the watershed below Lake Lanier is in low- or high-intensity urban development.

Serious water quality degradation and impairment to aquatic flora and fauna would be expected from such conditions (Paul and Meyer 2001, Mallin et al. 2001). An impervious surface cover model for the health of the park watershed was constructed by Reynolds and Hardy (2007), and was used to construct a time series analysis of 688 micro- (sub-) watersheds and sub-watershed condition comparing years 1991, 2001, and 2005 (*Figure 9*). Micro-watersheds were delineated using ArchHydro extension, and a flow accumulation model was used to develop a watershed layer at a 247.1-acre (100-hectare) threshold.

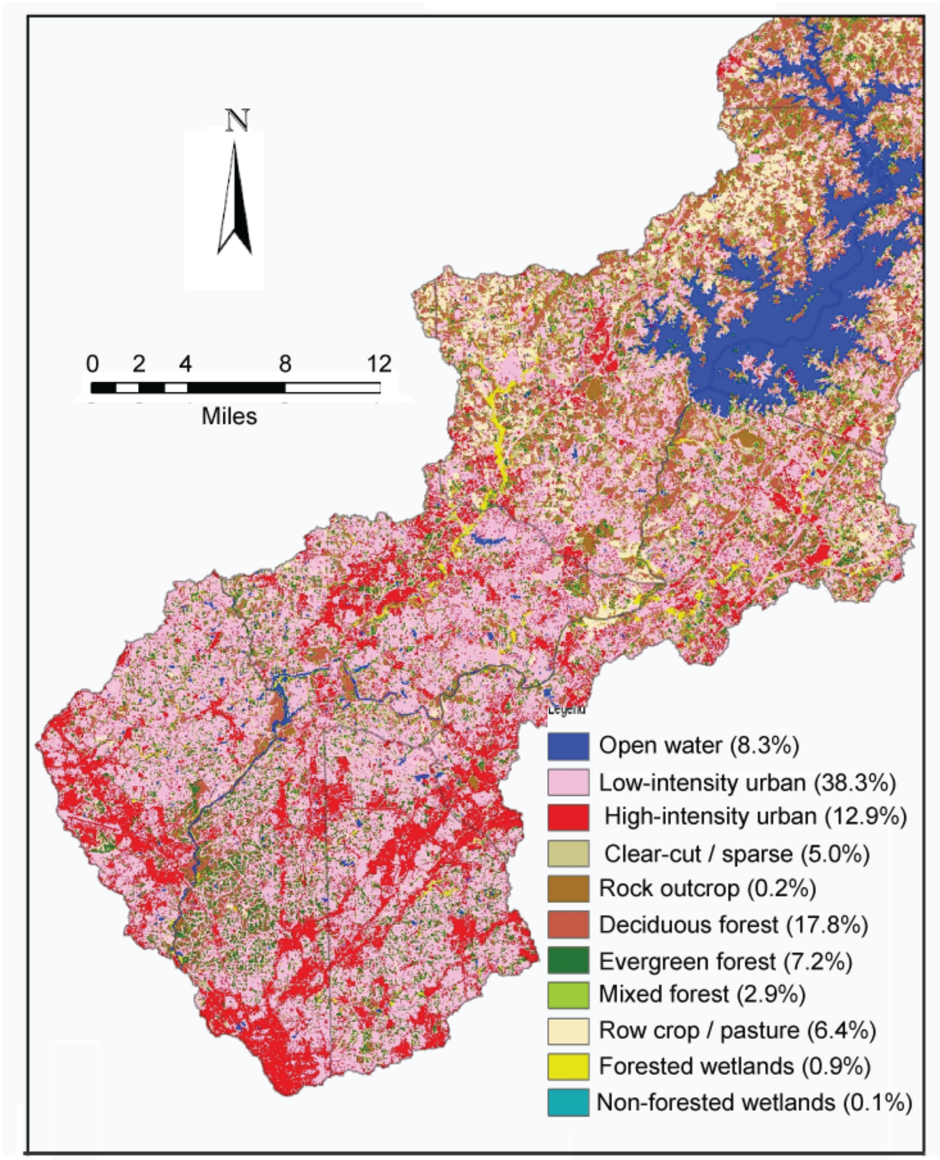


Figure 8. Map of land use in the portion of the Chattahoochee River watershed from Lake Lanier to the southernmost extension of the park, based on data layers from 2005 that were provided by the Natural Resources Spatial Analysis Laboratory at the University of Georgia. This map shows the large-scale urbanization (~81%) of the portion of the watershed that includes the park, with land use percentages below Lake Lanier indicated in parentheses after each category.

Remnant and fragment micro-watersheds (less than 100 acres in size) were joined to the largest adjacent watershed using the "Eliminate" geoprocessing tool in ArcGIS. Percent impervious area layers were obtained from NARSAL at the University of Georgia. The percent impervious area for micro-watersheds surrounding the park was estimated using Zonal Statistics++ in Hawth's tools (Reynolds and Hardy 2007). The analysis shows rapid urbanization in the Chattahoochee watershed portion containing the park over the past ~15 years. In 1991, 36.5% of the micro-watersheds (251 of a total of 688) were impacted or degraded; by 2005, 81.5% (561) were assessed as impacted or degraded.

Table 2. Land use (2000 data) in sub-watersheds affecting Park Section I (most upstream area; units 1-3, from Bowmans Island down to Settles Bridge). In headers, sub-watershed area is indicated in parentheses. From GA DNR (2003a).

	Unit 1 Bowmans Island		Unit 3 Settles Bridge	
Land Use	**Richland Creek (7,183 acres)**		**Level Creek (5,649 acres)**	
Open water	6	(0.1%)	21	(0.4%)
Low-intensity residential	2,052	(28.6%)	2,736	(48.4%)
High-intensity residential	58	(0.8%)	42	(0.7%)
High-intensity commercial, Industrial, transportation	446	(6.2%)	222	(3.9%)
Bare Rock, sand clay	22	(0.3%)	0	
Quarries, strip mines	246	(3.4%)	0	
Transitional	233	(3.2%)	70	(1.2%)
Forest	3,787	(52.7%)	2,146	(38.0%)
Agricultural (pasture/ hay, row crop)	156	(2.2%)	375	(0.7%)
Other grasses (urban, park, etc.)	177	(2.5%)	37	
Wetlands	0		0	

Table 3. Land use (2000 data) in sub-watersheds affecting Park Section II (units 4-8, from McGinnis Ferry down to Jones Bridge), and the mainstem Chattahoochee River in lower Section 2 through most of Section III (confluence with Johns Creek down to Morgan Falls, or from RM 329.3 down to RM 312.7) In headers, sub-watershed area is given in parentheses. From GA DNR (2003a, 2008a).

	Unit 5 Suwanee Creek		Units 8-12 Jones Br. To Gold Branch		Unit 8 Jones Bridge	
Land Use	**Suwanee Creek (31,539 acres)**		**Chattahoochee R. (167,682 acres)**		**Johns Creek (8,383 acres)**	
Open water	91	(0.3%)	2,518	(1.5%)	50	(0.6%)
Low-intensity residential	8,770	(27.8%)	38,715	(23.1%)	5,451	(65.0%)
High-intensity residential	256	(0.8%)	11,390	(6.8%)	86	(1.0%)
High-intensity commercial, Industrial, transportation	3,811	(12.1%)	4,616	(2.8%)	753	(9.0%)
Bare Rock, sand clay	0		1,638	(1.0%)	0	
Quarries, strip mines	0		251	(0.1%)	0	
Transitional	1,929	(6.1%)	--		265	(3.2%)
Forest	13,305	(42.2%)	53,730	(32.0%)	969	(11.6%)
Agricultural (pasture/ hay, row crop)	2,556	(8.1%)	13,963	(8.3%)	359	(4.3%)
Other grasses (urban, park, etc.)	181	(0.6%)	37,263	(22.3%)	333	(4.0%)
Wetlands	640	(2.0%)	3,598	(2.1%)	117	(1.4%)

Table 4a. Land use (2000 data) in sub-watersheds affecting Park Section III (Park Units 9-11, from Holcomb Bridge down to Vickery Creek). In headers, sub-watershed area is given in parentheses. From GA DNR (2003a).

Land Use	Unit 9 – Holcomb Br. Crooked Creek (5,783 acres)		Unit 10 – Island Ford Ball Mill Creek (2,538 acres)		Unit 11 – Vickery Cr. Big Creek (Hwy 400) (66,391 acres)	
Open water	17	(0.3%)	0		343	(0.5%)
Low-intensity residential	1,471	(25.4%)	2,157	(85.0%)	24,785	(37.3%)
High-intensity residential	873	(15.1%)	11,390	(6.8%)	1,453	(2.2%)
High-intensity commercial, Industrial, transportation	2,631	(45.5%)	39	(1.5%)	9,579	(14.4%)
Bare Rock, sand clay	0		0		0	
Quarries, strip mines	0		0		7	(~0%)
Transitional	139	(2.4%)	0		2,611	(3.9%)
Forest	647	(11.2%)	103	(4.0%)	14,299	(21.5%)
Agricultural (pasture/ hay, row crop)	0		0		10,768	(16.2%)
Other grasses (urban, park, etc.)	5	(0.1%)	105	(4.1%)	1,189	(1.8%)
Wetlands	0		0		1,357	(2.0%)

Table 4b. Land use (2000 data) in sub-watersheds affecting Park Section III (Park Units 12-13, from Holcomb Bridge down to Vickery Creek), and also the mainstem Chattahoochee River in lower Section III (just above Johnson Ferry) through Section IV (Morgan Falls Dam downstream from Paces Mill, to Peachtree Creek, or from RM 329.3 down to RM 312.7). In headers, sub-watershed area is given in parentheses. From GA DNR (2003a).

	Unit 12 Gold Branch Willeo Creek (10,664 acres)		Units 13-16 – above Johnson Ferry to Paces Mill Chattahoochee R. (291,264 acres)		Unit 13 Johnson Ferry March Creek (3,728 acres)	
Open water	142	(1.3%)	2,923	(1.0%)	0	
Low-intensity residential	9,179	(86.1%)	133,891	(46.0%)	2,273	(61.0%)
High-intensity residential	56	(0.5%)	11,936	(4.1%)	466	(12.5%)
High-intensity commercial, Industrial, transportation	433	(4.1%)	43,612	(15.0%)	609	(16.3%)
Bare Rock, sand clay	0		38	(~0%)	0	
Quarries, strip mines	0		931	(0.2%)	0	
Transitional	153	(1.4%)	8,439	(2.9%)	51	(1.4%)
Forest	623	(5.8%)	61,249	(21.0%)	312	(8.4%)
Agricultural (pasture/ hay, row crop)	69	(0.6%)	19,262	(6.6%)	0	
Other grasses (urban, park, etc.)	8	(0.1%)	6,262	(2.1%)	17	(0.4%)
Wetlands	2	(~0%)	2,625	(0.9%)	0	

Table 5. Land use (2000 data) in sub-watersheds affecting Park Section IV (units 14-16, from Cochran Shoals down to Paces Mill). In headers, sub-watershed area is given in parentheses. From GA DNR (2003a).

Land Use	Unit 14 Cochran Shoals		Unit 15 Palisades			
	Sope Creek (22,515 acres)		Long Is. Creek (5,131 acres)		Rottenwood Creek (12,701 acres)	
Open water	59	(0.3%)	11	(0.2%)	4	(~0%)
Low-intensity residential	16,097	(71.5%)	3,987	(77.7%)	2,615	(20.36%)
High-intensity residential	588	(2.6%)	302	(5.9%)	1,783	(14.0%)
High-intensity commercial, Industrial, transportation	3,263	(14.5%)	627	(12.2%)	6,628	(52.2%)
Bare Rock, sand clay	16	(0.1%)	0		0	
Quarries, strip mines	0		0		0	
Transitional	154	(0.7%)	8	(0.2%)	125	(1.0%)
Forest	1,612	(7.2%)	176	(3.4%)	1,234	(9.7%)
Agricultural (pasture/ hay, row crop)	233	(1.0%)	0		0	
Other grasses (urban, park, etc.)	493	(2.2%)	22	(0.4%)	312	(2.5%)
Wetlands	0		0		0	

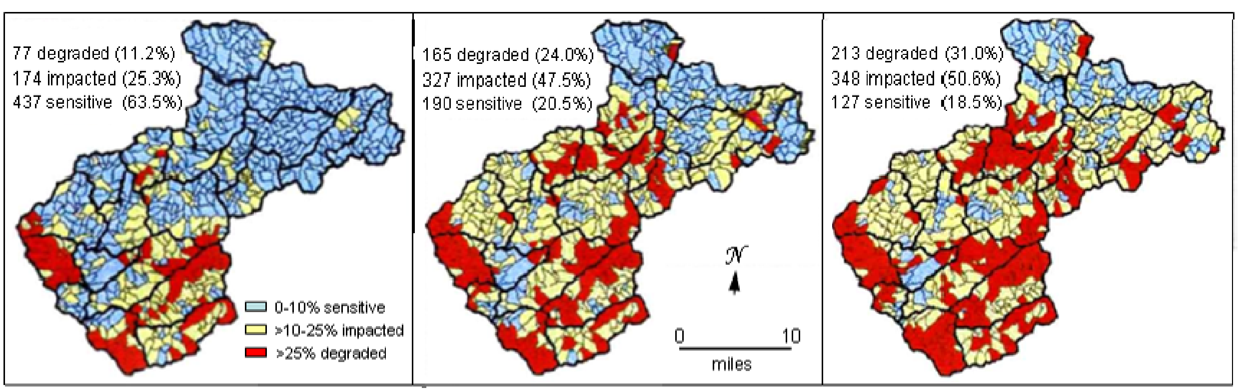


Figure 9. Impervious surface cover model for the health of the park watershed, considering a micro-watershed time series from 1991 to 2005. From Reynolds and Hardy (2007).

Hydrologic Information

General Area

The park region has a humid, subtropical temperature, often reaching the mid-90s (^{o}F) or higher in summer and decreasing to the mid-40s during winter, with a mean annual temperature of ~62.1^{o}F (Frick et al. 1998, GA DNR 2007b; Daymet – **www.daymet.org**). Mean annual precipitation is 50.17 inches, and snowfall is rare; evapotranspiration is about 32 inches per year (Frick et al. 1998, GA DNR 2007b, Georgia State Climatology Office 2007). Precipitation generally is greatest in February-March and least in October. A dry season extends from mid-summer to late fall (GA DNR 2007b).

The park lies entirely within the Piedmont Province, and the general drainage area is underlain by deeply weathered crystalline rock (Krankle and Vana-Miller 2000). The Chattahoochee River (total watershed 416 sq. mi.) in this area flows along the Brevard Fault Zone, a highly fractured zone ranging from about half a mile to two miles wide within the Gainesville Ridges District (Clark and Zisa 1976). The river is one of the oldest and most stable river channels within the U.S., "locked" in place along the fault zone within a relatively long, narrow watershed (NPS 2008a). It is heavily relied upon for potable water supplies (below).

The Lake Lanier reservoir (*Figure 2*; and see below) was completed in 1957 by the USACE for hydropower, water supply to the Atlanta metropolitan area, and flood control. The City's other main water source is the Etowah River and its multipurpose reservoir, Lake Allatoona, constructed in 1950. The flow of the Chattahoochee River through Atlanta is controlled by management of Lake Lanier, which has decreased the frequency of high- and low-flow events but has also caused large daily fluctuations in flows (tailwater fluctuations from 3.9 – 11.1 m) because of hydropower generation and other management practices (Couch et al. 1996, Kunkle and Vana-Miller 2000, Fitzhugh and Richter 2004).

Surface Waters

The Chattahoochee River is about 430 miles long and drains a watershed area of 8,770 square miles. Its average discharge over the entire basin is 11,500 cfs (Couch 1993). The park segments are included between river mile 348.3 at the Buford Dam downstream to river mile 303.5 (*Figures 2-6, 10*). The river drains about 416 square miles in this area (Kunkle and Vana-Miller 2000). A total of 15 major tributaries as well as many minor tributaries of the river occur in the present park area (*Figure 8*). The two largest tributaries within the park are Big Creek (mean daily discharge 108 cfs, maximum flow 2,410 - 3,970 cfs) and Suwanee Creek (mean daily discharge 67 cfs, maximum flow 2,150 - 4350 cfs) (NPS 2004a).

Hydrologic information is especially important for this park because its aquatic resources are significantly affected by the heavy reliance by the greater metropolitan Atlanta area for drinking water supplies from the mainstem Chattahoochee River. The park is projected to be more seriously affected by Chatthoochee water demands, throughout the watershed, as rapid human population growth continues (Jordan et al. 2006, ARC 2007).

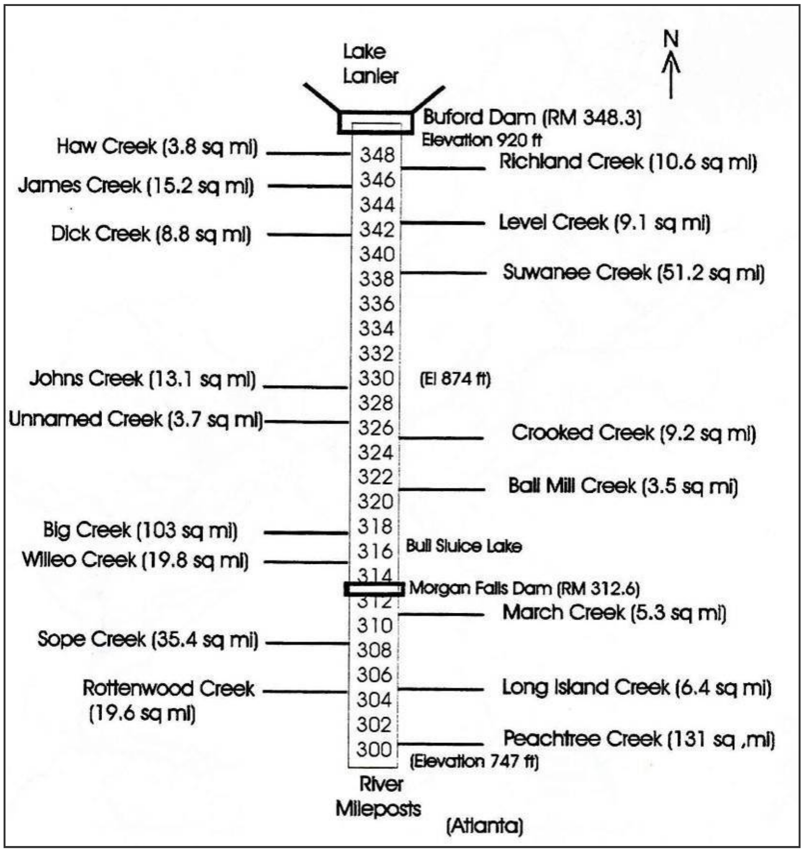


Figure 10. Schematic of tributaries with watersheds larger than three square miles that enter the Chattahoochee River within park segments. River mileposts are at the mouths of the tributaries; elevations and the two dams affecting the study area are also shown. Information from Burke (1994) in Kunkle and Vana-Miller (2000).

Two dams, the Buford Dam and the Morgan Falls Dam (*Table 6*), have altered normal, climate-driven surface water flows along the Chattahoochee in the park area and fragmented aquatic communities. The Buford Dam and its impoundment, Lake Lanier, are the upstream boundary of the park (river mile 348.3) (*Plate 3*), and the impoundment is large enough to hold the volume of 500-year floods (USACE 1998). The USACE has operated the dam since 1957, originally emphasizing hydroelectric power and flood control but, since 1989, emphasizing water supply (McMahon and Stevens 1995). Recreational uses have become more important as well. The much smaller second dam in the area, run-of-river Morgan Falls Dam, was constructed in 1903 at river mile 312.6 (*Plate 4*). After more than 100 years its impoundment, Bull Sluice Lake, now has extensive sediment deposits that have significantly reduced water storage (Kunkle and Vana-Miller 2000). Operation of these two dams, especially the Buford Dam, is required to maintain a minimum flow of at least 750 cfs in the Chattahoochee River downstream from the City of Atlanta's water intake at river mile 299.6 (Collier et al. 1996, USACE 1998).

Table 6. Dams and impoundments along the Chattahoochee River that affect the park (modified from Kunkle and Vana-Miller 2000) [Main Use codes are as follows: FC - flood control; N - navigation; P - hydroelectric power; R - recreation; WS - water supply; WQ - water quality (wastewater assimilation); FW - fish and wildlife habitat].

Dam / Impoundment	Owner / Date Completed	Main Uses *	River Mile / Elevation	Drainage Area (sq. mi.)	Total Storage Area (Acre-ft.)
Buford/ Lake Lanier (38,024 acres)	USACE/ 1957	FC, N, P, R, WS, FW	348.3/ 1,071 ft	1,040	1,917,000 (637,000 reserved for flood control)
Morgan Falls/ Bull Sluice Lake (580 acres)	GA Power/ 1903	P, WQ	312.6/ 866 ft	1,340	Originally 2,250

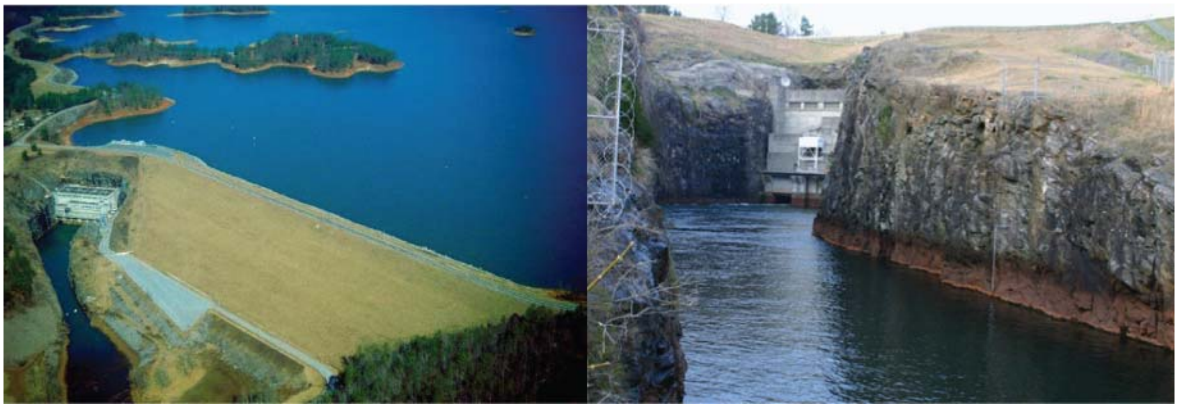


Plate 3. Left – Lake Lanier and Buford Falls Dam, U.S. Army Corps of Engineers Digital Visual Library (http://eportal.usace.army.mil/sites/DVL/default.aspx). Right – Close-up of the dam (http://georgiainfo.galileo.usg.edu/hoochbuford1.htm); photo by J. Kundell, used with permission.

Plate 4. The Morgan Falls Dam on the Chattahoochee River at river mile 312.6 between Park Units 12 (Gold Branch) and 13 (Johnson Ferry). Photo: http://ngeorgia.com/images/morganfallsdam1.jpg (with permission from Golden Ink, Inc.).

Before the Buford Dam was completed, major winter and early spring floods were common, and large floods of more than 30,000 cfs occurred once or twice during most decades (Cherry et al. 1980, Collier et al. 1996, Kunkle and Vana-Miller 2000). Since 1957, the Buford dam and releases from Lake Lanier generally have dominated Chattahoochee River flows within the park, except during major storms when runoff has more strongly influenced the river hydrograph

(USAE 1998). Releases can cause extreme variability in flow (GA DNR 1997). The outlet sluice has a maximum capacity of 11,600 cfs, but the dam can release up to 22,600 cfs without use of the emergency spillway (USACE 1998). The cycle of dam releases typically follows a weekly schedule, with five weekdays of short release periods followed by little or no water release on weekends (Kunkle and Vana-Miller 2000). River discharge below this dam averages from less than 700 (sometimes less than 500) cfs to more than 5,000 cfs. The surges especially adversely affect the river for about 20 miles down-stream from the dam, causing severe bank erosion and tree fall (Kunkle and Vana-Miller 2000). Tributaries to the river in this area are becoming like gorges as they approach the Chattahoochee, apparently because of a backwater effect caused by the rapid changes in water level, scouring of the riverbed, undercutting of banks, and channel erosion which increases suspended sediment loading (Kunkle and Vana-Miller 2000). The temperature of water released from the bottom of the Buford Dam generally fluctuates from 44-58^{o}F throughout the year, and is generally cooler than that of previous average temperatures in the Chattahoochee River.

The USGS presently operates 14 stream gaging stations in the park area of the Chattahoochee River watershed (Upper Chattahoochee River Basin; *Table 7*, *Figures 3-6*; *Appendix 1*). Three stations on the mainstem Chattahoochee River and one station each on tributaries Suwanee Creek, Big Creek (near Alpharetta), Sope Creek, and Crooked Creek – *Figures 4* and *5*) have discharge data available for (at least) the past decade, which is the main focus of this Report (*Figures 11 and 12, 13-left panels, 14,* and *15*). Data are also included below for discharge and gage height in the Chattahoochee River below Morgan Falls Dam (*Figure 13- right panels*), although annual averages are only available for the past ca. five years (2003-2007). In addition to average daily flow and stream height, near-real-time data on river discharge are available online about 6 hours post-collection. Over the past decade, annual average discharge at the northernmost edge of the park, the Chattahoochee River at Buford Dam, ranged from 757-881 cfs (during drought conditions in 2001-2002) to 2,494-2,660 cfs (during wet years in 1998 and 2005) (*Figure 9*). The daily variation of releases from Buford Dam is extreme, however, so that average and median values are considered to have limited meaning (Kunkle and Vana-Miller 2000). Downstream near Park Unit 11 (City of Roswell), annual average river discharge ranged from 789-1,026 cfs (2001-2002) to 2,875-3,014 cfs (1998, 2005) (*Figure 9*).

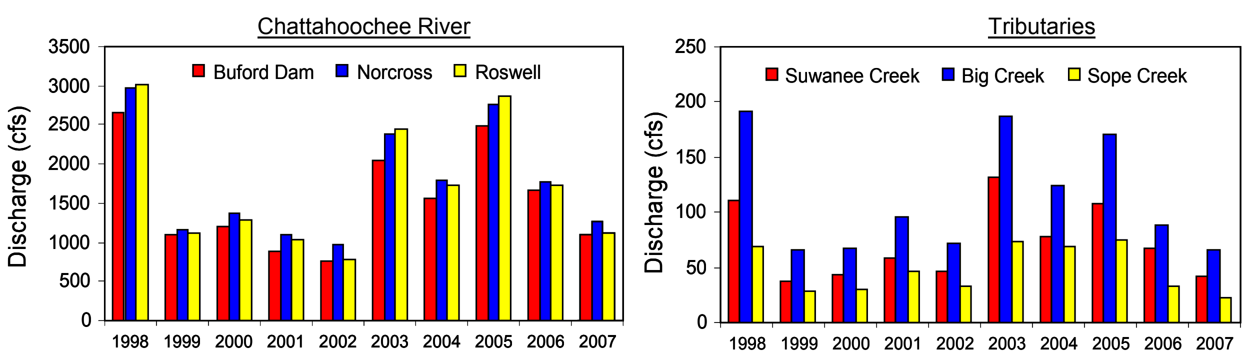


Figure 11. Annual average flow at the USGS stations that have available data over ca. the past decade including: (upper panel) Three stations in the Chattahoochee River, Buford Dam (USGS 02334430), Norcross (USGS 02335000), and above Roswell (USGS 02335450); and (lower panel) One station each on tributaries Suwanee Creek (USGS 02334885), Big Creek southeast of Alpharetta (USGS 02335700), and Sope Creek (USGS 02335870). See *Appendix 1* for detailed data.

Table 7. USGS stream stations (discharge data) in recent operation in or nearest to the park (~7-mile radius), listed in order from north to south (http://www.ga.usgs.gov). Sections I-IV refer to park sections as subdivided in this Report (see Table 1 and Figures 3-16, 17-20). Asterisk (*) ≡ ongoing.

Station	Description	Available Data
Chattahoochee River (Hydrologic Unit 03130001)		
Buford Dam (Section I) (RM 348.1) (USGS 02334430)	Lat. 34.1569, long. -84.0789 NAD83 Gwinnett County near Buford Drainage area 1,040 sq. mi. 912.04 ft above sea level NGVD29	1 Oct 55 - 30 Sep 07*
Norcross (Section II) (RM 330.8) (USGS 02335000)	Lat. 33.9972, long. -84.2019 NAD83 Gwinnett County Drainage area 1,170 sq. mi. 878.14 ft above sea level NGVD29	1 Oct 56 - 30 Jan 08*
Above Roswell (Section III) (RM 320.6) (USGS 02335450)	Lat. 33.9858, long. -84.3161 NAD83 Eves Rd., Fulton County Drainage area 1,220 sq. mi. 858.01 ft above sea level NGVD29	1 Aug 76 - 30 Sep 07*
Below Morgan Falls Dam (Section III) (400 ft. below dam) (USGS 02335815)	Lat. 33.9681, long. -84.3828 NAD83 Fulton Co., GA; drainage area 1,370 sq. mi. 843.48 ft above sea level NGVD29	1 Nov 00 - 30 Jan 08*
Tributaries		
Richland Creek (Section I) (USGS 02334480)	Suwanee Dam Rd. near Buford Lat. 34.1325, long. -84.0700 NAD27 Drainage area 9.34 sq. mi. 920.0 ft above sea level NGV029	1 Oct 95 - 31 Dec 96, 1 Jun 01 - 30 Sep 07*
Level Creek (Section I) (USGSS 02334578)	Suwanee Dam Rd. near Suwanee Lat. 34.0964, long. -84.0797 NAD27 Drainage area 5.04 sq. mi. 985 ft. above sea level NGVD29	June 01 - 30 Sep 07*
Dick Creek (Section I) (USGS 02334620)	Old Atlanta Rd., 3.5 miles west of Suwanee Lat. 34.0714, long. -84.1303 NAD27 On left bank of culvert, 0.8 mile upstream from confluence with Chattahoochee R. Drainage area 6.90 sq. mi.	1 Jan 04 - 30 Sep 07
Suwanee Creek (Section II) (USGS 02334885)	At U.S. Rte. 23, Suwanee, Gwinnett County Lat. 34.0322, long. -84.0894 NAD27 Drainage area 47 sq. mi. 909.71 ft. above sea level NGVD29	1 Oct 84 - 30 May 08*
Crooked Creek (Section III) (USGS 02335350)	Near Norcross, Gwinnett County Lat. 33.9650, long. -84.2650 NAD27 Drainage area 8.89 sq. mi. 869.40 ft. above sea level NGVD29	1 Apr 01 - 30 Sept 07*
Big Creek (Section III) (USGS 02335700)	Kimball Bridge Rd. 2.6 miles southeast of Alpharetta, Fulton County Lat. 34.0506, long. -84.2694 NAD83 Drainage area 72 sq. mi. 960.8 ft. above sea level	1 May 60 - 30 Sep 07*

Table 7. (Continued).

Station	Description	Available Data
Tributaries (continued)		
Big Creek (Section III) (USGS 02335757)	Below Hog Wallow Creek at Roswell, Fulton County Lat. 34.0175, long. -84.3533 NAD83 Drainage area 103.16 sq. mi. 940.00 ft above sea level NGVD29	1 May 04 – 30 Sep 07*
Willeo Creek (Section III) (USGS 02335790)	At GA HWY 120 near Roswell, Fulton County Lat. 34.0028, long. -84.3944 NAD83 Drainage area 16.10 sq. mi. 818.5 ft. above sea level NAVD88	11 May 07 - 6 Nov 08*
Sope Creek (Section IV) (USGS 02335870)	Columns Dr. near Marietta, Cobb County Lat. 33.9539, long. -84.4433 NAD83 Drainage area 29.2 sq. mi. 881.3 ft. above sea level	1 Oct 84 - 4 Nov 08*
Rottenwood Creek (Section IV) (USGS 02335910)	At Interstate North Parkway near Smyrna Lat. 33.8936, long. -84.4578 NAD27 Drainage area 18.6 sq. mi. 843.15 ft. above sea level NGVD88	22 Mar 07 - 7 May 08*

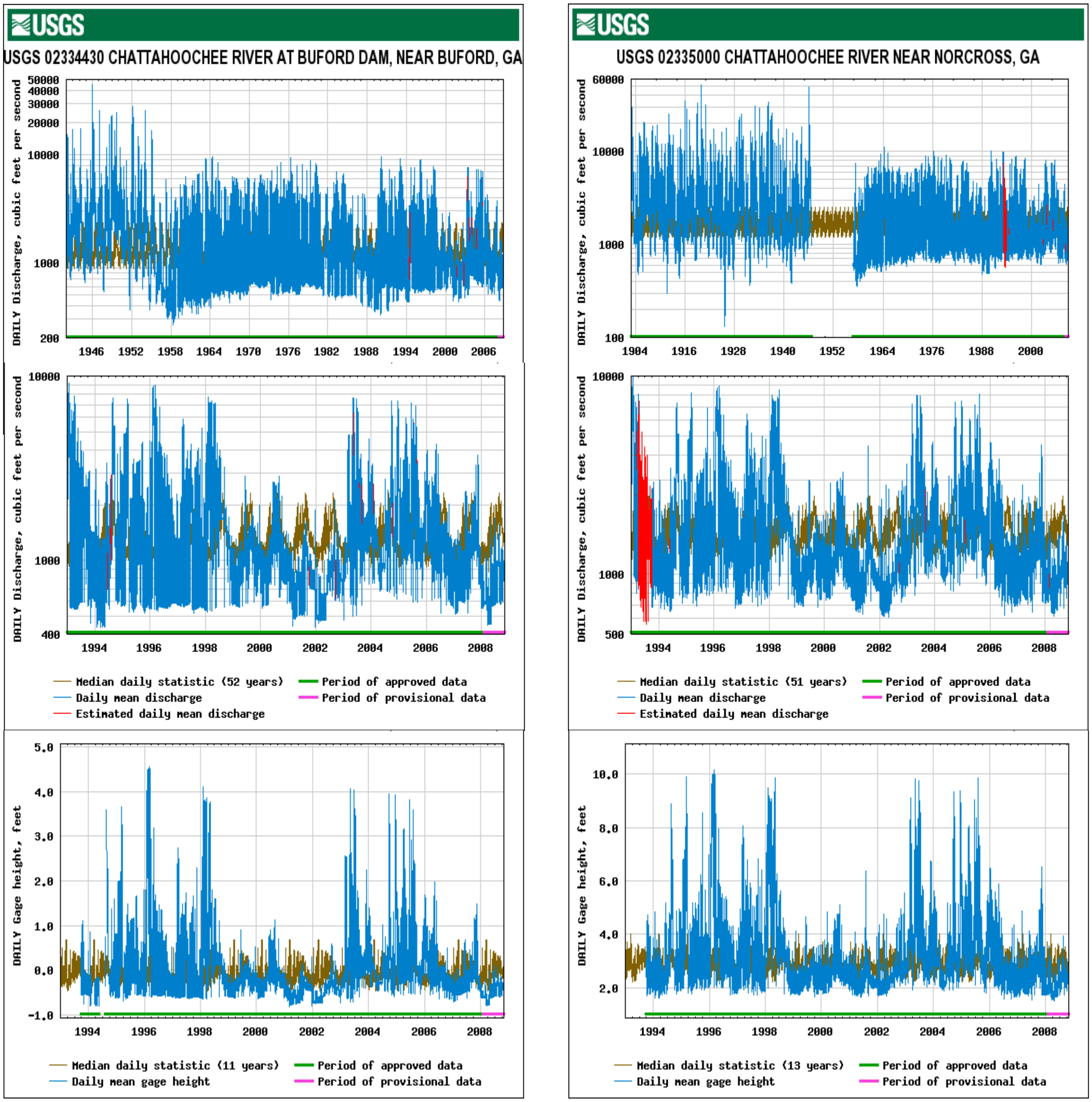


Figure 12. Left panels, Chattahoochee River at Buford Dam (USGS station 02334885): Daily discharge over the period of record (1945-), daily discharge and daily gage height over the recent ~decade. Right panels, Chattahoochee River near Norcross (USGS 02335000): Daily discharge over the period of record (1904-), and daily discharge and daily gage height over the past ~decade. From http://ga2.er.usgs.gov/gawater/index.cfm.

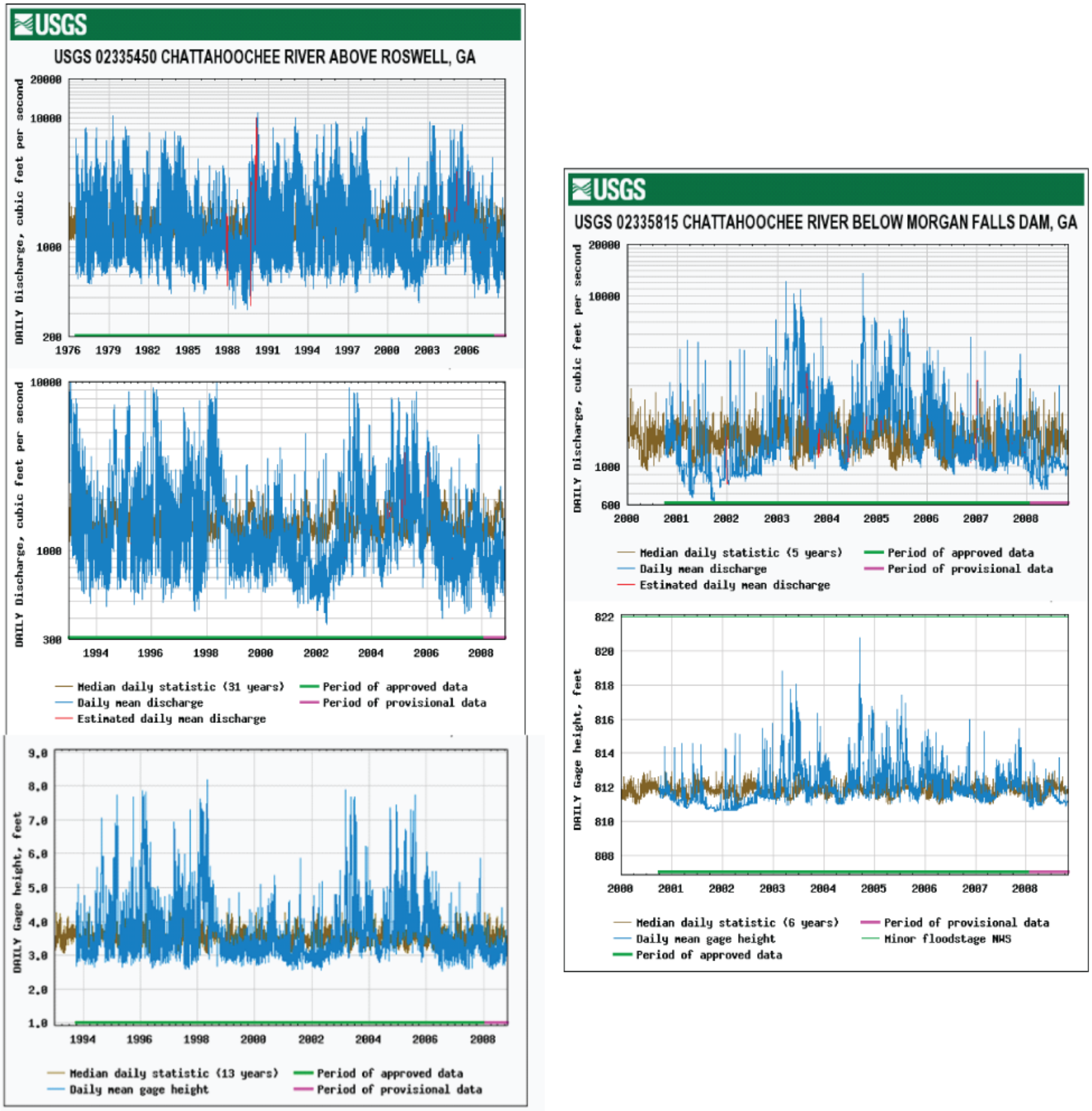


Figure 13. Left panels, Chattahoochee River above Roswell (USGS station 02335450): Daily discharge over the period of record (1976-), and daily discharge and daily gage height over the past ~decade. Right panels, Chattahoochee River below Morgan Falls Dam (USGS 02335815): Daily discharge over the period of record (1985-) and daily discharge and daily gage height over the past ~decade. From http://ga2.er.usgs.gov/gawater/index.cfm.

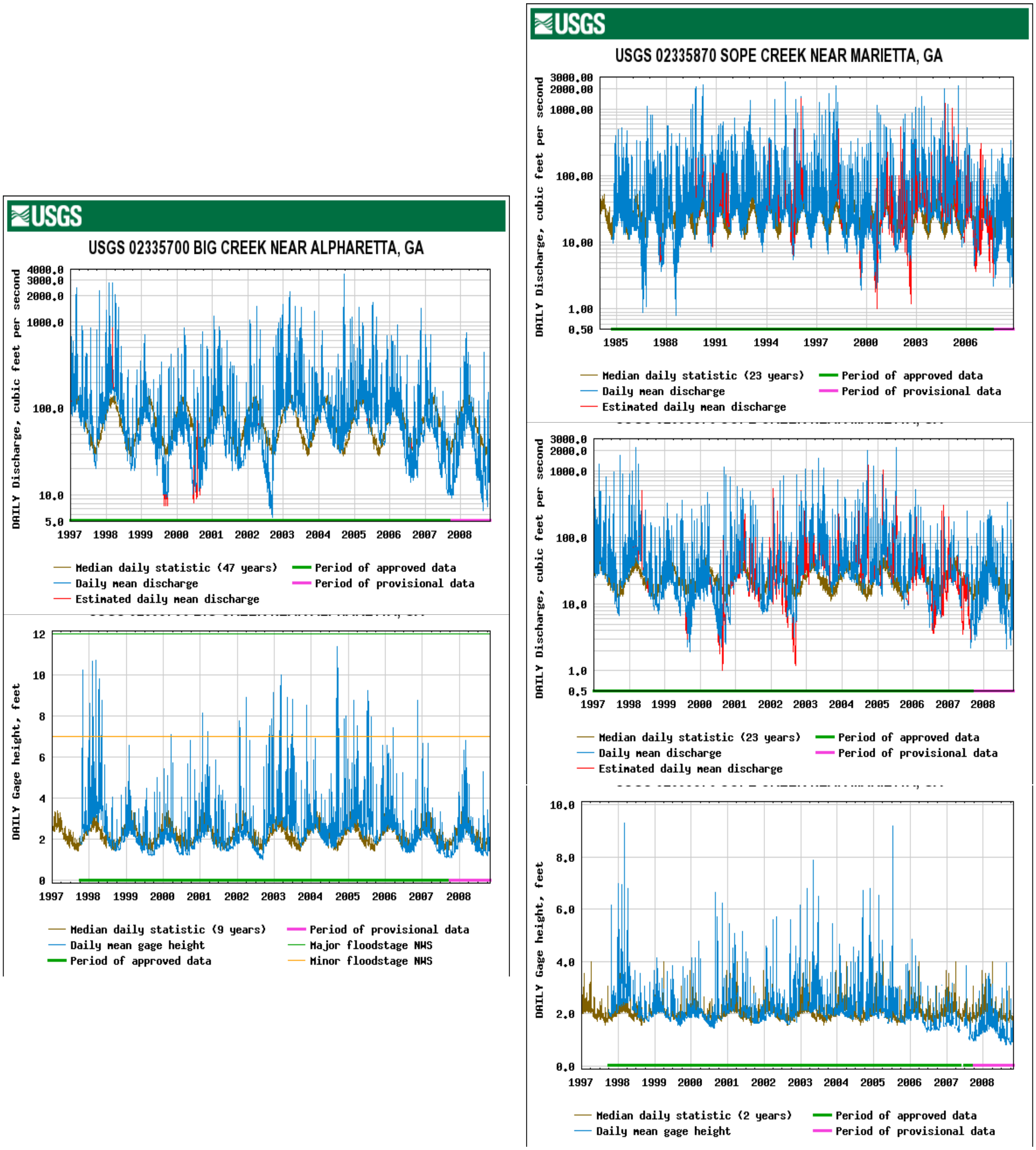


Figure 14. Left panels, Big Creek (USGS station 02334885): Daily discharge and daily gage height at Big Creek over the period of record (1997-). Right panels, Sope Creek (USGS 02335870): Daily discharge over the period of record (1985-) and daily discharge and daily gage height over the past ~decade. From http://ga2.er.usgs.gov/gawater/index.cfm.

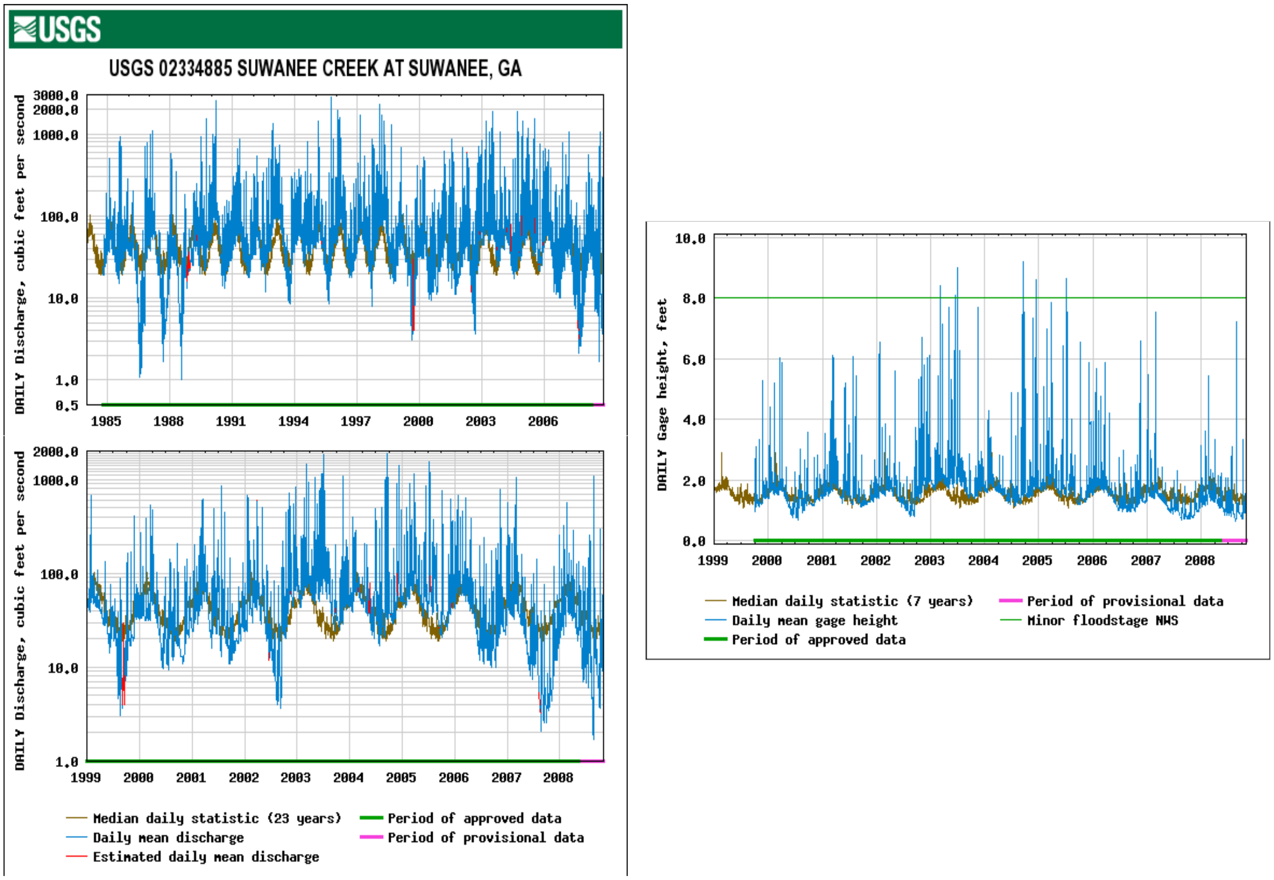


Figure 15. Suwanee Creek (USGS 02334885): Daily discharge over the period of record (1984-), and daily discharge and daily gage height over the past decade. From http://ga2.er.usgs.gov/gawater/index.cfm.

Wetlands

Although the basic geological characteristics of the area do not provide broad flood zones, the USFWS (2001) estimated, based on its National Wetland Inventory maps, that at least ~152 acres comprising 39 different types of wetlands, within 6 major types, occur in the park (e.g. *Plate 5*), which provide diverse habitats for waterfowl and wildlife (*Table 8*). It should be noted, however, that Chafin (1990) reported that the actual extent of the park's wetlands was probably underestimated from the U.S. FWS's National Wetland Inventory maps because some wetlands were not included.

Table 8. Acreage and relative abundance of major wetland types in the park, based upon the National Wetland Inventory maps of the U.S. FWS (2001). From NPS (2004a).

Major Wetland Type	Acres	Relative Abundance (% of Total Acres)
Palustrine forested	21.5	14.20%
Palustrine scrub/shrub	10.3	6.80%
Palustrine unconsolidated bottom or shore	7.8	5.20%
Palustrine Emergent	6.2	4.10%
Lacustrine	33.4	22.00%
Riverine	72.7	47.90%

Plate 5. Wetland at Bowmans Island during a low-water period (upper panel); and Bull Sluice Lake and an adjacent wetland in the Gold Branch Park Unit (middle and lower panels). Photos by E. Morris, 2008.

Among the major wetland types, riverine wetlands are defined to include all wetlands and deepwater habitats contained in natural or artificial channels that periodically or continuously contain flowing water, or that form a continuous link between two bodies of standing water (US FWS 2001). They are the major wetland type in the Park (ca. 48% of the total). Lacustrine wetlands, defined as non-flowing open water areas at least 20 acres in area that contain wetland vegetation, are second in abundance (22% of the total). They occur in topographic depressions or dammed river channels that lack trees, shrubs, persistent emergent plants, or emergent bryophytes with more than 30% coverage. Palustrine forested wetlands, representing ~14% of the total wetland acreage, are dominated by mature hardwood trees in floodplains and are flooded for varying periods. The remaining major types of wetlands in the Park include palustrine unconsolidated bottom or shore (~5%), palustrine emergent (~4%), and palustrine scrub/shrub wetlands that mostly are associated with beaver ponds.

Groundwater Resources

The Piedmont province consists mostly of sedimentary rocks with intrusions of crystalline igneous rock, ranging in age from pre-Cambrian to Triassic (Cederstrom et al. 1979, Leeth et al. 2006). The metamorphic and igneous crystalline rocks are sometimes overlain by pockets of unconsolidated, weathered rock debris called regolith. Shallow regolith deposits are about 100 feet or less in thickness. The Brevard fault zone (200 million years old) passes roughly through the center of the park in a northeast-southwest direction along the western edge of Gwinnett County (USACE 1987). Many smaller faults also occur in the area (Cressler et al. 1983, Clark and Pierce 1985). Soils range in texture from gravel-sandy loam to clay loam.

The park area has minimal groundwater resources. The water table is generally highest during April-May after winter rains, and lowest in October-November and during hot weather (Carter and Herrick 1951). Appreciable water-bearing fractures in the Atlanta area are mostly less than 250 feet in depth (Carter and Herrick 1951, Chapman and Peck 1997). Where aquifers have localized increases in permeability, which occurs mostly in the Forsyth County area, well yield can be up to ~150 gpm. Groundwater also occurs in small openings of the mantle rock and in the regolith, but well yields typically are less than 50 gpm (Couch et al. 1996). Dug wells in the Atlanta area generally yield only 2-5 gpm, and the average yield of drilled wells (average depth, 200-500 feet) for municipal or industrial use is only about 40 gpm.

Biological Resources

As mentioned, Buford Dam and Morgan Falls Dam have caused habitat fragmentation on the Chattahoochee River affecting the park segments, and often-extreme daily variability occurs in water discharge from Buford Dam as well. Oxygen deficits also can occur in the river below the dam in late summer – early fall (Kunkle and Vana-Miller 2000). On a broader scale, the Chattahoochee River has 14 impoundments from the Buford Dam downstream to the confluence with the Flint River, with the first impoundment constructed in 1834 (Brim Box and Williams 2000). The Apalachicola-Chattahoochee-Flint basin is the second most impounded system in the Southeast, with 1,417 dams recorded in the National Inventory of Dams (USACE 2005, Long and Martin 2008). Thus, the aquatic communities and habitats are extremely fragmented in the broader watershed. Aside from the obvious effect of dam construction on stream hydrology and habitat fragmentation, other major habitat alterations include bank erosion, streambed scour, species changes, increased sedimentation, and adverse changes in water quality such as increased temperature, decreased dissolved oxygen, and increased algal blooms and fish kills (Williams et al. 1993, Allan 1995, Watters 2000). The surged or pulsed water releases from dams used for hydroelectric power, such as the Buford Dam, impose sudden, extreme variability in water depth and temperature, leading to the elimination of many riverine species and significant alteration of aquatic food webs (Wetzel 2001).

Despite the park's extreme fragmentation, the Chattahoochee River is a uniting, connecting feature, and the park is vitally important to wildlife partly because it connects the Mountain and Piedmont physiographic provinces, thus serving as a migratory route and means of range extension (Wharton 1978, NPS 2004a). As the Atlanta metropolitan area continues to rapidly expand, the park will become more important as a wildlife refuge.

Microalgae

Information was not found on the microalgal assemblages in wetlands, streams and rivers, ponds, and impoundments in the park. Datasets are available, however, for phytoplankton assemblage composition and biomass as chlorophyll *a* in the Lake Lanier source water for the mainstem Chattahoochee segments that flow through the park. A survey of the Lake Lanier outflow area in November 2006 revealed the presence of a large bloom of the potentially toxic cyanobacterium *Microcystis aeruginosa* (*Plate 6*). This noxious organism can cause fish disease and death, but fortunately it does not survive flowing water conditions and its toxins also would be expected to be rapidly diluted with transport downriver (*Plate 7*; Burkholder 2002).

Plate 6. Eutrophic tailwater in the Chattahoochee River just below Buford Dam and 0.2 mile downstream (left and right panels, respectively). The olive green cast reflects the presence of a cyanobacterial bloom, which was confirmed by light microscopy. Photos by M. Mallin and J. Burkholder, November 2006.

Plate 7. Upper Chattahoochee River two miles downstream from Buford Dam, photographed on the same date in November 2006 and showing little evidence of the upstream cyanobacterial bloom. Photo by M. Mallin.

Wetland and Aquatic Macrophytes

There are numerous habitats in the park for wetland and aquatic macrophyte species (e.g. *Plates 5* and *8*). Species lists include a compilation by the NPS (2008c) information, and a recent survey (2000-2003) of ten Park Units by Hay and Parker (2003). In the latter effort, extreme river turbidity prevented adequate data collection from the Chattahoochee River on some dates, so herbarium specimens and plant composition data from wetlands and ponds from six sites (Buford Falls, Powers Island, Johnson Ferry, Cochran Shoals, Gumby Swamp and Sibley Pond along Sope Creek) was considered to supplement the survey information for the other six Park Units.

Considering both sources as well as species mentioned by Kunkle and Vana-Miller (2000), a total of 351 species of wetland and aquatic plants have been reported from the park (e.g. *Plate 8*), including 9 ferns (*Tables 9* and *10*). Of these, 19 species are predominantly aquatic, including 17 vascular species and 2 macroalgae, the charalean chlorophyte *Nitella flexilis* and the ochrophyte *Vaucheria* sp. Although mosses were not surveyed, the aquatic moss *Fontinalis novae-angliae* is abundant, as well, in rocky shoal areas of the park (see below). Wetland and aquatic species comprise about 38% of the total higher plant species (925 vascular species) reported in the park. Common wetland forest species in the park are alder, black gum, red maple, sweetgum, and water oak (Kunkle and Vana-Miller 2000).

Plate 8. Some wetland flora in the park (photos by E. Morris, 2008).

High turbidity at some Park Units is affecting some beneficial wetland species; for example, in the survey by Hay and Parker (2003), the extremely turbid waters of the Chattahoochee River in the Vickery Creek unit yielded very little aquatic vegetation. In contrast, highest number of aquatic macrophyte species was found at the Jones Bridge and Island Ford units, likely related to the increased water clarity of those units and the diversity of their habitats including rock surfaces, deep pools, shallow sandy areas, and river banks.

Little is known about the extent to which wetland and aquatic macrophytes are consumed by herbivores, except for three recent studies in the park that focused on selected species in the Chattahoochee River and its littoral fringe. Parker et al. (2007a) studied interactions between selected macrophyte and herbivore species and wrote (p.303), “In the Chattahoochee River, herbivory on macrophytes appears strong. We commonly observed Canada geese grazing along the shoals and riverbanks, with some groups of geese surpassing 100 individuals. There was also conspicuous evidence of grazing by beavers and muskrats.” The authors showed that hornleaf riverweed (Podostemum ceratophyllum) is consumed by various generalist herbivores (the amphipod Crangonyx, the isopod Asellus aquaticus, the crayfish Procambaras spiculifer, and Canada geese) preferentially over the common aquatic moss Fontinalis novae-angliae, despite the fact that the moss comprised ca. 90% of the total plant biomass on riverine rocky shoals. Feeding on the aquatic moss by the larger herbivores, crayfish and Canada geese, but not by the small amphipod and isopod, was deterred by an allelopathic substance (a C18 acetylenic acid, octadeca-9,12-dien-6-ynoic acid) that is produced by the moss. Parker et al. (2007a, p.302) suggested that “herbivory by larger generalist herbivores may drive the plant community structure toward chemically defended plants and favor the ecological specialization of smaller, less mobile herbivores on unpalatable hosts that represent enemy-free space”.

Table 9. Wetland and aquatic plant flora, excluding mosses and ferns (based upon Godfrey and Wooten 1981a,b), in the park, indicating predominant wetland vs. aquatic status. Asterisks (*) ≡ macroalgae or (**) non-native species; SPOC ≡ species of concern (compiled from NPS 2008c, Kunkle & Vana-Miller 2000, Hay & Parker 2003).

Predominantly Aquatic Species	
American water lily (white waterlily) (*Nymphae odorata)*	Parrot-feather (Brazilian watermilfoil) (*Myriophyllum aquaticum)***
Bladderwort (*Utricularia* sp.)	Slender waternymph (*Najas gracillima*)
Brazilian elodea (Brazilian waterweed, common waterweed) (*Egeria densa*)**	Small pondweed (*Potamogeton pusillus*)
Broad (Canada) waterweed (*Elodea canadensis*)	Stonewort (*Nitella flexilis*) *
Cutleaf watermilfoil (*Myriophyllum pinnatum*)	*Vaucheria* sp.*
Differentleaf waterstarwort (greater or larger waterstarwort) (*Callitriche heterophylla*)	Water hyacinth (common or floating water hyacinth (*Eichhornia crassipes*)**
Fanwort (Carolina fanwort) (*Cabomba caroliniana*)	Watershield (schreberi watershield) (*Brasenia schreberi)*
Fontinalis moss (*Fontinalis novae-angliae*)	Water-starwort (*Callitriche heterophylla*)
Hornleaf riverweed (threadfoot) (*Podostemum ceratophyllum)*	Waterthread pondweed (*Potamogeton diversifolius*)
Loose watermilfoil (*Myriophyllum laxum*)	
Predominantly Wetland Species	
Acid water arrowhead (*Sagittaria engelmannia*)	American wisteria (*Wisteria frutescens*)
Ague-weed (stiff gentian, stiff goldenrod) (*Gentiana quinquefolia)*	American witchhazel (*Hamamelis virginiana*)
Alder (*Alnus serrulata*)	Amphibious sedge (eastern narrowleaf sedge) (*Carex amphibola*)
Allegheny (ringen) monkeyflower (*Mimulus ringens*)	Aneilima (Asian spiderwort) (*Murdannia keisak*)**
Alligatorweed (*Alternanthera philoxeroides*)**	Angelicatree (devils walkingstick) (*Aralia spinosa*)
American bladdernut (*Staphylea trifolia*)	Anglestem primrose-willow (*anglestem waterprimrose*) (*Ludwigia leptocarpa*)
American burnweed (*Erechtites hieraciifolia*)	Annual blue grass (walkgrass) (*Poa annua*)**
American bur-reed (*Sparganium americanum*)	Annual blue-eyed grass (*Sisyrinchium rosulatum*)
American elder (*Sambucus canadensis*)	Apios americana (groundnut, potatobean) (*Apios americana*)
American elm (*Ulmus americana*)	Arrowfeather threeawn (*Aristida purpurascens*)

Table 9. (continued).

American germander (Canada or hairy germander, woodsage) *Teucrium canadense*)	Arrow-leaf tearthumb (arrowleaf knotweed, arrowvine) (*Polygonum sagittatum*)
American holly (*Ilex opaca*)	Ashleaf maple (box elder, box elder maple) (*Acer negundo*)
American hornbeam (*Carpinus caroliniana*)	Asiatic (common) dayflower (*Commelina communis*)**
American pokeweed (common pokeweed, inkberry, pigeonberry) (*Phytolacca americana*)	*Aster* sp.
American snowbell (snowbell) (*Styrax americanus*)	Atamasco lily (*Zephyranthes atamasco*)
American squawroot (squaw-root) (*Conopholis americana)*	Atlantic coreopsis (tall tickseed) (*Coreopsis tripteris*)
American sycamore (*Platanus occidentalis*)	Autumn bluegrass (*Poa autumnalis*)
American water plantain (*Alisma subcordatum*)	Azure bluet (*Houstonia caerulea*)
American water-willow (common water-willow, spike justicia) (*Justicia americana*)	
Baby (small) pondweed (*Potamogeton pusillus*)	Blunt-leaf (bristly) bedstraw (*Galium obtusum*)
Barnyard grass (watergrass) (*Echinochloa crus-galli*)**	Bog (northern marsh) yellowcress (*Rorippa palustris*, or *R. islandica*)
Beach (trailing) pearlwort (*Sagina decumbens*)	Bog hemp (*Boehmeria cylindrica*)
Beach false foxglove (*Agalinis fasciculata*)	Bog rush (*Juncus biflorus*)
Bearded (long-bracted) beggarticks (tickseed sunflower (*Bidens aristosa*)	Bog smartweed (*Polygonum setaceum*)
Bedstraw (catchweed bedstraw, cleavers) (*Galium aparine*)	Brazilian vervain (*Verbena brasiliensis*)**
Big bluestem (bluejoint, turkeyfoot) (*Andropogon gerardii*)	Bristled knotweed (tufted knotweed, oriental ladysthumb) (*Polygonum caespitosum*)
Bigroot morning glory (man-of-the-earth) (*Ipomoea pandurata*)	Bristly buttercup (*Ranunculus hispidus*)
Bitter dock (*Rumex obtusifolius*)**	Bristly dewberry (*Rubus hispidus*)
Bitternut hickory (*Carya cordiformis*)	Broadleaf arrowhead (wapato) (*Sagittaria latifolia*)
Bitterweed (common sneezeweed, fall sneezeweed, false sunflower (*Helenium autumnale*)	Broadleaf cattail (*Typha latifolia*)
Black gum (sour gum) (*Nyssa sylvatica*)	Broadleaf plantain (buckhorn plantain, common plantain) (*Plantago major*)**
Black tupelo (*Nyssa sylvatica*)	Broadleaf uniola (Indian woodoats) (*Chasmanthium latifolium*)
Black willow (*Salix nigra*)	Broadtooth hedgenettle (*Stachys tenuifolia*, or *S. latidens*)
Blister flower (bulbous buttercup, bulbous crowfoot) (*Ranunculus bulbosus*)**	Broomsedge (broomsedge bluestem, yellow bluestem) (*Andropogon virginicus, A. virginicus* var. *virginicus*)
Blisterwort (littleleaf buttercup) (*Ranunculus recurvatus)*	Brown widelip orchid (*Liparis lilifolia*)
Blue (hirsute) sedge (*Carex complanata*)	Bullbrier (common catbrier, common greenbrier, horsebrier) (*Smilax rotundifolia*)
Blue (mad dog) skullcap (*Scutellaria lateriflora*)	Bulrush (woolgrass) (*Scirpus cyperinus*)
Blue eyegrass (narrowleaf blue-eyed grass) (*Sisyrinchium angustifolium*)	Bur marigold (devil's beggartick) (*Bidens frondosa*)
Blue mistflower (*Conoclinium coelestinum*)	Bushy seedbox (*Ludwigia alternifolia*)
Blunt spikerush (blunt spikesedge) (*Eleocharis obtusa*)	Buttonbush (*Cephalanthus occidentalis*)
Camphor pluchea (camphor weed) (*Pluchea camphorata*)	Cockleburr (common or rough cockleburr) (*Xanthium strumarium*)
Canada clearweed (*Pilea pumila*)	Common (eastern) persimmon (*Diospyros virginiana*)
Canada goldenrod (*Solidago canadensis)*	Common (eastern, plains) cottonwood (*Populus deltoides*)
Canada lettuce (Canada woodnettle) (*Laportea canadensis*)	Common (lamp) rush (*Juncus effusus*)
Canada lily (*Lilium canadense*)	Common Chinese privet (*Ligustrum sinense*)**
Canadian (early) lousewort (*Pedicularis canadensis*	Common fox sedge (*Carex vulpinoidea*)

Table 9. (continued).

Canadian honewort (honewort) (*Cryptotaenia canadensis*)	Common goldstar (eastern yellow star-grass) (*Hypoxis hirsuta*)
Canadian rush (*Juncus canadensis*)	Common honeylocust (*Gleditsia triacanthos*)
Canadian serviceberry (*Amelanchier canadensis*)	Common meadowbeauty *(handsome Harry) (Rhexia virginica*)
Cardinal flower (*Lobelia cardinalis*)	Common morning glory (*Ipomoea purpurea*)**
Carolina elephantsfoot (*Elephantopus carolinianus*)	Common sheep (red or field) sorrel (*Rumex acetosella*)**
Carolina foxtail (tufted meadow-foxtail) (*Alopecurus carolinianus*)	Common sweetleaf (*Symplocos tinctoria*)
Carolina jessamine (evening trumpetflower) (*Gelsemium sempervirens*)	Common trumpetcreeper (cow itch) (*Campsis radicans*)
Carolina lily (*Lilium michauxii*)	Common water hemlock (poison parsnip, spotted cowbane) (*Cicuta maculata*)
Carolina primrose-willow (*Ludwigia bonariensis*)	Common winterberry (*Ilex verticillata*)
Carolina spiderlily (*Hymenocallis caroliniana*)	Creeping eryngo (*Eryngium prostratum*)
Cat greenbrier (*Smilax glauca*)	Creeping primrose-willow (creeping waterpurslane)
Chervil (hairy-fruit chervil) (*Chaerophyllum tainturieri*)	Crimsoneyed (swamp) rosemallow (*Hibiscus moscheutos*)
Chinese (Japanese) honeysuckle (*Lonicera japonica*)**	Cross-vine (trumpet-flower) (*Bignonia capreolata*, or *Anisostichus capreolata, A. crucifera*)
Climbing hempvine (climbing hempweed) (*Mikania scandens*)	Curley dock (narrowleaf dock, sour dock, yellow dock) (*Rumex crispus*)**
Clustervine (hairy clustervine) (*Jacquemontia tamnifolia*)	Curltop ladysthumb (curleytop knotweed, curleytop smartweed) (*Polygonum lapathifolium*)
Coastal doghobble (*Leucothoe axillaris*)	Curly virginsbower (swamp leather flower) (*Clematis crispa*)
Coastal plain (sweetscented) joepyeweed (*Eupatori-adelphus dubius*, or *Eupatorium purpureum*)	Cutleaf (green-head) coneflower (*Rudbeckia laciniata*)
Coastal plain willow (*Salix caroliniana*)	
Dallas (water) grass (*Paspalum dilatatum*)**	Dogfennel eupatorium (yankeeweed) (*Eupatorium compositifolium*)
Dark-green (green) bulrush (*Scirpus atrovirens*)	Dogtooth violet (*Erythronium americanum*)
Darkgreen sedge (*Carex venusta* or *C. oblita*)	Dotted smartweed (*Polygonum punctatum*)
Deadly (poison) hemlock (poison parsley) (*Conium maculatum*)**	Downy lobelia (*Lobelia puberula*)
Dense blazing star (*Liatris spicata*)	Drooping leucothoe (fetterbush, doghobble) (*Leucothoe fontanesiana*)
Denseflower knotweed (*Polygonum densiflorum*)	Drooping melonnettle (Guadeloupe cucumber) (*Melothria pendula*)
Devil's darning needles (virgin's bower, Virginia bower) (*Clematis virginiana*)	Dwarf (wooly) plantain (wooly Indianwheat) (*Plantago elongata,* or *P. pusilla)*
Ditch stonecrop (Virginia penthorum) (*Penthorum sedoides*)	Dwarf St. Johnswort (*Hypericum mutilum*)
Dogfennel (*Eupatorium capillifolium*)	Dye bedstraw (stiff marsh bedstraw) *Galium tinctorium)*
Early (naked) St. Johnswort (*Hypericum nudiflorum*)	Eastern poison ivy (*Toxicodendron radicans*)
Early meadow-rue (*Thalictrum dioicum*)	Eastern sedge (*Carex atlantica* or *C. incomperta*)
Early saxifrage (*Saxifraga virginiensis*)	Eastern smooth beardtongue (*Penstemon laevigatus*)
Early woodbuttercup (kidney-leafed buttercup, littleleaf buttercup) (*Ranunculus abortivus*)	Eastern sweetshrub (*Calycanthus floridus*)
Eastern baccharis (*Baccharis halimifolia*)	Eight-flower six-weeks grass (*Vulpia octoflora*)
Eastern bluestar (willow slimpod) (*Amsonia tabernaemontana)*	
Fairywand (*Chamaelirium luteum*)	Fox grape (*Vitis labrusca*)
Fall panic (fall panicgrass, fall panicum, western witchgrass) (*Panicum dichotomiflorum*)	Fragrant flatsedge (rusty flat sedge) (*Cyperus odoratus*)

Table 9. (continued).

Fescue sedge (*Carex festucacea*)	Fringed loosestrife (fringed yellow loosestrife) (*Lysimachia ciliata*)
Fiddle dock (*Rumex pulcher*)**	Fringed sedge (*Carex crinita*)
Florida anise (Florida anisetree) (*Illicium floridanum*)[SPOC]	Fringeleaf (sand) paspalum (slender crown grass, thin paspalum (*Paspalum setaceum*)
Forked rush (*Juncus dichotomus*)	Fringetree (white fringetree) (*Chionanthus virginicus*)
Fowl manna grass (*Glyceria striata*)	
Giant cane (*Arundinaria gigantea*)	Greater marsh St. Johnswort (*Triadenum walteri*)
Giant ironweed (*Veronia gigantea*)	Greater yellow lady's slipper (*Cypripedium pubescens*)
Graybark grape (*Vitis cinerea* var. *baileyana*)	Green arrow arum (Virginia peltandra) (*Peltandra virginica*)
Great blue lobelia (*Lobelia siphilitica*)	Green ash (*Fraxinus pennsylvanica*)
Greater bladder sedge (*Carex intumescens*)	Greenwhite sedge (*Carex albolutescens*, or *C. straminea*)
Hairy jointgrass (small carpgrass) (*Arthraxon hispidus*)**	Hedgehog woodrush (*Luzula echinata*)
Hairy woodrush (*Luzula acuminata*)	He-huckleberry (maleberry) (*Lyonia ligustrina*)
Harvestbells (moss gentian) (*Gentiana saponaria*)	Herbwilliam (threadleaf mockbishopweed) (*Ptilimnium capillaceum*)
Heartwing dock (heartwing sorrel) (*Rumex hastatulus*)	Hop sedge (*Carex lupulina*)
Hedge bindweed (bearbind, devil's guts) (*Calystegia sepium*)	
Indian cucumber (*Medeola virginiana*)	
Jack-in-the-pulpit (*Arisaema triphyllum*)	Johnson grass (*Sorghum halepense*)**
Japanese mazus (*Mazus pumilus*)**	Jumpseed (Virginia smartweed) (*Polygonum virginianum*)
Japanese stiltgrass (Nepalese browntop)** (*Microstegium vimineum*)	Juniper leaf (*Polypremum procumbens*)
Jewelweed (spotted touch-me-not) (*Impatiens capensis*)	Justiceweed (*Eupatorium leucolepis*)
Joe pye weed (hollow-stemmed joe pye weed, trumpetweed (*Eupatorium fistulosum*)	
Kidneyleaf grass of Parnassus (*Parnassia asarifolia*)	King of the meadow (*Thalictrum pubescens*)
Lady's-thumb (smartweed, spotted knotweed) (*Polygonum persicaria*)**	Leatherleaf clematis (sweet autumn virginsbower, yam-leaved clematis) (*Clematis terniflora*)**
Lanceleaf (small) greenbrier (*Smilax smallii*)	Leathery rush (*Juncus coriaceous*)
Lanceleaf loosestrife (*Lysimachia lanceolata*)	Little bluestem (*Schizachyrium scoparium*, or *Andropogon scoparius*)
Large (spotted) spurge (*Chamaesyce maculata*)	Littlehead nutrush (*Scleria oligantha*)
Largeseed (southern) forget-me-not (*Myosotis macrosperma*)	Lizard's tail (*Saururus cernuus*)
Late eupatorium (lateflowering thoroughwort) (*Eupatorium serotinum*)	Long Beach primrose-willow (*Ludwigia brevipes*)
Laurel greenbrier (*Smilax laurifolia*)	Low spearwort (weak buttercup) (*Ranunculus pusillus*)
Laurel oak (*Quercus laurifolia*)	Low spikesedge (*Kyllinga pumila*)
Leafy bulrush (*Scirpus polyphyllus*)	
Manyflower marshpennywort (umbrella pennyroyal) (*Hydrocotyle umbellata*)	Mexican (red) morningglory (redstar) (*Ipomoea coccinea*)**
Maritime groundcherry (white crownbeard) (*Verbesina virginica*)	Mountain (piedmont) azalea (*Rhododendron canescens*)
Marsh primrose-willow (marsh seedbox) (*Ludwigia palustris*)	Mountain meadow-rue (*Thalictrum clavatum*)
Maryland meadowbeauty (*Rhexia mariana*)	Muscadine grape (*Vitis rotundifolia*)
Meadow (tall) buttercup (*Ranunculus acris*)**	
Naked (smooth) elephantfoot (*Elephantopus nudatus*)	Northern marsh yellowcress (*Rorippa islandica*)

Table 9. (continued).

Needlepod rush (*Juncus scirpoides*)	Northern spicebush (*Lindera benzoin*)
Needle-tip blue-eyed grass (*Sisyrinchium mucronatum*)	
Orange coneflower (*Rudbeckia fulgida*)	Owlfruit (sawbeak) sedge (stalk-grain sedge) (*Carex stipata*)
Overcup oak (*Quercus lyrata*)	
Palespike lobelia (*Lobelia spicata*)	Possumhaw (*Ilex decidua*)
Partridgeberry (*Mitchella repens*)	Possumhaw viburnum (*Viburnum nudum*)
Pennsylvania knotweed (Pennsylvania smartweed or pinkweed) (*Polygonum pensylvanicum*)	Post oak (*Quercus stellata*)
Philadelphia daisy (fleabane) (*Erigeron philadelphicus*)	Prickly Florida (sawtooth) blackberry (*Rubus argitis*)
Piedmont rhododendron (*Rhododendron minus*)	Primrose violet (*Viola primulifolia*)
Pignut hickory (*Carya glabra*)	Pumpkin ash (*Fraxinus profunda*)
Pine barren flatsedge (*Cyperus retrorsus*)	Purple false foxglove (*Agalinis purpurea*)
Pitted (white) morning glory (whitestar) (*Ipomoea lacunosa*)	Purplehead sneezeweed (*Helenium flexuosum*)
Poor-joe (rough buttonweed) (*Diodia teres*)	Purple-leaf willowherb (willowweed) (*Epilobium coloratum*)
Red maple (*Acer rubrum*)	River birch (*Betula nigra*)
Red mulberry (*Morus rubra*)	Rosepink (squarestem rosegentian) (*Sabatia*
Red turtlehead (*Chelone obliqua*)	Rough bentgrass (*Agrostis scabra*)
Ricefield flatsedge (*Cyperus iria*)**	Roundfruit hedgehyssop (*Gratiola virginiana*)
Sampson's snakeroot (*Psoralea psoralioides*, or *Orbexilum pedunculatum*, *O. pedunculatum* var. *psoralioides*)	Southern watergrass (*Luziola flutans*)
Saw greenbrier (*Smilax bona-nox*)	St. Andrew's cross (*Hypericum hypericoides*)
Shagbark hickory (*Carya ovata*)	Stiff cowbane (*Oxypolis rigidior*)
Shallow sedge (*Carex lurida*)	Stiff dogwood (*Cornus foemina*)
Sharpwing monkeyflower (*Mimulus alatus*)	Stiff marsh bedstraw (*Galium tinctorium*)
Shortbristle horned beaksedge (*Rhynchospora*	Stout wood reed-grass (sweet wood-reed) (*Cinna arundinacea)*
Shortleaf spikesedge (*Cyperus brevifolius*, or *Kyllinga brevifolia*)	Strawcolored flatsedge (strawcolored nutgrass) (Cyperus strigosus)
Silky dogwood (*Cornus amomum*)	Striped cream violet (*Viola striata*)
Silver maple (*Acer saccharinum*)	Sugar berry (sugar hackberry) (*Celtis leavigata*)
Silver maple (*Acer saccharinum*)	Summer grape (*Vitis aestivalis*)
Slender woodoats (spike uniola) (*Chasmanthium laxum*)	Swamp azalea (*Rhododendron viscosum*)
Slimpod rush (*Juncus diffusissimus*)	Swamp chestnut oak (*Quercus michauxii*)
Smallflower (sticktight) buttercup (*Ranunculus parviflorus)***	Swamp smartweed (*Polygonum hydropiperoides*) (*Ludwigia repens*)
Smallflower (waxy) thoroughwort (*Eupatorium semiserratum or E. glaucescens) semiserratum* or *E. glaucescens*)	Swamp sneezeweed (swamp sunflower) (*Helianthus angustifolius*)
Southern arrowwood (*Viburnum dentatum*)	Sweetbay (*Magnolia virginiana*)
Southern magnolia (spike uniola) (*Magnolia grandiflora)*	Sweetgum (*Liquidambar styraciflua*)
Southern red oak (*Quercus falcata*)	Switchcane (*Arundinaria gigantea*)
Southern rein (palegreen) orchid (*Habenaria flava*, or Platanthera flava)	Switchgrass (old switch panic grass) (*Panicum virgatum)*
Thyme-leaf speedwell (*Veronica serpyllifolia*)	Tuliptree (tulip poplar, yellow poplar) (*Liriodendron tulipifera)*
Tiny bluet (*Houstonia pusilla*)	Turk's-cap lily (*Lilium superbum*)
Trumpet honeysuckle (*Lonicera sempervirens*)	

Table 9. (continued).

Vasey grass (*Paspalum urvillei*)**	Virginia sweetspire (*Itea virginica*)
Virginia bugleweed (Virginia water horehound) (*Lycopus virginicus*)	Virginia threeseed mercury (*Acalypha rhomboidea*)
Virginia buttonweed (*Diodia virginiana*)	Virginia water horehound (*Lycopus virginicus*)
Virginia dayflower (*Commelina virginica*)	Virginia wild rye (*Elymus virginicus*)
Virginia dwarfdandelion (*Krigia virginica*)	
Water oak (*Quercus nigra*)	White verbena (white vervain) (*Verbena urticifolia*)
Water primrose (*Ludwigia palustris*)	Whiteleaf leather flower (*Clematis glaucophylla*)
Water-pimpernel (*Samolus parviflorus*)	Whorled loosestrife (whorled yellow loosestrife) (*Lysimachia quadrifolia*)
Waterpod (*Hydrolea quadrivalvis*)	Willow oak (*Quercus phellos*)
Waterpod (*Hydrolea quadrivalvis*)	Winged elm (*Ulmus alata*)
Waxyleaf meadow-rue (*Thalictrum revolutum*)	Wingleaf primrose-willow (wingleaf water primrose) (*Ludwigia decurrens*)
Weedy dwarf-dandelion (*Krigia cespitosa*)	Wingstem (*Verbesina alternifolia*)
White avens (*Geum canadense*)	Woodvamp (*Decumaria barbara*)
White screwstem (*Bartonia verna*)	Wrinkleleaf goldenrod (*Solidago rugosa*)
White turtlehead (*Chelone glabra*)	
Yaupon (*Ilex vomitoria*)	Yellowfruit sedge (*Carex vulpinoidea* or *C. annectens*)
Yellow crownbeard (*Verbesina occidentalis*)	Yellowroot (*Xanthorhiza simplicissima*)

Table 10. Wetland and aquatic ([A]) fern species that occur in the park (NPS 2008c).

Asplenium ladyfern (*Athyrium filix-femina* spp. *asplenioides*) – shaded woods, swamps, stream banks, acid bogs
Broad beechfern (*Thelypteris hexagonoptera*, or *Phegopteris hexagonoptera*) – moist woodlands
Carolina mosquitofern (*Azolla caroliniana*)[A]
Chainfern (netted chainfern) (*Woodwardia areolata*) – acidic bogs, wet woods
Cinnamon fern (*Osmunda cinnamomea*) – open areas in swamps
Maidenfern (maidenhair) (*Adiantum pedatum*) – stream banks, shady moist woods
New York fern (*Thelypteris noveboracensis*) – moist, humus-rich, deciduous woods
Royal fern (*Osmunda regalis*) – swampy areas, fens, damp woodlands
Sensitive fern (*Onoclea sensibilis*) – open swamps, marshes, low woods

Beavers also were found to significantly affect native as well as exotic (see below) wetland plant community structure at the park through herbivory (Parker et al. 2007b). In field experiments, herbivory by beavers reduced aquatic plant biomass by 60% and plant litter by 75%, and also substantially affected wetland/aquatic plant species composition. The perennial forb lizard's tail (*Saururus cernuus*) was less than 5% of the plant biomass in beaver-grazed areas, but was more than 50% of plant biomass in areas where beavers were excluded for two years. In supporting experiments, beavers preferentially consumed lizard's tail over several other plants. Bulrush (*Scirpus cyperinus*) tussocks provided lizard's tail plants an associational refuge from beaver herbivory.

Terrestrial Vegetation

Appalachian and Coastal Plain species overlap into the Piedmont in the park area. The dominant forest cover is oak/pine (black and red oaks – *Quercus velutina, Q. rubra*; loblolly pine

– *Pinus taeda*; shortleaf pine – *Pinus echinata*; Virginia pine – *Pinus virginiana*) but, because of human disturbance, the landscape and vegetation cover in the Chattahoochee River corridor is mixed fields, forest stands, and planted trees, along with an array of introduced exotic species (Kunkle and Vana-Miller 2000). Other common terrestrial forest species include ash (*Fraxinus* spp.), dogwood (*Cornus florida*), elm (*Ulmus* spp.), hickory (*Carya ovata*), sycamore (*Platanus occidentalis*), willows, (*Salix* spp.), and tulip trees which can also thrive in wetlands.

Aquatic Macroinvertebrates

From a qualitative and quantitative evaluation of the mainstem Chattahoochee River (RM 337.8 to RM 301.3) and four tributaries (Suwanee, Crooked, Big, and Sope Creeks) in the early 1970s, the Georgia Water Quality Control Board (1971) reported, even at that time, that macroinvertebrate fauna was depauperate or lacking. Macroinvertebrates appeared to be adversely affected by the low-temperature waters downstream from Buford Dam. Aquatic macroinvertebrates in that area have been reported to be limited by the reduced thermal maxima, seasonally low dissolved oxygen availability, paucity of allochthonous materials upon which many of them feed, shifting sand substratum, and extreme fluctuations in water levels and current velocities at variable time scales (Nestler et al. 1984). In other efforts, GA DNR (1966) qualitatively sampled aquatic macroinvertebrates from seven stations on Sope Creek and reported only 2-12 taxa (mostly genus level). In 1973 the area was re-assessed and conditions were evaluated as more degraded than in 1966 (GA DNR 1973).

A macroinvertebrate survey also was undertaken by a flyfishing guide seasonally in most years from 1998 through February 2005, using Hester-Dendy samplers (project duration) and a Surber sampler (2000-) (Eggert 2005). Sites included Bowmans Island, Settles Bridge, Jones Bridge, Island Ford, Morgan Falls, and Cochran Shoals. A Hilsenhoff Family Biotic Index for macroinvertebrates was calculated for each replicate sample, following Hilsenhoff (1988). A retired entomologist identified the macroinvertebrates, and the data were summarized by Eggert (2005). No changes in habitat quality were apparent for macroinvertebrates over the sampling duration. Eggert (2005) identified the need for long-term, more detailed (species-level) data on aquatic macroinvertebrates in the park.

Aquatic biota (macroinvertebrate and fish) sampling is required as a responsibility of the counties under their MS4 stormwater permits (see p. 98 of this Report), and the data formats and summary information range from raw data sheets to excellent compilations by CCR Environmental, Inc. (2007) and CH2MHill (2008) for Fulton County (December 2006: Johns Creek and March Creek) and Gwinnett County (fall season each year from 2004-2007: Richland, Level, Suwanee and Crooked Creeks), respectively (*Table 11*). The Richland, Level and Crooked Creek stations coincide with USGS stations 233480, 234578, and 2335350, respectively (*Figures 3* and *4*); the Suwanee Creek station nearest to the park is about 3.5 miles upstream (Burnette Road, urbanizing area – see *Table 11*). The two Fulton County sites, JO-1 and MA-1 also coincide with county water quality sampling stations (*Figures 4* and *5*). Forsyth County provided data through consultant CH2MHill for Dick Creek (station DKF-1) for sampling in 1999, 2005, and 2007. Data were also available from Cobb County for Rottenwood Creek (RT-5 – winter 1999) and Little Nancy Creek (NA2 – winter 1999, fall 2003, fall 2005). In these efforts, benthic macroinvertebrates were assessed under a modified Georgia Bioassessment Protocol (GA DNR 2007c). A total of 182 taxa were found in one or more of the nine streams, including 1 nematode, 8 molluscs, 16 annelids, and the remainder arthropods (157, or 86% of the total, including about half (89 taxa) as dipterans). Based upon the macroinvertebrate assessment, the overall ecological condition of the streams was fair (Dick Creek, March Creek, Rottenwood Creek, Little Nancy Creek), poor (Richland Creek, Johns Creek, Crooked Creek), and very poor (Level Creek, Suwanee Creek) (*Tables 11* and *12*). None of the streams received a "good" or "very good" (the latter, indicating little disturbance) assessment (*Table 12*).

Table 11. Available data for aquatic macroinvertebrate species present in the Park, including Richland, Level, Suwanee, and Crooked Creeks from sampling efforts in fall of 2004, 2005, 2006, and 2007 (CH2M Hill 2008a); Dick Creek from sampling efforts in 1999, 2005, and 2007 (CH2M Hill 2000, 2008b); Johns Creek and Marsh Creek from sampling efforts in December 2006 (CCR Environmental 2007); Rottenwood Creek from sampling efforts in winter 1999 (Cobb County data); and Little Nancy Creek from sampling efforts in winter 1999, fall 2003, and fall 2005 (Cobb County data). An asterisk (*) indicates taxa that were evaluated as common (10 animals or more were found) in one or more sampling efforts. Note that family names are included if taxa were present that were not identified below that level (x ≡ present; --- ≡ absent; n.s. ≡ not sampled).

Taxon	Richland Creek	Dick Creek	Level Creek	Suwanee Creek	Johns Creek	Crooked Creek	Marsh Creek	Rottenwood Creek	L. Nancy Creek
Nematoda	x	---	---	---	---	---	---	n.s.	n.s.
Mollusca									
Corbicula fluminea	x	---	---	x*	---	---	x	n.s.	n.s.
Fermissa rivularis	---	---	x	---	x	---	---	n.s.	n.s.
Ferressia sp.	---	---	x	---	---	---	x	n.s.	n.s.
Fossaria sp.	x	---	x	x	---	---	---	n.s.	n.s.
Menetus dilatatus	---	x	---	---	---	x	---	n.s.	n.s.
Physella sp.	---	x	x	x	---	x	---	n.s.	n.s.
Pisidium sp.	---	---	---	---	---	---	x	n.s.	n.s.
Sphaerium sp.	---	---	---	x	---	---	---	n.s.	n.s.
Annelida									
Dero sp.	---	---	x	---	---	x	---	n.s.	n.s.
Hirudinea	---	x	---	---	---	---	---	n.s.	n.s.
Limnodrilus hoffmeisteri	---	x	x	x	---	---	---	n.s.	n.s.
Lumbricidae	x	x	---	x	---	x	---	n.s.	n.s.
Lumbriculidae	x*	x	x	x*	x	x	x	n.s.	n.s.
Naididae	---	x	x	---	---	x	---	n.s.	n.s.
Nais behningi	x	---	---	---	---	---	---	n.s.	n.s.
Nais communis	x	x	---	x	---	x	---	n.s.	n.s.
Nais sp.	x	x	x	---	---	x	---	n.s.	n.s.
Pristina leidyi	x	x	---	---	---	---	---	n.s.	n.s.
Pristina sp.	x	---	---	---	---	---	---	n.s.	n.s.
Pristinella sp.	x	---	---	---	---	---	---	n.s.	n.s.
Slavina appendiculata	x	---	x*	---	---	x	---	n.s.	n.s.
Stylaria lacustris	---	x	---	---	---	---	---	n.s.	n.s.
Tubificidae w.h.c.	x	x	x	x	x	x	---	n.s.	n.s.
Tubificidae w.o.h.c.	x*	x	x*	x*	---	x	---	n.s.	n.s.
Arthropoda									
Amphipoda									
Crangonyxsp.	---	---	x	x	---	---	---	n.s.	n.s.
Arachnoidea									
Atractides sp.	---	---	x	---	---	---	---	n.s.	n.s.
Libertia sp.	---	---	---	---	x	---	---	n.s.	n.s.
Crustacea									
Ostracoda	---	x*	x	x	---	x	---	n.s.	n.s.

Table 11. (continued).

Taxon	Richland Creek	Dick Creek	Level Creek	Suwanee Creek	Johns Creek	Crooked Creek	Marsh Creek	Rottenwood Creek	L. Nancy Creek
Copepoda	---	x	x	---	---	x	---	n.s.	n.s.
Cladocera									
Ceriodaphnia sp.	---	---	x	---	---	x	---	---	---
Chydoridae	---	x*	x	---	---	---	---	---	---
Decopoda									
Cambaridae	x	x	---	x	---	x	---	n.s.	n.s.
Cambarus sp.	---	---	---	---	---	---	x	n.s.	n.s.
Orconectes sp.	x	---	---	---	---	---	---	n.s.	n.s.
Procambarus sp.	x	---	x	x	x	x	---	n.s.	n.s.
Isopoda									
Caecidotea sp.	---	---	---	x	---	---	---	n.s.	n.s.
Insecta									
Ephemeroptera									
Baetis flavistriga	x*	x	x	x	---	x	x	---	---
Baetis intercalaris	x*	x	---	x*	x	x	---	---	---
Baetis sp.	x*	x	x	---	---	x	---	---	x*
Caenis sp.	---	x	---	---	---	---	---	---	---
Collembola	---	x	---	---	---	---	---	---	---
Labiobaetis sp.	---	x	---	---	---	---	---	---	---
Maccaffertium (Stenonema) modestum	---	x	---	---	---	---	x	---	---
Maccaffertium (Stenonema) sp.	---	x	x	---	x	x*	---	x	x*
Pseudocloeon sp.	x	x	x	---	---	x	---	---	---
Tricorythodes sp.	---	x	---	---	---	---	---	---	---
Odonata									
Argia sp.	x	x	x	x*	---	x	---	x	x
Boyeria grafiana	---	x	---	---	---	---	---	---	---
Boyeria vinosa	---	x	---	---	---	---	x	---	---
Boyeria sp.	---	---	---	---	---	---	---	---	x
Calopteryx sp.	x	x	x	---	---	---	x	x	---
Ischnura sp.	---	---	---	---	---	---	---	---	x
Coenagrionidae	---	x	---	---	x	---	---	---	---
Enallagma sp.	---	---	---	x	---	---	---	---	---
Gomphidae	---	---	---	x	---	---	---	---	---
Hetaerina sp.	---	x	---	---	---	---	---	---	---
Macromia sp.	---	---	---	x	---	---	---	---	---
Progomphus obscurus	---	x	x	---	---	x	---	---	---
Hemiptera									
Rhagovelia obesa	x	---	---	---	---	---	---	---	---
Heteroptera									
Gerridae	---	x	---	---	---	---	---	---	---
Veliidae	---	x	---	---	---	---	---	---	---
Megaloptera									
Corydalus cornutus	---	x	---	---	---	---	---	x	---
Nigronia serricornis	x	---	---	---	---	---	---	---	---
Nigronia sp.	---	x	---	---	---	---	---	---	---
Sialis sp.	---	x	---	---	---	---	---	---	---
Plecoptera									
Leuctra sp.	---	x	---	---	---	---	---	---	---
Tallaperla sp.	x	---	---	---	---	---	---	---	---
Trichoptera									

Table 11. (continued).

Taxon	Richland Creek	Dick Creek	Level Creek	Suwanee Creek	Johns Creek	Crooked Creek	Marsh Creek	Rottenwoo d Creek	L. Nancy Creek
Cheumatopsyche sp.	x*	x*	x*	x*	x	x*	x*	x	x*
Chimarra aterrima	---	---	x	---	x	x	x*	---	---
Chimarra sp.	---	---	---	---	---	---	---	x	x
Diploctrona modesta	x	---	---	---	---	---	---	---	---
Eccopturaxanthenes	x	---	---	---	---	---	---	---	---
Hydropsychidae	x*	x	---	x*	x	---	---	---	---
Hydropsyche betteri	x	x	---	x	---	x	x*	x	x*
Hydropsyche sp.	x*	x	---	---	x	---	x*	---	---
Hydroptila sp.	---	---	---	---	---	x	---	---	---
Lype diversa	x	---	x	---	---	---	---	---	---
Paragnetina sp.	---	---	---	x	---	---	---	---	---
Triaenodes sp.	x	x	x	x	---	---	---	---	---
Coleoptera									
Anchytarsus bicolor	x	---	---	---	---	---	---	x	---
Anycronyxvariegatus	x	x	x	x	---	x	---	x	---
Curculionidae	---	---	---	---	---	---	x	---	---
Dubiraphia sp.	---	x	---	---	---	---	---	x	---
Ectopria sp.	---	---	x	---	---	---	---	---	x
Enochrus sp.	---	---	---	x	---	---	---	---	---
Helichus basalis	---	x	---	---	---	---	---	---	---
Hydroporini sp.	---	x	---	---	---	---	---	---	---
Macronychus glabratus	---	x	---	---	---	---	---	---	---
Microcylloepus pusillus	---	x	---	---	---	---	---	---	---
Oulimnius latiusculus	---	x	---	---	---	---	---	---	---
Staphylinidae	---	x	---	---	---	---	---	---	---
Stenelmis sp.	x	---	---	---	---	---	---	---	x
Ablabesmyia mallochi	x	x	x	x	---	x	---	x	x
Ablabesmyia rhamphe	x	x	x	x	---	x	---	---	---
Anopheles sp.	---	---	x	---	---	x	---	---	---
Antocha sp.	x	---	---	---	---	---	---	x	x
Atrichopogon sp.	---	x	---	---	---	---	---	---	---
Bezzia/Palpomyia sp. gp.	---	x	---	---	---	---	---	---	---
Brillia flavifrons	x	---	---	---	x	x	x	---	---
Brillia sp.	---	---	---	---	---	---	---	x	---
Cardiocladius obscurus	---	---	---	---	---	---	x*	---	x
Ceratopogonidae	---	x	---	---	---	---	---	---	---
Chelifera sp.	---	x	---	---	---	---	---	---	---
Chironomidae	---	x	---	---	---	---	---	---	x
Chironomus sp.	x	x	x*	---	---	x	---	x	---
Cladopelma sp.	---	x	---	---	---	---	---	---	---
Cladotanytarsus sp.	---	x*	---	---	---	---	---	---	---
Clinotanypus sp.	---	x	---	---	---	---	---	---	---
Conchapelopia sp.	x*	x	x*	x*	---	x	x	---	---
Corynoneura sp.	x*	x	x	x	x	x	x	---	x
Cricotopus bicinctus	x	x	---	x*x	x	x	---	---	
Cricotopus sp.	x	x	x		x*x	x	x	x	x
Cryptochironomus sp.	x	x	x	x	---	x	---	x	x
Culicidae	---		---	---	---	x	---	---	---
Diamesinae sp.	---	---	---	---	---	---	---	x	x
Dicrotendipes neomodestus	---	---	x*	---	---	x	x	---	---
Dicrotendipes sp.	---	x*	---	---	---	x	---	x	---

Table 11. (continued).

Taxon	Richland Creek	Dick Creek	Level Creek	Suwanee Creek	Johns Creek	Crooked Creek	Marsh Creek	Rottenwood Creek	L. Nancy Creek
Dixella sp.	---		x	---	---	---	---	---	---
Empididae	---		x---	---	---	---	---	---	---
Endochrionomus sp.	---	x	---	---	---	---	---	---	---
Eukiefferiella claripennis	---		---	---	x	---	x	---	x
Eukiefferiella sp.	---	---	---	---	---	---	---	---	x
Hemerodromia sp.	x	x	x	x	---	---	---	x	x
Labrundinia sp.	---	x	x	x	---	x	---	---	---
Limonia sp.	---	---	---	---	---	---	---	x	---
Lopescladius sp.	---	---	---	---	---	x	---	---	---
Microtendipes pedullus	---	x	x	---	x	---	x	---	---
Microtendipes sp.	---	------	---	---	---	---	x	---	
Nabrundinia sp.	---	---	x	x	---	x	---	---	---
Nanocladius distinctusx	---	---	x	x	x	x	---	---	
Nanocladius sp.	---	---	---	---	---	---	---	---	x
Nilotanypus sp.	---	---	---	---	---	x	---	---	---
Orthocladius lignicola	---	---	x	---	---	---	---	---	---
Orthocladius sp.	---	---	---	x	---	---	x*	x	x
Paracladopelma sp.	---	---	x	---	---	x	---	---	---
Parakiefferiella sp.	x	x	x	x	xx	x	---	x	x
Paralauterborniella nigrohalteralis	---		x	x	---	x	---		
Parametriocnemus lundbecki	---	x	---	---	---	---	---	---	---
Parametriocnemus sp.	---	---	---	---	---	---	---	---	x
Paratendipes sp.	x	x	x*	---	---	---	---	---	x
Phaenopsectra obediens group	---	---	---	---	---	---	---	x	x
Phaenopsectra punctipes	---	---	x	---	---	---	---	---	---
Phaenopsectra sp.	---	---	---	---	---	---	---	x	x
Polypedilum convictum	---	x	---	---	---	---	---	---	---
Polypedilum fallax	x	x	x	x	---	x---	---	---	
Polypedilum flavum	x*	---	x*	x*	---	x	---	---	---
Polypedilum halterale	x	x	x	x	---	x	---	---	---
Polypedilum illinoense	x*	x	x	x	---	x*	---	---	---
Polypedilum sp.	---	---	---	---	---	---	---	x	x
Potthastia longimana	x	---	x	---	---	---	---	---	---
Procladius sp.	---	x	x	x	---	---	---	---	---
Prodiamesa olivacea	x	---	---	---	---	---	---	---	---
Prosimulium sp.	---	---	---	---	---	---	---	---	x
Psectrocladius sp.	x	---	---	---	---	x	---	---	---
Pseudochironomus sp.	---	---	---	x	---	---	---	---	---
Pseudorthocladius sp.	---	x	---	---	---	---	---	---	---
Rheocricotopus robacki	x	x	x	x*	x	x	---	---	x
Rheocricotopus sp.	---	---	---	---	---	---	---	x	x
Rheosmittia sp.	x*	x*	x	x	---	x	---	---	---
Rheotanytarsus exiguus	x	---	---	x*	x	x	x	---	---
Rheotanytarsus sp.	x*	x	x*	x*	---	x*	---	x	x
Robackia demeijerei	x*	x	---	x	x	x	---	---	---
Saetheria tylus	x	x	x*	---	---	x*	---	---	---
Simulium sp.	x	x	---	---	x*	x	x*	x	x*
Stenochironomus sp.	x	x	x	x	x	x	---	x	x
Synorthocladius sp.	---	---	---	---	---	---	---	x	---
Tanytarsus sp.	x*	x	x*	x	x	x	---	x	x

Table 11. (continued).

Taxon	Richland Creek	Dick Creek	Level Creek	Suwanee Creek	Johns Creek	Crooked Creek	Marsh Creek	Rottenwoo d Creek	L. Nancy Creek
Thienemanniellaxena	x*	x	---	x*	---	x	x	---	---
Thienemannimyia group	---	x	---	---	---	---	---	---	x
Tipulidae	x---		---	---	---	---	---	---	---
Tribelos jucundus	x---	x*	---	---	x	---	---	---	
Trebelos sp.	---	---	x	x	---	x	---	---	---
Tvetenia paucunca	---	---	---	x	x*	x	x	---	---
Simulium sp.	x	---	x	---	---	x	---	---	---
Tipula sp.	x	x	x	---	x	x	x	x	x
Trichoclinocera sp.	---	x	---	---	---	---	---	---	---
Tvetenia bavarica group	---	x	---	---	---	---	---	---	---
Tvetenia sp.	---	---	---	---	---	---	---	---	x
Xylotopus par	---		x	---	---	---	---	---	---
Zavrelia sp.	---		x	---	---	x	---	---	---
Zavrelimyia sp.	x		---	---	x	x	---	---	---
Total taxa	**73**	**101**	**70**	**59**	**28**	**73**	**29**	**31**	**39**
Ecological Condition	**Poor**	**Fair***	**Very Poor**	**Very Poor**	**Poor**	**Poor**	**Fair/ Poor**	**Fair**	**Fair**

* Ecological condition is denoted for Dick Creek considering 1999, 2000, and 2005 data only. New GA DNR (2007c) standard operating procedures for macroinvertebrate biological assessment no longer have qualitative ratings and do not use reference reaches for bioassessments. Therefore, an assessment rating narrative description is not available for Dick Creek considering the available 2007 data.

Other available information on bivalve molluscs is also discouraging. The southeastern U.S. was once known to have the highest mussel diversity in North America (Burch 1975, Turgeon et al. 1998). The Appalachicola River basin had the highest number of species of freshwater gastropods and bivalves, the most endemic species, and the highest proportion of endemic species to total molluscan fauna of the western Florida rivers (Johnson 1972). Historically, 45 unionid mussel species were present in the Appalachicola-Chattahoochee-Flint River basin (Couch et al. 1996). During the 1900s, however, at least 7% of the mussel fauna have become extinct, more than 40% are federally listed as threatened or endangered, and 24% are species of special concern, with the status of 5% undetermined (Williams and Neves 1995). Surveys in the upper Chattahoochee River during the late 1950s - late 1960s detected only eight mussel species (Brim Box and Williams 2000).

In 1998 the U.S. FWS listed five mussel species (fat three-ridge - Amblema neislerii, shinyrayed pocketbook - Lampsilis subangulata, Gulf moccasinshell - Medionidus penicillatus, Ochlockonee moccasinshell - Medionidus simpsonianus, and oval pigtoe - Pleurobema pyriforme) as endangered, and two species (Chipola slabshell - Elliptio chipolaensis, purple bankclimber - *Elliptoideus sloatianus*) as threatened (U.S. FWS 1998). A freshwater mussel status survey conducted in November 2003 at 18 sites in the park detected no live mussels, and only one highly weathered shell (the latter, from a species called sculptured pigtoe, *Quincuncina infucata*) (O'Brien and Brim Box 2003). Aquatic snails were found at only one site; even the exotic Asian clam (*Corbicula fluminea*) was absent at 7 of the 18 sites surveyed. Finally, GeoSyntec Consultants (2006) surveyed the Morgan Falls area for rare, threatened and endangered species. They noted that the shinyrayed pocketbook and Gulf moccasinshell historically occurred in that area, but found no populations and concluded that the two species apparently have been extirpated from the Morgan Falls area of the mainstem Chattahoochee River.

Table 12. Macroinvertebrate community ratings and attributes (GA DNR 2004). The number of streams surveyed in the past decade in or near the park (9 in total) is indicated under the respective evaluation category (Biological Condition Category) in the left column.

Biological Condition Category	% Comparability to Reference Score	Attributes
Very Good	≥ 83%	Comparable to the best situation to be expected within an ecoregion. A balanced trophic structure, with an optimum community composition for the stream size and habitat. Exceptional or unusual assemblages of species are usually present, with sensitive species abundant. Species richness is high and the stream exhibits outstanding conditions.
Good	74 – 82%	A relatively balanced community composition, with a balanced trophic structure. Species richness is relatively high for the stream size and habitat present, and sensitive species are present.
Fair (4 of 9 streams)	49 – 73%	Community composition is lower than expected due to a loss of intolerant taxa, with an increase in the percent contribution of tolerant forms. The community structure (composition and dominance) for stream size and habitat quality is adequate. Some expected species are absent or in low abundance.
Poor (3 of 9 streams)	25 – 48%	Fewer taxa due to the loss of most intolerant forms. An overall reduction in EPT taxa.* Community structure and habitat quality are less than desirable but do meet expectations in some areas. Expected species are absent or in low numbers. Streams in this category exhibit low species richness, with tolerant species predominating. Sensitive species are absent. These streams exhibit significant levels of habitat degradation at increasing frequencies.
Very Poor (2 of 9 streams)	< 25%	Assigned to streams with few species present, with only the most tolerant species remaining. The community is lacking diversity, with few or no EPT taxa.* Extreme habitat degradation has substantially altered the stream's characteristics.

* EPT ≡ Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).

The authors of the 2000-2003 survey attributed the absence of mussel fauna in the park area to habitat alterations, especially dam construction and associated habitat fragmentation, bank erosion, streambed scour, sedimentation/pollution and other habitat degradation, hydrologic changes, other species changes such as declines of required host fish, and increased temperatures / decreased dissolved oxygen concentrations in impounded water (O'Brien and Brim Box 2003). Some if not most or all of the endemic threatened and endangered species also have had to compete for habitat, unsuccessfully, with the exotic Asian clam (see below).

Fish

Releases of cold water from Buford Dam have altered the natural thermal regime of the river, and colder water temperatures have enabled development of a nonnative trout fishery downstream from Lake Lanier to Atlanta (Couch et al. 1996 – see below). Cold water is drawn through turbines from the reservoir hypolimnion at a depth of ca. 68 feet, so that the tailrace water is cold year-round (Gilbert and Reinert 1978, Kunkle and Vana-Miller 2000). Fluctuating flows change the species composition and abundance of fish differently in shoreline versus midstream habitats. Shoreline species are most adversely affected and the extent of the change depends on the severity of flow regime alteration and distance downstream from a dam (Bain and Boltz 1989, Kunkle and Vana-Miller 2000).

Table 13. Fish species listed as present or probably present (*) in park waters emphasizing the Chattahoochee River, documented through one or more types of evidence as references, vouchers, and observations (NPS 2008c; also GeoSyntec Consultants 2006, for the highscale shiner). Double asterisk (**) ≡ non-native species; NH ≡ not listed in historical records; NNPS ≡ small cryptic species not listed in NPS (2008c), but common in wetlands and small ponds in the general area and considered to be present. SPOC ≡ species of concern.

Alabama hogsucker (*Hypentelium etowanum*)	Greater jumprock (*Moxostoma lachneri*)*
American gizzard shad (hickory shad, mud shad, skipjack) (*Dorosoma cepedianum*)	Green sunfish (*Lepomis cyanellus*)
Asian swamp eel (rice eel, swamp eel) (*Monopterus albus*)** NH	Highscale shiner (*Notropis hypsilepis*) a, NNPS, SPOC
Banded sculpin (*Cottus carolinae*)	Largemouth bass (*Micropterus salmoides*)
Bandfin shiner (*Luxilus zonistius*)*	Longnose shiner (*Notropis longirostris*)*
Black bullhead (*Ameiurus melas*)*	Mosquitofish (Gambusia affinis)NNPS
Black crappie (*Pomoxis nigromaculatus*)	Mottled sculpin (Cottus cf. bairdi)
Blackbanded darter (*Percina nigrofasciata*)	Quillback (quillback carpsucker) (*Carpiodes cyprinus*)*
Blacktail shiner (*Cyprinella venusta*)	Rainbow trout (redband trout, steelhead) (*Oncorhynchus mykiss*)
Bluefin stoneroller (*Cyprinella callitaenia*)*	Red shiner (rainbow dace) (*Cyprinella lutrensis*)*, **
Bluegill (*Lepomis macrochirus*)	Redbreast sunfish (*Lepomis auritus*)
Bluehead chub (Nocomis leptocephalus)	Redear sunfish (*Lepomis microlophus*)
Bluestripe shiner (*Cyprinella callitaenia*)[SPOC]	Shadow bass (*Ambloplites ariommus*)*
Bowfin (*Amia calva*)	Shoal bass (*Micropterus cataractae*)**
Brook trout (char, salter, sea trout) (*Salvelinus fontinalis*)*	Silverjaw minnow (*Notropis buccatus*)*
Brown bullhead (*Ameiurus nebulosus*)	Smallmouth bass (*Micropterus dolomieu*)*
Brown trout (*Salmo trutta*)[NH]	Snail bullhead (*Ameiurus brunneus*)
Chain pickerel (*Esox niger*)	Southern brookLamprey (*Ichthyomyzon gagei*)*
Channel (graceful) catfish (*Ictalurus punctatus*) ** Spottail shiner (*Notropis hudsonius*)NH	Southern studfish (*Fundulus stellifera*)*
Clear chub (*Hybopsis* cf. *winchelli*)*	Spotted bass (*Micropterus punctulatus*)*
Common (European) carp (*Cyprinus carpio*)**	Spotted sucker (*Minytrema melanops*)*
Creek chub (creek chubsucker) (*Semotilus atromaculatus*)*	Striped jumprock (*Moxostoma rupiscartes*)*
Dixie chub (*Semotilus thoreauianus*)*	Tadpole madtom (*Noturus gyrinus*)
Eastern mosquitofish (*Gambusia holbrooki*)	Warmouth (*Chaenobryttus gulosus*)
Flat bullhead (*Ameiurus platycephalus*)*	White sucker (*Catostomus commersonii*)
Golden shiner (*Notemigonus crysoleucas*)*	Yellow perch (*Perca flavescens*)
Goldfish (*Carassius auratus* L.)**	Yellowfin shiner (*Notropis lutipinnis*)
Grass (redfin) pickerel (*Esox americanus*)	
Species Apparently Extirpated [a]	
Unidentified buffalo (*Ictiobus* sp.)	Grayfin redhorse (*Moxostoma* sp. cf. *poecilurum*) White catfish (*Ameiurus catus*)
White crappie (*Pomoxis annularis*)	Redeye bass (*Micropterus coosae*)
Yellow bullhead (*Ameiurus natalis*)	Speckled madtom (*Noturus leptacanthus*)
Black madtom (*Noturus funebris*)	Stoneroller (*Campostoma anomalum*)

[a] Based on Gilbert and Reinert (1978), Hess (1981), Couch et al. (1995), DeVivo (1996), and Kunkle and Vana-Miller (2000). This section pertains to the entire park area and omits consideration of apparent extirpations from specific tributaries. For example, the bluestripe shiner, included in the NPS (2008c) list of fish species still present or probably present in the park, was described by GeoSyntec Consultants (2006) as having formerly occurred in Big Creek but has not been collected in the area near Morgan Falls Dam since the 1950s and likely has been extirpated from that area. The status of one species, the high- scale shiner, is in question (see SPOC section below). The goldfish was listed as present in Rottenwood Creek (sampled 11 May 99 – Cobb County data).

Table 14. Fish species found in three tributaries – Sope Creek, Rottenwood Creek, and Willeo Creek – of the Chattahoochee River in the park area in the early 1990s (most recent information available, except for Dick Creek – also see Table 14), with information about abundance. X ≡ present; ---- ≡ absent. From Couch et al. (1995) and DeVivo (1996).

Species	Sope Creek	Rottenwood Creek	Willeo Creek
Alabama hogsucker	Common	Common	Common
Bandfin shiner	Common	----	x
Black crappie (Willeo)	----	----	x
Blackbanded darter	Common	x	Common
Bluefin stoneroller	Common	x	x
Bluegill	Common	Common	Common
Bluehead chub	Common	----	Common
Brown bullhead	----	x	----
Creek chub	x	----	----
Fathead minnow	Common	----	Common
Flat bullhead	x		
Golden shiner	x	Common	----
Green sunfish	x	Common	Common
Green x bluegill hybrid (*Lepomis cyanellus* x *macrochirus*)	----	x	----
Largemouth bass	x	x	x
Mosquitofish	----	Common	x
Red shiner	----	Common	x
Redbreast sunfish	Common	Common	Common
Redbreast sunfish x green hybrid (*Lepomis auritus* x *cyanellus*)	----	x	----
Redbreast sunfish x bluegill hybrid (*Lepomis auritus* x *macrochirus*)	x	x	----
Redear sunfish	----	----	x
Snail bullhead	Common	x	----
Southern studfish	x	----	x
Warmouth	x	x	x
White sucker	x	x	---
Yellowfin shiner	Common	----	Common

Fish in the park area have substantially declined in species richness over time, while numbers of exotic species have increased. Historically (late 1970s – early 1980s), 50 fish species (42 native, 8 non-native) were reported in the Chattahoochee River (Buford Dam to Peachtree Creek) and some of its tributaries (Richland, Crooked, Dick, Level, Johns, James, Suwanee, and Big Creeks; Couch et al. 1995). However, surveys conducted in the early 1990s, including about 70% of the tributaries in the park, yielded only 35 species (Kunkle and Vana-Miller 2000) (*Tables 13* and *14*). Similarly, 27 species (including 3 hybrids) were found in three tributaries of the Chattahoochee River (Sope Creek, Rottenwood Creek, and Willow Creek) in the early 1990s. The NPS (2008c) lists 53 species as present (31 species, including 5 exotics) or "probably present" (21 species) – thus, 31 species have been verified as still present in the park, includingstocked brown trout and two relatively new exotic invasive species, the Asian swamp eel and the red shiner (see below). Based on comparison of historic with more recent, although sparse, data, at least ten species apparently have been extirpated (*Table 13*).

More recent data on fish species present in Richland, Level, Suwanee, Crooked, Johns, and March Creeks near the park (*Table 15*) were collected and assessed using the Index of Biotic Integrity (IBI) criteria (*Table 16*) developed for fish communities in the Piedmont Ecoregion (GA DNR 2007d), following Barbour et al. (1999). Fish sampling was conducted at Johns and March Creeks in October and November of 2006; sampling of the other three streams was conducted in October 2005 (CH2M Hill 2007). CH2M Hill (2000, 2008b) reported data for Dick Creek as well (July/Aug. 1999, July 2005, Aug. 2007). Data were also collected by Cobb County, using IBI criteria, for Rottenwood Creek (May 1999) and Little Nancy Creek (May 1999, Aug 2004). The data indicate that fish community health in these streams is poor (Dick Creek, Crooked Creek, Little Nancy Creek) or very poor (Richland Creek, Suwanee Creek, Marsh Creek, Rottenwood Creek), except in Johns Creek where fish community health was evaluated as “fair” (CCR Environmental, Inc. 2007, CH2M Hill 2007) (see p.114 of this Report). The most common species remaining in one or more of these streams were the Alabama hogsucker, bluefin stoneroller, bluegill, bluehead chub, creek chub, and yellowfin shiner. Many of the fish species found in the 2005 survey were represented by one to a few individuals in only one stream (CH2M Hill 2007).

The Chattahoochee River is the southernmost habitat in the U.S. for trout, and the state of Georgia stocks rainbow, brook and brown trout in park river segments. The USFWS-operated Chattahoochee Forest Hatchery produces about one million trout per year, but most of them are stocked (in cooperation with GA DNR and the USACE) into tailwaters, streams and reservoirs in northern Georgia (Fannin County and surrounding area (U.S. FWS 2007; P. Thompson, GA DNR, pers. comm., 2008). The Buford Hatchery (*Plate 9*), operated by GA DNR, is the source of most of the trout that are stocked into the Chattahoochee River in the park at access sites from the Buford Dam downstream to Paces Mill. The optimal flow for trout is less than WS-operated Chattahoochee Forest Hatchery produces about one million trout per year, but most of them are stocked (in cooperation with GA DNR and the USACE) into tailwaters, streams and reservoirs in northern Georgia (Fannin County and surrounding area (U.S. FWS 2007; P. Thompson, GA DNR, pers. comm., 2008). The Buford Hatchery (*Plate 9*), operated by GA DNR, is the source of most of the trout that are stocked into the Chattahoochee River in the park at access sites from the Buford Dam downstream to Paces Mill. The optimal flow for trout is less than 2,000 cfs, and the reach of the Chattahoochee from Morgan Falls Dam down to Peachtree Creek provides the most valuable trout habitat because of abundant shoals – wide, shallow areas with a steep gradient (12.5 feet per mile) and bedrock/ boulder substrata (Nestler et al. 1984) (*Plate 10*).

Table 15. Fish species in eight streams of the park area, sampled in October 2005 (Richland, Suwanee, and Crooked Creeks); 1999, 2005 and 2007 (Dick Creek); October - November 2006 (Johns and Marsh Creeks); 1999 (Rottenwood Creek); and 1999 and 2004 (Little Nancy Creek). Asterisks (*) indicate taxa that were evaluated as abundant. The data for Richland Creek, Suwanee Creek, Johns Creek, Crooked Creek, and Marsh Creek are from CH2M Hill (2007); the data for Dick Creek are from CH2M Hill (2000, 2008b); and the data for Rottenwood Creek and Little Nancy Creek are from Cobb County. The Ecological Condition (Biotic Integrity Class) is also noted.

Taxon	Richland Creek	Dick Creek	Suwanee Creek	Johns Creek	Crooked Creek	Marsh Creek	Rottenwood Creek	L. Nancy Creek
Alabama hogsucker	x	x*	x	x*	x	---	x	x
Blackbanded darter	---	x	x	x	x	---	x	---
Bluefin stoneroller	---	x*	---	x*	x	x*	---	x
Bluegill	x	x*	x	x*	x	---	x	x*
Bluehead chub	x	x*	x	x*	x	---	---	x*
Brown bullhead	---	x	---	---	---	---	x	x
Creek chub	x	x	---	x	---	x*	---	---
Golden shiner	---	x	---	---	x	---	---	x
Goldfish	---	---	---	---	---	---	x	---
Green sunfish	x	x*	x	x	x	x	x	x*
Largemouth bass	---	x	---	x	x	---	---	x
Longnose shiner	---	---	---	x	---	---	---	x
Mosquitofish	---	---	x	---	---	---	x	---
Mottled sculpin	---	x	---	---	---	---	---	---
Red shiner	---	---	---	---	---	---	x	---
Redbreast sunfish	x	x*	x	x	x	x	x	x
Redear sunfish	---	---	---	x	---	---	x	---
Snail bullhead	---	x	x	x	---	---	x	x
Southern studfish	---	x	---	x	---	---	---	---
Spottail shiner	---	---	x	---	---	---	---	---
Spotted bass	---	------		---	---	---	x	---
Spotted sucker	---	---	x	---	---	---	---	---
Striped jumprock	---	---	---	x	---	---	---	---
Sunfish hybrid	---	x	x	---	---	---	x	x
Tadpole madtom	---	x	---	x	---	---	---	---
Warmouth	---	---	x	---	x	---	x	x
White sucker	---	---	---	x	---	---	x	x
Yellow bullhead	---	---	---	---	---	---	x	x
Yellowfin shiner	x	x*	---	x*	---	---	---	x*
Total Species	**7**	**17**	**12**	**17**	**10**	**4**	**16**	**16**
Ecological Condition	**Very Poor**	**Poor**	**Very Poor**	**Poor**	**Poor**	**Very Poor**	**Very Poor**	**Poor**

The river in the park vicinity thus provides a valuable recreational fishery resource for greater metropolitan Atlanta (e.g. *Plate 11*). Angler use on the Chattahoochee River has been tracked by creel surveys in 1983, 1990 and 2000. Older surveys listed harvest of stocked trout at 85% (1983 – Martin 1985) and 63% (1990 – unpubl. data reported by Klein 2003). The number of catchable trout stocked below Buford dam increased from ca. 130,000 in 1983, to 181,000 in 1990, to ca. 354,000 by 1997 (Kunkle and Vana-Miller 2000, Klein 2003). Fishing pressure was assumed to be high and increasing based on past studies. During 2000, however, evaluation ofmortality of stocked catchable (length 228 mm) rainbow trout and brown trout indicated that (i) annual mortality was 69% (rainbow trout) to 87% (brown trout); (ii) natural mortality was considerably higher than fishing mortality for both species; and (iii) exploitation rates for both species were below 17% (Klein 2003). During 2000-2002, ca. 192,000 - 284,000 rainbow trout and 33,200 - 44,800 brown trout were stocked per year in the Buford Dam tailwaters by the GA

DNR-WRD. Thereafter (2003-2006, most recent statistics available), ca. 130,400 -152,100 rainbow trout have been stocked per year. About 24,200 - 24,600 brown trout were stocked in 2003-2004; further stocking of browns has not been done because a population has established and appears to be doing well on its own (P. Thompson, GA DNR-WRD, pers. comm., 2008). Most of the fish stocked are 9-10 inches in length, but about 30,000 trout are grown to 12 or more inches for a delayed harvest fishery (B. Couch, GA DNR, pers. comm., 2008).

Table 16. Fish IBI Scores, Biotic Integrity Classes, and associated attributes (GA DNR 2005).

Total IBI Score	Integrity Class	Attributes
52-60	Excellent	Comparable to the best situations without human disturbance; all regionally expected species, including most intolerant ones; balanced trophic structure
44-50	Good	Species richness somewhat below expectations due to loss of some intolerant species; trophic structure showing some signs of stress trophic structure
34-42	Fair	Fewer species than expected, including loss of intolerant species; skewed
26-32	Poor	Dominated by tolerant species, habitat generalists, or omnivores; few top Carnivores; hybrids and diseased fish often present
8-24	Very Poor	Few fish present, mostly introduced or tolerant forms, hybrids; disease and other health-related anomalies; stream community is highly stressed

Plate 9. Scenes from the Buford Hatchery. Photos by E. Morris, 2008.

Plate 10. Snag (Island Ford) and boulder/riffle habitats (Cochran Shoals) in park waters. Photos by E. Morris, 2008.

Plate 11. Some anglers in park waters. Photos by E. Morris, 2008.

Amphibians and Reptiles

A total of 63 reptiles and amphibians have been reported from the park, including 23 species of amphibians (12 frogs and toads, and 11 newts and salamanders) and 40 species of reptiles (9 lizards, 22 snakes, 9 turtles) (*Table 17*). In a comparison of 16 parks that included this park, Tuberville et al. (2005) noted that larger parks had higher species richness (*Figure 16*). Yet, although this park was among the smaller parks in areal extent, and although this park is fragmented with considerable border area, it was second from the highest in number of native species. The backwater and floodplain pools in the park, as well as areas of confluence of the river with its tributaries, provide important habitat for herpetofauna.

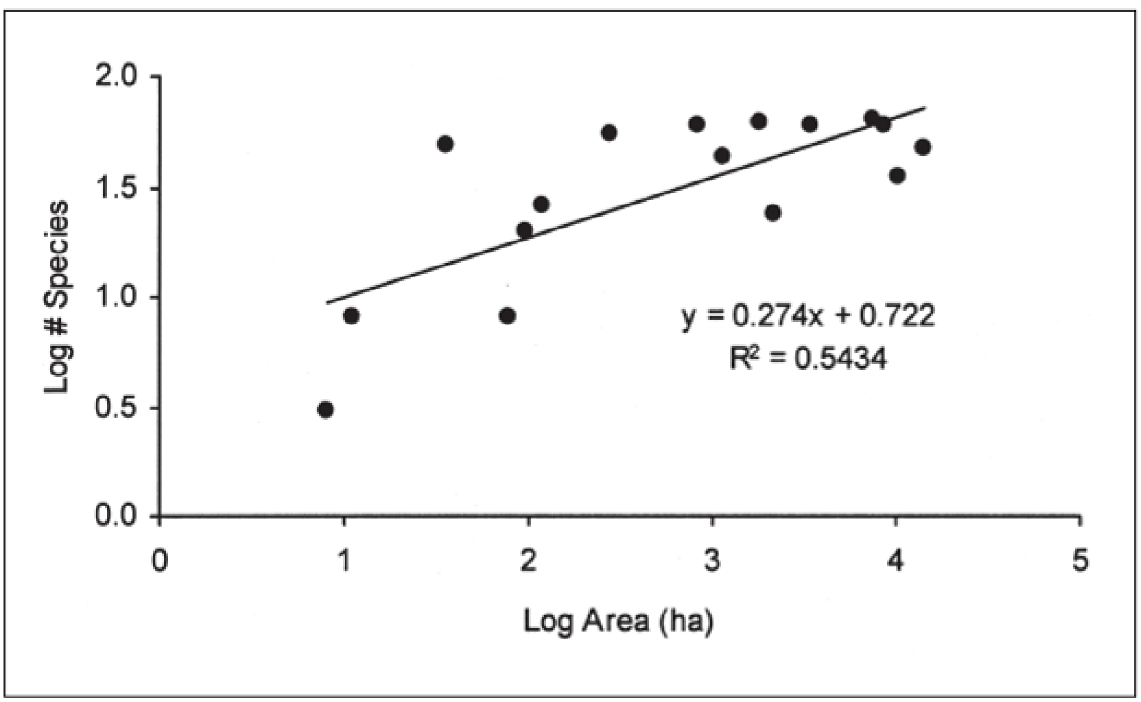


Figure 16. Relationship between land area (in hectares) and herpetofauna species richness, excluding exotic (introduced) species, among 16 parks within the Southeast Coast Network of the NPS, including this park, showing the strong positive linear relationship between (log-transformed) land area and species richness (P = 0.001). From Tuberville et al. (2005), with permission from Southeastern Naturalist.

Table 17. Herpetofauna of the park, documented through one or more types of evidence as references, vouchers, and observations (NPS 2004b, Tuberville et al. 2005). Asterisk (*) ≡ probably present (cited on the OCMU species list but not documented in the most current inventory); double asterisk (**) ≡ non-native species.

AMPHIBIANS

Frogs and Toads

American bullfrog (*Rana catesbeiana*)
American toad (*Bufo americanus*)
Eastern narrow-mouthed toad (*Gastrophryne carolinensis)*
Eastern spadefoot (*Scaphiopus holbrookii*)
Fowler's toad (*Bufo fowleri*)
Gray (Cope's gray) treefrog (*Hyla versicolor*)
Green frog (*Rana clamitans*)
Northern cricket frog (*Acris crepitans*)
Pickerel frog (*Rana palustris*)
Southeastern chorus frog (*Pseudacris feriarum*)
Southern (Florida) leopard frog (*Rana spenocephala*)
Spring peeper (*Pseudacris crucifer*)

Newts and Salamanders

Dusky salamander (*Desmognathus fuscus*)
Eastern newt (*Notophthalmus viridescens*)
Marbled salamander (*Ambystoma opacum*)
Red salamander (*Pseudotriton ruber*)
Seal salamander (*Desmognathus monticola*)
Slimy salamander (*Plethodon glutinosus*)
Southern redbacked salamander (*Plethodon serratus*)
Southern two-lined salamander (*Eurycea cirrigera*)
Spotted salamander (*Ambystoma maculatum*)
Spring salamander (*Gyrinophilus porphyriticus*)
Three-lined salamander (*Eurycea guttolineata*)

REPTILES

Lizards

Broadheaded skink (*Eumeces laticeps*)
Eastern fence lizard (*Sceloporus undulatus*)
Eastern glass lizard (*Ophisaurus ventralis*)
Five-lined (common) skink (*Eumeces fasciatus*)
Green anole (*Anolis carolinensis*)
Little brown (ground) skink (*Scincella lateralis*)
Six-lined racerunner (*Cnemidophorus sexlineatus*)
Slender glass lizard (*Ophisaurus attenuatus*)
Southeastern five-lined skink (*Eumeces inexpectatus*)

Snakes

Brownsnake (*Storeria dekayi* or *S. victa*)
Common garter snake (*Thamnophis sirtalis*)*
Common kingsnake (*Lampropeltis getula*)
Corn snake (*Elaphe guttata*)
Eastern hog-nosed snake (*Heterodon platirhinos*)
Eastern ribbon snake (*Thamnophis sauritus*)
Eastern rat snake (*Elaphe obsoleta*)
Eastern worm snake (*Carphophis amoenus*)
Florida redbellied cooter (*Pseudemys nelsoni*)
Milksnake (*Lampropeltis triangulum*)
Northern water snake (*Nerodia sipedon*)
Plain-bellied watersnake (*Nerodia erythrogaster*)
Queensnake (*Regina septemvittata*)
Racer (eastern racer) (*Coluber constrictor*)
Redbellied snake (*Storeria occipitomaculata*)
Ring-necked snake (*Diadophis punctatus*)
Rough green snake (*Opheodrys aestivus*)**
Scarletsnake (*Cemophora coccinea*)
Smooth earth snake (*Virginia valeriae*)
Southeastern crowned snake (*Tantilla coronata*)
Southern (common) copperhead (*Agkistrodon contortrix*)
Yellowbellied kingsnake (*Lampropeltis calligaster*)

Turtles

Common (eastern) box turtle (*Terrapene carolina*)
Common (eastern) mud turtle (*Kinosternon subrubrum)*
Common musk turtle (stinkpot) (*Sternotherus odoratus)*
Common (pond) slider (*Trachemys scripta*)
Common snapping turtle (*Chelydra serpentina*)
Eastern painted turtle (*Chrysemys picta*)
Loggerhead musk turtle (*Sternotherus minor*)
River cooter (*Pseudemys concinna*)
Spiny softshell (*Apalone spinifera*)

Birds
The NPS (2008c) lists 191 species of birds that have been observed in the park, and along with recent sitings of whooping cranes (A. Reynolds, pers. comm., 2006), 25% (48) of the 192 species are associated with aquatic habitats (*Table 18*). The park's location at the southern terminus of the Appalachian Mountains and forest acreage make it especially attractive habitat for birds,

particularly during spring and fall migrations. Nearby Kennesaw Mountain National Battlefield Park has been designated a globally Important Bird Area (IBA Programme of BirdLife International: http://www.birdlife.org), the first area so designated in the state, and a focus area for bird conservation (Cooper 2000). The number of bird species reported for the two parks is similar (191 versus 185), and includes a large percentage of neotropical migrants.

No federally listed threatened or endangered avian species are known to nest in the park (Watson 2005). Audubon WatchList has indicated that the cerulean warbler is declining, and that the major threat mentioned for this species is development and urban sprawl (Audubon 2002).

Mammals
Based on a survey of the park in 2003 (excluding bats), together with information from museum collections, a total of 44 species of mammals are present (40) or probably present (4) in the park (*Table 19*). Six species are associated with aquatic habitats, including the American beaver, American mink, marsh rice rat, muskrat, northern river otter, and swamp rabbit (the latter listed as probably present). Five exotic species are listed as present, none of which are associated with aquatic habitats. The USGS (2008) also indicated a high probability for the big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), ground skink (*Scincella lateralis*), and hoary bat (*Lasiurus cinereus*) to be present in the park vicinity. Three species (American black bear, *Ursus americanus*; mountain lion, *Puma concolor*; red wolf, *Canis rufus*) have been extirpated. The eastern woodrat (*Neotoma floridana*) is also native to the area, but there was no evidence of its occurrence in the park.

This is a narrow park with a large perimeter surrounded by development that prevents or restricts immigration and emigration (Heaney and Patterson 1986, Trani 2002) and accelerates impacts of pollution within the isolated park grounds. Carnivores, which generally have large home ranges, would be expected to be disproportionately affected (Golly 1962, Matthiae and Stearns 1981, Choate et al. 1994). Coyotes, which have extended their natural range, and exotic feral cats are carnivores that are better adapted to live near urbanized settings and at least partially occupy the niches that previously were occupied by the carnivores that have been extirpated. White-tailed deer and beavers are two species of concern in the park, and populations of both appear to be on the increase. Beavers are "ecosystem engineers" whose dam-building activities alter water flow and water quality. They can cause considerable damage and loss of desirable tree species and other wetland/aquatic vegetation (e.g. Parker et al. 2007b) (*Plate 12*). In terrestrial habitats, high deer populations consume forest understory species, so their grazing can lead to depressed forest regeneration. Five species, the cotton mouse, eastern fox squirrel, eastern spotted skunk, oldfield mouse, and woodchuck, are of concern as potentially problematic native encroaching species.

Table 18. Bird species that have been observed at the park (NPS 2008c). Asterisk (*) ≡ species documented near the park, and the park has appropriate habitat; asterisks (**) ≡ non-native species; L ≡ listed (imperiled); SPOC ≡ species of concern.

Species associated with aquatic habitats

American bittern (*Botaurus lentiginosus*)
American coot (*Fulica americana*)
American pipit (*Anthus rubescens*)
Belted kingfisher (*Ceryle alcyon*)
Bonaparte's gull (*Larus philadelphia*)
Blue-winged teal (*Anas discors*)
Canada goose (*Branta canadensis*)
Cattle egret (*Bulbulcus ibis*)
Common loon *(Gavia Immer*)
Common snipe (*Gallinago gallinago*)
Double-crested cormorant (*Phalacrocorax auritus*)
Gadwall *(Anas strepera*)
Great blue heron (*Ardea herodias*)
Great egret (*Ardea alba*)
Greater scaup (*Aythya marila*)
Greater white-fronted goose (*Anser albifrons*)
Greater yellowlegs (*Tringa melanoleuca*)
Green heron (*Butorides virescens*)
Green-winged teal *(Anas crecca*)
Herring gull (*Larus argentatus)*
Hooded merganser (*Lophodytes cycyllatus*)
King rail (*Rallus elegans*)
Least sandpiper (*Calidris minutilla*)
Lesser yellowlegs (*Tringa flavipes*)
Louisiana waterthrush (*Seiurus motacilla*)
Mallard (*Anas platyrhynchos*)
Marsh wren (*Cistothorus palustris*)
Merlin (*Falco columbarius*)
Northern pintail (*Anas acuta*)
Northern shoveler (*Anas clypeata*)
Northern waterthrush (*Seiurus noveboracensis*)
Osprey (*Pandion haliaetus*)
Pectoral sandpiper (*Calidris melanotos*)
Pied-billed grebe *(Podilymbus podiceps)*
Red-breasted merganser (*Mergus serrator*)
Red-winged blackbird (*Agelalus phoeniceus*)
Ring-billed gull (*Larus delawarensis*)
Sandhill crane (*Grus canadensis*)
Sedge wren (*Cistothorus platensis*)
Solitary sandpiper (*Tringa solitaria*)
Sora (*Porzana carolina*)
Spotted sandpiper (*Actitis macularius*)
Swamp sparrow (*Melospiza georgiana*)
White ibis *(Endocimus albus)*
Whooping crane (*Grus americana*)
Wilson's snipe (*Gallinago delicata*)
Wood duck (*Aix sponsa*)
Yellow-crowned night heron (*Nyctanassa violacea*)

Other species

American crow (*Corvus brachyhynchos*)
Acadian flycatcher (*Empidonax virescens*)
American goldfinch (*Carduelis tristis*)
American kestrel (*Falco sparverius*)
American redstart (*Setophaga ruticilla*)
American robin (*Turdus migratorius*)
American wigeon (A*nas americana*)
Bald eagle (*Haliaeetus leucocephalus*)[SPOC]
Baltimore (northern) oriole (*Icterus galbula*)
Barn swallow (*Hirunndo rustica*)
Barred owl (*Strix varia*)
Bay-breasted warbler (*Dendroica castanea*)
Black and white warbler (*Minotita varia*)
Blue-headed (solitary) vireo (*Vireo solitarius*)
Blue-winged warbler (*Vermivora pinus*)
Bobolink (*Dolichonyx oryzivorus*)
Brewster'swarbler (*Vermivora leucobronchialis*)
Broad-winged hawk (*Buteo platypterus*)
Brown creeper (*Certhia americana*)
Brown thrasher (*Toxostoma rufum*)
Brown-headed cowbird (*Molothrus ater*)
Brown-headed nuthatch (*Sitta pusilla*)
Canada warbler (*Wilsonia canadensis*)
Cape May warbler (*Dendroica tigrina*)
Carolina chickadee (*Poecile carolinensis*)
Carolina wren (*Thryothorus ludovicianus*)

Table 18. (Continued).

Black vulture (*Coragyos atratus*)	Cedar waxwing (*Bombycilla cedrorum*)
Black-billed cuckoo (*Coccyzus erthropthalmus*)	Cerulean warbler (*Dendroica cerulea*)[SPOC]
Blackburnian warbler (*Dendroica fusca*)	Chestnut-sided warbler (*Dendroica pensylvanica*)
Blackpoll warbler (*Dendroica striata*)	Chimney swift (*Chaetura pelagica*)
Black-throatedblue warbler (*Dendroica caerulescens*)	*Chipping sparrow (Spizelia passerina)*
Black-throated green warbler (*Dendroica virens*)	Cliff swallow (*Petrochelidon pyrrhonota*)
Blue grosbeak (*Passerina caerulea*)	Common grackle *(Quiscalus quiscula)*
Blue jay (*Cyanocitta cristata*)	Connecticut warbler (*Oporornis agilis*)
Blue-gray gnatcatcher (*Poliopotilia caerulea*)	Cooper's hawk (*Accipter cooperii*)
Dark-eyed junco *(Junco hyemalis*)	Ovenbird (*Seiurus aurocapilla*)
Downy woodpecker *(Picoides pubescens*)	Palm warbler (*Dendroica palmarum*)
Eastern bluebird (*Sialia sialis*)	Peregrine falcon (*Falco peregrinus*)[a SPOC]
Eastern kingbird (Tyrannus tyrannus)	Philadelphia vireo (*Vireo philadelphicus*)
Eastern meadowlark *(Sturnella magna*)	Pileated woodpecker (*Dryocopus pileatus*)
Eastern palm warbler (*Dendroica palmarum hypochrysea)*	*Pine siskin (Carduelis pinus)*
Eastern phoebe (*Savornis phoebe)*	Pine warbler (*Dendroica pinus*)
Eastern screech owl *(Otus asio*)	Prairie warbler *(Dendroica discolor)*
Eastern (roufous-sided) towhee (*Pipilo erythrophthalmus)*	Prothonotary warbler (*Protonotaria* citrea)
Red-bellied woodpecker *(Melanerpes carolinus)*	Purple finch *(Carpodacus purpureus)*
Eastern wood pewee *(Contopus virens*)	Purple martin (*Progne subis*)
Eurasian collared dove (Streptopelia decaocto)**	Red-breasted nuthatch *(Sitta canadensis*)
European starling *(Sturnus vulgaris*)**	Red-eyed vireo (*Vireo olivaceus*)
Field sparrow (*Spizella pusilla*)	Red-headed woodpecker (*Melanerpes erthrocephalus*)
Fish crow (*Corvus ossifragus*)	Red-shouldered hawk (*Buteo lineatus*)
Fox sparrow *(Passerella iliaca*)	Red-tailed hawk (*Buteo jamaicensis*)
Golden-crowned kinglet (*Regulus satrapa*)	Rock dove (*Columba livia)*
Golden-winged warbler (*Vermivora chrysoptera*) [SPOC]	Rose-breasted grosbeak (*Pheucticus ludovicianus*)
Grasshopper sparrow (*Ammodramus savannarum*)	Ruby-crowned kinglet (*Regulus calendula*)
Gray catbird (*Dumetella carolinensis*)	Ruby-throated hummingbird (*Archilochus columbris*)
Gray-cheeked thrush (*Catharus minimus*)	Rusty blackbird (*Euphagus carolinus*)
Great crested flycatcher (*Myiarchus crinitus*)	Savannah sparrow (*Passerculus sandwichensis*)
Great horned owl (*Bubo virginianus*)	Scarlet tanager (*Piranga olivacea*)
Hairy woodpecker (*Picoides villosus*)	Sharp-shinned hawk (*Accipter striatus*)
Henslow's sparrow (*Ammodramus henslowii*) [SPOC]	Song sparrow (*Melospiza melodia*)
Hermit thrush (*Catharus gullatus*)	Summer tanager (*Piranga rubra*)
Hooded warbler (*Wilsonia citrina*)	Swainson thrush (*Catharus ustulatus*)
House finch (*Carpodacus mexicanus*)	Tennessee warbler (*Vermivora peregrina*)
House (English) sparrow (*Passer domesticus*)**	Tree swallow (*Tachycineta bicolor*)
House wren (*Troglodytes aedon*)	Tufted titmouse (*Baeolophus bicolor*)
Indigo bunting (*Passerina cyanea*)	Turkey vulture (*Cathartes aura*)
Kentucky warbler (*Oporornis formosus*)	Veery (*Catharus fuscescens*)

Table 18. (Continued).

Killdeer (*Charadrius vociferus*)	Vesper sparrow (*Pooecetes gramineus*)
Lawrence's warbler (*Vermivora lawrencii*)	Western palm warbler (*Dendroica palmarum*)
Le Conte's sparrow (*Ammodramus leconteii*)	White crowned sparrow (*Zonotrichia leucophrys*)
Lincoln's sparrow (*Melospiza lincolnii*)	*White-breasted nuthatch (Sitta carolinensis)*
Magnolia warbler (*Dendroica magnolia*)	*White-eyed vireo (Vireo griseus)*
Mourning dove (*Zenaida macroura*)	*White-throated sparrow (Zonotrichia albicollis)*
Mourning warbler (*Oporornis philadelphia*)	*Whooping crane (Grus americana)a*
Nashville warbler (*Vermivora ruficapilla)*	Wild turkey *(Meleagris gallopavo)*
Northern cardinal (*Cardinalis cardinalis*)	*Wilson's warbler (Wilsonia pusilla)*
Northern flicker (*Colaptes auratus*)	*Winter wren (Troglodytes troglodytes)*
Northern harrier (*Circus cyaneus*)	*Wood thrush (Hylocichla mustelina)*
Northern mockingbird (*Mimus polyglottos*)	*Worm-eating warbler (Helmitheros vermivorum)*
Northern parula (*Parula americana*)	Yellow warbler *(Dendroica petechia)*
Northern rough-winged swallow (*Stelgidopteryx serripennis)*	Yellow-bellied flycatcher *(Empidonax flaviventris)*
Olive-sided flycatcher (*Contopus cooperi*)	Yellow-bellied sapsucker *(Syphrapicus varius)*
Orange-crowned warbler (*Vermivora celata*)	Yellow-billed cuckoo *(Coccyzus americanus)*
Orchard oriole (*Icterus spurius*)	Yellow-breasted chat *(Icteria virens)*

Table 19. Mammalian species listed as occurring at the park (* ≡ probably present; ** ≡ exotic introduced species; ne ≡ native encroaching; NPS 2008c; and supporting information from USGS 2008).

Species associated with aquatic habitats	
American beaver (*Castor canadensis*)	Muskrat (muskbeaver) (*Ondatra zibethicus*)
American mink (*Mustela vison*)	Northern river otter (*Lontra canadensis*)
Marsh rice rat (*Oryzomys palustris*)	Swamp rabbit (*Sylvilagus aquaticus*)*
Other species	
Big brown bat (*Eptesicus fuscus*)	Hoary bat (*Lasiurus cinereus*)
Black rat (R*attus rattus*)**	House mouse (*Mus musculus*)**
Bobcat (*Lynx rufus*)	Least shrew (*Cryptotis parva*)
Common muskrat (*Ondatra zibethicus*)	Long-tailed weasel (*Mustela frenata*)*
Common gray fox (*Urocyon cinereoargenteus*)	Meadow jumping mouse (*Zapus hudsonius*)
Cotton mouse (*Peromyscus gossypinus*) ne	Meadow vole (*Microtus pennsylvanicus*)
Coyote (*Canis latrans*)	Northern raccoon (*Procyon lotor*)
Eastern chipmunk (*Tamias striatus*)	Northern short-tailed shrew (*Blarina brevicauda*)
Eastern cottontail (*Sylvilagus floridanus*)	Norway rat (*Rattus norvegicus*)**
Eastern fox squirrel (*Sciurus niger*) ne	Oldfield mouse (*Peromyscus polionotus*) ne
Eastern gray squirrel (*Sciurus carolinensis*)	Red fox (*Vulpes vulpes*)
Eastern harvest mouse (*Reithrodontomys humulis)*	Southeastern shrew (*Sorex longirostris*)
Eastern mole (topos) (*Scalopus aquaticus*)	Southern flying squirrel (*Glaucomys volans*)*
Eastern red bat (*Lasiurus borealis*)	Striped skunk (*Mephitis mephitis*)
Eastern spotted skunk (*Spilogale putorius*) ne	Virginia opossum (*Didelphis virginiana*)
Feral cat (*Felis catus*)**	White-footed mouse (*Peromyscus leucopus*)
Feral dog (*Canis familiaris*)**	White-tailed deer (*Odocoileus virginianus*)
Golden mouse (*Ochrotomys nuttalli*)*	Woodchuck (*Marmota monax*) ne
Hispid cotton rat (*Sigmodon hispidus*)	Woodland vole (*Microtus pinetorum*)

Species of Concern as Endangered, Threatened, or Rare

A total of 18 SPOCs may still occur in CHATT; the status of 4 of these, mussel species, is most uncertain. One wetland macrophyte SPOC, the Florida anise or Florida anisetree, occurs in the park and has been listed as endangerd by GA DNR (2008b,c). The state's "endangered" status refers to a species that is in danger of extinction throughout all or part of its range. Eight terrestrial SPOCs in the park area include bay star-vine (*Schisandra glabra* - threatened), Georgia aster (*Symphyotrichum georgianum* - threatened), goldenseal (*Hydrastic canadensis* - endangered), mountain witch-alder (*Fothergilla major* - threatened), piedmont barren-strawberry or barren strawberry (*Waldsteinia lobata* - rare), pink ladyslipper (*Cypripedium acaule* – unusual), and Ozark bunchflower or false hellebore (*Veratrum woodii* - rare) (GA DNR 2008b,c). The state's "threatened" status refers to a species that likely will become endangered in the foreseeable future throughout all or parts of its range. "Rare" status refers to a species that may not be endangered or threatened but should be protected because of scarcity (GA DNR 2008b,c). "Unusual" state status refers to a species that merits special consideration because of concerns about commercial exploitation. One of these species, Georgia aster, is also federally listed as "C", a candidate species that is under review for federal listing as endangered or threatened (GA DNR 2008b,c).

Plate 12. Evidence of beaver damage to vegetation in park wetlands. This photo (by E. Morris) was taken at a 47-acre wetland restoration project at the Johnson Ferry Park Unit.

Four mussel species that previously were in the park area (present status presumed extirpated; not detected for more than a decade – see above), listed by both GA DNR and U.S. FWS as endangered, are the fat threeridge (*Amblema neislerii*), shinyrayed pocketbook, Gulf moccasinshell, and oval pigtoe (GA DNR 2008c). These species have been federally listed as endangered since 1997. In addition, the purple bankclimber (*Elliptio chipolaensis*), previously known from the park area (present status unknown), is state and federally listed as threatened. All five species prefer main-channel or large-stream sandy habitats with slow to moderate currents. Two of these species, the Gulf moccasinshell and shinyrayed pocketbook, have been reported as apparently extirpated from the mainstem Chattahoochee River in downstream park segments around Morgan Falls Dam (GeoSyntec Consultants 2006).

Two species of fish, the bluestripe shiner and the highscale shiner, are state-listed as rare SPOCs (GA DNR 2008c). The bluestripe shiner is a SPOC as a result of its decreased populations after extensive hybridization with the exotic invasive red shiner following its introduction (DeVivo 1995, 1996). The distribution and habitat preferences of the highscale shiner are not well understood (DeVivo 1996). It has been described as absent from the park area (DeVivo 1996, NPS 2008c) although common above Lake Lanier (DeVivo 1996); however, unverified USGS data described it as present in tributaries of the greater Atlanta metropolitan area (DeVivo 1996). In addition, GeoSyntec Consultants (2006) described it as possibly occurring in Big Creek within the park area.

At present, no SPOC hepatofauna or mammals are listed as present or probably present in the park. Among other vertebrates, five bird species, the bald eagle, cerulean warbler, golden-winged warbler, Henslow's sparrow, and the peregrine falcon, are listed as SPOCs by GA DNR (2008c). The golden-winged warbler is state-listed as endangered; the bald eagle is state- and federally listed as threatened; and the Cerulean warbler, Henslow's sparrow, and peregrine falcon are state-listed as rare. Four of the five species are included in the NPS (2008x) list of species that have been seen in the park; the fifth, a probable siting of a peregrine falcon, was reported near Morgan Falls dam in 2005 (GeoSyntec Consultants 2006).

Exotic and Invasive Species

A total of 114 exotic invasive terrestrial plant species inhabit the park, including 8 species described as abundant and 12 species described as common (*Table 20*). In addition, many exotic landscaping trees occur in the park (Kunkle and Vana-Miller 2000). Exotic insects include the forest day mosquito (*Aedes albopictus*), the red imported fire and (*Solenopsis invicta*), and the southern pine beetle (*Dentroctonus frontalis*), which has adversely affected pine vegetation (NPS 1989). The red imported fire ant (*Solenopsis invicta*) is an invasive species from South America, introduced to the U.S. in the 1930s (Porter and Savignano 1990). This aggressive species has largely displaced the two fire ant species native to the Southeast, *Solenopsis geminata* and *Solenopsis exloni* (Porter and Savignano 1990). The southern pine beetle also has adversely affected terrestrial ecosystems in the park (NPS1989), and is considered the most destructive forest insect pest in the southeastern U.S. (Clarke 1995). Three non-native bird species (European starling, Eurasian collared dove, house sparrow) and five non-native mammal species (black rat, feral cat, feral dog, house mouse, Norway rat) inhabit the park (*Tables 18* and *19*).

Aquatic ecosystems are especially vulnerable to biological invasions (Cook 1993). A total of 33 non-native invasive aquatic and wetland species occur in park waters, including 9 that have been evaluated as abundant (aquatic species Brazilian elodea, and wetland species Chinese honeysuckle, Chinese privet, Japanese stiltgrass, and leatherleaf clematis) or common (wetland species aneilima, annual blue grass, broadleaf plantain, and hairy jointgrass) (NPS 2008x, *Tables 10* and *20*). These species appear to be displacing native flora (Hay and Parker 2003). Eight additional species, including the aquatic species parrotfeather, are of unknown status.

Table 20. Abundant and common invasive exotic higher plant species in the park (NPS 2008c). See *Table 10* for species names of wetland and aquatic taxa.

Wetland and Aquatic Species	
Brazilian elodea	Abundant
Chinese honeysuckle	Abundant
Chinese privet	Abundant
Japanese stiltgrass	Abundant
Leatherleaf clematis	Abundant
Aneilima	Common
Annual blue grass	Common
Broadleaf plantain	Common
Hairy jointgrass	Common
Alligatorweed	Unknown
Bitter dock	Unknown
Common morning glory	Unknown
Dallas grass	Unknown
Fiddle dock	Unknown
Mexican morningglory	Unknown
Parrotfeather	Unknown
Smallflower buttercup	Unknown
Common sheep sorrel	Uncommon or Rare
Common water hyacinth	Uncommon or Rare
Crowsfoot grass	Uncommon or Rare
Curly dock	Uncommon or Rare
Lady's thumb	Uncommon or Rare
Meadow buttercup	Uncommon or Rare
Ricefield flatsedge	Uncommon or Rare
Vasey grass	Uncommon or Rare
Terrestrial Species	
Autumn olive (oleaster) (*Elaeagnus umbellata*)	Abundant
Bird's nest (Queen Anne's lace, wild carrot (*Daucus carota*)	Abundant
Blowball (common dandelion, faceclock) (*Taraxacum officinale*)	Abundant
Chickweed (common or nodding chickweed) (*Stellaria media*)	Abundant
Chinese privet (*Ligustrum sinense*)	Abundant
Cocksfoot (orchardgrass) (*Dactylis glomerata*)	Abundant
Ox-eye daisy (*Leucanthemum vulgare*)	Abundant
Sticky chickweed (*Cerastium glomeratum*)	Abundant
Common henbit (giraffehead, henbit deadnettle) (*Lamium amplexicaule*)	Common
Common lambsquarters (white goosefoot) (*Chenopodium album*)	Common
Creeping charlie (gill-over-the-ground, ground ivy) (*Glechoma hederacea*)	Common
Dutch clover (ladino or white clover) (*Trifolium repens*)	Common
English ivy (*Hedera helix*)	Common
Hairy jointgrass (small carpgrass) (*Arthraxon hispidus*)	Common
India mockstrawberry (Indian strawberry) (*Duchesnea indica*)	Common
Kudzu (*Pueraria lobata*)	Common
Mimosa (mimosa tree, powderpuff tree, silktree) (*Albizia julibrissin*)	Common
Multiflora rose (*Rosa multiflora*)	Common
Thorny elaeagnus (thorny olive) (*Elaeagnus pungens*)	Common
Wild garlic (*Allium vineale*)	Common

In Hay and Parkers' (2003) recent survey, Brazilian elodea was described as common throughout the Chattahoochee River in the park. Wart-removing herb was common along the river banks and wetland areas at Cochran Shoals, Gumby Swamp, and Johnson Ferry, and formed impenetrable emergent mats by the end of the growing season. Parrotfeather occurred sporadically in the Chattahoochee River at Jones Bridge and Island Ford, but were more locally persistent in the Gumby Swamp wetland of the park. Large floating mats of it were identified as a concern because of displacement of native flora and provision of mosquito breeding habitat. A single population of alligatorweed was found at the Palisades (west) unit near the end of the second summer of the survey, suggesting that this species may be a recent addition to the Chattahoochee River.

On an encouraging note, exotic invasive wetland and aquatic species in the park are consumed by various native herbivores that effectively may help to provide biotic resistance to the plant invasions. For example, native generalist crayfish populations were found to prefer the invasive exotic plant aneilima (Asian spiderwort) over native freshwater plants by a 3:1 ratio when plants were paired by taxonomic relatedness (Parker and Hay 2005). In other experiments, beaver herbivory reduced the abundance of invasive aquatic parrotfeather by nearly 90% (Parker et al. 2007b).

One mollusc species (Asian clam) and five fish (Asian swamp eel or rice eel, channel catfish, common carp, red shiner, shoal bass – *Tables 11 and 12, Plate 13*) are invasive exotic species in park waters. The Asian clam was first noted in Georgia waters in 1971, and had become widespread by the early 1990s (Sickel 1973, Counts 1991). It can form dense populations of thousands of individuals per square meter of stream or river bottom, and typically outcompetes native species to dominate the benthic fauna (Sickel 1986).

Plate 13. Three invasive exotic species in the park, including (left to right) the Asian clam (photo by N. Burkhead - at http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=92, used with permission); the Asian swamp eel (photo by P. Shafland, FL Fish and Wildlife Conservation Commission – at http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=974, used with permission); and the red shiner (photo by G.W. Sneegas – at http://gwsphotos.com/images/141.jpg, used with permission).

Two examples of exotic invasive fish species are included here. The red shiner is a habitat generalist native to the south and central plains west of the Mississippi River (Nico and Fuller 2008). It was first noted in the Chattahoochee River basin in 1978, and likely was introduced by bait bucket releases (Couch et al. 1995, Nico and Fuller 2008). Its initial colonization typically is followed by rapid reproduction, dispersal, and aggressive colonization. Its hybridization with fish such as the bluestripe shiner has greatly reduced bluestripe shiner populations, resulting in the status of that species as a SPOC. Red shiners adversely affect the distribution and abundance of native fishes. Since its introduction to the Chattahoochee, it has become the dominant or co-dominant species in water quality-impaired streams of the greater metropolitan Atlanta area, including several tributaries of the park.

As a second example, the Asian swamp eel was first detected in the park near Roswell, GA by NPS personnel during 1991, probably as an aquarium release (Straight et al. 2006). The species most similar to the eels found in the park is *Monopterus albus*, although recent genetic research has indicated that the park specimens may be a separate species. This large (3 ft. or more in length) nocturnal generalist, voracious predator is air-breathing, can tolerate low-oxygen conditions in waterways, has a wide temperature tolerance and, in general, is highly adaptable (Straight et al. 2006). Declines in native fish species have been attributed to it in other areas, and it appar-ently eliminated native sunfishes in the pond at the Chattahoochee Nature Center where it first was detected (USGS 2008a). Because it is a generalist predator, it is a potential threat to native fishes, frogs, and aquatic invertebrates (USGS 2008a). Its present status in the park is unknown.

In addition to these exotic/invasive fish, whereas brown trout are native to the Chattahoochee, some of the non-native rainbow trout that have been stocked in the river have moved to warmwater tributaries to spawn, and their offspring now thrive year-round. Thus, technically they would be defined as invasive (Long et al. 2008; P. Thompson, GA DNR, pers. comm., 2008). Ironically, the documented spawning and young-of-year survival of this invasive species is an indicator of high watershed integrity (Long et al. 2008).

Although the climate generally is too cold to allow alligators (American alligator, *Alligator mississippiensis*) to overwinter, occasionally they are illicitly released into the Chattahoochee River near Atlanta. For example, in June 2007 an alligator (length ~6-8 feet) was captured by GA DNR near an overpass of the Atlanta beltline (I-285; 14 June 2007, AP Press). It was found and removed at the Powers Island unit of the park near a popular trail and canoe launch area.

Assessment of Park Water and Air Resources

The park's drinking water is supplied from the Chattahoochee River by County water treatment plants. Park Units with the bathroom sign in *Figures 3-6* have running water, and most are on sewer lines except for Island Ford and Jones Bridge (including CREEC) which are on septic tanks (C. Hughes, NPS, pers. comm., July 2008).

Surface Water Quality

The park is located in the Upper Middle Chattahoochee River sub-basin, designated by GA DNR as HUC 03130002. Locations for sampling stations near or within the park, discussed in this section, were obtained from the U.S. EPA STORET, a repository for water quality, biological, and physical data, and from Cobb, Gwinnett, Forsyth, and Fulton Counties. The USGS NWIS database was also used. GA DNR-EPD maintains a water quality database as well, but it will not be available until 2009 (Mr. Michael Basmajian, GA DNR-EPD Watershed Protection Branch – Ambient Monitoring Unit, pers. comm., 2008). Latitudes and longitudes for the sites were imported from Microsoft Excel into ArcMap and converted to GIS point files. *Figures 17-20* repeat the illustration of water quality and stream gaging stations in the park area that were shown in *Figures 3-6*. The two sets of figures were designed so that readers can assess sampling station locations with respect to roads and other land use features (*Figures 3-6*) and, for the latter sections of this Report, also with respect to major sources of water pollution (*Figures 17-20*).

For Figures 17-20, the data layers were obtained from the GA DNR EPD Watershed Protection Branch. Data sets for landfills, land application sites, and 303d-listed streams were downloaded from GA DNR (2000a,b).

Surface water quality has been degraded in the Chattahoochee and various of its tributaries in the park area for at least the past two decades, based on historic records (Kunkle and Vana-Miller 2000). A general management plan, development concept plan, and environmental assessment were completed for the park in 1989 (NPS 1989). About a decade later, in recognition of the fact that intense surrounding or encroaching urbanization threatens the natural resources of the park, a Water Resources Management Plan was developed (Kunkle and Vana-Miller 2000). This section continues the theme of this Report, namely, to provide an update over the past ~decade since that plan was developed.

Over the past ~decade, 39 stations have been monitored for water quality in the park area, but close scrutiny reveals serious gaps in water quality information. Of the 22 stations (56% of the total) that are presently in operation, 5 have data that are collected only quarterly or less frequently, and 10 of the remaining 17 stations have data on some parameters only quarterly or less frequently (*Table 21; Appendices 2* and 3). Only 1 station, Forsyth County JSF-1 (Park Unit Orrs Ferry – James Creek), has biweekly to monthly data collection on all parameters sampled; 4 other stations have biweekly data on a few parameters versus monthly, bimonthly, quarterly, or less frequent data on the other parameters sampled. Seven stations have ongoing data collection in the mainstem Chattahoochee River within the park area (*Table 21*). The 7 stations are operated by Fulton County (2 stations), potable WTPs (3 stations), and the NPS (2 stations with 2 parameters sampled at each – the BacteriALERT program, in partnership with other agencies; see below). Surprisingly, ***no*** stations are presently operated by GA DNR-EPD in or near the park, although it should be noted that GA DNR is a member of the BacteriALERT partnership program (2 stations as mentioned). Four USGS stations are in operation, 3 of which are jointly operated with counties. Thus, water quality stations presently are operated almost entirely by the counties (14 stations + 3 shared between counties and the USGS, or 77% of the stations), potable WTPs (~14%), and the NPS (~9%). Parameters are sampled bimonthly or less frequently at many of the stations (*Table 21*, *Appendices 2* and *3*), which would miss most pollution spills and would also be insufficient to characterize nonpoint pollution contributed by most storm events.

The data from these various sources were checked by each individual entry for quality control/ assurance, a process that revealed numerous errors in data entry that were detected, checked with the source agency, and corrected before their inclusion in this Report and its appendices. These available data indicate pervasive water quality degradation from excessive fecal coliform bacteria, suspended solids, nutrients (inorganic nitrogen as nitrate+nitrite and/or ammonium, and total phosphorus), and various toxic metals (*Tables 22* and *23, Figures 21-24, Appendices 2-4*).

This is the case despite the fact that the Chattahoochee River in the park area is heavily depended upon as a potable water supply for the greater metropolitan Atlanta area, and also heavily used for fishing, canoeing and other recreational activities (Kunkle and Vana-Miller 2000, ARC 2007).

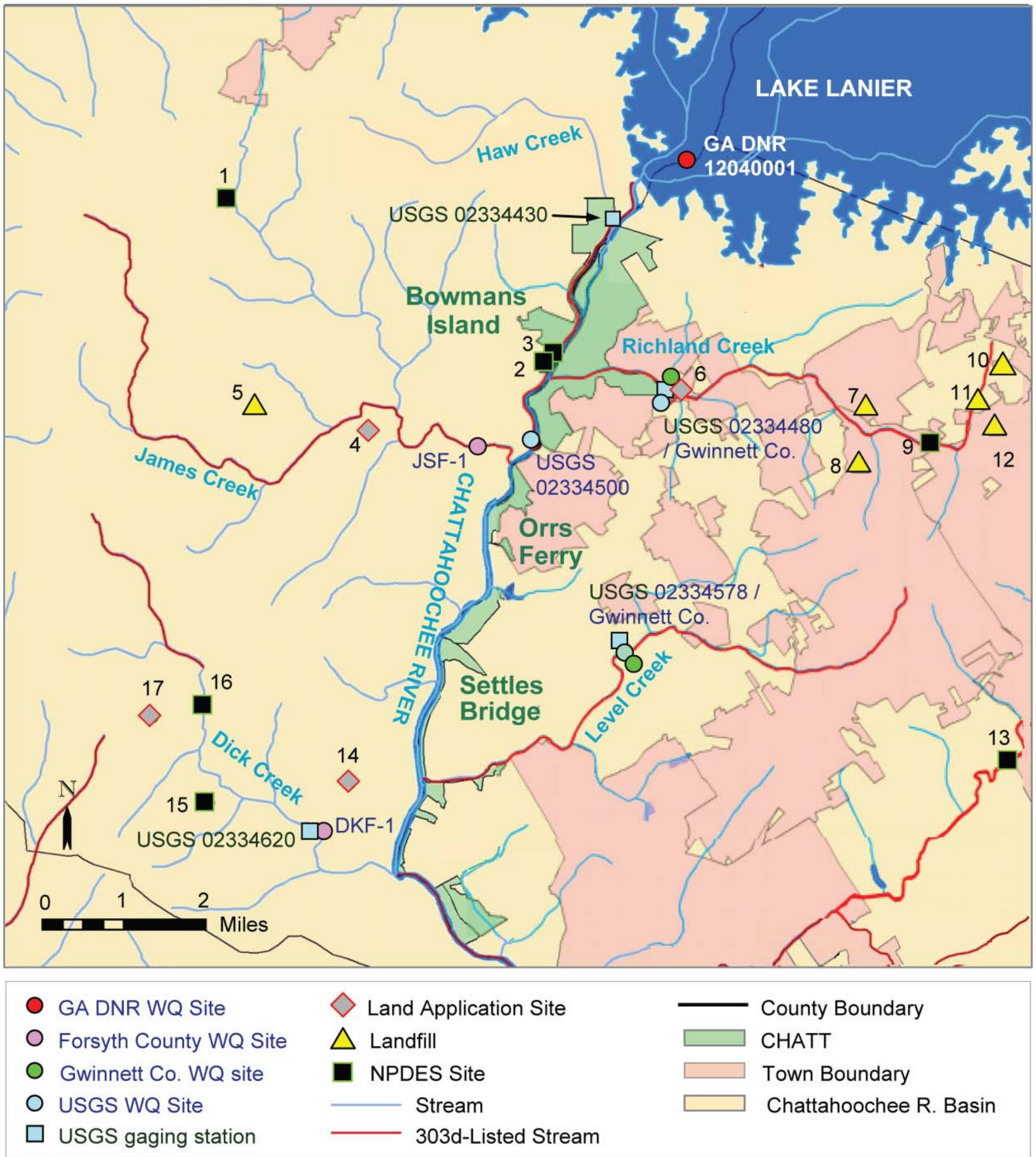


Figure 17. Map showing Section I (northernmost area) of the park, indicating Park Units, water quality sampling sites, and stream gaging sites in relation to pollution sources including land application sites (LASs), landfills, NPDES point source sites, and town boundaries reflecting urban/suburban runoff (created by the NCSU CAAE). Streams officially recognized as water quality-impaired (303d-listed) are also indicated. Numbered sites are as follows:

1. W. Cumming Quarry
2. Buford Trout Hatchery Outfall No. 1
3. Buford Trout Hatchery Outfall No. 2
4. Windermere Urban Reuse LAS
5. Miller/Trammel Trammel Rd. landfill
6. Sugar Hill LAS
7. Sugar Hill Appling Rd. PH1 landfill
8. BFI Richland Creek landfill
9. Buford - Westside WPCP
10. Buford - Tuggle Greer Rd. landfill
11. Buford landfill
12. Buford - Peachtree Ind. Blvd. landfill
13. Buford - Southside WPCP
14. Old Atlanta Club LAS
15. Martin Marietta Aggr. - Forsyth Quarry
16. Forsyth County - Dick Creek Water Reclamation Facility (wastewater treatment plant)
17. Capital Resources LAS

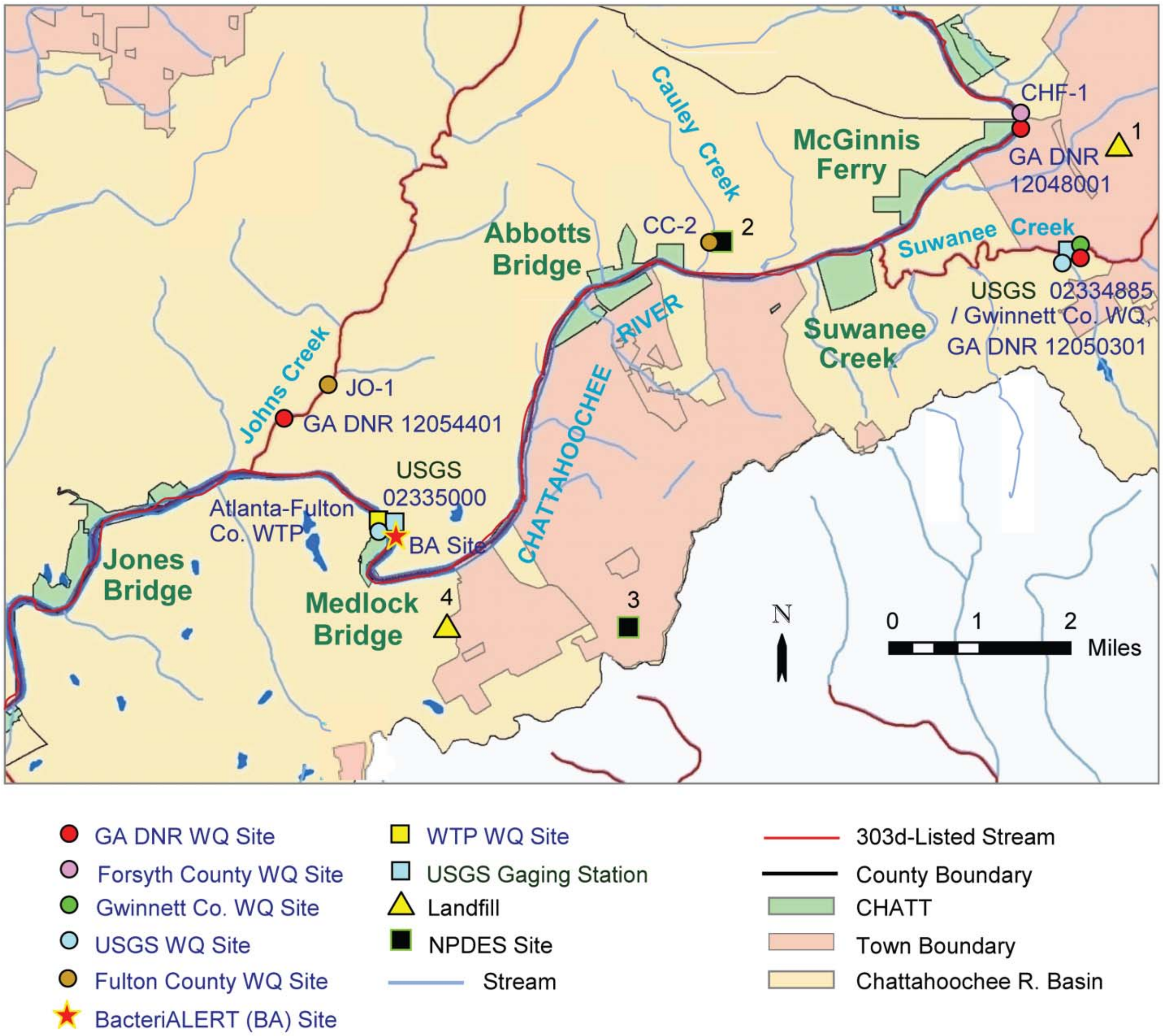


Figure 18. Map showing Section II of the park and indicating Park Units, water quality sampling sites, and stream gaging sites in relation to pollution sources including land application sites, landfills, NPDES point source sites, and town boundaries reflecting urban/suburban runoff (created by the NCSU CAAE). Streams officially recognized as water quality-impaired (303d-listed) are also indicated. Numbered sites are as follows:

1. Suwanee landfill # 944
2. Fulton County - Cauley Creek WRF
3. Lafarge Building Materials
4. Gwinnett Landfill Inc.

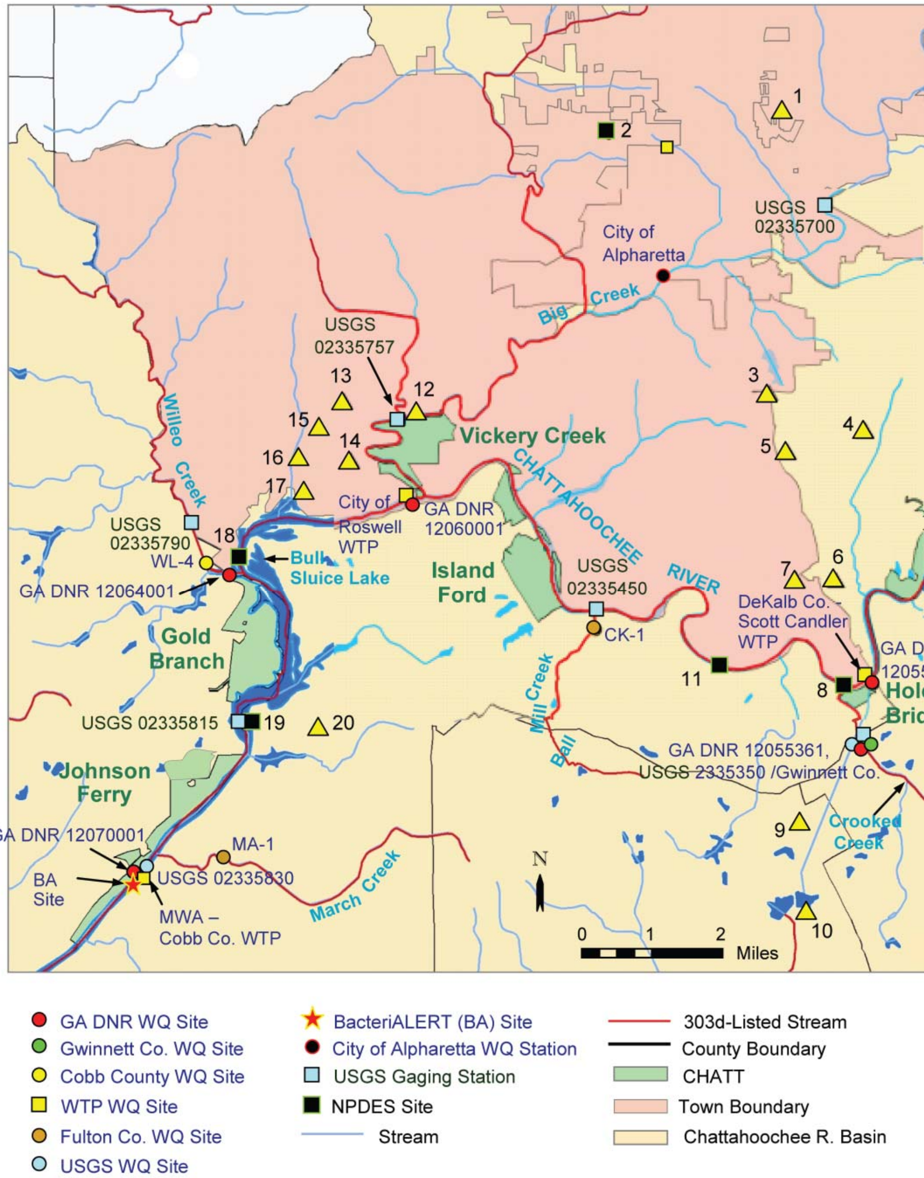


Figure 19. Map showing Section III of the park and indicating Park Units, water quality sampling sites, and stream gaging sites in relation to pollution sources including land application sites, landfills, NPDES point source sites, and town boundaries reflecting urban/suburban runoff (created by the NCSU CAAE). Streams officially recognized as water quality-impaired (303d-listed) are also indicated. Numbered sites are as follows:

1. Strickland - Kimball Br. Rd. landfill
2. Lafarge Building Materials
3. Worley - Nesbitt Ferry Rd. landfill # 923
4. Hamil - Brumbelow Rd. landfill
5. Nesbitt Ferry Rd. - landfill # 921
6. Rivermont – Holcombe Br. Rd. landfill # 924
7. Holcombe Br. Baptist Church - landfill # 922
8. Gwinnett Co. - Crooked Cr./North WPCP
9. Glaze landfill (# 869)
10. Laurelwood - landfill #868
11. Fulton Co. - Johns Cr. WRF
12. Oxbo - landfill # 916
13. Roswell First Baptist Ch. - landfill # 915
14. Town & Country Motors - landfill # 919
15. GA. Hwy 120 - landfill # 917
16. Hagerman - landfill # 918
17. Azalea - Willeo Rd. - landfill # 920
18. Fulton Co. - Big Cr. WPCP
19. Georgia Power Co., Morgan Falls
20. Fulton Co. - Morgan Falls landfill

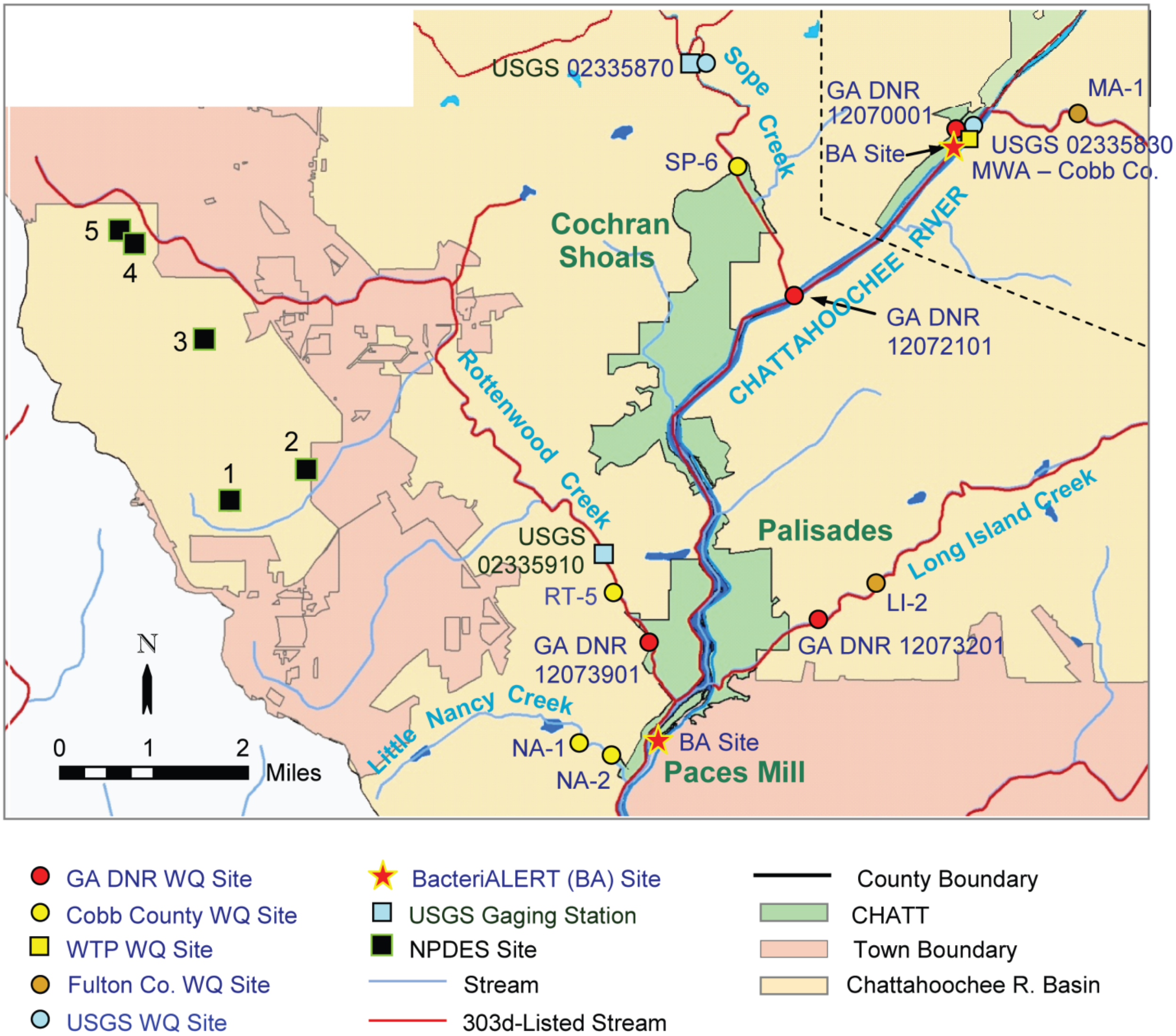


Figure 20. Map showing Section IV (southernmost area) of the park and indicating Park Units, water quality sampling sites, and stream gaging sites in relation to pollution sources including land application sites, landfills, NPDES point source sites, and town boundaries reflecting urban/suburban runoff (created by the NCSU CAAE). Streams officially recognized as water quality-impaired (303d-listed) are also indicated. The six NPDES sites are all for USAF Lockheed Plant No. 6, which has five discharge points that are all designated under one permit identification number (see below). Note that the area defined by the dashed lines in the upper right includes stations that are within Section III (see *Figure 19*).

The detailed analysis summarized in *Table 23* revealed that excessive nutrient concentrations commonly occur throughout the park area, especially for nitrate but also for ammonium and total phosphorus. These findings support a study by USGS NWQAP in 2002- 2004 which reported that urban development in the Atlanta was associated with increased concentrations of nitrogen in stream waters (Sprague et al. 2007). All four Sections of the park have stations with excessive TSS concentrations as well. The data suggest that BOD_5 and TP may be lower in Section IV (Park Units 14-16, tributaries of the Chattahoochee River segment from Cochran Shoals to Paces Mill) than in Sections I-III (Table 23, Figures 21-24). Excessive concentrations of toxic metals, most commonly cadmium, copper, lead, and zinc (also aluminum in Little Nancy Creek, affecting the Paces Mill Park Unit), also characterize all four Sections of the park, with unacceptable water quality conditions from toxic metals being especially frequent in park Sections I-III.

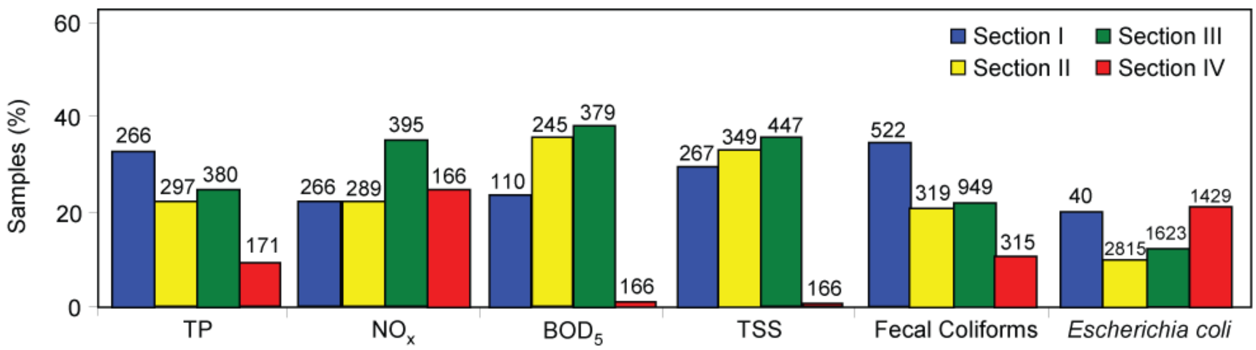


Figure 21. Percentage of samples that exceeded recommended values (fecal coliforms and *E. coli* > 400 mpn/100 mL – U.S. EPA 2003; BOD_5 > 3 mg/L – Mallin 2006; nutrients NO_x and TP > 100 µg/L – Mallin 2000; TSS > 25 mg/L – U.S. EPA 2000) for six water quality parameters, by section, over ~the past decade. Numbers over bars ≡ total sample number in each section by parameter. Note that county data for BOD_5 often were available as "< 5 mg/L". Following statistical protocols (Ellis and Gilbert 1980, Zirschky et al. 1985), half of that value (2.5 mg/L) was used as the median for many sites, which would correspond to "zero" data that exceeded the recommended value for acceptable water quality. Thus, this approach is believed to be conservative; it is uncertain as to the number of actual exceedances that occurred for BOD_5.

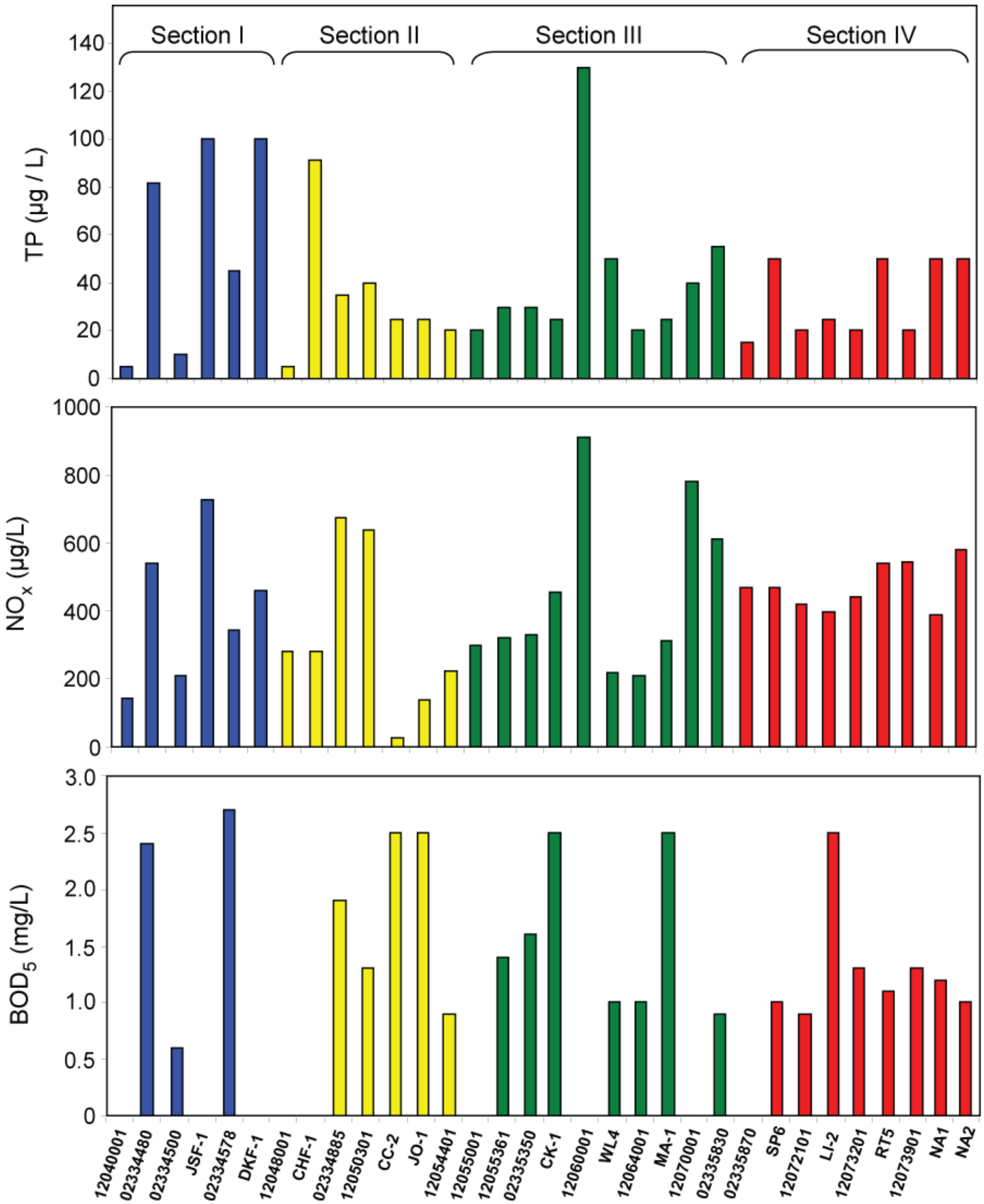


Figure 22. Median total phosphorus (TP), nitrate+nitrite (NO_x), and biochemical oxygen demand (five-day, BOD_5), by station and Section, in the park during the past ~decade. While TP concentra-tions indicated mesotrophic conditions, or moderate nutrient enrichment, nearly all median nitrate concentrations are above 100 µg/L, which can stimulate nuisance algal blooms in riverine ecosystems (Mallin 2000, Wetzel 2001). Nitrate is an important nutrient that stimulates algal growth in freshwaters, secondary to or along with phosphorus (Wetzel 2001), and in many systems algal blooms are best controlled by co-management of N and P (e.g. Touchette et al. 2007). In all Sections, median BOD_5 was less than the level that indicates degraded conditions (3 mg/L; Mallin 2006), although median levels are approaching 2.5 mg/L at some stations throughout the park.

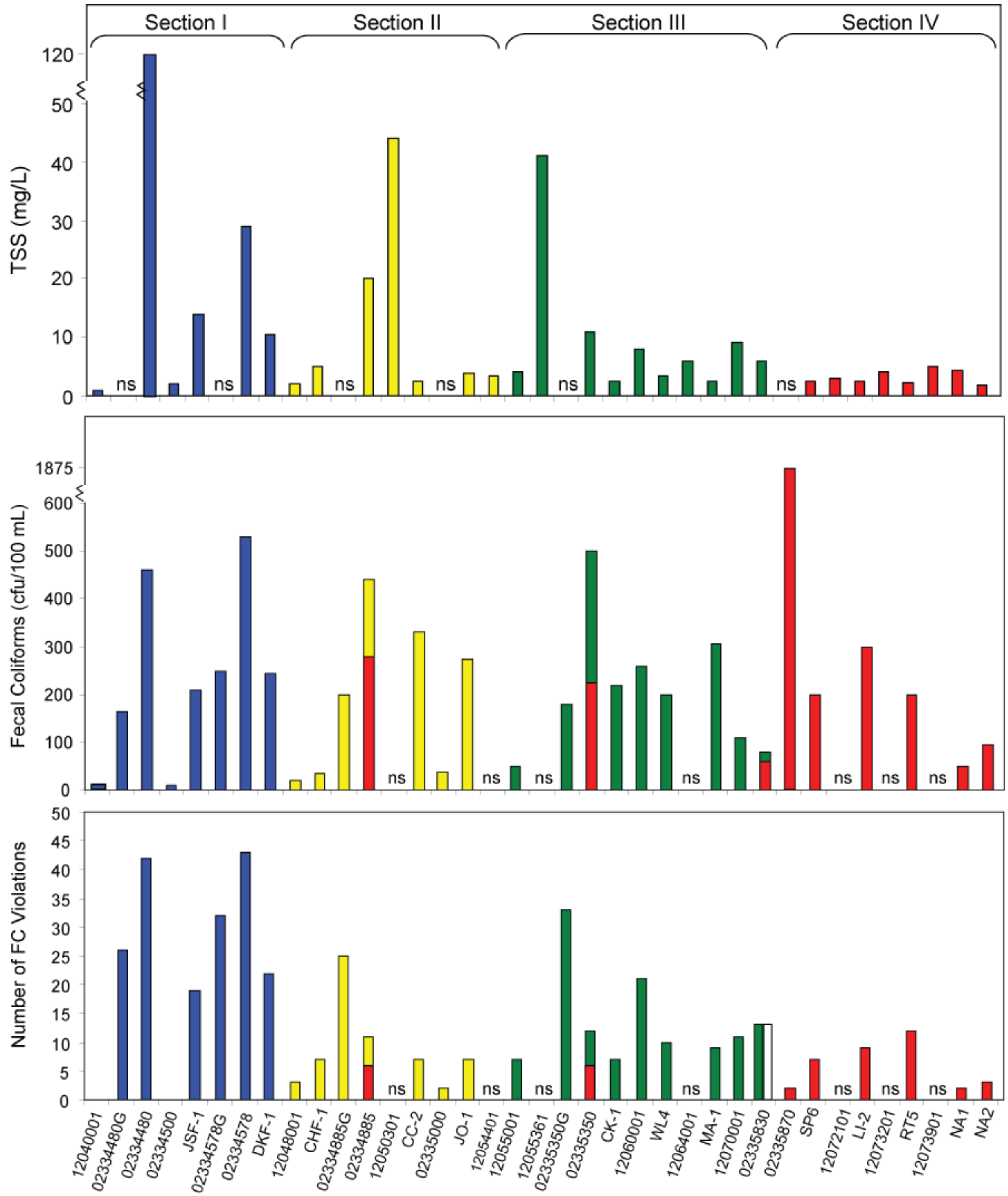


Figure 23. Median total suspended solids (TSS), fecal coliform densities (FC), and number of FC violations of the state standards, by station and Section, in the park during the past ~decade. From the available data, 4 stations among Sections I-III had median TSS concentrations above the recommended value of 25 mg/L for acceptable water quality (U.S. EPA 2000), and 5 stations among representing all Sections had median FC densities above the recommended value of 400 mpn/100 mL for acceptable water quality (U.S. EPA 2003). As the lower panel illustrates, all four Sections had stations with FC violations in 10% or more of the samples, with the most numerous violations in Section 1.

Table 21. Synopsis of water quality sampling in the park area over the past decade (note that the sampling duration and frequency vary depending upon the parameter). Stations are presented by Section, from north to south. The most recent date indicates the period for which data were available (see *Appendix 3* for details). Stations in blue in operation as of late 2008 – early 2009.

Station – Location	Duration	Sampling Frequency (Approximate)
Source Water – Lake Lanier		
GA DNR 12040001	Oct 01 - Aug/Oct 04	bimonthly or every 6 months
Section I [5 stations; 4 in operation]		
1) USGS 2334480 / Gwinnett County Bowmans Island - Richland Creek	Jul 01 - Jul/Aug 08	weekly 4 times per year (fecal coliforms [FC])
	Jul 01 - Feb/Jun/Aug 08	monthly or every ~6 weeks
	Jul 01 - Aug 03	monthly
	Jul 04 - Oct 07	monthly
	Jul/Aug 04 - Aug 08	monthly or every ~6 weeks
	Aug 07	1 date
	Apr 08	1 date
2) USGS 02334500 Bowmans Island / Orrs Ferry - Chattahoochee R., Buford	Jan - Dec 00	biweekly, monthly, or on 2 dates
3) Forsyth County JSF- Orrs Ferry - James Creek	May 05 - Aug 08	biweekly, monthly, or bimonthly
4) USGS 2334578 / Gwinnett County Settles Bridge - Level Creek	Jul 01 - Apr 08	weekly 4 times per year (FC); monthly or quarterly, or on 1-2 dates
5) Forsyth County DKF-1 Settles Bridge - Dick Creek	May 05 - Aug 08	biweekly, monthly, or bimonthly
Section II [10 stations; 6 in operation]		
1) GA DNR 12048001 McGinnis Ferry - Chattahoochee River	Mar 01 - Jun/Aug/ Dec 04	weekly, biweekly, or monthly
2) Forsyth County CHF-1 McGinnis Ferry - Chattahoochee River	May 05 - Aug 08	biweekly, monthly, or bimonthly
3) USGS 02334885 / Gwinnett Co. Suwanee Creek - Suwanee Creek	Jul 01 - Aug 08	weekly 4 times per year (FC)
	Jan 98 - Aug 08	monthly, bimonthly, or 1 date
	Jan 98 - Aug 00	monthly
	Mar 98 - Aug 03	monthly
	Jun 99 - Apr 00	quarterly
	Jun 99 - Mar 01	monthly
	Jan - Oct/Dec 00	monthly
	Jan 00 - Aug 08	monthly to bimonthly
	Jan 01 - Oct 02	monthly
	Jan 01 - Feb 03	twice per year
	Jan 01 - Oct 07	monthly
	Nov 02 - Sep 03	monthly
	Nov 02 - Mar 08	quarterly

Table 21. (Continued).

Station – Location	Duration	Sampling Frequency (Approximate)
4) GA DNR 12050301 - Suwanee Creek	Jan 99 - Feb/Aug/Sep 03 Jan 99 - Aug 00 Jan - Dec 00 Feb - Oct 02 Nov 02 - Sep 03	biweekly, monthly, or bimonthly twice per day, or bimonthly monthly biweekly, monthly, or bimonthly bimonthly
5) Fulton County CC-2 Abbotts Bridge - Chattahoochee River	Apr 07 - Apr 08 Mar - Nov 07	1-4 times per year weekly or quarterly (fecal bacteria)
6) USGS 02335000 Chattahoochee R., Norcross	Oct 00 - Nov 07	every 3 days, biweekly, or 1-3 dates
7) BacteriALERT Site 1 Medlock Bridge - Chattahoochee River	Oct 00 - Nov 08	daily (Escherichia coli; turbidity data also taken*)
8) Atlanta-Fulton County WTP Chattahoochee R., Norcross (data not included in this Report)	May 1994 - present	hourly, daily, monthly, or yearly
9) Fulton County JO-1 Jones Bridge - Johns Creek	Sep 06/Apr 07 - Apr 08 Jun 06 - Feb 08	1-4 times per year weekly or quarterly (bacteria)
10) GA DNR 12054401 Jones Bridge - Johns Creek	Jan - Dec 00	biweekly, monthly, or 2 dates
Section III [14 stations; 7 in operation]		
1) GA DNR 12055001 Chattahoochee River, Holcomb Bridge	Mar 01/Jan 02 - Jun/ Aug/Dec 04	weekly, biweekly, or monthly
2)DeKalb Co. - Scott Candler WTP Holcomb Bridge - Chattahoochee R.	Jan 05 - Jul 2006 Aug 2006 - Mar 09	daily (fecal coliform bacteria) daily (*Escherichia coli*)
3) GA DNR 12055361 - Crooked Creek	Jan/Feb 99 - May/Sep 03 Jan/Jun 99 - Sep 00 Jan - Dec 00 Feb - Oct 02 2 dates in 00	biweekly, monthly or bimonthly monthly monthly monthly twice
4) USGS 02335350 / Gwinnett County Crooked Creek	Jul 01 - Aug 08 Jul 01/Apr 02 - Feb/Apr/ Aug 08	weekly 4 times per year (FC) biweekly, monthly, bimonthly 1-2 dates
5) Fulton County CK-1 Island Ford - Ball Mill Creek	Sep 06/Apr 07 - Apr 08 Jun 06 - Nov 07	1-4 times per year weekly or quarterly (fecal bacteria)
6) City of Alpharetta – Big Creek	Jun 99 - Feb 02 Jun 99 - Feb 09 Jun 00 - Aug 06 Feb 02 - Feb 09 Feb 02, Apr 05	3 dates weekly to 4-month intervals 1-3 times per year 1-8 times per year 2 dates
7) GA DNR 12060001	Mar 01 - Jun/Dec 04 Jan 02 - Jun 04	monthly bimonthly
8) Cobb County WL-4 Gold Branch - Willeo Creek	Feb 98 - Mar 08 Nov 07, Mar 08	quarterly 1x per year

Table 21. (Continued).

Station – Location	Duration	Sampling Frequency (Approximate)
9) GA DNR 12064001 Gold Branch - Willeo Creek	Jun 99 - Dec 00 Jan - Dec 00 27 Apr, 6 Nov 00	biweekly or monthly monthly 2 dates
10) Fulton County MA-1 Johnson Ferry - March (Marsh) Creek	Sep 06/Apr 07 - Apr 08 Jun 06 - Nov 07	1-4 times per year weekly or quarterly (fecal bacteria)
11) GA DNR 12070001 Chattahoochee R., Johnson Ferry just upstream from intake of Cobb Co. potable WTP (Marietta Water Authority [MWA] - J.E. Quarles WTP)	Mar 01 - Dec 04 Nov 01 - Dec 03 Jan 02 - Jun 04	monthly monthly biweekly to monthly
12) Marietta Water Authority, Cobb County James Quarles WTP raw water intake - Chattahoochee River	Sep 07 - Mar 09	daily (Escherichia coli)
13) BacteriALERT Site 2	Oct 01 - Nov 02	daily (*Escherichia coli*; turbidity data also taken*)
14) USGS 02335830 Chattahoochee R., Johnson Ferry	Mar 99 - Apr 00 Jan - Dec 00 27 Apr, 6 Nov 00 Oct 01 - Nov 02	5-day intervals to biweekly monthly 2 dates weekly
Section IV [10 stations; 5 in operation]		
1) USGS 02335870 - Sope Creek	Apr 98 Apr 98 - Jul 99 Apr 98 - Sep 01 Apr 98 - Oct 02 Apr 98 - Sep 03 Apr 98 - Aug/Sep/Oct 08 Jun 99 - Apr 00 Jun 99 - Mar 02 Nov 01 - Oct 02 Nov 02 - Jul 03	1 date bimonthly monthly monthly or once per year monthly monthly bimonthly 6-month intervals quarterly bimonthly
2) Cobb County SP-6 Cochran Shoals - Sope Creek	Mar 98 - Oct 08/Jan 08 Jan 08	1-4 times per year 1 date
3) GA DNR 12072101 Cochran Shoals - Sope Creek	Jan - Dec 00 27 Apr, 6 Nov 00	biweekly or monthly 2 dates
4) Fulton County LI-2 Palisades - Long Island Creek	Sep 06/Apr 07 - Apr 08 Jun 06 - Nov 07	1-4 times per year weekly or quarterly (fecal bacteria)
5) GA DNR 12073201 Palisades - Long Island Creek	Jan - Dec 00 27 Apr, 6 Nov 00	biweekly or monthly 2 dates
6) Cobb County RT5 Palisades - Rottenwood Creek	Jan 98 - Aug/Dec 07	1-4 times per year

Table 21. (Continued).

Station – Location	Duration	Sampling Frequency (Approximate)
7) GA DNR 12073901 Palisades - White Water Creek	Jan 99 - Sep 03 Jan - Dec 00 Jan 00 - May 02 Jan 00 - Sep 03 Feb 02 - Sep 03 00 - 03	monthly or bimonthly monthly bimonthly monthly or bimonthly quarterly 1x or 2x per year
8) BacteriALERT Site 3 Medlock Bridge - Chattahoochee River	Oct 00 - Nov 08	daily (*Escherichia coli*; turbidity data also taken*)
9) Cobb County NA-1 Paces Mill - Little Nancy Creek	Jun 00 - Sep 07/Mar 08 Jan 08, Mar 08	2-5 times per year 2 dates
10) Cobb County NA-2 Paces Mill - Little Nancy Creek	Jun 02 - Sep 07/Mar 08 Jan 08, Mar 08	2-5 times per year 2 dates

Table 22. Water quality guidelines (reference condition, 25th percentile) for some potentially toxic metals (total concentration, in µg/L) in freshwater streams of SECN parks, including CHATT (U.S. EPA 2000, 2002, 2003; Byrne 2004). CMC ≡ the criterion maximum concen-tration; CCC ≡ the criterion continuous concen-tration, within a pH range of 6.5-9.

Parameter	CMC	CCC
Aluminum	750	81
Cadmium	2	0.25
Chromium III	570	74
Chromium IV	16	11
Copper	13	9
Lead	65	2.5
Mercury	1.4	0.77
Nickel	470	52
Zinc	120	87

Table 23. Summary of the percentage of the total samples per station with unacceptable water quality conditions, and the parameter(s) involved (n.m. ≡ not measured; n.a. ≡ not available; n, 2 ≡ based upon only 2 dates; diss'd. Cu ≡ not measured except for dissolved copper); * ≡ 17% of SRP samples were also unacceptably high). Unacceptable water quality conditions are as follows: DO and pH were in violation of the state standards (GA DNR 2008d). For fecal coliforms (FC) or *Escherichia coli* (EC), blue+bold = geometric means (gms) available ($\geq$ 4 samples [FC] or $\geq$ 5 [EC] within a 30-day period) and the data were in violation of the state standards (FC) or the U.S. EPA standards (EC). For other fecal coliform, gms could not be calculated because of insufficient sampling. These data suggest degraded conditions: The first percentage is for samples that exceeded the state standard values considered for gms [FC] or for samples that exceeded the U.S. EPA standard value considered for gms [EC]. The second percentage for both FC and EC indicates samples that exceeded the U.S. EPA's (2003) recommendation of $\leq$ 400 mpn/100 mL (see pp. 94-95 of this Report). ** ≡ two different methods were used (see *Appendix 2*). Nutrients exceeded concentrations known to support noxious algal blooms (Mallin 2000). BOD_5 exceeded 3 mg/L (Mallin 2006). Other parameters exceeded values recommended for acceptable water quality (U.S. EPA 2000) including TSS (> 25 mg/L maximum) and heavy metals (Al, Cu, Hg, Pb, Ni, Zn – see *Table 22*). Note that toxic metals are total values unless otherwise indicated; ? or $\geq$ ≡ the percentage of samples with excessive values could not be determined from the data reported. The U.S. EPA (2002) recommends that pH is maintained within the range 6.5-9, but this report follows Georgia regulations (pH $\geq$ 6.0). Grey-shaded stations in Park Sections I, II and III indicate USGS stations ("a" and "b") sampled by Gwinnett County for fecal coliform bacteria. See *Appendices 2-4* for detailed information.

Location/ Station #		Nutrients				Fecal				
		NH_4^+	NO_3^-	TP	BOD_5	Bacteria	TSS	Turb	Toxic Metals	Other
Lake Lanier		---	64%	---	---	---	---	---	---	---
Chattahoochee River										
I	**1a**	n.m.	n.m.	n.m.	n.m.	**39%** 33% or 23%	n.m.	n.m.	n.m.	---
	1b	48%	100%	46%	48%	60% or 53%	53%	50%	Cd ? Cu $\geq$ 40% Pb $\geq$ 41% Zn 27%	pH 3%
	2	42%	83%	---	---	6% or 0%	---	---	---	---
	3	n.m.	36%	36%	n.m.	**33%** 35% or 32%	43%	23%	Dissolved Cu 2%	DO 1% *E. coli* 20%
	4a	n.m.	n.m.	n.m.	n.m.	**43%** 43% or 32%	n.m.	n.m.	n.m.	---
	4b	51%	97%	34%	42%	61% or 54%	51%	50%	Cd? Cu $\geq$ 12% Pb $\geq$ 23% Zn 11%	pH 8%
	5	n.m.	98%	33%	n.m.	**44%** 45% or 37%	40%	25%	n.m. excecpt dissolved Cu	*E. coli* 20%
II*	**1**	9%	96%	---	---	**8%**	6%	---	n.m.	*E. coli* 5%
	2	n.m.	n.m.	88%	7%	**0%** 12% or 12%	17 %	9%	n.m. except dissolved Cu	DO 1%
	3a	n.m.	n.m.	n.m.	n.m.	**67%** 33% or 23%	n.m.	n.m.	n.m.	---
	3b	92%	99%	31%	38%	**39%** 55% or 50%** 56 or 38%**	46%	38%	Cd ? Cu 17% Pb 52% Zn 4%	DO, pH 1% *E. coli* 75%

Table 23. (Continued).

Location/ Station #		Nutrients				Fecal				
		NH_4^+	NO_3^-	TP	BOD_5	Bacteria	TSS	Turb	Toxic Metals	Other
	4	92%	100%	33%*	35%	n.m.	63%	39%	Cd 100% Diss'd Cd 100% Cu 18% Pb 51% Zn 3%	pH 1%
	5	---	20%	---	---	**50%**	---	n.m.	Cu 25%	*E. coli* 29%
	6	n.m.	n.m.	n.m.	n.m.	11% or 11%	n.m.	n.m.	n.m.	***E. coli* 19%** *E. coli* 11%
	7	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.a.	n.m.	***E. coli* 17%** *E. coli* 10%
	9	---	50%	---	---	**50%** 35% or 35%	---	n.m.	---	*E. coli 30%*
	10	---	92%	---	---	n.m.	---	---	Cd 100% (n,2)	---
III	**1**	9%	98%	---	---	**18%** 21% or 13%	13%	2%	n.m.	*E. coli* 8%
	2	---	---	---	---	**16%**	---	---	---	***E. coli* 3%**
	3	25%	100%	35%	35%	n.m.	61%	31%	Cd 100% Diss'd Cd 100% Cu 28% Pb 53% Zn 23%	DO 5% pH 2%
	4a	n.m.	n.m.	n.m.	n.m.	**75%** 35% or 29%	n.m.	n.m.	n.m.	---
	4b	25%	99%	34%	41%	**44%** 65% or 52%** 50% or 38%**	46%	34%	Cd ? Cr ? Cu $\geq$ 29% Pb $\geq$ 40% Zn 22%	pH 1% DO 1%
	5	---	100%	---	---	**25%** 45% or 35%	n.m.	n.m.	---	*E. coli* 35%
	6	34%	67%	49% (SRP)	n.m.	**100%** 34% or 34%	n.m.	5%	Cu 53%	DO 8% Fecal strep 30% or 28%
	7	2%	100%	58%	---	**45%** 44% or 40%	13%	4%	Cu 3% Pb 3%	DO 9% *E coli* 32%
	8	---	97%	17%	---	34% or 29%	---	---	Cd ? Cu 3% Pb 3%	DO 9%
	9	25%	92%	---	8%	n.m.	---	---	Cd 100%	DO 8%
	10	---	100%	---	---	**75%** 55% or 45%	---	---	Cd ?	*E coli* 45%
	11	13%	100%	2%	2%	**27%** 25% or 21%	24%	2%	n.m.	*E. coli* 11%
	12	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	*E. coli* 7%
	13	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.a.	n.m.	***E. coli* 21%** *E. coli* 11%
	14	58%	100%	25%	---	**21%** 18% or 22%** 13% or 13%**	18%	18%	Cd ?	pH 1% *E coli* 20% or 10%**
IV	**1**	n.m.	n.m.	7%	n.m.	50% or 50%	n.m.	---	n.m.	DO, pH 1% *E. coli* 60% or 40%**

Table 23. (Continued).

Location / Station #	Nutrients				Fecal Bacteria	TSS	Turb	Toxic Metals	Other
	NH_4^+	NO_3^-	TP	BOD_5					
2	---	100%	12%	---	27% or 21%	---	---	Pb 3%	---
3	36%	91%	9%	9%	n.m.	9%	8%	Cd 100%	---
4	---	100%	---	---	50% 45% or 45%	---	N.M.	Cd ?	*E. coli* 45% or 50%
5	25%	100%	---	8%	n.m.	---	n.m.	Cd 100%	DO 5%
6	---	100%	17%	---	40% or 34%	3%	---	Cd ? Cu 3% Pb 9%	---
7	25%	100%	6%	8%	n.m.	31%	8%	Cd 100%	---
8	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.a.	n.m.	***E. coli* 55%** *E. coli* 21%
9	n.m.	100%	3%	---	15% or 6%	---	3%	Cd ? Al 100%	---
10	n.m.	100%	13%	---	17% or 13%	---	---	Cd ? Al 50%	---

* Data from station 8 in Sectin II, the Atlanta-Fulton WTP, are not included as explained in Report text

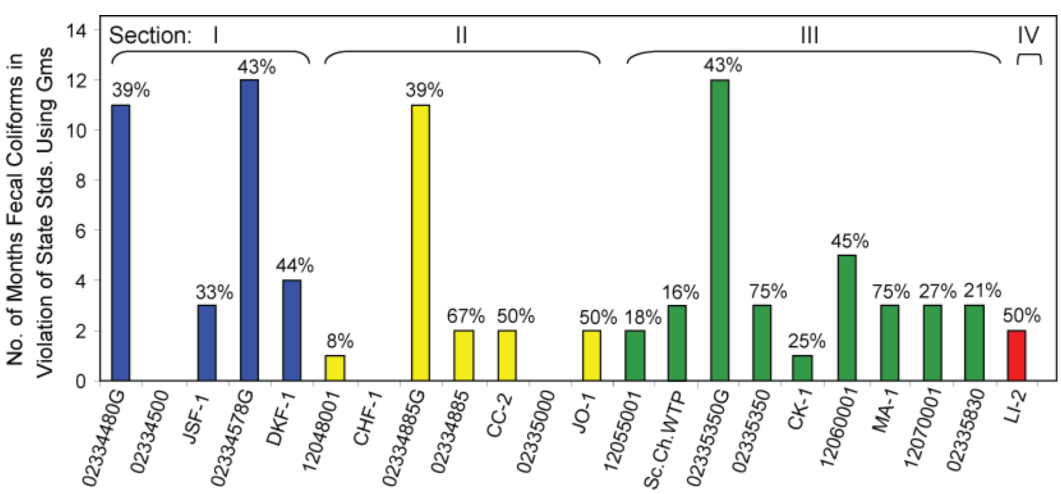


Figure 24. Number and percentage of months that fecal coliform samples violated state standards, considering data for which geometric means (gms) could be calculated.

Four potable water treatment plants (WTPs) that are located within ~two miles' distance or less from the park segments were also checked for water quality databases. In park Section II, the Atlanta-Fulton County WTP (*Figures 4* and *18*; same location as USGS 02335000; data, mostly redundant with other stations, are not included in this Report) has an online monitoring station at its intake on the Chattahoochee River and measures temperature, alkalinity, pH, turbidity, and conductivity daily. Data are also collected monthly at this WTP for total coliform bacteria and total organic carbon (TOC), and yearly for nitrate and volatile organic compounds (VOCs). The other three WTPs are in Section III: The Water Production Laboratory of DeKalb County's Scott Candler Filter Plant *(Figures 5* and *19*), at the same location as station GA DNR 12055001, analyzes Chattahoochee River water daily Monday through Friday for turbidity, threshold odor, total coliforms, and *Escherichia coli* (*Table 23, Appendices 2* and *3*). *Cryptosporidium* and *Giardia* are analyzed monthly. The data for fecal bacteria from the Scott Candler Filter Plant are included in this Report. Previously, fecal coliform bacteria were analyzed (3 January 2005 - 31 July 2006), and then this WTP switched to analysis of *Escherichia coli* rather than fecal coliforms (1 August 2006 - present). Fecal coliform densities ranged from < 1 to 11,000 mpn/100 mL; *E. coli* densities ranged from < 1 to 7,940 mpn/100 mL (*Table 23, Appendices 2* and *3*). The River Station Operator also checks turbidity at 3-hour intervals, but the records are not electronic; and temperature is recorded hourly 24/7.

During 2001-2004, the City of Roswell's Big Creek WTP (same station as GA DNR 12060001; *Table 23, Appendix 2*) sampled daily for alkalinity, hardness, pH, turbidity, iron, and manganese. Fecal coliform bacteria were sampled ~biweekly, TOC was sampled monthly, and once per year samples were taken for EPA inorganics and synthetic organics. Finally, the James E. Quarles WTP (Marietta Water Authority [MWA], Cobb County – *Figures 5* and *19*) does not sample for total fecal coliforms, but provided data for *Escherichia coli* that have been taken daily since September 2007 (*Table 21, Figure 25, Appendix 2*). Of the 159 days sampled through March 2009, the data ranged from below reporting limits to 7,820 mpn/100 mL. A total of 6% of the samples (32 dates) exceeded 200 mpn/100 mL (May - October) or 1,000 mpn/100 mL (November - April). There were no violations of the geometric mean for each month, but it should be noted that total fecal coliform concentrations would be expected to have been higher than the data for this species alone.

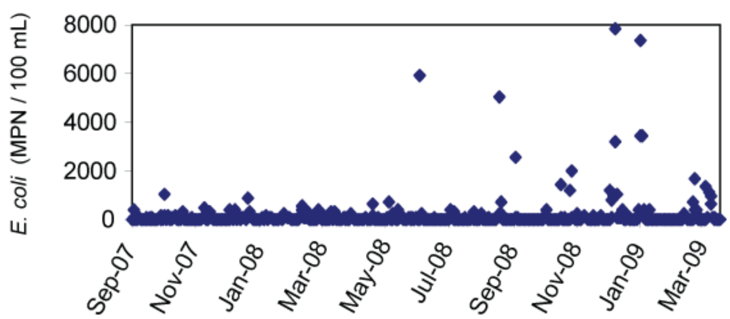


Figure 25. Data for *Escherichia coli* sampled daily by the MWA - Cobb County WTP, from September 2007 - March 2009.

Special mention is included here of a program called BacteriALERT. An estimated 30% of the ~3.5 million park visitors annually engage in various recreational activities in Chattahoochee River segments (USGS 2008b). Because of NPS concerns about potential adverse health effects from chronically high levels of fecal coliform bacteria in the river, the ongoing BacteriALERT network was initiated in park waters during fall 2000. BacteriALERT is a partnership between State and Federal agencies and non-government organizations, including the NPS, the USGS, GA DNR-EPD, the Upper Chattahoochee RiverKeeper, the Georgia Conservancy, and the Trust for Public Lands.

BacteriALERT provides information to the general public about exceedances of the U.S. EPA criteria for fecal coliform levels to protect health safety (USGS 2008b). Two stations (formerly three) are sampled daily (*Figures 4, 6, 18,* and *20*); in the area covered, the designated uses for the Chattahoochee River are drinking water and recreation. The program provides data on total coliform bacteria, the fecal coliform bacterial species *Escherichia coli*, and turbidity (*Figure 26*).

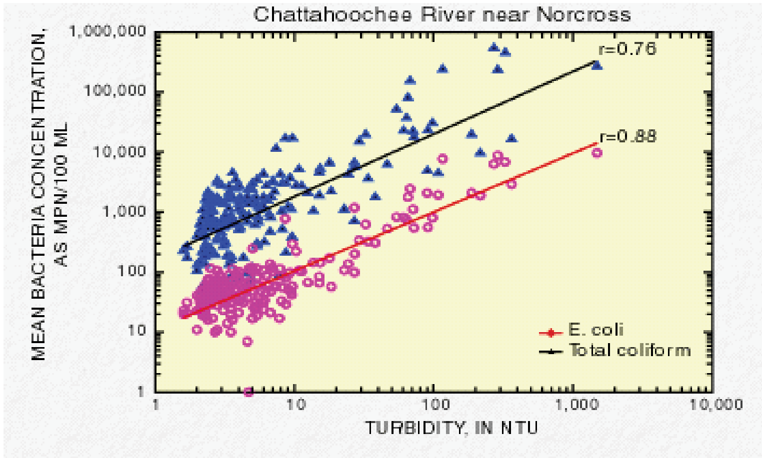


Figure 26. Relationship between turbidity and fecal bacteria in the Chattahoochee River near the Holcomb Bridge Park Unit. A strong positive relationship was also found between stream flow and turbidity, and between turbidity and both total coliform bacterial densities and *Escherichia coli* bacterial densities. Available at: http://ga2.er.usgs.gov/bacteria/sites.cfm.

Data summaries are posted on a freely accessible website within four hours of sample collection. The data also are interpreted for relationships between coliform bacteria and meteorological, hydrological, and other water quality conditions such as stream flow. BacteriALERT has the most high-frequency dataset available on fecal coliform bacteria in the park area (*Figure 27*).

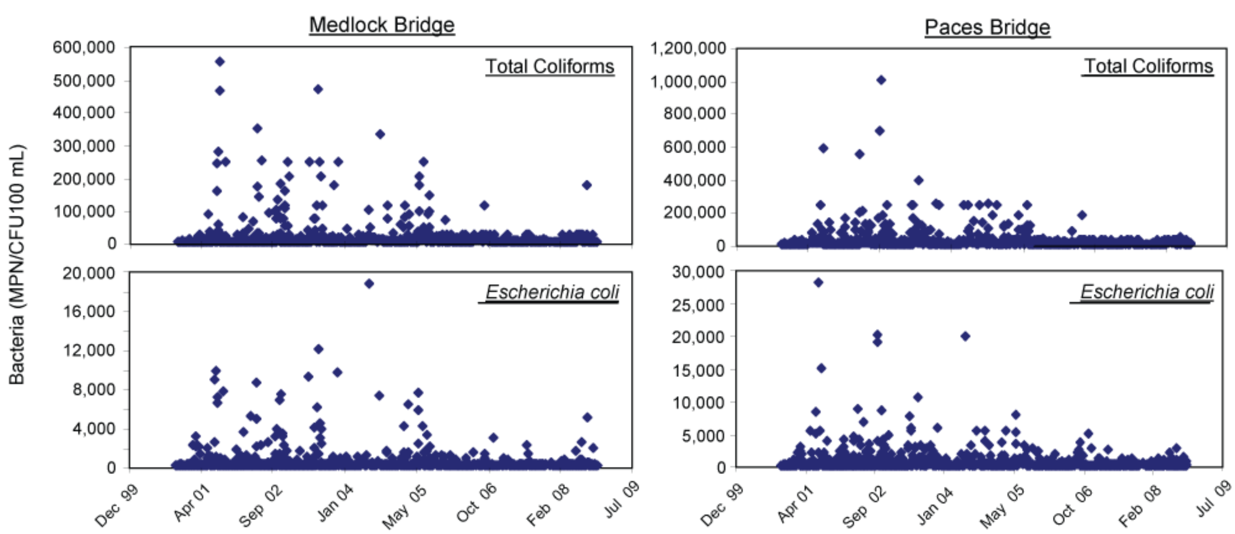


Figure 27. Total coliforms and *Escherichia coli* fecal bacteria at Medlock Bridge and Paces Bridge from the Chattahoochee River in the park (Park Sections II and IV, respectively). Data obtained from the BacteriALERT program (USGS 1998).

NPS (2004a) also described a now-dated study by the USGS in 1994-1995 of water-column concentrations of pesticides, herbicides, and radon in Sope Creek, Big Creek, and Suwanee Creek. Concentrations of insecticides (e.g. the highly toxic organophosphate pesticides diazinon and chlorpyrifos) in surface waters were reported to often exceed the criteria to protect aquatic life, pesticides had contaminated groundwater as well (see below). Between 2002 and 2004, the USGS NAWQA Program evaluated the effects of urbanization on pesticide concentrations along an urban land cover gradient during low-flow conditions in the Atlanta metropolitan area. Total insecticide and herbicide concentrations generally increased significantly with increasing urban land cover (Sprague and Nowell 2008).

Historically there has been improvement in DO sags, which used to affect more park streams, especially below Buford Dam (see review by Kunkle and Vana-Miller 2000). Few violations of the state standard (5.0 mg/L daily average; minimum at any time, 4.0 mg/L; GA DNR 2008d) have been detected in the past ~decade (*Table 23, Appendices 2* and *3*). Temperature alterations, described in the 1990s, continue to be a problem; elevated temperatures in the river and tributary streams have been caused by sediment loading, loss of shade trees along stream banks, and wastewater discharges (NPS 2004a). In addition, during December – January the release of warmer, vertically mixed water from Lake Lanier causes mid-winter warming (NPS 2004a). As mentioned, aberrantly cold temperatures also occur in the river below Lake Lanier because of releases of cold hypolimnetic water for power generation (NPS 2004a).

In 2000 the Apalachicola-Chattahoochee-Flint River basin was listed in the top 10 most endangered American rivers in 1999 (American Rivers; see http://www.americanrivers.org /site/ Page Server? pagename=AR7_MER). The present analysis of the available data over the last decade indicates that park waters continue to show ongoing degradation. Hay and Parkers' (2003) summary, for example, of the present status of surface waters flowing into and through the park holds true five years later: "Because the land surrounding the [Chattahoochee] river is heavily urbanized …extreme turbidity during rains is common, and raw sewage is often dumped directly into the river."

Drinking Water

As of 2000 it was estimated that on average, ca. 446 mgd were withdrawn from the Chattahoochee River in the area for drinking water and industrial use (Kunkle and Vana-Miller 2000). Twelve other GA DNR-permitted users (golf courses, athletic clubs, small industries) each were withdrawing more than 10,000 gallons per day. The Chattahoochee River and Lake Lanier presently supply about 75% and 10%, respectively, of the water supply used by nearly four million people in the Atlanta greater metropolitan area, including the park (Kunkle and Vana-Miller 2000, GA DAA 2005). Seven potable water treatment plants presently are in operation in the area, with two other serving Atlanta that intake water above Peachtree Creek (Plate 14, Table 24). Considerable expansion of capacity is planned (Table 24).

After severe droughts in the 1980s, Atlanta proposed to increase withdrawals from the Chattahoochee River, but this proposal was contested largely over concern for the potential downstream effects on the Apalachicola Bay estuary which supports more than 90% of Florida's oyster production (USACE 1998). Conflicts over water use led to a water compact in 1997 between Georgia and Florida, also involving the Flint River and Alabama (Richter et al. 2003). The Tri-State Water Allocation program is managed by the Apalachicola-Chatta-hoochee-Flint River Commission, which was charged with developing a Water Allocation Formula for the Chattahoochee River including the park. The objective is to provide an equitable basis for sharing water supplies among the states. In 1991 the commission instituted a comprehensive study of the Alabama-Coosa-Tallapoosa/ Apalachicola-Chattahoochee-Flint Rivers to make water use demand estimates through 2050, estimate the extent to which supplies can meet the projected demands, and develop water supply management alternatives. The USACE (1998) prepared a NEPA programmatic environmental impact statement for the effort. The three states approved Interstate Compacts in 1997 (NPS 2004a), but ongoing conflicts remain (see p. 108 of this Report).

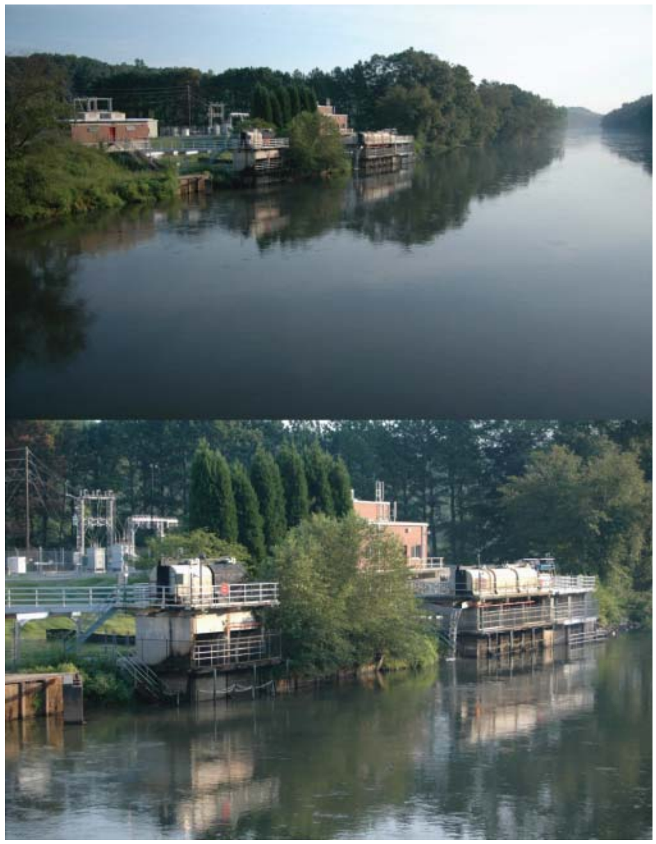


Plate 14. The Cobb-Marietta Water Authority's water treatment plant at Johnson Ferry on the Chattahoochee River. Photo by E. Morris, summer 2008.

Drinking water quality standards are set by both federal and state legislation; the main federal law is the Safe Drinking Water Act (SDWA), and the primary state law is the Georgia Safe Drinking Water Act (GSDWA). The SDWA directs the U.S. EPA to ensure that public water systems meet minimum standards for specific contaminants, and the U.S. EPA has granted the GA DNR-EPD the primary responsibility for enforcing the standards. Nevertheless, GA DAA (2005, p.9) reported a disturbing situation regarding protection of drinking water resources and other waters: "…The state's water-related activities are conducted by multiple programs within multiple agencies… [and] are subject to multiple laws and regulations enacted at different times for different purposes…. With few exceptions, information is not maintained to evaluate the effectiveness of the state's water-related activities….[GA DNR] EPD compiles some statistical data regarding water quality and the quality of lakes, rivers and marshes, and prepares some technical analyses of the condition of the state's groundwater and its aquifers…. However, none of these data are used to establish specific performance objectives…. The Governor's Budget Report for fiscal year 2005, for example, does not contain any performance measures for evaluating EPD's effectiveness in protecting the state's water resources."

Table 24. Potable WTPs in the existing park area and just upstream and downstream from it, and planned increased capacity by 2030. Modified from Kunkle and Vana-Miller (2000), ARC (2003), CH2MHill (2003), and MNGWPD (2008).

Water Treatment Plant	Permitted Monthly Average (mgd)	Increased Capacity (2030)
Forsyth and Cumming WTPs (Lake Lanier) HUC 031300010807	33	104
Gwinnett County (Lake Lanier/Shoal Creek/Lakeside HUC 031300010809	140	155
Buford (Lake Lanier) (GA1350000)	2	4
DeKalb County (Chattahoochee River) HUC 031300010907	140	175
Roswell (Big Creek) HUC 031300011001	2	5
Cobb County (CCMWA Quarles WTP) HUC 031300011101	73	86
Atlanta/Fulton County WTP HUC 031300010905	104	155
Atlanta (intake above Peachtree Creek – Hemphill and Chattahoochee WTPs) HUC 031300011106	127	201
Total	**619**	**885**

This general lack of enforcing water quality standards (GA DNR 2008d) or recommended guidelines for acceptable water quality (U.S. EPA 2000, 2002) has led to the following description of Georgia's waters, including the Chattahoochee River, by the GA DAA (2005): "In 2000, 60% of all waters assessed in the state did not fully meet the quality expectations for their designated uses; aging or lack of water infrastructure in growth areas causes industrial and municipal source pollution; and nonpoint source pollution is widespread and needs to be controlled by reducing nutrient loads, minimizing erosion and sedimentation, managing stormwater, and using BMPs and other measures to meet federal court order requirements for total maximum daily loads for streams and lakes across the state."

Groundwater Quality

Groundwater quality standards are set by federal (Safe Drinking Water Act, Clean Water Act) and state legislation (Safe Drinking Water Act, Water Quality Control Act, Water Well Standards Act (GA DAA 2005). The GA DNR-EPD's Regulatory Support Program is the main regulatory and technical assistance entity that evaluates and attempts to protect groundwater quality (GA DAA 2005). Limited data on groundwater quality in the park area are available from a ~decade- old study by the USGS of the Willeo, Sope, and Rottenwood Creek basins (Frick 1997).

A previously mentioned study by the USGS in 1994-1995 assessed three tributaries in the park, and detected pesticides in more than half of the well and spring samples that were collected (NPS 2004a). The termiticide and agricultural pesticide dieldrin was most commonly detected, and occurred in 30% of the wells and 47% of the springs. Tetrachloroethene, used in drycleaning, was found in one well and one spring; and radon exceeded the U.S. EPA standard of 300 picocuries per liter in 87% of the groundwater samples.

Sources of Pollutants

Urbanization in the greater metropolitan Atlanta area contributes a wide array of pollution sources (e.g. *Plate 15*). GA DNR's (1998a) Chattahoochee River Basin Management Plan noted concerns about six sources of water quality degradation, still relevant, including (i) fecal coliforms; (ii) heavy metals; (iii) elevated water temperatures from urbanization, loss of riparian trees, urban runoff and wastewater discharges; (iv) low dissolved oxygen below the Buford Dam because of hypolimnetic releases from Lake Lanier; (v) erosion and sedimenta-tion from urban runoff, road construction, and other development; and (vi) toxic substance accumulations in fish tissues (mercury, PCBs, chlordanes). Mikalsen (1989) reviewed water quality conditions in urban areas of Georgia, and identified additional concerns, still relevant, such as (vii) excessive nutrients such as nitrate and phosphorus that promote algal blooms; (viii) elevated nutrients and elevated temperatures that interact to favor low-oxygen-tolerant species while reducing or eliminating populations of "clean water", higher-oxygen-requiring species such as stoneflies; and (ix) increased inputs of other toxic substances such as pesticides, herbicides, and petrochemicals in urban runoff. Clearly, a decade later this situation has not appreciably changed, despite development of TMDLs for many of the surface waters upstream from and within the park.

Suspended sediment loading is contributed from erosion because of land disturbance, and from urban runoff. High turbidity and sediment loads are common in park surface waters, especially after storm events (NPS 2004a) (*Plates 16* and *17*). The sediment particles adsorb pesticides, herbicides, some toxic metals, oil and grease, and nutrients such as ammonium and phosphorus; they also increase stream temperatures and help to depress dissolved oxygen levels (Paul and Meyer 2001, NPS 2004a).

Fecal coliforms are high in many streams because of urban runoff (including NO_x from car exhausts, pet wastes etc.), other domestic animal wastes, sewer leaks and overflows, leaking septic systems, illicit waste discharges, and other nonpoint sources, and wastes from wildlife and waterfowl (GA DNR 2003a, 2008a; NPS 2004a). Fecal coliform bacterial contamination often co-occurs with nutrient pollution and, as mentioned, is contributed by nonpoint runoff (carrying NO_x from car exhausts, pet wastes etc.); sewer line overflows, leaks and breaks; raw sewage spills; septic system leaks; and wastes from domestic as well as wild animals. Fecal coliform bacteria can sometimes indicate the presence of other microbial pathogens that cause human disease (Mallin et al. 2001).

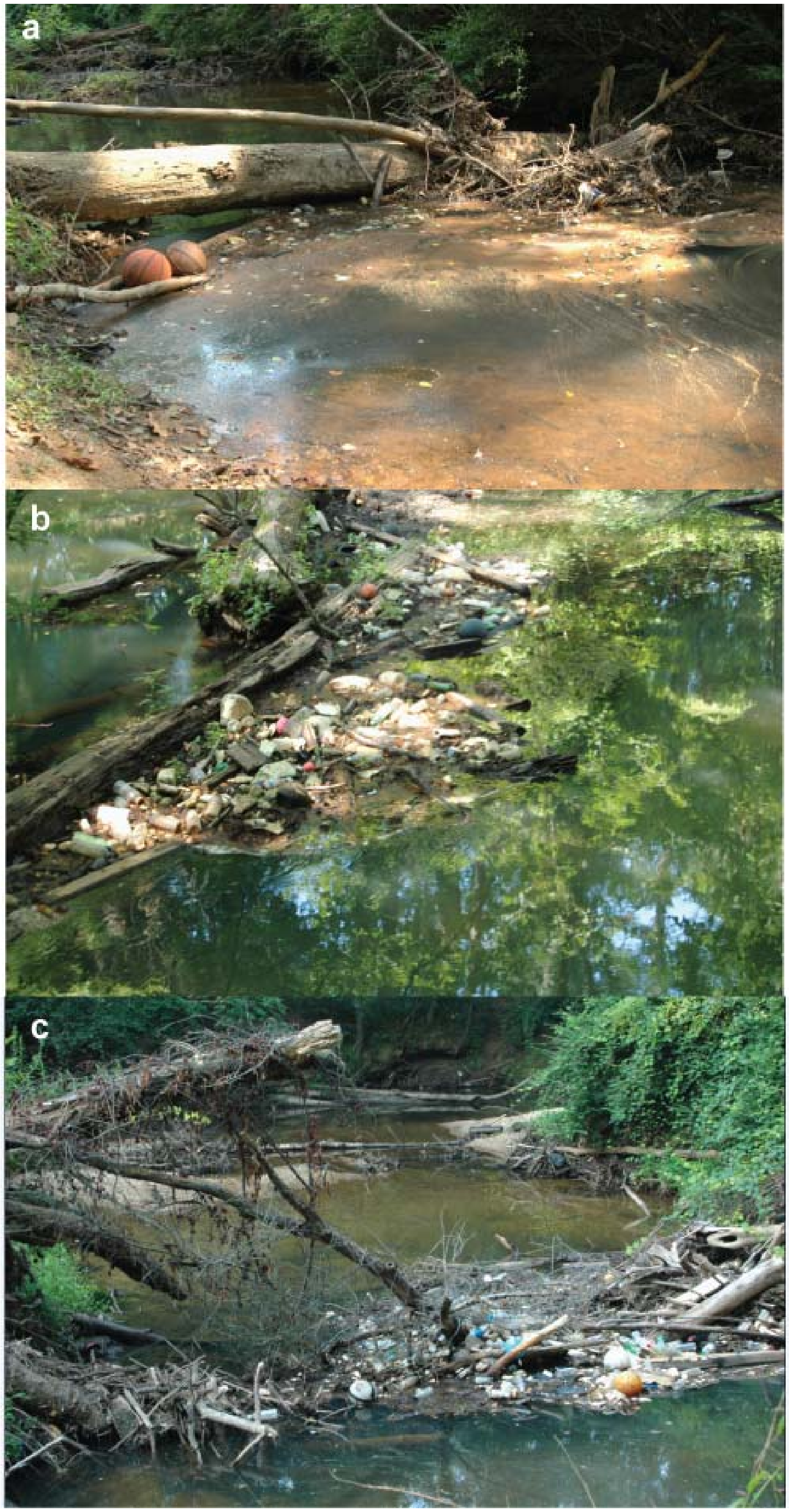


Plate 15. Examples of an urban garbage portfolio in park streams, a common site because of the surrounding urbanization: Willeo Creek at Gold Branch (upper panel), Powers Island at Cochran Shoals (middle panel), and Long Island Creek at Palisades (lower panel). Photos by E. Morris, 2008.

Plate 16. Streams degraded by sediment loading at Bowmans Island. Photos by E. Morris, 2008.

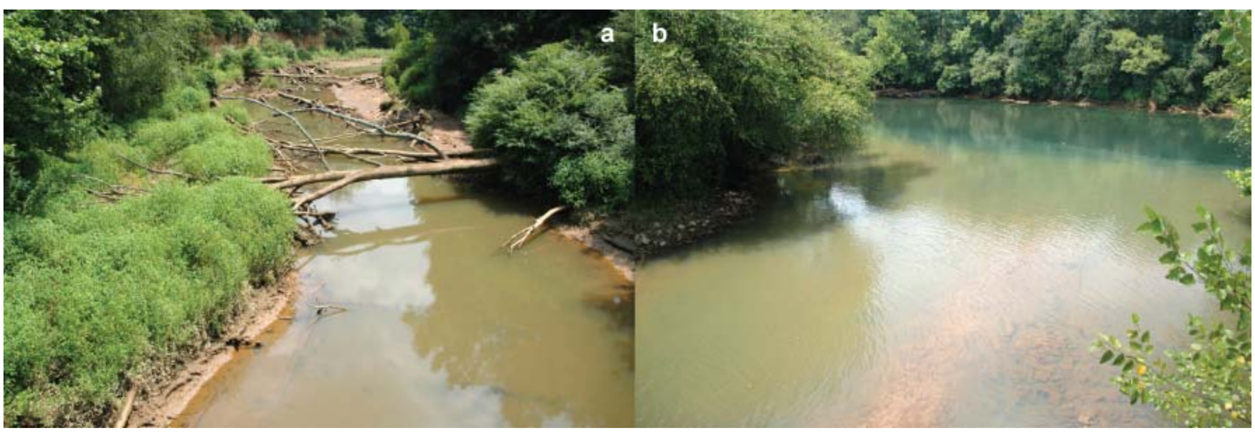


Plate 17. Suwanee Creek: (a) Upstream from its confluence with the Chattahoochee River, showing degradation from high sediment loading; (b) at its confluence with the mainstem Chattahoochee River (Suwanee Creek is in the foreground). Photos by E. Morris, 2008.

Excessive nutrients and organic materials that contribute to BOD come from sewage (treated as well as untreated) added by point sources but also added by nonpoint sources such as septic tanks and sludge land application fields (e.g. *Plate 18*), lawns, domestic animal wastes, and exposed soil at construction sites (National Research Council 2000).

Plate 18. Spray field for municipal sludge near McGinnis Ferry; the park and the Chattahoochee River are in the background behind the trees. Photo by E. Morris, 2008.

As mentioned, heavy metals, especially cadmium, copper, lead, and/or zinc, were described as excessive in some streams in urbanizing areas. In the mid-1990s, toxic metals were the second most common pollutants of concern in park surface waters after fecal coliforms (Kunkle and Vana-Miller 2000), and the status of heavy metals contamination has not improved based upon the most recent available data (*Table 23, Appendices 2* and *3*). Metals pollution has been attributed to urban runoff, and from bottom water and sediments of Lake Lanier via releases from Buford Dam, especially during December - February after vertical mixing (NPS 2004a).

There is no natural source for PCBs; rather, PCB contamination is of industrial origin (GA DNR 2003b). Chlordane is also assumed to be of industrial origin (Nomeir and Hajjar 1987), whereas mercury pollution is being contributed by urban sources and airshed sources outside the Chattahoochee watershed (Baeyens et al. 1996, Qumerais et al. 1999).

The MNGWPD (2003) assessed water resources in the area during the early 2000s and reported that the "amount of stormwater runoff and treated wastewater flowing into [the area's] waterways has increased dramatically in the last 30 years. More than 1,000 miles of the District's rivers, streams, and lakes do not meet state water quality standards. The primary cause is polluted stormwater runoff. The health of the region's large lakes, including Lake Lanier…, is threatened by stormwater runoff" from urbanization (GA DAA 2005). The District also reported that the wastewater service needs of the area are projected to double by 2030, requiring waste-water treatment capacity to expand substantially during that timeframe. The general malaise and multiple effects of urbanization continue to degrade the park's aquatic natural resources.

Point Sources

NPDES permit information and any compliance actions were accessed from the U.S. EPA Enforcement and Compliance History Online (ECHO) Permit Compliance System, or from the modernized ECHO Integrated Compliance Information System (http://www.epa-echo.gov/echo/compliance_report_water.html). Point sources affecting the park include sewage treatment plants and various industrial discharges. As of 2000 it was estimated that ~50 mgd of treated water were discharged to the Chattahoochee River within the park by eight wastewater treatment plants within four counties (Kunkle and Vana-Miller 2000). Since that time, some of the treated sewage volume has been rerouted for discharge into the lower water column of Lake Lanier. In 2006, for example, Gwinnett County received permission to discharge up to 40 mgd of treated sewage into the reservoir (Shelton 2006), and the reservoir receives point source pollution from 47 other sewage treatment plants (Perry 2005). While this situation clearly affects the source water of the Chattahoochee River for the park, at present 14 point sources (with discharge at least 0.25 mgd) add more than 70 mgd to receiving surface waters in the park area (*Figures 17-20, Plate 19*). Of these, about half have been out of compliance with their permits during one or more dates in the past three years (*Table 25*). Section I has the most point sources (7), followed by Sections III and IV (5 each), with Section II having only two point sources (*Figures 17-20*).

Sewerage infrastructure contributes to pollution of park waters as well. The NPS has mapped an extensive network of sewer pipelines located within the park and surrounding area (NPS 2004a). Many of the pipelines transect the park under easement agreements with local governments (*Plate 20*), and some of them have leaked or broken. In 1999, for example, GA DNR EPD records indicated that ca. 26 million gallons of raw or partially treated sewage spilled into the Chattahoochee River and its tributaries within the park (NPS 2004a). The park maintains a database of sewage spills.

Accidental spills of fuels and numerous other chemicals commonly occur on bridges that cross over the Chattahoochee River or on other roads within the park. Park staff maintain a database that tracks the types and quantities of materials released (NPS 2004a). It is anticipated that more of the point sources in the area, over time, will adopt advanced treatment (CH2MHill 2003).

Nonpoint Sources

Impervious surface cover alters the hydrology and geomorphology of streams, leading to predictable changes in stream habitat that adversely affect beneficial aquatic flora and fauna (Paul and Meyer 2001). Urban runoff, along with municipal and industrial point source discharges, increase loadings of nutrients, metals, pesticides, other toxic contaminants, and pathogenic microorganisms to receiving waters. It has been estimated that every day in Atlanta, 54 acres of tree canopy are lost and replaced with 28 acres of impervious surface (NARSAL 2006). In the CHATT watershed, every day 22 acres of trees are replaced with 17 acres of impervious surface (Reynolds and Hardy 2007). As mentioned, the impervious surface in the CHATT watershed nearly doubled between 1991 and 2005 (Reynolds Hardy 2007). The largest increase in impervious surface has occurred in Big Creek, Johns Creek, and Suwanee Creek in Forsyth and Gwinnett Counties, which are among the fastest growing in the nation (Reynolds and Hardy 2007). The pollutants carried by urban runoff stress the health and depress the survival of beneficial aquatic life, and the increased runoff in turn increases flooding, streambed scouring, sedimentation, bank erosion, and accumulation of litter and other solid wastes (NPS 2004a) (e.g. *Plates 15-17*). The overall net effect is degraded water quality (*Table 26*), depressed biodiversity, and loss of beneficial aquatic life (Olsen 1984, Hadley and Ongley 1989).

Plate 19. Treated sewage bubbling into the Chattahoochee River from an outfall diffuser area in the Holcomb Bridge Park Unit at the Horseshoe Bend Country Club. Note responding algal growth (top panel) and a canoeist in the background (center panel). Photos by E. Morris, 2008.

Plate 20. Examples of the numerous sewer pipes that traverse or empty into park waters, including (a) Gold Branch – Willeo Creek, (b) Suwanee Creek – turbid Suwanee Creek at its confluence with the Chattahoochee River, (c-e) Vickery Creek, and (f) Cochran Shoals showing straight-pipe runoff into the Chattahoochee River. Photos by E. Morris, 2008.

Land disturbance during construction in ongoing, increasing urban development of the Chattahoochee basin is a major source of suspended solids. Under the NPDES construction stormwater permit system, GA DNR-EPD is charged with regulating discharges of stormwater from construction sites greater than five acres (GA DNR 2008e,f). The situation, however, is "death by a thousand cuts"; enforcement is difficult because of budgetary constraints, and many construction sites are less than five acres in area. Thus it is estimated that about 80% of all water pollution in the area comes from nonpoint sources in developed and developing urban areas (NPS 2004a). High turbidity and sediment loads are common in park waters, especially after storm events (NPS 2004a) (*Plates 15* and *16*). The sediment particles adsorb pesticides, herbicides, some toxic metals, oil and grease, and nutrients such as ammonium and phosphorus; they also increase stream temperatures and help to depress dissolved oxygen levels (Paul and Meyer 2001, NPS 2004a).

Table 25. The 14 point source contributors that discharge 0.25 mgd or more in the park area above Peachtree Creek, and violations of permit compliance during the past ~three years (Jul 05 - Jun 08). These sources collectively discharge more than 70 mgd. Permit information is from GA DNR (2008f); compliance information is from U.S. EPA (2008).*

Park Section Point Source	NPDES Permit	Receiving Stream	Violation
Section I			
Blue Circle Aggregates Cumming Quarry	GA0046850	Daves Creek	----
Buford Trout Hatchery Outfalls 1, 2	GA0026174	Chatt. River	----
Buford - Westside WPCP (0.25 mgd)	GA0023175	Richland Creek	----
Buford - Southside WPCP (2 mgd)	GA0023167	Suwanee Creek	pH, fecal coliforms, ammonia, TP, TSS
Martin Marietta Aggregates - Forsyth Quarry	GA0047562	Dick Creek	----
Forsyth County - Dick Creek WRF (0.76 mgd)	GA0038563	Dick Creek	----
Section II			
Fulton County - Cauley Creek WRF (0.5 mgd)	GA0038440	Cauley Creek	Turbidity
Lafarge Building Materials	GA0048640	Chatt. River trib.	----
Section III			
Georgia Power Co., Morgan Falls	GA0001511	Chatt R.	----
Fulton County - Big Creek WPCP (24 mgd)	GA0024333		BOD5, COD, 5-day flow in conduit or through WPCP, COD, TSS
Gwinnett County - Crooked Creek/ North WPCP (36mgd)	GA0026433	Lake Lanier	Chlorine, total residual ammonia, total COD, BOD5
Fulton County - Johns Creek WRF (7 mgd)	GA0030686	Johns Creek	pH, TP
Lafarge Building Materials	GA0047601	Big Creek trib. Foe Killer Creek	
Section IV			
USAF Lockheed Plant No. 6 (5 discharge points - 2 mgd each, total of 10 mgd)	GA0001198	Rottenwood Creek Poor House Creek	pH, aluminum, BOD5, TOC

* Note that two major sources of sewage described by Kunkle and Vana-Miller (2000), the Cobb County Sutton WPCP (GA0026140, RM 300.5; permitted discharge, 40 mgd) and the Clayton WPCP in Atlanta (GA0021482, RM 300.4; permitted discharge, 100 mgd), discharge to the Chattahoochee River below the present park.

There are three superfund sites near the park (*Table 27*). In addition, there are four municipal sludge land application sites in the park, all near Section I (*Table 28, Figure 17*). Six landfills occur near Section I as well, four of which ceased operations more than a decade ago but likely are still contributing nonpoint pollution (*Table 28*). Near Park Sections II and III are two landfills and 15 landfills, respectively (*Figures 18* and *19*), and two of the landfills near Section III ceased operations in the late 1980s (*Table 28*). There are no land application sites or landfills near Park Section IV.

Table 26. Mean concentrations of pollutants in precipitation events, depending upon the amount of impervious surface area (imperv. ≡ imperviousness; TCu ≡ total copper; TZn ≡ total zinc). From the ARC (1998) in Georgia Department of Community Affairs (2003).

		Event Mean Concentrations (mg/L)									
Land Use	**% Imperv**	**BOD**	**TDS**	**COD**	**TSS**	**TP**	**TKN**	**NO_3^-N + NO2-N**	**TCu**	**TZn**	**NH_4^+N**
Forest/open	0.50	8	100	51	216	0.09	0.46	0.25	0.00	0.00	0.00
Agriculture	0.50	4	678	72	400	0.40	209	0.50	0.04	0.10	0.001
Large-lot single family (> 2 acre)	10.00	10.1	91	58	235	0.19	0.6	0.34	0.01	0.04	0.00
Low-density single family (1-2 acres)	12.00	11	100	190	280	0.67	0.20	2.85	0.03	0.22	0.004
Low- to medium-density single family (0.5-1 acre)	19.00	15	71	75	279	0.47	1.37	0.69	0.04	0.12	0.004
Medium-density single family (0.5-1 acre)	26.00	10.80	100	83	140	0.47	2.36	0.96	0.05	0.12	0.003
Townhouse/apartment	48.00	10.80	51	70	109	0.19	1.24	0.69	0.02	0.14	0.003
Commercial	85.00	9.71	100	190	248	0.66	3.20	1.18	0.04	0.28	0.005
Office/light industrial	70.00	15.00	58	77	93	0.66	3.20	1.18	0.04	0.19	0.003
Heavy industrial	80.00	9.70	100	61	91	0.24	1.28	0.63	0.04	0.19	0.001
Average	35.10	10.41	145	93	209	0.36	22.1	0.87	0.03	0.14	0.0024

Source: Watershed Management Model User's Manual (ARC 1998).

Instream sand and gravel dredging occupies about 8% of the 48-mile segment of the Chattahoochee River within the park, mostly near the McGinnis Ferry, Abbotts Bridge, and Island Ford Units (Kunkle and Vana-Miller 2000) (e.g. *Plate 21*). There is a high demand for sand and gravel as construction materials in the expanding Atlanta metropolitan area, and instream gravel is especially desirable because stream abrasion produces durable, rounded, more chemically inert, well-sorted gravel. While sand dredging can improve aquatic habitat by creating small, short pools as habitat for fish and aquatic insects, removal of gravel and debris (snags etc.) is detrimental to aquatic life. Instream mining can also create more bank erosion, substrata instability, and loss of desirable substrata that lead to loss of critical habitat (Martin and Hess 1986, Meador and Layher 1998). Issuance of permits for these activities is under the purview of the USACE under Section 404 of the Clean Water Act. The Metropolitan River Protection Act allows instream mining if bank erosion is avoided and the effluent returned to the river is equal to or less than the water withdrawn. The land-based activities are also controlled by the Chattahoochee Corridor Plan. Within the park, the NPS issues Special Use Permits for the sand and gravel operations. The USACE also allows the NPS to place conditions on USACE permits affecting the park.

Not surprisingly, based upon an in-depth assessment, CH2Hill (2003) predicted that without additional watershed management efforts, impervious surface area will exceed 20% in the upper Chattahoochee basin in portions of Gwinnett, Fulton, and Cobb Counties, seriously in excess of the 7-10% impervious area coverage that has been identified as the maximum allowable in order to maintain healthy adjacent aquatic ecosystems (Schueler 1994, Mallin et al. 2001, Paul and Meyer 2001).

Table 27. Superfund sites within five miles of the park

Site	Name	Location
GAD980559413	Morgan Falls Landfill	Roswell, Fulton Co., 0.3 mile east of the Chattahoochee River at Morgan Falls Dam (no longer operational)
GAD980842777	Safety-Kleen 3-013-02	Norcross, Gwinnett Co., 1.8 mile south of the Chattahoochee River
GAD981472236	Anacomp Inc.	Cyanide Storage Bldg., Buford, Gwinnett Co., 4.75 miles east of the Chattahoochee River

Table 28. Land application sites (LAS, with permit numbers) and landfills (L; or sanitary landfill, SL, also indicating whether still operational and if not, when operations ceased) in the park area. Note that LAS, L, or SL sites were not found in Park Section IV.

Section I	
Windermere Urban Reuse	LAS GAU020195
Sugar Hill	LAS GAU020003
Old Atlanta Club	LAS GAU030980
Capital Resources	LAS GAU020082
Miller/Trammel Trammel Road (ceased Dec 91)	Landfill 058-007D
Sugar Hill Appling Road PH1 (ceased Jul 93)	Landfill 067-016D(SL)
BFI, Richland Creek	Landfill 067-032D(SL)
Buford - Tuggle Greer Road (ceased Jun 88)	Landfill 067-019D(L)
Buford (ceased operation Dec 87)	Landfill 067-008D
Buford - Peachtree Ind. Blvd. PH2 (ceased Mar 89)	Landfill 067-030D(SL)
Section II	
Suwanee	Landfill #944
Gwinnett Landfill Inc.	Landfill 067-054D(L)
Section III	
Laurelwood	Landfill # 868
Glaze Landfill	Landfill # 869
Strickland - Kimball Bridge Road	Landfill # 914
Roswell First Baptist Church	Landfill # 915
Oxbo	Landfill # 916
GA Hwy 120	Landfill # 917
Hagerman	Landfill # 918
Town & Country Motors	Landfill # 919
Azalea - Willeo Road	Landfill # 920
Nesbitt Ferry Road	Landfill # 921
Holcombe Bridge Baptist Church	Landfill # 922
Worley - Nesbitt Ferry Road	Landfill # 923
Rivermont - Holcombe Bridge Road	Landfill # 924
Hamil - Brumbelow Road (ceased Oct 88)	Landfill 060-054D(L)
Fulton County - Morgan Falls (ceased Aug 88)	Landfill 067-007D(SL)

Plate 21. In-stream mining operation near river mile 317.5 on the Chattahoochee River in the park. Photos by E. Morris, 2008.

Assessment of Biological Resources With Respect To Water and Air Quality

The water use classifications for the Chattahoochee River and its tributaries near the park vary; all are designated for fishing, and some are also designated for drinking water supplies and/or for recreation (Water Quality Control, Chapter 391-3-6(13); see pp. 87-90 of this Report). The fishing classification, as stated in Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(6)(c), is established to protect the "Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality" (GA DNR 2008d).

Water Quality Standards

The State of Georgia has ambient water quality standards for common water quality parameters including dissolved oxygen (> 5 mg/L daily average), pH (between 6.0 and 8.5), turbidity (50 NTU for freshwater), and chlorophyll *a* (µg/L) (GA DNR 2008e) (*Appendices 5* and *6*). In addition, water quality samples collected within a 30-day period that have a geometric mean fecal coliform count exceeding 200 cfu/100 mL during May through October, or exceeding 1,000 mpn/100 mL during November through April, are in violation of the bacteria water quality standard for drinking water and the water quality standard for waters with designated use as Fishing. The state has also developed water use classifications and in-stream water quality standards for each use (*Table 29*). Clarification is warranted on the methods and units used for analysis of fecal bacteria, as GA DNR's (2007e) standardized methods for the region report in different units. Analysis of fecal coliforms may use either standard method 9221E (detection limit 2 cells or colony-forming units [CFU] as most probable number [mpn]/100 mL) or standard method 9222D (detection limit 1 colony/100 mL).

Table 29. Georgia water use classifications and in-stream water quality standards for each use (GA DNR 2008d; Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(6)(a), 391-3-6-.03(6)(b), and 391-3-6-.03(6)(c)).

	BACTERIA (fecal coliforms)		DISSOLVED OXYGEN (except trout streams)[a]		pH	TEMPERATURE (except trout streams)[a]	
Use Classifcation	**30-day Geom. Mean[b]**	**Maximum**	**Daily Avg. (mg/L)**	**Minimum (mg/L)**	**Std. Units**	**Maximum Rise (^oF)**	**Maximum (^oF)**
Drinking Water requiring treatment	1,000 Nov-Apr	4,000 Nov-Apr	5.0	4.0	6.0-8.5	5	90
	200 May-Oct	---					
Recreation	200 (frw.)[c]	---	5.0	4.0	6.0-8.5	5	90
	100 (coastal)						
Fishing	1,000 Nov-Apr	4,000 Nov-Apr	5.0	4.0	6.0-8.5	5	90
	200 May-Oct						
Coastal Fishing [d]							
Wild River			No alteration of natural water quality				
Scenic River			No alteration of natural water quality				

[a] Standards for Trout Streams for dissolved oxygen are an average of 6.0 mg/L and a minimum of 5.0 mg/L. No temperature alteration is allowed in Primary Trout Streams, and a temperature change of 2oF is allowed in secondary Trout Streams.

[b] Fecal coliform densities are in units of number / 100 mL (Geom. ≡ geometric). Geometric means should be "based on at least 4 samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours". The geometric mean of a series of N terms is the Nth root of their product. Example: the geometric mean of 2 and 18 is the square root of 36. Note: U.S. EPA (2003) recommends consideration of 400 mpn/100 mL as the highest acceptable level of fecal coliforms if samples are taken less frequently.

[c] Frw. ≡ freshwater.

[d] Standards are the same as for Fishing with exception of dissolved oxygen, which is site-specific.

Two points complicate assessment of Chattahoochee water quality in the park area from the perspective of contamination by fecal bacteria. First, although the state's standards are based upon geometric means of at least 4 samples collected within a 30-day period, most water quality stations do not collect or have not collected samples for fecal bacteria that frequently. In other words, for example, at the stations it maintained, GA DNR did not collect fecal coliform data frequently enough to assess whether water quality was in violation of its state standard.

Second, more than 20 years ago, the U.S. EPA imposed water quality standards for *Escherichia coli* counts at freshwater beaches used for swimming as follows: The geometric mean of at least 5 samples collected over a 30-day period should not exceed 126 *E. coli* cells or cfu per 100 mL; and for a single water sample, *E. coli* counts should not exceed 235 cells or cfu per 100 mL. Analysis of *Escherichia coli* may use either standard method 9221B.1 (detection limit 2 mpn/100 mL) or 9221F (detection limit 2 mpn/100 mL) (GA DNR 2007e). Although there are no bathing beaches *per se* along the Chattahoochee in the park area, there is sufficient water contact through tubing, rafting, wading etc. to warrant analogous concern. Thus, the BacteriALERT web site refers to the U.S. EPA standards for *E. coli* at beaches where there is extensive water contact (see http://ga2.er.usgs.gov/bacteria/epastandards.cfm). The U.S. EPA recommended that states adopt either *E. coli* standards or standards for enterococci bacteria as more reliable indicators of degraded waters that pose human health risks. Georgia has not yet adopted state standards for either parameter, but in the absence of comparable or stricter state standards, the federal standards apply. Moreover, for waters that are not used for substantial human contact, the U.S. EPA (2003) recommends consideration of more than 400 mpn fecal coliform bacteria per 100 mL as indicative of water quality degradation, from data not collected with sufficient frequency to calculate geometric means.

Given the above information, in this Report several approaches were taken to assess water quality degradation from fecal bacteria, as follows: For all of the datasets considered, wherever there were sufficient data, geometric means were calculated for fecal coliforms and assessed using the state standards; and wherever there were sufficient data, geometric means were calculated for *E. coli* and assessed using the U.S. EPA standards for waters with substantial human contact. Where the frequency of data collection was insufficient to calculate geometric means, the data were analyzed for suggestion of water quality degradation considering (i) the state standards for fecal coliform bacteria (although based upon geometric means) and (ii) the U.S. EPA recommendation of > 400 mpn fecal bacteria (used to assess both fecal coliform data and *E. coli* data).

Georgia's *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(5)(c) state that "All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimatewater uses". Stream segments are placed on the state's Impaired Waters (303(d)) list based on water quality and biota sampling data (*Appendices 5* and *6*). For the water use classification of Fishing, the criterion violated is listed as Biota Impacted (Bio(F)), reflecting the fact that studies have shown a significant impact of water quality-related habitat degradation on fish (GA DNR 2008c,d). Potential causes may be urban runoff, (other) nonpoint sources, and/or a municipal facility(s) (point sources). For fecal coliforms (microbial pathogens), the standards were developed in consideration of general recreational uses, although the state's general policy is not to encourage swimming in any surface waters (GA DNR 2003a, 2008a). A stream is placed on the "partial support" list if more than 10% of the samples exceed the fecal coliform criteria and on the not support list if more than 25% of the samples exceed the standard.

Georgia also has an in-stream criterion for PCBs, found in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6, revised in November 2005: Georgia Regulation 391-3-6-.03(5)(e)(iv) states that "Instream concentrations of chemical constituents [including PCBs] listed by the U.S. EPA as toxic priority pollutants pursuant to Section 307(a)(1) of the Federal Clean Water Act (as amended) shall not exceed indicated criteria under annual average or higher stream flow conditions" (GA DNR 2007b, 2008e). The state's in-stream target, 0.00017 µg/L, is protective of the GA DNR fish consumption advisory action level of 0.1 mg/kg, and the Federal Drug Administration action level of 2.0 mg/kg for fish consumption. PCB exposure has been related to an array of adverse health effects in fish, birds, and mammals, including toxic effects on the liver, gastrointestinal system, blood, skin, endocrine system, immune system, nervous system, and reproductive system, as well as developmental effects and malignant tumors (GA DNR 2007b, and references therein; Adams et al. 1999, GA DNR 2007b).

In addition, GA DNR-EPD has recommended fish consumption guidelines for mercury, PCBs, and chlordane from Buford Dam to Morgan Falls Dam, and a separate set of recommendations for the river below Morgan Falls Dam. The guidelines are revised each year based upon ongoing sampling results. Because of their carcinogenic potential, it was recommended that PCBs should not exceed 100 ppb in fish. GA DNR also stated that the need for a health advisory is “clear, particularly for children and pregnant and nursing mothers” (Kunkle and Vana-Miller 2000).

GA DNR’s management strategies to reduce contamination in impaired streams in urban areas include sustained compliance with NPDES permit limits and requirements; adoption of National Resource Conservation Service Conservation Practices; application of best-management practices that are appropriate to specific agricultural and urban land uses; further development and streamlining of mechanisms for identifying, reporting, and correcting illicit connections, breaks, and other sanitary sewer or waste containment problems; for fecal coliforms, adoption of local ordinances requiring periodic septic system inspection, pumpout, and maintenance; and public education (GA DNR 2003a, 2008a).

In addition to these standards, Phase I NPDES permits regulate stormwater discharges associated with specific industrial activities (including construction sites $\geq$ 1 acre in area) and large and medium municipal separate storm sewer systems (MS4s) that serve populations of 100,000 or more. MS4 permits are supposed to prohibit non-stormwater discharges (i.e., illicit discharges) from entering into storm sewer systems and require controls or best-management practices to reduce pollutant discharges to the “maximum extent practicable” (GA DNR 2008e,f). The intent is to reduce exposure of stormwater to pollutants. In the park area, 99.2% of the Chattahoochee River watershed (167,682 acres) from Johns Creek to Morgan Falls, 100% of the Long Island Creek watershed (5.16 acres), and 95% of the Suwanee Creek watershed (14.09 acres) are in storm sewer MS4 areas (GA DNR 2008a).

Impaired Surface Water Quality and Habitat

The most recent Management Plan, presently in draft form (NPS 2008a), described a major concern for CHATT as progressive, increased water quality degradation from urban runoff, including sediment loading, fecal coliform bacteria, toxic metals, and other toxic organic substances. In recognition of the deterioration of surface water quality in the area (*Table 23*), GA DNR (2008e,g) has included much of the mainstem Chattahoochee and most of its major tributaries in the park area on its 303d list of impaired waters that do not support or only partially support their designated use(s) (*Plates 14-16, Table 30*). Every Park Unit except for #16, Paces Mill, is affected by one or more impaired streams.

The most visible pollutant is TSS from high suspended sediment loading (*Plates 15, 16,* and *22*). Two streams in the area, Suwanee Creek and Long Island Creek, are on the state’s 303d list as no longer meeting their designated uses for fish/fishing because of habitat degradation from excessive sedimentation and other urban runoff effects (*Table 30*, and see below). Land use categories that contribute sediment loading have been estimated for Suwanee Creek and Long Island Creek (*Table 31*); such partitioning among land use types was not attempted for sources of fecal coliforms.

Much of the mainstem Chattahoochee River and most of its tributaries in the park area are impaired for excessive fecal coliform bacterial densities (*Table 30*). Other microbial pathogens were reported in the park in the 1990s, including protozoans *Giardia* and *Cryptosporidium* which can cause serious human illness and death (NPS 2004a, LeChevallier et al. 1991).

The mainstem Chattahoochee River from Morgan Falls Dam to Peachtree Creek is impaired for fish consumption because of excessive PCBs in fish tissues (below). In 1995, GA DNR sampled fish in the mainstem Chattahoochee River for 43 parameters including pesticides, herbicides, PCBs, and other CECs, and reported that in some park waters, levels of mercury, PCBs, and chlordane exceeded U.S. EPA recommendations and the state of Georgia for fish consumption (Kunkle and Vana-Miller 2000). In Park Section IV, Rottenwood Creek is impaired for macroinvertebrate community health (BioM) (*Table 30*).

Plate 22. Haw Creek near the northern edge of the park, showing high turbidity, excessive sedimentation, and other urban debris. Photo by E. Morris, 2008.

In the mid- to late 1990s, four tributaries (Sope Creek, a tributary to Sope Creek, Rottenwood Creek, and Willeo Creek) were included on the state's 303d list as impaired for fishing because of elevated cadmium, copper and lead (tributary to Sope Creek) or lead (the other three streams). GA DNR-EPD sampling efforts in 1994-1995 established toxic metals as second to fecal coliforms as pollutants of concern (Kunkle and Vana-Miller 2000). Although these metals as well as zinc and aluminum (the latter, in Little Nancy Creek as mentioned) remain at excessive water-column concentrations in many park waters (*Table 23, Appendices 2* and *3*), there is no mention at present of impairment to these streams from toxic metals on the state's 2008 303d list (*Table 30*). Moreover, GA DNR only samples the sites shown in *Figures 3-6* and *17-20* during one year (monthly or less frequently) every five years. Thus, the river used most heavily in the state for drinking water supplies is sampled by the state's environmental agency every five years.

Table 30. Surface water quality sampling stations and status (± impaired, and parameter(s) causing impairment) in the outfall area of Lake Lanier and the park area (within about 5 miles upstream from the park, considering four sections containing the 16 Park Units). From GA DNR (2008e,g).*

Area	Station/Data Description	Designated Use(s)	Status (± Supporting Designated Use(s), and Parameter(s) Causing Impairment)
Lake Lanier	GA DNR 12040001	Recreation, Drinking water, Hydropower etc.	Assessment pending
Park Section I			
# 1 Bowmans Island			
Haw Creek	----	Fishing	Supporting
Richland Creek (headwaters to Chattahoochee R.)	USGS 02334480 / Gwinnett Co.	Fishing	Partially supporting (fecal coliforms - impaired from urban runoff). TMDL completed.
Chattahoochee R.	GA DNR 12043001 Gwinnett/Forsyth Co.s	Fishing	Supporting
# 2 Orrs Ferry			
James Creek	Forsyth Co. JSF-1	Fishing	Not supporting (fecal coliforms). TMDL completed.
# 3 Settles Bridge			
Level Creek (headwaters to Chattahoochee R.)	USGS 02334578 / Gwinnett Co.	Fishing	Not supporting (fecal coliforms - impaired from urban and other non-point [NP] runoff). TMDL completed.
Dick Creek	Forsyth Co. DKF-1	Fishing	Supporting in park area
Section II			
# 4 McGinnis Ferry			
Chattahoochee R. (Dick Cr. to Johns Cr.) Forsyth/Fulton Cos.	GA DNR 12048001 Forsyth Co. CHF-1	Drinking water, Recreation	Not supporting (pH, 12 miles) – impaired from urban runoff; also NP. Prioritized for TMDL in 2012.
# 5 Suwanee Creek			
Suwanee Creek (Mill Cr. to Chattahoochee R.)	USGS 02334485 / Gwinnett Co. GA DNR 12050301	Fishing	Not supporting (fecal coliforms; biota-impacted from sediment loading). Impaired from urban runoff. TMDL completed for fecal coliforms, TSS.
# 6 Abbotts Bridge			
Cauley Creek	Fulton Co. station CC-2 up from Abbotts Bridge	Fishing	Supporting
# 7 Medlock Bridge			
Chattahoochee R.	----	Fishing	Supporting
# 8 Jones Bridge			
Johns Creek	GA DNR 12054401, Fulton Co. JO-1	Fishing	Not supporting (fecal coliforms) - impaired from urban runoff. TMDL completed.

Table 30. (Continued).

Area	Station/Data Description	Designated Use(s)	Status (+ Supporting Designated Use(s), and Parameter(s) Causing Impairment)
Sections II-III			
Chattahoochee River, Johns Creek to Morgan Falls (Gwinnett/Fulton/Cobb Co.s)	----	Drinking water, Recreation	Partially supporting (fecal coliforms, pH – 17 miles) - impaired from urban runoff. TMDL drafted for fecal coliforms in 2007; TMDL development for pH has been deferred to U.S. EPA.
Section III			
# 9 Holcomb Bridge			
Chattahoochee River (Fulton/Gwinnett Co.s)	GA DNR 12055001	Drinking water, Recreation	Not supporting (fecal coliforms, pH)
Crooked Creek (Gwinnett Co.)	GA DNR 12055361, USGS 02335350	Fishing	Not supporting (fecal coliforms) - impaired from urban runoff. TMDL completed.
# 10 Island Ford			
Ball Mill Creek (Fulton/Dekalb Co.s)	Fulton Co. CK-1	Fishing	Not supporting (fecal coliforms) TMDL completed.
# 12 Gold Branch			
Willeo Creek (Cobb/Fulton Co.s - Gilhams Lake to Chatt R.	GA DNR 12064001 Cobb Co. WL4	Fishing	Not supporting (fecal coliforms) - impaired from urban runoff. TMDL completed.
# 13 Johnsons Ferry			
March (Marsh) Creek (Fulton Co. – headwaters to Chattahoochee R.)	Fulton Co. MA-1	Fishing	Not supporting (fecal coliforms) - impaired from urban runoff. TMDL completed.
Sections III - IV			
Chattahoochee River, Morgan Falls Dam to Peachtree Creek (Fulton/Cobb Co.s)	GA DNR 12070001 GA DNR 12070011	Recreation, Drinking water, Fishing	Not supporting (12 miles - fecal coliforms; fish consumption guidelines - PCBs). TMDLs completed for both parameters.

Table 30. (Continued).

Area	Station/Data Description	Designated Use(s)	Status (+ Supporting Designated Use(s), and Parameter(s) Causing Impairment)
Section IV			
# 14 Cochran Shoals			
Sope Creek (Cobb Co. – headwaters to Chattahoochee R.)	Cobb Co. SP6; GA DNR 12072101	Fishing	Not supporting (fecal coliforms) - impaired from urban runoff. TMDL completed.
# 15 Palisades			
Chattahoochee R. (Long Island Shoals/Whitewater Creek trib.)	GA DNR 12073901	Recreation, Drinking water	Not supporting (fecal coliforms; fish consumption guidelines - PCBs) - see above.
Long Island Creek (Fulton Co. – headwaters to Chattahoochee R.)	GA DNR 12073201	Fishing	Not supporting (fecal coliforms; biota-impacted from sediment loading). Impaired from urban runoff. TMDL completed for fecal coliforms; TMDL drafted for biota (fish - SS) in 2007.
Rottenwood Creek (Cobb Co. – headwaters to Chattahoochee R.)	Cobb Co. RT5	Fishing	Not supporting (fecal coliforms; also BioM ≡ macroinvertebrate community impacted). Impaired from urban runoff. TMDL completed for fecal coliforms.
# 16 Paces Mill			
Little Nancy Creek	Cobb Co. NA1	Fishing	Supporting
Little Nancy Creek	Cobb Co. NA2	Fishing	Supporting

Table 31. Estimated contribution of land use type to sediment loading in Long Island Creek and Suwanee Creek, the two streams that are impaired because of suspended sediment loading (GA DNR 2007a).

Source	Long Island Creek (tons per year)		Suwanee Creek (tons per year)	
Open water	---	---	---	---
Low-intensity residential	179.7	(45.47%)	538.2	(38.19%)
High-intensity residential	15.8	(4.00%)	42.7	(3.03%)
High-intensity comm/ indust/ transp	1.9	(0.47%)	12.4	(0.88%)
Quarries, strip mines, rocks	---	---	---	---
Roads	140.3	(35.50%)	353.4	(25.08%)
Deciduous forest	2.6	(0.66%)	16.7	(1.18%)
Evergreen forest	1.9	(0.49%)	3.6	(0.25%)
Mixed forest	0.0	(0.01%)	0.8	(0.06%)
Row crops, pasture	4.7	(1.19%)	326.3	(23.15%)
Other grasses (urban, recreational)	47.8	(12.10%)	71.4	(5.06%)
Woody wetland	0.4	(0.09%)	38.1	(2.70%)
Non-forested wetland (fresh)	---	---	---	---

TMDLs have been developed for some of the impaired waters in or near the park (*Tables 30* and *32*), beginning in 1998 for fecal coliforms in James Creek which is still impaired because of high fecal coliform levels (GA DNR 2008e,g). The TMDLs are supposed to be "platforms for establishing courses of actions to restore water quality" (GA DNR 2008a); procedures are to be set in place to track and evaluate implementation of corrective management practices and activities. GA DNR's management strategies to reduce contamination in impaired streams in urban areas include sustained compliance with NPDES permit limits and requirements; adoption of National Resource Conservation Service Conservation Practices; application of best-management practices that are appropriate to specific agricultural and urban land uses; further development and streamlining of mechanisms for identifying, reporting, and correcting illicit connections, breaks, and other sanitary sewer or waste contain-ment problems; for fecal coliforms, adoption of local ordinances requiring periodic septic system inspection, pumpout, and maintenance; and public education (GA DNR 2003, 2008a).

Insufficient Monitoring to Evaluate or Protect the Chattahoochee and Its Tributaries

The 5-year rotational sampling cycle for water quality that has been imposed by GA DNR in the late 1990s meant that the state environmental agency which is responsible for maintaining acceptable water quality did not sample the Chattahoochee River or its tributaries over 4-year periods (Dunbar 2007). Thus, the responsibility for water quality data collection had to fall elsewhere – to the federal USGS or to local county governments which, because of funding constraints and prioritization issues, do not sample most of its stations in the park area with consistency or sufficient frequency (weekly to biweekly) to capture many precipitation events that carry nonpoint pollution into park waters (see *Table 21*).

Unfortunately, however, GA DNR presently is not adhering to even a four-year gap in sampling. Although the state agency has not officially changed to another monitoring schedule, since 2005 it has deviated significantly from that schedule (Mr. M. Basmajian, GA DNR-EPD Watershed Protection Branch, Ambient Monitoring Unit, pers. comm. 2008). USGS historically has done most of the stream monitoring sample collection for the state agency as part of a cooperative agreement, and GA DNR has continued to use the USGS in that capacity but at a greatly reduced number of stations. In 2009, USGS will do no basin rotation stations but, rather, only some long-term statewide trend stations that are far from the park. GA DNR is planning to "ramp up sample collections but on special one-year projects, not basin rotation" (M. Basmajian, pers. comm., 2008). Thus, there is apparently is no plan by GA DNR or the USGS to sample the Chattahoochee or its tributaries in the park area in the future, and the state agency has conducted very limited sampling in these waters since the last basin rotation in 2000, nearly a decade ago. The state agency's limited more recent data post-2000 are not expected to be available until 2009 (M. Basmajian, pers. comm., 2008).

Table 32. TMDLs developed for the mainstem Chattahoochee River and tributaries in the park area (GA DNR 1998, 2003a,b, 2007a, 2008a).

Stream	"Preasent"Load* (1998-2008)	Reduction Needed	Allowable Average Load	Load Allocation (Waste Load Allocation)
Fecal Coliform TMDLs (counts/30 days*; Fishing, Recreation, Drinking Water)*				
Section I				
Richland Creek	3.32×10^{13}	85%	5.04×10^{12}	3.08×10^{12} (WLA 3.54×10^{10})
James Creek	? [1.392×10^{11} as of 1998]	none, as of 1998	1.392×10^{11} as of 1998 (175 cfu/100 mL)	"no reduction needed" as of the 1998 TMDL which has not been updated
Level Creek	2.72×10^{13}	86%	3.90×10^{12}	2.15×10^{12}
Section II				
Suwanee Creek	5.80×10^{13}	85%	8.62×10^{11}	5.05×10^{12} (WLA 1.76×10^{11})
Johns Creek	3.26×10^{12}	61%	1.26×10^{12}	5.46×10^{11}
Chattahoochee River (Johns Creek - Morgan Falls)	1.23×10^{15}	57%	5.32×10^{14}	1.46×10^{14} (WLA 1.86×10^{12})
Section III				
Crooked Creek	3.62×10^{12}	77%	8.36×10^{10}	2.85×10^{11}
Ball Mill Creek	2.49×10^{12}	51%	1.23×10^{12}	1.01×10^{11}
Big Creek	1.01×10^{13}	39%	6.17×10^{12}	1.00×10^{12}
Willeo Creek	1.51×10^{12}	22%	1.18×10^{12}	3.68×10^{11}
March (Marsh) Creek	9.64×10^{11}	60%	3.85×10^{11}	1.24×10^{11}
Chattahoochee River (Morgan Falls - Peachtree Creek)	3.16×10^{14}	48%	1.64×10^{13}	8.57×10^{13} (WLA 5.15×10^{12})
Section IV				
Sope Creek	3.87×10^{14}	83%	6.46×10^{13}	2.09×10^{13}
Long Island Creek	5.69×10^{11}	52%	2.75×10^{11}	8.02×10^{10}
Rottenwood Creek	3.02×10^{12}	68%	9.79×10^{10}	1.74×10^{11} (WLA 4.10×10^{11})
Sediment TMDLs (Biota-Impacted)				
Section II				
Suwanee Creek	1,500.4 tons/year	55.58%	666.5 tons/year	192.9 tons/year
Section IV				
Long Island Creek	395.1 tons/year	38.18%	244.3 tons/year	73.3 tons/year
PCBs TMDL (fish consumption)**				
Chattahoochee River (Morgan Falls - Peachtree Creek)	0.13 kg/day	99.20%	1.07×10^{-3} kg/day	(1.07×10^{-3} kg/day) - WLA [WLA: Σ(QWLA *0.00017µg/L)]

*30-day geometric mean for bacterial counts (colony-forming units); date when loads were developed varies from 1998 to 2008, depending on the stream or the river segment.

** The TMDL for PCBs for the Chattahoochee River equals the annual average flow at Atlanta (ca. 2,570 cfs multiplied by the water quality standard (0.00017 µg/L).Also see GA DNR (2008h).

Lack of Enforcement of Water Quality Regulations

The fact that water quality degradation has continued over the past several decades – and certainly, over the past decade – improving for few parameters (e.g. DO – Kunkle and Vana-Miller 2000), underscores an overall failure by state and federal authorities to enforce water quality regulations (e.g. *Plate 23*). As in other areas of this nation, the problem likely is directly related to the lack of sufficient funds for state and federal environmental agencies (National Research Council 2000). Insufficient funds translate into lack of enforcement through, for example, insufficient numbers of state inspectors in urban construction areas and other sites of pollution sources.

Plate 23. Construction of a new wastewater treatment plant (upper panel) at Holcomb Bridge on the Chattahoochee River, including a clear violation of sediment erosion control regulations (lower panel). Photo by E. Morris, 2008.

Air Quality Standards

The federal Clean Air Act has set standards for six "criteria" pollutants (including two categories for one of these, particulate matter) that must meet a health-based regulatory standard (*Table 33*; GA DNR 2007b). The regulatory standards are health-based, and concentrations above the standards are considered unhealthy for sensitive groups (GA DNR 2007b). For example, the 8-hour ozone standard is attained when the average of the fourth highest concentration measured is equal to or below 0.08 ppm (0.085 ppm with the EPA rounding convention) averaged over three years. The standards for the six criteria pollutants are fairly straightforward except for the $PM_{2.5}$ standard: To be in compliance with the federal air $PM_{2.5}$ standard, an area must have an annual arithmetic mean concentration of less than or equal to 15 µg $PM_{2.5}$ /m^3. An additional requirement imposed a stricter standard for fine particulate matter as of December 2006, wherein the 98th percentile 24-hour concentration must be less than or equal to 35 µg $PM_{2.5}$ /m^3 (GA DNR 2007b).

Another large group of compounds, air toxics, is monitored in the Air Toxics Network. Sources of these pollutants include vehicle emissions, stationary source emissions, and natural sources. One air toxic, lead, is designated as a criteria pollutant (above). Attainment standards have not been set for any of the other air toxics. Air toxics are analyzed annually for theoretical lifetime cancer risk and potential non-cancer health effects.

The Georgia Air Sampling Network of GA DNR-EPD collects data from stations across the state, including six stations in the Atlanta area (Fulton County) near the park, two in Cobb County, one in Gwinnett County, and four in DeKalb County (see below) (GA DNR 2007b). Monitoring is conducted year-round except for ozone, which is sampled from March through October, and except for the continuous Photochemical Assessment Monitoring Stations (PAMS) which sample volatile organic compounds only in summer (June to August). All official monitoring that is conducted in support of the National Ambient Air Quality Standards (NAAQS) is required to use U.S. EPA-defined reference methods and undergoes extensive quality assurance review. Sites are selected to measure the highest observable concentrations, and to determine representative concentrations in areas of high population density, determine the impact of significant sources or source categories on ambient pollution levels, determine general background concentrations, and determine the concentrations of selected compounds that contribute to formation of ground-level ozone (GA DNR 2007b). Data from EPD's continuous monitors are published at http://www.georgiaair.org/amp. The data are updated hourly.

Table 33. U.S. EPA standards for six "criteria" pollutants as required by the Clean Air Act, indicating recent modifications (cross-outs; GA DNR 2007b).

Compound	Primary Standard	Secondary Standard	Units	Time Interval
Sulfur dioxide (SO_2)	----	0.50	ppm	3-hour
	0.14	----	ppm	24-hour
	0.03	----	ppm	annual mean
Particulate matter ($PM_{2.5}$)	15	same as primary	µg/m^3	annual arithmetic mean (3 years)
	98th percentile ~~65.0~~[a]/35.0	same as primary	µg/m^3	24-hour
Particulate matter (PM_{10})	~~50.0~~[b]	same as primary	µg/m^3	annual arithmetic mean
	150	same as primary	µg/m^3	24-hour
Carbon monoxide (CO)	2nd maximum 35.0	----	ppm	1-hour
	2nd maximum 9.0	----	ppm	8-hour average
Ozone (O_3)	4th maximum 0.085	same as primary	ppm	8-hour average
Nitrogen dioxide (NO_2)	0.053	same as primary	ppm	annual mean
Lead (Pb)	1.5	same as primary	µg/m^3	calendar quarter

Air Resources

Among the stations of the Georgia Air Sampling Network near the park, the six stations in Atlanta (Fulton County) that are nearest to the park collectively monitor for ten parameters, including only 1 station that monitors for O_3, 1 station that monitors for CO, NO_2, VOCs, SVOCs, and/or TMs; 3 stations that monitor for $PM_{2.5}$ and/or TM_{10}, and 2 stations that monitor for SO_2 (*Table 34*). These parameters include five of the six that are presently on the criteria pollutant list (exception, lead). There are also two sites in Cobb County, west of the park, that monitor for O_3 and/or $PM_{2.5}$ (24h FRM), including one in Kennesaw Mountain National Battlefield Park; one site in Gwinnett County, east of the park, that monitors for O_3 and $PM_{2.5}$ (24h FRM and cont.); and four sites in DeKalb County, southeast of the park, that collectively monitor for various parameters including all six criterion pollutants (*Table 34*).

As of 2006, all of Georgia has been in compliance with the standards for four of the six criteria pollutants – Pb, SO_2, CO, and NO_2 – and in compliance with one of the two categories of a fifth criteria pollutant, PM (PM_{10}) (GA DNR 2007b). Nevertheless, air quality is a serious concern for the park because violations of the federal/state ozone standard and the $PM_{2.5}$ standard have continued to occur for several years. Thirteen counties surrounding the park, including Cobb, Gwinnett, Fulton, Forsyth and DeKalb Counties (also Rockdale, Coweta, Cherokee, Henry, Clayton, Fayette, Paulding, and Douglas Counties), were collectively designated a non-attainment area for air quality under the Clean Air Act because of ozone violations (8-hour ozone non-attainment area; GA DNR 2007b; e.g. *Figure 28*). The Atlanta ozone non-attainment area was officially expanded in 2004 to include Barrow, Bartow, Carroll, Hall, Newton, Spalding, and Walton Counties, based upon new monitoring data and implementation of the 8-hour ozone standard (GA DNR 2007b). Thus, the Atlanta ozone non-attainment area now includes 20 counties surrounding the park. The same 20 counties in the metropolitan Atlanta area are also a non-attainment area for $PM_{2.5}$, along with portions of Heard and Putnam Counties (GA DNR 2007b) (*Figure 29*). This situation is a growing concern considering that the Atlanta metropolitan population center is projected to continue rapid growth (ARC 2007). It is anticipated that air quality, including smog, ozone, particulates, and many other contaminants (GA DNR 2007b), will continue to degrade with increasing population growth (ARC 2007).

Ozone is monitored in March through October, since that period is when ozone production mostly occurs. This pollutant is a serious health concern because it attacks the mammalian respiratory system, causing coughs, chest pain, throat irritation, increased susceptibility to respiratory infections, and impaired lung functioning. In fact, moderate ozone levels can interfere with performance of normal daily activities by people who have asthma or other respiratory diseases. Of more concern than acute affects are potential chronic effects of repeated exposure to ozone, which can lead to lung inflammation and permanent scarring of lung tissue, loss of lung function, and reduced lung elasticity.

Table 34. Georgia air sampling station locations in the general airshed of the park during 2006, and parameters monitored (most recent available information). Parameters are indicated as ozone (O_3), carbon monoxide (CO), $PM_{2.5}$ (particulate matter [PM], up to 2.5 μm in maximum dimension – continuous or 24th FRM, Federal Reference Method, the official measurement technique), PM_{10} (PM up to 10 μm in maximum dimension), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), volatile organic compounds (VOCs, toxic [TO] types 14/15), semi-volatile organic compounds (SVOCs), and trace metals (TMs). From GA DNR (2007b).*

Station Name and Number	O_3	CO	$PM_{2.5}$ cont.	$PM_{2.5}$ 24th FRM	PM_{10}	NO_2	NO_y	SO_2	VOCs (TO-14/15)	SVOCs	TMs
					Atlanta (Fulton County)						
Fulton County Health Department #131210001	---	---	---	---	x	---	---	---	---	---	---
Utoy Creek #131210020	---	---	---	---	---	---	---	---	x	x	x
E. Rivers School #131210032	---	---	---	x	x	---	---	---	---	---	---
Georgia Tech #131210048	---	---	---	x	x	x	---	x	---	---	---
Confederate Ave. #131210055	x	---	x	---	---	---	---	x	---	---	---
Roswell Road #131210099	---	x	---	---	---	---	---	---	---	---	---
					Cobb County						
National Guard, Kennesaw #13067003	x	---	---	x	---	---	---	---	---	---	---
Macland Aq. Center, Powder Springs #130670004	---	---	---	x	---	---	---	---	---	---	---
					Gwinnett County						
Gwinnett Tech, Lawrenceville #131350002	x	---	x	x	---	---	---	---	---	---	---
					DeKalb County**						
Police Department, Doraville #130892001	---	---	---	x	x	---	---	---	---	---	---
Idlewood Rd., Tucker #130893001	x	---	---	---	---	x	x	---	---	---	---
South DeKalb, Decatur #130890002	x	x	x	x	---	x	x	---	x	---	x

* A seventh station in Atlanta, Fire Station 8 (#131210039), was discontinued because it did not meet siting requirements. Its sampling for $PM_{2.5}$ FRM was moved to the Georgia Tech site as indicated.

** The Tucker site and South DeKalb site in DeKalb County also monitor for PAMS VOCs and carbonyls. In addition, the South DeKalb site monitors for $PM_{2.5}$ speciation. A fourth site in DeKalb County, DMRC (#130890003) in Decatur, monitors only for lead (Pb), and is the only site in the general park area that tracks this sixth criterion pollutant.

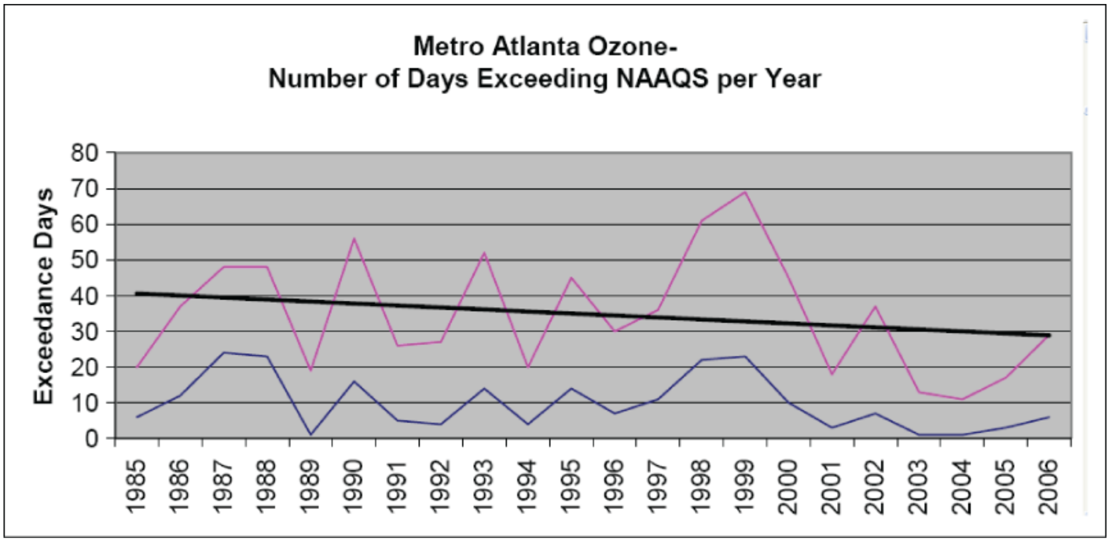
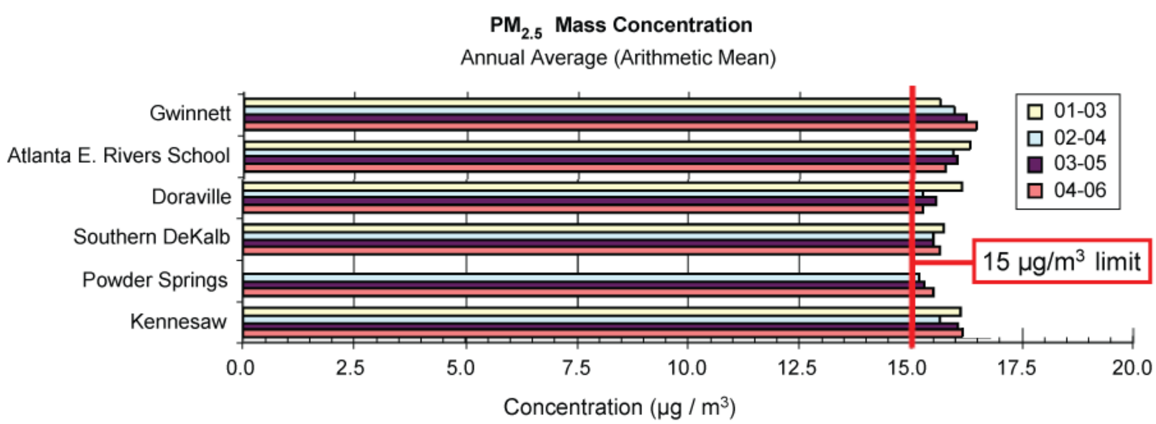


Figure 28. Metropolitan Atlanta ozone – number of violation days per year from 1985 through June 2006 (GA DNR 2007b).



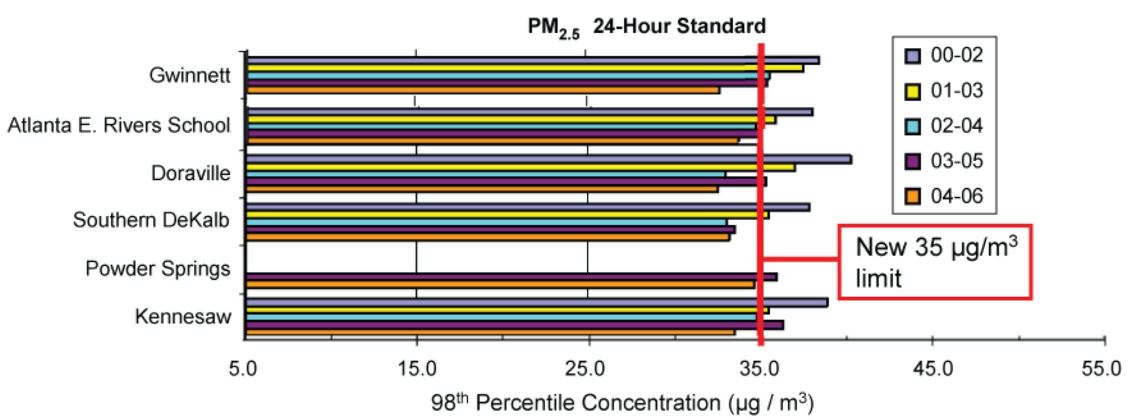


Figure 29. The fine-particulate ($PM_{2.5}$) design value, daily standard at six sites with available data, showing exceedances of the old standard at sites in the Atlanta metropolitan area near the park, exceedances of the new standard in 2000-2003 in all sites for which data were available, exceedances of the new standard in 2002-2004 in Gwinnett County, and exceedances of the new standard in 2003-2005 at four of the six sites (modified from GA DNR 2007b).

Fine particulate matter ($PM_{2.5}$) is produced by various sources including industrial combustion, residential combustion, and vehicle exhaust, or when combustion gases are chemically transformed into particles (GA DNR 2007b). The state monitors 53 particle species such as gold, sulfate, lead, arsenic and silicon. Recent research has indicated that $PM_{2.5}$ is a human health concern because it can penetrate into sensitive areas of the lungs and cause persistent coughs, phlegm, wheezing, more serious respiratory and cardiovascular disease, cancers, and premature death at particle levels well below the existing standards (Schwela 2000, U.S. EPA 2004, GA DNR 2007b). Mounting evidence indicates that $PM_{2.5}$ enhance delivery of other pollutants and allergens deep into lung tissue where the effects are exacerbated. Especially sensitive groups include children, the elderly, and people with cardiovascular or lung diseases such as asthma. $PM_{2.5}$ also impair visibility and contribute to haze in the humid conditions that characterize the north Georgia climate (U.S. EPA 2004).

The largest coal-fired power plant in the US, Georgia Power's Robert W. Scherer Plant, is just north of the City of Macon, GA in the City of Juliette, about 65 miles southeast of the park. The Scherer coal-fired power plant emits ~25.3 million tons of carbon dioxide (CO_2) per year, more than Brazil's entire power sector (Goodell 2006) (*Table 35*), and it is ranked 20th in the world for CO_2 emissions (2007 list of the Center for Global Development). In addition to CO_2 emissions, this power plant also discharges substantial sulfur dioxide (SO_2, involved in acid deposition), mercury and other toxic pollutants to the airshed that can affect the Atlanta metropolitan area.

Table 35. Air releases (as of 2000 and thus, somewhat outdated) by five coal-fired power plants, within ~3 to 65 miles from the park, that can affect the park's air quality (directional distance from the park: w. ≡ west, s. ≡ south, se. ≡ southeast). All releases are given in tons per year except mercury, which is given in pounds per year. Total air releases ≡ the sum of NO_x, SO_2, CO_2, PM_{10}, VOCs, acid gases, and mercury. From Clean Air Task Force for Clear the Air (2002).

Plant	Total Reported Air Releases	NO_X	SO_2	CO_2	$PM_{2.5}$	PM_{10}	VOCs	Acid Gases	Hg (lbs.)
Bowen (Bartow Co., ~31 miles w.)	21,431,524	43,437	155,374	21,220,502	1,116	2,460	247	9,514	637
Hammond (Floyd Co., ~57 miles w.)	5,503,241	16,867	28,282	5,456,480	233	512	63	1,037	90
Jack Mcdonough (Cobb Co., ~3 miles s.)	3,352,699	5,375	28,242	3,317,349	143	314	39	1,380	61
Scherer (Monroe Co., ~65 miles se.)	23,837,942	38,145	91,286	23,701,644	1,005	1,807	320	4,740	758
Wansley (Heard Co., ~47 miles s.)	9,976,494	19,079	69,218	9,883,816	424	936	117	3,268	251
Yates (Coweta Co., ~38 miles s.)	6,794,686	10,640	45,104	6,736,643	287	633	77	1,589	194

Deposition of airborne toxic substances from various sources may be contributing to the elevated concentrations of certain heavy metals (e.g. lead, zinc) that have been detected in surface waters in the park (DeVivo 2006). The Bowen Plant, ca. 31 miles west of the park, has almost as much total air pollutant emissions as the Scherer Plant (*Table 35*), and is the third largest CO_2 emitter in the US. Emissions from several other coal-fired power plants in airsheds that also can affect the park are shown in *Table 35*.

Considering the U.S. EPA's Air Quality Index (AQI), air quality in the greater Atlanta metropolitan area was evaluated as only "moderate" for 210 days in 2006 because of ozone and particulates, "unhealthy for sensitive groups" (e.g. children, the elderly, and immunocompromised individuals) for 28 days, and unhealthy (all people) for 8 days (*Tables 36* and *37*).

As of 2002, Georgia ranked 5th among the states for SO_2, 10th in CO_2 emissions, and 11th for ozone-contributing NO_x (top contributor in the US, the Bowen Plant) (Southern Alliance For Clean Energy; http://www.cleanenergy.org/ inYourState / subpage.cfm?ID=16). The top two contributors of CO_2 emissions in the U.S. are the Scherer and Bowen Plants; the Bowen Plant also is the number-one contributor of SO_2 emissions and 14th-highest contributor of NO_x emissions. By 2005, the Bowen Plant was to be equipped with two scrubbers to help control SO_2 emissions (Southern Alliance for Clean Energy; website above). By 2013, the Scherer Plant plans to complete an air quality control system that reportedly will remove more than 80% of the mercury, particulates, sulfur dioxide and nitrous oxides from emissions (base, emissions in 2000). While these estimated reductions would be significant, the remainder still would represent a major source of air quality degradation affecting the park.

Acid deposition can adversely affect or kill aquatic life and harm human health (Abelson 1987, Herlihy et al. 1991, Baker and Christensen 1992), and can act synergistically with ozone to harm human health as well (Abelson 1987). The major pollutants from coal-fired power plants, including those involved in acid deposition (SO_2, mostly from coal-fired power plants, and NO_x from coal-fired power plants, car exhausts and other sources) can be transported long distances across airsheds (Schwela 2000). There are four acid deposition sites in Georgia, including three in north Georgia (Summer- Dawsonville, and Hiawassee) and one in central eastern Georgia (McDuffie County). The four sites monitor acid deposition weekly, and the data show a significant increasing trend for acid deposition in north Georgia (*Figure 30*).

Surface Water Supplies: Drinking Water Versus Ecological Needs

Freshwater ecosystems have been evaluated as among the most imperiled of natural environments worldwide, due to human appropriation of freshwater (Gleick 2006). The Chattahoochee River is the most heavily used water resource in Georgia (USGS 2008). The river watershed above Atlanta is the smallest drainage area in the U.S. that provides a major portion of the water supply for a major metropolitan area. The Chattahoochee supplies more than 70% of the drinking water for the greater metropolitan Atlanta area, already more than 450 mgd by ~2000 (Kunkle and Vana-Miller 2000). River water is also used for industrial supplies, irrigation, power generation, navigation and recreation.

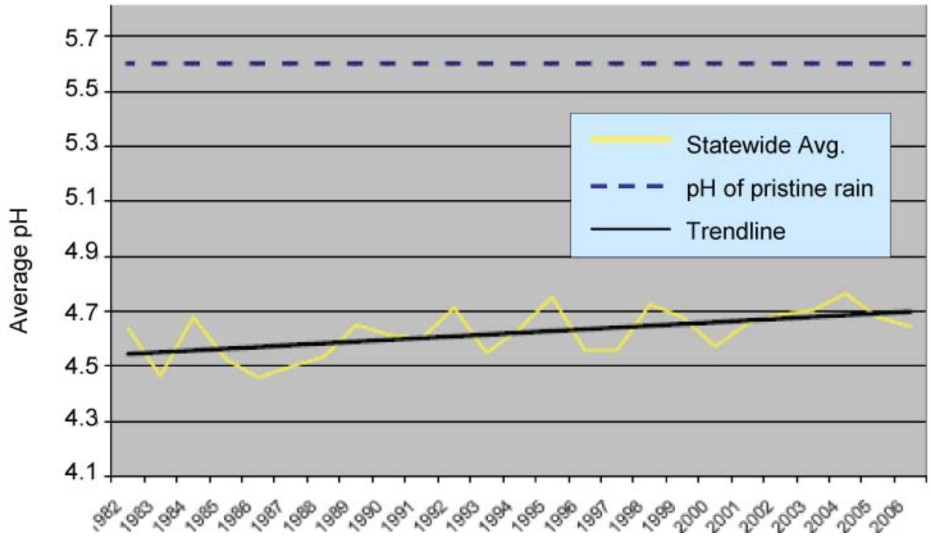


Figure 30. Statewide acid deposition trends (1982-2006; from GA DNR 2007b).

Table 36. U.S. EPA's Air Quality Index (AQI) criteria (modified from GA DNR 2007b).

Maximum Pollutant Concentration								
$PM_{2.5}$ (24hr) µg/m^3	**PM_{10} (24hr) µg/m^3**	**SO_2 (24hr) ppm**	**O_3 (8hr) ppm**	**CO (8hr) ppm**	**NO_2 (1 hr) ppm**	**AQI Value**	**Descriptor (color-coded)**	**EPA Health Advisory**
< 15.4	< 54	< 0.034	< 0.064	< 4.4	None	**0-50**	**GOOD**	Air quality satisfactory; little or no risk from air pollution
15.5 - 40.4	55- 154	0.035 - 0.144	0.065 - 0.084	4.5 - 9.4	None	**51 - 100**	**MODERATE**	Air quality acceptable, but for some pollutants there may be a moderate health concern for a small number of unusually sensitive people
40.5 - 65.4	155 - 254	0.145 - 0.224	0.085 - 0.104	9.5 - 12.4	None	**101 - 150**	**UNHEALTY for Sensitive Groups**	Sensitive groups (people with lung or heart disease) are at greater risk from exposure to particulate pollution, ozone
65.5 - 150.4	255 - 354	0.225 - 0.304	0.105 - 0.124	12.5 - 15.4	None	**151 - 200**	**UNHEALTHY**	Everyone may begin to sustain health effects; members of sensitive groups may experience more serious health impacts
150.5 - 250.4	355 - 424	0.305 - 0.604	0.125 - 0.374	15.5 - 30.4	0.65 - 1.24	**201 - 300**	**VERY UNHEALTHY**	AQI values trigger a health alert; everyone sustain more serious health effects. If related to high ozone, If related to high ozone, restricted to morning or late evening to minimize exposure
250.5 - 500.4	425 - 604	0.605 - 1.004	None	30.5 - 50.4	1.25 - 2.04	**301 - 500**	**HAZARDOUS**	AQI values over 300 trigger health warnings of emergency conditions; the entire populace is more likely to be affected

Table 37. U.S. EPA air quality index (AQI) for the Atlanta metropolitan area in 2006 (pollutants monitored – O_3, SO_2, CO, NO_2, PM_{10}, $PM_{2.5}$). From GA DNR (2007b).

Good (0 - 50)	Moderate (51 - 100)	Unhealthy for Sensitive Groups (101 - 150)	Unhealthy (151 - 200)	Very Unhealthy (201 - 300)
119	210	28	8	0

The Chattahoochee is heavily depended upon for potable water supplies by communities from northeastern Georgia downstream to the Apalachicola Bay, Florida (Jordan and Wolf 2006). As of 2000, the ARC reported 427 million cubic meters of water use from the Chattahoochee River (including Lake Lanier) and tributaries (ARC 2000). As of 2003, inter-basin transfers were reported to remove more than 50 mgd from the Chattahoochee River in the park area (ARC 2003, Johnson et al. 2003). Water pollution, clearly a serious problem in the Chattahoochee River near Atlanta (Couch et al. 1996), would be expected to worsen if increased consumption of water from the river reduces its dilution capacity.

The MNGWPD was created in 2001 by the Georgia General Assembly (Senate Bill 130) to address water resource requirements for the rapidly growing Atlanta metropolitan area while also attempting to preserve and protect water resources in 16 counties surrounding metropolitan Atlanta, including the five counties in the park area. The District described pollution from urban stormwater runoff, treated sewage, and other sources as an increasing, serious challenge in efforts to ensure safe drinking water. Water supply service needs are projected to double in the Atlanta metropolitan area by 2030, and it has been projected that by 2030, all major sources of water supply may be fully tapped (GA DAA 2005). If there is moderate population growth in the area, it is projected that water demand by 2030 will be 1,035 million cubic meters per year. If high population growth occurs, water demand by 2030 is predicted to be at ~1,190 million cubic meters per year. In either case, about 480 million cubic meters of the demand would have to come from increased withdrawals from the Chattahoochee and Etowah Rivers (MNGWPD 2003, Fitzhugh and Richter 2004). After years of negotiation, however, the states have failed to reach agreement on a formula for allocating water in the Chattahoochee Basin (Jordan and Wolf 2006). Recently, in fact, a federal judge fundamentally has questioned whether the City of Atlanta has the legal right to depend upon Lake Lanier as its primary source of drinking waters (Shelton 2008).

The park, in its vulnerable location immediately downstream from Lake Lanier, stands to be significantly affected by the Tri-State Compact with respect to the amount of water that will be available to it. As development and associated water demands continue to increase rapidly, the upper Chattahoochee is expected to become increasingly sensitive to droughts. Droughts are a key factor in efforts to agree upon water allocations among Georgia, Florida and Alabama (GA DAA 2005).

Groundwater

Whereas surface water withdrawals in the Chattahoochee basin were projected to be about 460 mgd by 2005, groundwater withdrawals were projected to be only about 4 mgd (GA DNR 1998a). Despite the fact that surface water provides most of the supply for municipal and industrial use, reduction in groundwater reserves is occurring in the park area (Lettenmaier et al. 1999, Baron et al. 2008).

Soil surveys for Cobb, Fulton, Forsyth, and Gwinnett Counties indicate that most of the soils in the area have moderate or severe limitations for septic tank use (National Resources Conservation Service 1996). However, the rapidly expanding urbanization of the area surrounding the park includes many subdivisions with septic tanks, built outside present sewerage districts (Kunkle and Vana-Miller 2000). Groundwater in areas of urban land use is also generally more vulnerable to contamination by potentially toxic VOCs, and recharge of VOCs to groundwater may be enhanced in urban areas by structures such as recharge basins and shallow injection wells (Zogorski et al. 2006).

Ecosystem Effects

Urban Pollution and Aquatic Food Webs: During 1998-2003, GA DNR studied fish populations in the Chattahoochee River basin, and used an Index of Biotic Integrity (IBI) and modified Index of Well-Being (IWB) to identify fish population health as Excellent, Good, Fair, Poor, or Very Poor. Long Island Creek and Suwanee Creek, listed as "biota-impacted" streams on the state's 303d list of impaired waters (*Table 30*), had IBI values indicating that fish community health was "Poor" or "Very Poor" (GA DNR 2008e). However, the present 303d list appears to miss some if not many impaired aquatic ecosystems in the park. As noted on p.48 and in *Tables 15* and *16* of this Report, 7 of 8 streams, including Richland, Dick, Suwanee, Crooked, Marsh, Rottenwood, and Little Nancy Creek, that were characterized for fish communities in 1999 or 2005-2007 were evaluated as Poor or Very Poor in ecological condition, including consideration of the IBI as well as various ecosystem features. The eighth stream, Johns Creek, received the best evaluation which was only a "Fair". These findings were supported by evaluation of macroinvertebrate communities from nine streams near or in the park, using GA DNR's (2007c) GBP. As indicated on p.43 and in *Tables 11* and *12* of this Report, Richland, Level, Johns, and Crooked Creeks, and Suwanee Creek were all evaluated as "Poor" to "Very Poor" in macroinvertebrate community ecological condition; Marsh Creek was evaluated as "Fair" to "Poor"; and Dick Creek, Rottenwood Creek, and Little Nancy Creek were evaluated as "Fair". Thus, the highest ranking was only "Fair".

As mentioned, a general cause identified for the impairment has been lack of viable habitat due to stream sedimentation (GA DNR 2007a). Fish are at the apex of the stream food webs. Their Fair/Poor to Very Poor rankings suggest that urban pollution has caused serious degra-dation and loss of biodiversity for the park's aquatic flora and fauna in other trophic levels, as well. The stream and wetland food webs likely are also affected by pathogenic microbes whose presence is indicated, to some extent, by high fecal coliform bacteria densities, and by toxic substances from urban runoff. A telling sign is the success of the exotic invasive fish species, the red shiner. This species is common in Rottenwood Creek in the park (*Tables 14* and *15*), and likely will be found to be common or abundant in other park streams as data become available. This species thrives under harsh conditions such as low flow, high turbidity, and poor water quality, and it aggressively colonizes severely degraded habitats.

The draft Management Plan for the park (NPS 2008a) identified several key issues of concern in continuing efforts to protect natural and cultural resources, in recognition of the fact that the park is surrounded by rapidly developing communities and thus is highly sensitive to the many impacts of encroaching urbanization and overuse. The Plan states that increased sediment loading to surface waters from adjacent land disturbance and development is expected to exacerbate soil/bank erosion in the park's streams, and to further degrade water quality and adversely affect aquatic life. Fish in park waters are also carrying a body burden of toxic substances, based upon present fish consumption guidelines posted by GA DNR (2008h; see below).

Air Pollution and Park Resources: The natural resources of the park are being adversely affected by air pollutants such as ozone that can cause foliar injury to terrestrial and emergent wetland vegetation (GA DNR 2007b). The Scherer and Bowen Plants are also major emitters of mercury and particulates (see http://www.opc.com/TheEnvironment/FutureImprovements/index.htm). Elevated CO_2 emissions in the park area, from the Scherer Plant and other sources, are contributing to global warming which is projected to have long-term, significant adverse impacts on ecosystems in central Georgia, as across the globe (Penuelas and Filella 2001, United Nations IPCC 2007).

Baron et al. (2008) described climate change as already redefining U.S. national parks, including this park, and advised park managers to begin to include climate change considerations into all activities and plans. To increase resilience of the natural biota, Baron et al. (2008) recommended reducing habitat fragmentation and loss, invasive species, and pollution; protecting important ecosystem and physical features; restoring damaged systems and natural processes; and reducing the risks of catastrophic loss through establishing refugia, relocating valued species, replicating populations and habitats, and attempting to maintain representative examples of beneficial species populations. The extent to which any of this can be done for this park is unclear, given the major urbanization that surrounds it. Pervasive, chronic damage to the park's natural resources from air as well as water pollution, over the past decades and projected to increase, is a major concern.

Invasive/Exotic and Nuisance Species: Invasive/exotic and nuisance species are an increasing concern for this park. One of the 14 Park Units is included in the NPS Southeast Coast Network's Exotic Plant Management module that is being managed by Cumberland Island National Seashore (DeVivo 2006). Although numerous invasive/exotic species are thriving in the park, little is known about the present status of their impacts on native terrestrial flora and fauna, and information is also mostly lacking about the extent to which exotic aquatic species threaten the park's surface waters and wetlands. Large floating mats of parrotfeather watermilfoil have been identified as a concern in some Park Units because of displacement of native flora and provision of mosquito breeding habitat (Hay and Parker 2003).

Human Health Issues

The high fecal coliform concentrations that commonly characterize about three-fourths of the park's surface waters (Sections I-III) indicate degraded conditions as well as the potential presence of pathogenic microbes that can cause hepatitis, gastroenteritis, gangrene, dysentery, ear infections, and other human illness (2008a). These waters sometimes contain fecal coliform levels that are unacceptable for human health safety during water-contact recreational activities (2008a) (*Plate 24*). Moreover, as an important, renewable source of drinking water, the health of the Chattahoochee River is a serious concern to millions of people both in the Atlanta metropolitan area and downstream from it to the Apalachicola Bay, Florida.

Plate 24. Sign posted by the NPS, warning of human health hazard from high fecal coliform bacteria in the Chattahoochee River in the Park. Photo by the NPS in 2001 (available at http://ga2.er.usgs.gov/bacteria/SummaryAll.cfm).

Fish in the Chattahoochee River were sampled in 1995 by GA DNR-EPD for 43 parameters including pesticides, herbicides, PCBS, and various other toxic organic substances. Of the 43 parameters, levels of Hg, PCBs, and chlordane above those recommended by the U.S. EPA and the State of Georgia for fish consumption were measured in fish from some locations of the park (Kunkle and Vana-Miller 2000). The most recent fish consumption guidelines (GA DNR 2008h) indicate an ongoing problem: people are advised to consume no more than one meal per week of largemouth bass taken from the river segments from Buford Dam to Morgan Falls Dam because of mercury contamination. Restrictions are not presently advised for consumption of common carp, brown trout, rainbow trout, or yellow perch. For fish taken from river segments extending from Morgan Falls Dam to Peachtree Creek, GA DNR (2008h) advises eating no more than one meal per week of jumprock sucker because of mercury contamination, and no more than one meal per month of common carp because of PCB contamination. Restrictions are not presently advised for largemouth bass below Morgan Falls Dam, or for brown trout or bluegill sunfish.

There is strong potential for adverse chronic impacts of ozone and $PM_{2.5}$ air pollutants on the health of park staff and frequent visitors. As of 2004, the State of Georgia ranked 11th in the nation for total deaths, 11th for hospitalizations, and 11th for heart attacks related to fine-particulate pollution from coal-fired power plants (American Lung Association 2004; Southern Alliance for Clean Air 2004, at http://www.cleanenergy.org/inYourState/subpage.cfm?ID=16).

Air pollution is also contributing to high incidence of asthma for children in the area (Clean Air Task Force 2002). As mentioned, air quality in the greater Atlanta metropolitan area was evaluated as only “moderate” for 210 days in 2006 because of ozone and particulates, “unhealthy for sensitive groups" (e.g. children, the elderly, and immunocompromised individuals) for 28 days, and unhealthy (all people) for 8 days (*Tables 36* and *37*). Elevated levels of these fine particles have been linked to increased illness and premature death from heart and lung disorders such as asthma and chronic bronchitis. NO_x also react with volatile organic compounds to form ozone which, as mentioned, causes lung inflammation, asthma, emphysema, and increased morbidity/ mortality risks in humans. Acid precipitation causes and aggravates many human respiratory diseases, and is estimated to be the third largest cause of lung disease in the U.S. (after smoking and indoor radon). Elevated CO_2 emissions in the greater Atlanta metropolitan area, from the Scherer and Bowen Plants and other sources, are contributing to global warming which is projected to have long-term, significant repercussions for adverse human health impacts in the park and the surrounding region (e.g. Cifuentes et al. 2001, Patz et al. 2005).

Other Issues of Concern

Population Growth and Land Use Changes

The expanding Atlanta Metropolitan Area is adding more than 100,000 new residents per year(e.g. April 2006 - April 2007; ARC 2007). About 4.5 million people now reside there – a population larger than 24 states, according to 2006 U.S. Census estimates. The counties surrounding the park are among the fastest growing in the nation (MNGWPD 2008, NPS 2008a). It has been estimated that by 2035, nearly seven million people will reside in the Metropolitan North Georgia Water Planning District (*Figure 31*), which includes the park area; and 2,206,000 people will be employed in the Atlanta metropolitan area, representing growth of 40% over the 2000 employment base (ARC 2001, CH2MHill 2003, MNGWPD 2008). Major construction of industrial, commercial, and housing developments has occurred over the past two decades and continues to rapidly expand close to this narrow, linear park. By 2030, it is predicted that 75% of the land use in the upper Chattahoochee basin will be urban/residential; agricultural use will decline by 75% and undeveloped lands will decline by 50%, while urban land use will increase by 33% and residential land use almost double (CH2MHill 2003, MNGWPD 2008; *Figure 32*).

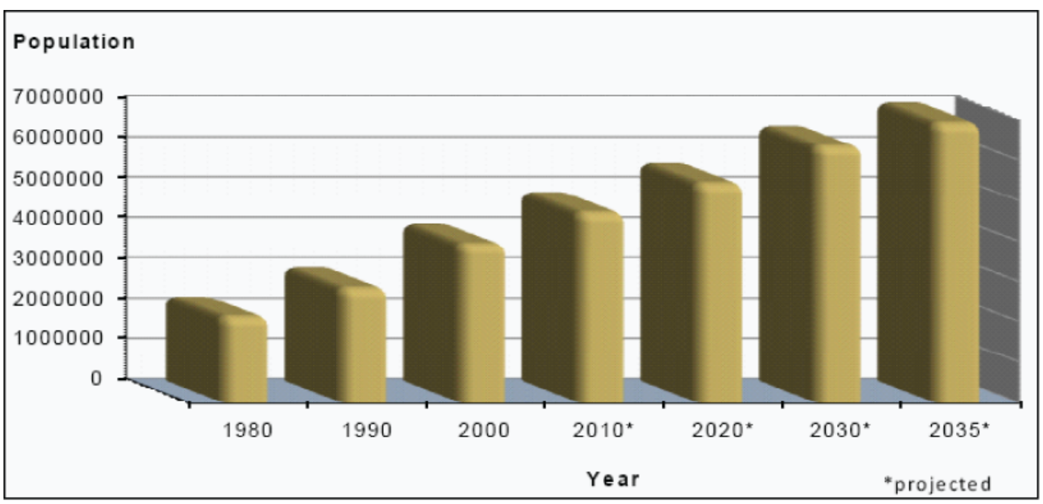


Figure 31. Historical population growth in the Metropolitan North Georgia Water Planning District, which includes the study area (see *Figure 32*), from 1980 to (projected) 2035. Sources for these data were the U.S. Census Bureau (1980-2000) and the Atlanta Regional Commission (2010-2035), as given in MNGWPD (2008).

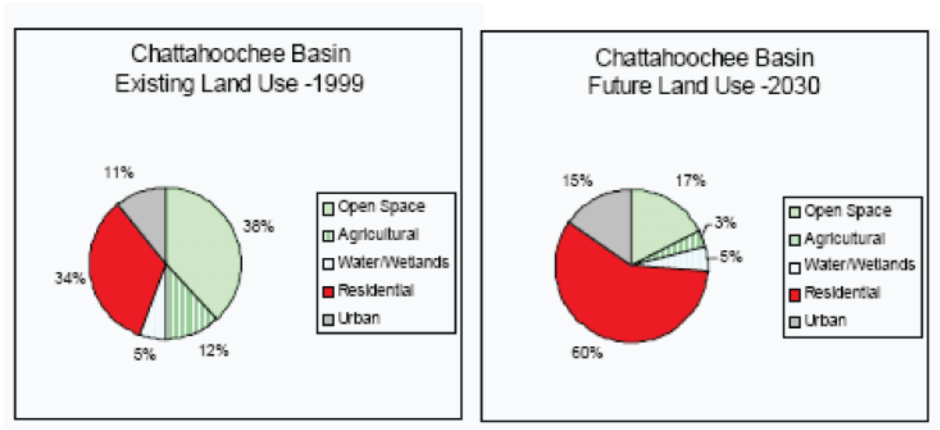


Figure 32. Projected land use changes in the upper Chattahoochee River basin by 2030. From CH2MHill (2003).

Physical Impacts From Activities in the Park

The new Management Plan (draft, 2008x) addresses major concerns about projected major increased levels and types of visitor use. Key questions considered were:

- How can the park accommodate increasing numbers of visitors while continuing to provide effective infrastructure such as water and wastewater facilities, roads, and parking areas?; and
- How can the park provide effective educational and interpretive programs for increasing numbers of visitors?

A major concern is that encroaching development is leading to creation, by people in adjacent residential areas, of numerous informal, unmaintained trails in the park (*Plate 25*). These "social trails" disturb native vegetation and can cause soil erosion, especially in more steeply sloped areas (NPS 2008a). A second concern is that the construction and operation of the facilities (drinking water, wastewater) and infrastructure (roads, parking areas) needed to accommodate projected increased numbers of visitors will adversely affect the park's natural resources.

Plate 25. Informal, unmaintained "social trail" immediately adjacent to the park, also showing a home from an adjacent low-density housing development. Photo by E. Morris, 2008.

There have been problems with lack of parking for park visitors since the 1990s (NPS 2004b). Limited parking facilities and an abundance of adjacent residential neighborhoods have led many visitors to walk or bicycle to the park. Informal access or social trails are especially prevalent around Island Ford, McGinnis Ferry, Johnson Ferry, Vickery Creek, and Palisades (NPS 2004b). Transit service is not provided within the park, and pedestrian/bicycle/vehicle conflicts have continued to be a problem in Park Units such as Island Ford and Jones Bridge. The general public has expressed concern about conflicts between local private property owners and park-on acquisitions, and has identified a need for improved traffic and safety and improved parking and roads to access the park (NPS 2004b). Crowding problems with multi-users extend to the Chattahoochee River itself: For example, as recreation use continues to increase along the river, the potential is expected to increase for sand and gravel mining to cause aesthetic or safety concerns, or otherwise conflict with recreational activities (NPS 1989). Related other stressors to the park's natural and historic resources include heavy use and erosion of hiking trails (e.g. *Plate 26*).

Plate 26. Erosion of a park path near Willeo Creek. Photo by E. Morris, 2008.

Some park areas have additional protection from physical disturbance. For example, park lands and waters north of Highway 120 (Abbotts Bridge Road) and all parklands acquired since 19 December 1999 are closed to pets to help protect wildlife. A notable exception is that horses are allowed to used designated equestrian trails on the Forsyth County side of the Bowmans Island Unit (NPS 2008a). Acquisition for horses is impractical elsewhere in the park, considering the limited trail mileage and steep sections that would be highly vulnerable to erosion. Other precautions are taken to protect park wildlife, since the Park Units are basically green islands in an urban setting. The park is closed to viewing of wildlife with artificial lights. It is also prohibited to take wildlife from the park, which helps to discourage poaching. Motor boats are not allowed at Island Ford and Sibley Ponds, which are small ponds that are used for environmental education programs and fishing. The area surrounding the Ivy Mill Ruins, a fragile site that is eligible for the National Register of Historic Places, is closed to visitors because they could not be accommodated without permanent damage to the resources (NPS 2008a).

Other Continuous Land Issues and Impacts

A major recreational value that has been expressed by visitors is “the desire to achieve a sense of solitude within natural areas of the park” (NPS 2008a). Noise pollution from the high-volume traffic and other activities of the surrounding Atlanta metropolitan area has been identified as a major concern affecting park wildlife and visitors (NPS 2008a). The “endless days” phenomenon created by considerable light pollution is an accompanying concern. Illicit dumping and other inputs of trash and refuse are a chronic problem for many areas of the park (NPS 2008a), and spillover crime from the Atlanta metropolitan area is another ongoing concern.

Synopsis of Stressors to the Park

The present and potential stressors that are affecting or may affect the park are summarized in *Table 38*. Overwhelmingly, the most pressing stress on the natural resources of the park is from adjacent urbanization and the multitude of water quality and air quality impacts associated with the voracious, rapidly expanding and massive development of the greater Atlanta metropolitan area. The amount of stormwater runoff has increased dramatically over the past 30 years in this urbanizing area (GA DAA 2005). Excessive nutrients, heavy metals, PCBs, and very likely other toxic contaminants such as pesticides are adversely affecting the park's streams. Microbial pathogens are a pervasive problem in most Park Units, indicated by high fecal coliforms, and they may be adversely affecting fish and other aquatic life as well as posing a threat to human health. The park provides an extreme example of a situation that typifies many other parks in the SECN (Byrne 2004), with surface waters downstream from 303(d)-listed degraded waters outside NPS jurisdiction. A total of 15 of 18 major tributaries along the 48-mile segment of the Chattahoochee River are degraded, most of them throughout their entire length, and about two-thirds of the river segment in the park area is degraded as well.

Over the past several years park visitation has incrementally decreased, despite Atlanta's record-breaking population growth (NPS 2004b). A suspected cause is public perceptions about degraded water quality and related health issues (NPS 2004b). As mentioned, in 2000 the Apalachicola-Chattahoochee-Flint River basin was listed in the top ten most endangered American rivers (see http://www.americanrivers.org/site/PageServer?pagename=AR7_MER). The increasing demands on water supplies from human population growth also pose an increasing threat to surface and groundwater resources in the park over the coming decades.

Surface water quality and aquatic communities are sustaining impacts from air pollution including acidification, mercury and other heavy metals etc. The seasonal or lower frequency of sampling to evaluate water quality is insufficient to detect the spikes in these pollutants that are known to occur depending upon weather patterns. Thus, for example, available pH data are inadequate to evaluate the extent to which acid spates (sudden influxes of highly acidic water at the beginning of storm events) are affecting the aquatic food webs (e.g. Morris et al. 1989). Air pollution likely is also adversely affecting terrestrial vegetation, for example, as foliar damage from high ozone in the park area. In addition, the high ozone and $PM_{2.5}$ levels in the park airshed pose a threat to the health of park staff and frequent visitors.

Table 38. Present-day and potential stressors that are affecting or may affect the park's natural resources (ND = no data or insufficient data to make judgment; NA = not applicable; NP = no problem; EP = existing problem; PP = pending problem).

Stressor	Surface Waters	Groundwater	Airshed	Forest	Human Health
Acidification	EP	ND	EP	EP	EP
Algal blooms	EP	NA	NA	NA	ND
Encroaching urbanization*	EP	EP	EP	EP	EP
Erosion (including dust)	EP	ND	EP	EP	EP
Excessive nutrients**	EP	ND	EP	EP	NP
Exotic invasive species	EP	NA	ND	EP	ND
Fecal bacteria, other microbial pathogens	EP	ND	NA	ND	EP
Habitat disruption	EP	EP	NA	EP	EP
Highway construction	EP	ND	EP	EP	EP*
Hypoxia	EP	NA	NA	NA	NP
Light pollution	ND	NA	NA	ND	ND
Metals contamination	EP	ND	ND	ND	EP
Noise pollution	ND	NA	NA	EP	EP
Ozone pollution	ND	NA	EP	EP	EP
Particulate matter pollution	EP	EP	EP	EP	EP
Other toxic substances	EP	EP	EP	ND	ND
Sedimentation	EP	ND	EP	NA	EP
Temperature alteration below Buford Dam	EP	NA	NA	NA	NA
Trash/refuse pollution	EP	ND	NA	EP	ND
Urban island heat effects	EP	ND	EP	ND	EP
Water demand	EP	PP	NA	ND	EP/PP

* Will increase likelihood of collisions with wildlife.

** Is adding more air pollution because of car exhausts.

A diverse group of invasive/exotic and nuisance plant and animal species threatens the natural resources of the park. In addition to known significant effects of exotic species on land resources, increasing urbanization surrounding the park may be promoting an increase in nuisance native or invasive species such as foxes, coyotes and deer, and associated negative effects. Aside from species lists, however, little is known about aquatic impacts from invasive/ exotic species.

Over the past ~decade, the size of floodplains has been increasing in the metropolitan Atlanta area because of increased stormwater runoff, resulting in severe stream bank erosion, loss of land and vegetation, and other damage (see http://apps.atlantaga.gov/citydir/dpcd/cdp/section_1121291920390.html_). In addition, the area is sustaining an "urban heat island" effect because of increased temperatures from the large amount of impervious area (see above website; also, Paul and Meyers 2001, Center for Watershed Protection 2003).

Illicit dumping and other inputs of trash and refuge are a major problem in the park area (e.g. *Plate 15*). In 2000, for example, the city of Atlanta was required by a federal consent order to remove 568 tons of trash, including seven cars, from tributaries to the Chattahoochee (Georgia River Network; see http://www.garivers.org/pdf_files/river_basin_facts/chattahoochee.pdf). Other concerns are the numerous social trails that disturb native vegetation and cause soil erosion, potential impacts on natural resources of the park from continued construction and operation of facilities and infrastructure needed to accommodate visitors, noise and light pollution from surrounding urban activities, and spillover crime from the Atlanta metropolitan area.

Recommendations To Address Impairments, Potential Impacts, and Undocumented Water Bodies

General Comments

The Chattahoochee River National Recreation Area was established to protect and preserve the values of the river from "development and other uses that would otherwise impair or destroy them…for the public benefit and enjoyment" (NPS 2008a). Regardless, clearly this park is under siege from the relentless urbanization that surrounds it.

Within the past decade, the GA DNR has developed various TMDLs for the Chattahoochee River and most of its tributaries in the area that includes the park (GA DNR 1998, 2003a,b, 2007a, 2008a). The TMDLs are supposed to be "platforms for establishing courses of actions to restore water quality" (GA DNR 2008a); procedures are to be set in place to track and evaluate implementation of corrective management practices and activities. It is imperative that the State of Georgia legislature and environmental agency track and ensure the effectiveness of the TMDLs for the Chattahoochee River and tributaries affecting the park's water quality. The following additional recommendations can be addressed within NPS jurisdiction.

Specific Recommendations

The following major recommendations consider the information from this Report (past ~decade), and also revisit the recommendations put forth in the Chattahoochee Water Management Plan of 2000 (Kunkle and Vana-Miller 2000) and in NPS (2004a) as a means of assessing progress in protecting the park's natural resources. Certain of the recommendations from about a decade ago have been addressed here or elsewhere. For example, this Report is accompanied by the water quality data available for park surface waters as referenced therein, contained within Excel files in electronic format. Thus, it addresses the primary technical assistance recommendation made by Kunkle and Vana-Miller (2000), namely, to conduct a more complete inventory and analysis of the past ~decade of water quality data available from the counties, state, STORET, USGS NWIS, and other sources. In other efforts, since the 2000 Plan's publication, sewer pipeline information has been compiled in GIS maps as a tool to help track pipeline and manhole sewage leaks into park waters. The NPS has also been instrumental in helping to develop better guidelines for instream sand and gravel mining. In addition, the NPS has worked to evaluate land acquisition options from a water resource protection perspective. However, the following recommendations from that Plan, germane to this Report, remain to be addressed or should be more strongly addressed. Additional recommendations (*) are based upon consideration of the compiled data of the past ~decade.

- A top priority is to conduct a one-year sampling program in park surface waters including the Chattahoochee River and its major tributaries with biweekly or, at a minimum, monthly sampling frequency. At least two stations in each of the four sections of the park and at least one station on each tributary should be sampled for, at a minimum, water temperature, pH, dissolved oxygen, suspended solids, turbidity, nutrients (TN, TP, nitrate, ammonium, BOD_5), fecal coliform densities, and chlorophyll *a* concentrations. This effort should be repeated at three-year intervals. This program should include additional monitoring of representative storm events because they are known to contribute most nonpoint source pollution from urban runoff and other sources.*

- Once per year during an appropriate seasonal timeframe, the fish and macroinvertebrates (benthic fauna, aquatic insects) should be assessed at these stations.*

- Data should be collected at least quarterly on toxic substance concentrations in *sediments*
- and *fish* tissues. Parameters of focus should include, at a minimum, cadmium, copper, lead, zinc, mercury, and PCBs.*

- The NPS developed a bacterial water quality monitoring program, BacteriALERT, to help safeguard human health safety in the park's recreational waters. BacteriALERT includes a system that displays water pollution and water quality information, although limited to fecal bacteria and turbidity. The program, originally with three stations, is now down to two, and three had been inadequate to accomplish the program goal. This important program needs to be expanded strategically to include additional stations in park waters.*

- As a fifth top priority, data from the above three recommendations should be used to prioritize restoration of degraded areas, and to identify the major actions that will be needed.*

- As a sixth priority, updated economic evaluation is needed of the recreational value of the park, including the economic threat of water quality degradation.*

- Some of the major existing sources of water quality impacts on the park's aquatic resources have been identified in this Report. Inventory of other major sources of water pollution, for which computerized information mostly is not available, is needed for septic tanks in large-scale subdivisions, new highway projects, numerous new shopping centers, and other sources that are being added through the rapid surrounding increase in urbanization and urban sprawl. The data should be used to create GIS maps of these sources, and these maps can be upgraded to help the NPS track pollution and its impacts in park waters.

- The NPS should confer with the USACE and other agencies to evaluate the effects of the Tri-State Water Allocation Formula, once approved and applied, to assess whether the allocated flows are sufficient to support recreation and healthy fisheries in the park.

- The NPS should also work with the USACE to address more effectively the bank sloughing problem caused by hydroelevation surge flows.

- Wetlands in each park unit should be more clearly delineated and described. Large-scale as well as more detailed maps are needed, and wetland vegetation should be inventoried.

- A sampling program is needed to establish present conditions and track exotic/invasive species, and assess their impacts on aquatic and wetland resources in the park, so that park staff can develop active management strategies to optimize control.*

- The streams in Park Units nearest the Buford Dam (especially Bowmans Island) should be monitored for stream bank erosion from water release activities, and for tree damage.

- The NPS should assess incidence of foliar injury to park plants from ozone pollution, including common wetland bioindicator species such as yellow poplar and American elder. More generally, data are needed to assess the extent to which air pollution is affecting the park, and to forecast how increasing air pollution from the greater Atlanta metropolitan area will affect its waters and other natural resources.*

- The park should continue to work to strengthen education outreach to teach visitors about the importance of greenspaces such as this park in ecosystem sustainability.*

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Appendix 1. USGS discharge and stream height data for the Chattahoochee River and tributaries in or within ~five miles upstream from the park, considering active or recently maintained stations

See Table 7 for more information about the stations.

USGS 02334430 CHATTAHOOCHEE RIVER AT BUFORD DAM, NEAR BUFORD, GA

Annual Averages

Water Year	00060, Discharge, cubic feet per second	00065, Gage height, feet
1956	855.4	
1957	855.7	
1958	910.9	
1959	1,591	
1960	2,397	
1961	2,170	
1962	2,497	
1963	2,011	
1964	2,840	
1965	1,994	
1966	1,791	
1967	2,167	
1968	2,884	
1969	2,012	
1970	1,975	
1971	1,748	
1972	2,601	
1973	2,775	
1974	2,307	
1975	2,346	
1976	2,887	
1977	2,113	
1978	2,310	
1979	2,249	
1980	2,904	
1981	1,309	
1982	1,269	
1983	2,179	
1984	2,414	
1985	1,367	
1986	1,242	
1987	1,389	
1988	1,152	
1989	1,132	
1990	2,960	
1991	1,902	

Water Year	00060, Discharge, cubic feet per second	00065, Gage height, feet
1992	1,818	
1993	3,089	
1994	1,596	
1995	2,248	0.441
1996	2,665	0.732
1997	1,842	0.229
1998	2,660	0.792
1999	1,093	-0.228
2000	1,209	-0.141
2001	880.6	-0.406
2002	756.9	
2003	2,038	
2004	1,568	
2005	2,494	
2006	1,633	0.141
2007	1,103	

USGS 02334430 CHATTAHOOCHEE RIVER AT BUFORD DAM, NEAR BUFORD, GA

Monthly Averages

YEAR	00060, Discharge, cubic feet per second, Monthly mean in cfs (Calculation Period: 1955-10-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1955										579.5	717.4	716.7
1956	706.2	626.8	619.0	1,421	1,808	1,040	996.6	512.1	515.9	535.6	577.7	470.4
1957	486.0	506.6	1,796	3,296	685.6	424.2	531.9	486.0	482.7	427.1	536.2	431.9
1958	431.1	558.5	465.8	655.5	564.5	732.6	1,054	2,227	2,850	1,531	1,241	1,506
1959	2,235	677.1	463.0	481.2	1,110	2,407	2,493	2,845	2,003	1,430	1,349	2,193
1960	1,602	3,409	2,731	4,273	2,029	2,394	2,215	2,687	2,546	1,200	2,428	2,047
1961	1,697	1,222	2,392	3,449	2,303	2,057	2,571	2,714	1,902	1,969	1,885	2,523
1962	3,617	1,788	4,262	4,338	2,046	2,203	1,314	1,961	2,008	1,938	3,837	736.3
1963	732.2	728.9	833.6	2,641	3,778	1,507	3,119	2,825	1,368	1,648	2,161	1,090
1964	1,554	2,976	4,428	6,996	6,799	1,956	1,684	1,518	1,315	2,405	2,846	1,884
1965	1,416	1,202	2,563	3,008	1,986	1,808	1,553	1,479	1,745	1,188	1,106	946.2
1966	964.7	1,693	3,725	1,590	2,931	2,395	1,509	1,682	1,744	1,600	1,143	1,336
1967	2,208	1,760	1,823	1,273	1,783	3,503	2,355	2,963	4,266	3,548	2,693	3,682
1968	4,688	2,681	2,504	2,501	2,070	1,864	2,281	3,040	2,992	2,141	1,430	1,122
1969	1,399	1,325	1,573	3,371	2,222	1,687	2,962	2,097	2,789	1,664	3,759	2,458
1970	1,319	1,297	1,145	837.7	1,092	1,910	2,065	3,003	3,146	3,287	1,307	1,134
1971	1,048	888.8	864.8	1,147	1,842	1,507	1,850	3,921	2,066	2,773	2,613	1,351
1972	3,310	3,643	2,665	1,495	2,479	2,101	2,011	3,051	3,772	3,133	1,201	1,039
1973	1,084	3,633	3,527	4,185	3,937	4,969	2,411	2,433	1,864	1,996	2,522	1,279
1974	3,561	3,104	1,333	3,810	2,499	1,831	1,797	2,232	1,824	3,617	4,093	1,163
1975	1,122	1,348	3,333	3,796	2,708	1,815	1,407	1,877	1,849	1,686	2,099	2,159
1976	2,764	2,652	2,607	5,701	3,740	3,992	2,685	2,516	2,102	1,350	1,347	1,047
1977	1,272	1,089	2,497	5,834	2,249	1,985	2,126	2,636	1,903	1,128	1,414	2,410
1978	4,134	3,701	2,307	1,741	2,021	1,600	2,071	2,736	2,524	3,059	2,340	1,120
1979	1,141	1,073	1,296	5,170	4,034	2,334	1,679	2,111	1,598	2,276	2,048	1,535
1980	2,840	2,065	4,156	6,716	3,643	2,408	2,397	2,459	2,306	1,944	1,079	1,093
1981	985.0	990.3	1,030	835.9	901.3	1,042	1,500	2,138	2,137	2,121	2,022	1,156
1982	964.0	966.4	963.1	1,015	993.8	1,001	1,066	1,313	1,635	1,171	1,062	1,979
1983	2,013	2,608	2,696	3,706	2,535	1,986	2,112	2,736	1,575	1,509	1,694	1,388
1984	2,587	2,665	2,941	2,911	4,009	1,938	1,944	3,233	2,136	1,800	1,653	1,055
1985	1,010	944.4	1,126	984.4	961.6	1,359	1,846	1,702	1,937	1,403	1,319	1,287
1986	1,087	960.2	981.8	982.2	1,056	1,164	2,271	1,280	1,069	1,044	1,032	994.4
1987	874.8	784.3	685.5	1,522	1,089	1,238	1,762	2,909	2,707	1,882	1,351	1,033
1988	858.8	847.4	962.5	917.0	1,010	1,214	1,317	1,257	1,160	1,054	1,046	974.1
1989	818.6	802.4	729.3	705.2	826.4	784.1	1,225	2,363	2,226	2,430	2,163	1,838
1990	3,002	5,846	5,077	3,856	2,185	2,078	2,304	2,781	2,193	2,208	1,767	1,368
1991	1,056	1,017	778.6	1,151	3,647	1,858	2,115	2,385	3,405	3,983	1,615	1,011
1992	1,132	1,034	1,921	2,047	2,134	1,467	2,461	1,635	1,296	2,263	1,952	4,900
1993	5,833	3,508	3,520	3,935	2,448	2,312	2,487	1,978	1,898	2,047	1,151	1,189
1994	1,002	986.8	844.2	812.8	1,066	1,764	1,320	3,793	3,137	1,258	1,598	2,289

USGS 02334430 CHATTAHOOCHEE RIVER AT BUFORD DAM, NEAR BUFORD, GA

Monthly Averages (cont'd.)

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1955-10-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	2,337	3,401	4,058	1,281	2,029	1,829	2,178	2,246	2,524	1,317	1,503	1,724
1996	2,773	6,504	4,226	2,535	2,873	2,228	2,221	2,449	1,788	1,572	1,164	1,014
1997	995.4	1,529	3,090	2,103	2,254	2,432	1,674	1,799	2,477	1,811	1,216	1,343
1998	2,569	5,325	4,404	3,357	3,654	2,335	2,645	1,731	1,722	1,337	1,208	963.0
1999	801.0	786.0	860.7	910.9	982.8	1,523	985.3	1,320	1,428	1,097	1,024	1,066
2000	828.4	857.4	866.4	859.7	1,073	1,883	1,841	1,974	1,113	1,168	958.2	968.9
2001	863.6	769.7	598.9	628.9	791.3	697.0	1,002	1,148	952.4	869.2	776.1	747.4
2002	585.2	592.7	515.6	564.4	608.0	799.7	887.1	1,032	1,096	971.8	788.7	766.7
2003	961.9	1,494	3,191	1,883	4,025	2,976	3,483	2,246	1,591	1,380	1,747	2,089
2004	2,107	1,370	1,229	931.5	912.9	955.8	1,612	1,558	2,923	2,495	1,485	3,652
2005	1,978	1,762	2,410	2,983	1,906	2,750	3,139	3,185	2,090	1,245	1,289	2,164
2006	2,446	1,823	1,554	1,761	2,193	1,540	1,145	1,243	1,191	1,199	960.7	962.6
2007	847.3	867.8	902.2	922.6	1,128	1,525	1,147	1,284	1,486			
Mean of monthly Discharge	1,740	1,860	2,080	2,420	2,150	1,870	1,900	2,170	2,010	1,780	1,640	1,510

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 1993-10-01 -> 2006-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993										0.377		-0.267
1994	-0.394			-0.520					0.893	-0.203	0.007	0.449
1995	0.463	1.105	1.530	-0.166	0.415	0.248	0.412	0.450	0.605	-0.040	0.038	0.146
1996	0.785	3.074	1.666	0.742	0.831	0.452	0.444	0.567	0.179	0.055	-0.207	-0.305
1997	-0.326	0.029	1.00	0.395	0.512	0.610	0.135	0.206	0.644	0.225	-0.168	-0.075
1998	0.739	2.621	1.942	1.289	1.446	0.542	0.749	0.157	0.167	-0.054	-0.165	-0.316
1999	-0.430	-0.447	-0.406	-0.365	-0.296	0.050	-0.264	-0.053	0.006	-0.214	-0.236	-0.197
2000	-0.401	-0.399	-0.393	-0.390	-0.239	0.297	0.245	0.369	-0.152	-0.076	-0.241	-0.280
2001	-0.414	-0.496	-0.690	-0.661	-0.531	-0.597	-0.366	-0.217			-0.396	-0.432
2002	-0.646	-0.658	-0.713	-0.673	-0.631	-0.460	-0.375	-0.257		-0.275	-0.428	-0.471
2003	-0.370	0.038	1.335	0.338		1.109			0.203	0.073	0.323	0.527
2004		0.106	-0.017	-0.289	-0.297	-0.268	0.192	0.146	1.076		0.061	1.478
2005	0.383	0.206	0.705	1.103	0.329	0.907			0.490	-0.099	-0.089	0.477
2006	0.700	0.307	0.077	0.212	0.541	0.107	-0.201	-0.142	-0.203			
Mean of monthly Gage height	0.01	0.46	0.50	0.08	0.19	0.25	0.10	0.12	0.36	-0.02	-0.13	0.06

USGS 02335000 CHATTAHOOCHEE RIVER NEAR NORCROSS, GA

Annual Averages

Water Year	00060, Discharge, cubic feet per second	00065, Gage height, feet
1957	1,001	
1958	1,029	
1959	1,663	
1960	2,614	
1961	2,350	
1962	2,699	
1963	2,263	
1964	3,304	
1965	2,467	
1966	2,272	
1967	2,273	
1968	3,041	
1969	2,046	
1970	1,967	
1971	1,841	
1972	2,911	
1973	3,150	
1974	2,638	
1975	2,704	
1976	3,298	
1977	2,378	
1978	2,555	
1979	2,531	
1980	3,165	
1981	1,400	
1982	1,479	
1983	2,577	
1984	2,909	
1985	1,606	
1986	1,378	
1987	1,584	
1988	1,244	
1989	1,358	
1990	3,398	
1991	2,183	
1992	2,053	
1993	3,431	
1994	1,757	
1995	2,336	3.920
1996	2,910	4.439
1997	2,086	3.541
1998	2,963	4.524
1999	1,164	2.465

Water Year	00060, Discharge, cubic feet per second	00065, Gage height, feet
2000	1,362	2.729
2001	1,103	2.434
2002	970.8	
2003	2,392	
2004	1,793	3.305
2005	2,754	
2006	1,766	3.258
2007	1,256	2.559

USGS 02335000 CHATTAHOOCHEE RIVER NEAR NORCROSS, GA

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1956-10-01 -> 2008-01-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1956										606.0	698.0	626.1
1957	705.0	708.6	2,075	3,556	863.7	568.8	598.1	500.5	522.9	501.7	703.7	558.1
1958	528.9	793.4	681.0	861.7	696.2	791.5	1,138	2,253	2,858	1,562	1,277	1,554
1959	2,331	847.2	646.9	607.9	1,251	2,506	2,450	2,791	2,046	1,554	1,477	2,324
1960	1,852	3,748	3,085	4,618	2,196	2,576	2,431	2,815	2,792	1,312	2,562	2,233
1961	1,807	1,828	2,555	3,747	2,436	2,220	2,705	2,833	1,947	2,017	2,056	3,049
1962	3,757	2,132	4,548	4,551	2,208	2,326	1,442	2,100	2,163	2,077	4,059	970.5
1963	1,048	1,016	1,324	2,999	3,908	1,875	3,427	2,929	1,448	1,759	2,468	1,382
1964	2,166	3,478	5,362	8,042	7,509	2,219	1,960	1,738	1,613	2,813	3,208	2,395
1965	1,885	1,661	3,205	3,650	2,563	2,351	2,001	1,772	2,069	1,472	1,363	1,192
1966	1,360	2,483	4,671	2,145	3,610	2,928	1,855	2,048	2,139	1,553	1,236	1,449
1967	2,401	1,893	1,904	1,404	1,911	3,554	2,466	3,098	4,423	3,589	2,842	3,920
1968	4,871	2,788	2,823	2,709	2,289	2,060	2,407	3,108	3,021	2,024	1,437	1,192
1969	1,519	1,365	1,673	3,495	2,341	1,641	2,917	2,150	2,775	1,636	3,740	2,464
1970	1,327	1,295	1,254	867.1	995.1	1,951	2,031	2,944	3,093	3,341	1,355	1,233
1971	1,233	1,119	1,213	1,294	1,813	1,479	1,868	3,811	2,231	2,958	2,800	1,643
1972	4,047	4,242	3,002	1,823	2,758	2,331	2,234	3,148	4,006	3,222	1,320	1,326
1973	1,398	4,157	4,234	4,830	4,420	5,476	2,712	2,652	2,187	2,202	2,844	1,524
1974	4,297	3,685	1,649	4,425	2,765	2,070	1,780	2,573	1,969	3,756	4,433	1,330
1975	1,410	1,883	4,098	4,415	3,316	2,068	1,576	2,116	2,036	1,950	2,457	2,474
1976	3,288	3,199	3,463	6,337	4,226	4,390	3,011	2,659	2,187	1,464	1,430	1,232
1977	1,587	1,220	3,166	6,875	2,446	2,040	2,264	2,760	2,034	1,280	1,687	2,677
1978	4,724	4,055	2,588	1,998	2,231	1,685	2,171	2,906	2,729	3,252	2,588	1,253
1979	1,376	1,429	1,631	5,985	4,357	2,584	1,808	2,256	1,834	2,388	2,366	1,653
1980	3,258	2,362	4,998	6,852	4,128	2,633	2,498	2,524	2,315	2,070	1,203	1,190
1981	1,094	1,214	1,102	1,023	1,022	1,058	1,466	2,181	2,156	2,277	2,143	1,319
1982	1,307	1,284	1,056	1,362	1,195	1,169	1,224	1,555	1,859	1,495	1,217	2,455
1983	2,419	3,221	3,155	4,562	2,957	2,320	2,410	2,947	1,815	1,665	2,084	2,245
1984	3,158	3,277	3,473	3,540	4,757	2,290	2,256	3,730	2,416	2,003	1,902	1,254
1985	1,182	1,224	1,285	1,131	1,151	1,565	2,243	2,101	2,205	1,522	1,423	1,449
1986	1,240	1,068	1,175	1,150	1,133	1,238	2,410	1,459	1,220	1,189	1,290	1,269
1987	1,260	1,071	1,019	1,762	1,207	1,334	1,812	3,004	2,770	1,955	1,405	1,118
1988	1,030	1,037	1,068	1,048	1,064	1,217	1,369	1,319	1,285	1,163	1,114	1,021
1989	1,001	1,051	953.0	942.8	975.5	1,094	1,636	2,691	2,631	2,969	2,686	2,350
1990	3,748	6,709	6,053	4,205	2,396	2,218	2,420	2,925	2,345	2,389	1,886	1,586
1991	1,340	1,285	1,116	1,358	4,254	2,176	2,399	2,643	3,690	4,196	1,828	1,165
1992	1,412	1,356	2,178	2,306	2,387	1,640	2,694	1,886	1,512	2,655	2,606	5,778
1993	6,802	4,236	3,867	4,159	2,577	2,283	2,455	1,938	1,804	2,086	1,287	1,298
1994	1,230	1,247	1,122	1,053	1,128	2,007	1,591	3,875	3,120	1,385	1,617	2,401
1995	2,393	3,883	4,240	1,418	1,992	1,915	2,138	2,259	2,484	1,865	1,938	1,953
1996	3,306	6,797	4,717	2,608	3,011	2,318	2,223	2,497	1,845	1,652	1,332	1,172
1997	1,319	2,038	3,473	2,384	2,523	2,635	1,918	1,908	2,700	2,035	1,426	1,594
1998	2,991	5,944	4,996	3,960	4,045	2,466	2,679	1,904	1,734	1,364	1,252	1,053
1999	965.0	992.0	975.7	999.0	1,054	1,587	1,038	1,291	1,393	1,184	1,155	1,164
2000	1,051	1,062	1,119	1,132	1,161	1,970	1,907	2,104	1,322	1,187	1,130	1,108

USGS 02335000 CHATTAHOOCHEE RIVER NEAR NORCROSS, GA

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1956-10-01 -> 2008-01-30) Calculation period restricted by USGS staff due to special conditions at/near site											
2001	1,071	967.5	1,042	828.6	910.5	1,007	1,429	1,389	1,139	1,034	920.5	948.5
2002	985.9	778.1	852.0	750.0	879.6	912.0	1,016	1,178	1,379	1,217	1,221	1,311
2003	1,315	1,955	3,709	2,092	4,459	3,448	3,876	2,342	1,679	1,490	2,016	2,276
2004	2,412	1,757	1,415	1,143	1,073	1,163	1,724	1,639	3,420	2,600	1,761	3,982
2005	2,232	2,171	2,830	3,255	1,995	2,925	3,582	3,492	2,137	1,438	1,525	2,503
2006	2,945	2,163	1,655	1,831	2,100	1,515	1,134	1,223	1,164	1,200	1,116	1,102
2007	1,123	1,101	1,170	1,063	1,210	1,575	1,342	1,439	1,630	1,834	2,207	1,146
2008	905.9											
Mean of monthly Discharge	2,070	2,240	2,480	2,770	2,390	2,070	2,080	2,340	2,180	1,950	1,870	1,750

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 1993-11-01 -> 2008-01-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993											2.652	2.659
1994	2.548	2.589	2.419	2.310		3.527	3.074	5.501	4.708	2.820	3.068	4.065
1995	4.022	5.695	6.010	2.847	3.573	3.471	3.672	3.835	4.057	3.346	3.524	3.474
1996	4.904	8.265	6.253	4.275	4.558	3.816	3.705	3.998	3.306	3.043	2.679	2.474
1997	2.693	3.570	5.090	3.920	4.029	4.158	3.361	3.312	4.194	3.515	2.793	3.090
1998	4.681	7.590	6.652	5.679	5.644	4.017	4.239	3.430	3.176	2.757	2.626	2.355
1999	2.227	2.264	2.238	2.229	2.295	2.956	2.271	2.619	2.747	2.483	2.466	2.485
2000	2.307	2.324	2.414	2.455	2.476	3.476	3.388	3.671	2.783	2.638	2.569	2.519
2001	2.452	2.285	2.376	2.043	2.171	2.187	2.782	2.755	2.400	2.270	2.139	2.221
2002	2.277	2.027	2.128	1.980	2.186	2.256	2.416	2.643		2.835	2.878	2.948
2003	2.819	3.682	5.730	3.817	6.473	5.313	5.825			2.955	3.662	4.094
2004	4.174	3.289	2.846	2.363	2.234	2.398	3.296	3.188	5.172	4.306	3.319	5.797
2005		3.828	4.663	5.012	3.481	4.560		5.200	3.725	2.789	2.789	4.075
2006	4.589	3.820	3.260	3.436	3.760	2.997	2.470	2.605	2.520	2.522	2.391	2.359
2007	2.401	2.363	2.473	2.304	2.496	3.035	2.635	2.728		3.261	3.831	2.450
2008	2.058											
Mean of monthly Gage height	3.15	3.83	3.90	3.19	3.49	3.44	3.32	3.50	3.53	2.97	2.89	3.14

USGS 02335450 CHATTAHOOCHEE RIVER ABOVE ROSWELL, GA

Annual Averages

Water Year	00060, Discharge, cubic feet per second	00065, Gage height, feet
1977	2,321	
1978	2,534	
1979	2,458	
1980	3,131	
1981	1,411	
1982	1,478	
1983	2,595	
1984	2,912	
1985	1,602	
1986	1,271	
1987	1,538	
1988	1,164	
1989	1,246	
1990	3,333	
1991	2,184	
1992	2,083	
1993	3,485	
1994	1,728	3.725
1995	2,313	
1996	2,832	4.438
1997	2,071	3.985
1998	3,014	4.587
1999	1,123	3.268
2000	1,285	3.385
2001	1,026	3.182
2002	789.4	3.046
2003	2,438	
2004	1,734	
2005	2,875	
2006	1,729	
2007	1,126	

USGS 02335450 CHATTAHOOCHEE RIVER ABOVE ROSWELL, GA

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1976-08-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976								2,549	2,116	1,460	1,423	1,256
1977	1,587	1,200	3,152	6,601	2,324	1,933	2,190	2,648	2,055	1,274	1,687	2,754
1978	4,786	4,054	2,594	1,970	2,201	1,664	2,117	2,776	2,606	3,079	2,532	1,222
1979	1,351	1,425	1,585	5,899	4,156	2,496	1,738	2,145	1,866	2,371	2,364	1,642
1980	3,256	2,341	5,049	6,784	4,124	2,541	2,383	2,437	2,280	2,107	1,210	1,225
1981	1,107	1,305	1,125	1,007	1,021	1,047	1,494	2,175	2,093	2,248	2,200	1,371
1982	1,379	1,366	1,067	1,436	1,168	1,116	1,199	1,470	1,722	1,477	1,279	2,565
1983	2,481	3,381	3,202	4,545	2,907	2,323	2,382	2,826	1,837	1,605	2,188	2,394
1984	3,071	3,224	3,422	3,480	4,778	2,245	2,301	3,807	2,408	1,989	1,933	1,345
1985	1,249	1,359	1,287	1,048	1,078	1,469	2,188	2,137	2,118	1,469	1,380	1,397
1986	1,123	950.0	1,048	966.4	1,041	1,145	2,238	1,312	1,141	1,238	1,320	1,276
1987	1,283	1,049	1,034	1,620	1,116	1,302	1,712	2,866	2,615	1,826	1,373	1,095
1988	1,052	991.4	925.3	1,008	916.5	1,065	1,228	1,236	1,241	1,106	1,050	939.8
1989	909.2	951.0	873.9	809.8	814.9	997.2	1,531	2,467	2,483	2,871	2,659	2,282
1990	3,756	6,781	6,114	4,046	2,275	2,095	2,293	2,812	2,266	2,313	1,828	1,568
1991	1,344	1,300	1,181	1,364	4,289	2,203	2,367	2,633	3,742	4,239	1,938	1,212
1992	1,476	1,450	2,206	2,288	2,370	1,628	2,688	1,928	1,500	2,640	2,646	5,797
1993	6,797	4,208	3,982	4,286	2,694	2,365	2,545	1,986	1,856	1,975	1,235	1,238
1994	1,194	1,213	1,125	1,014	1,057	2,006	1,643	3,844	3,160	1,325	1,562	2,435
1995	2,375	4,085	4,432	1,348	1,865	1,838	2,000	2,177	2,423	1,912	1,886	1,840
1996	3,270	6,872	4,851	2,521	2,724	2,056	2,075	2,395	1,741	1,605	1,335	1,174
1997	1,370	2,133	3,471	2,358	2,477	2,563	1,862	1,803	2,727	2,026	1,410	1,592
1998	3,097	6,152	5,213	4,150	4,220	2,434	2,623	1,856	1,619	1,280	1,222	1,056
1999	975.7	1,019	985.1	941.5	1,017	1,558	993.2	1,145	1,295	1,142	1,132	1,118
2000	996.3	953.1	1,045	1,089	1,006	1,775	1,762	1,990	1,397	1,114	1,090	1,049
2001	1,038	962.0	1,101	754.0	822.5	895.6	1,303	1,213	945.5	695.0	624.0	728.8
2002	915.8	715.0	838.1	595.6	717.4	702.9	842.0	910.2	1,179	1,125	1,172	1,273
2003	1,115	1,833	3,907	2,045	4,952	3,743	4,157	2,344	1,495	1,368	2,036	2,275
2004	2,361	1,668	1,267	949.4	821.9	1,007	1,693	1,607	3,774	2,680	1,798	4,183
2005	2,280	2,291	3,116	3,444	1,918	3,028	3,868	3,724	2,082	1,286	1,310	2,395
2006	2,979	2,253	1,739	1,890	2,145	1,489	1,026	1,141	1,112	1,105	1,057	978.0
2007	1,045	986.8	1,086	887.0	984.0	1,523	1,189	1,200	1,477			
Mean of monthly Discharge	2,030	2,270	2,390	2,360	2,130	1,810	1,990	2,170	2,010	1,800	1,610	1,760

USGS 02335450 CHATTAHOOCHEE RIVER ABOVE ROSWELL, GA

Monthly Averages

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 1993-10-01 -> 2008-01-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993										3.925	3.422	3.421
1994	3.351	3.370	3.283	3.183	3.246	3.956	3.736	5.102	4.680	3.495	3.650	4.301
1995	4.234	5.302		3.498	3.882	3.869	3.935	4.079	4.204	3.825	3.918	3.839
1996	4.742	6.770	5.634	4.374	4.374	3.939	3.971	4.193	3.777	3.653	3.452	3.319
1997	3.496	4.070	4.924	4.219	4.295	4.389	3.867	3.773	4.380	3.946	3.511	3.706
1998	4.737	6.454	5.924	5.366	5.310	4.261	4.379	3.902	3.682	3.429	3.385	3.239
1999	3.166	3.205	3.167	3.100	3.162	3.581	3.143	3.261	3.387	3.268	3.269	3.269
2000	3.150	3.106	3.189	3.240	3.154	3.771	3.755	3.939	3.503	3.291	3.270	3.225
2001	3.204	3.131	3.228	2.913	2.977	3.057	3.397	3.343	3.131	2.994	2.913	3.025
2002	3.118	2.887	2.990	2.844	3.014	3.022	3.115	3.189	3.419	3.368	3.424	
2003	3.319	3.883		4.012		5.076	5.369	4.284		3.529		4.266
2004	4.318	3.837	3.491	3.167	3.032	3.242	3.764		4.971	4.424	3.893	5.335
2005		4.236		4.967	3.943	4.633	5.124	5.048	4.052	3.487	3.504	4.341
2006		4.257	3.845	3.918	4.074	3.589	3.221	3.321	3.307	3.282		3.198
2007	3.269	3.212	3.296	3.111	3.170		3.376	3.367	3.589	3.776	4.162	3.322
2008	3.044											
Mean of monthly Gage height	3.63	4.12	3.91	3.71	3.66	3.88	3.87	3.91	3.85	3.58	3.52	3.70

USGS 02335815 CHATTAHOOCHEE RIVER BELOW MORGAN FALLS DAM, GA

Annual Averages

Water Year	00060, Discharge, cubic feet per second
2003	2,909
2004	2,016
2005	3,009
2006	1,830
2007	1,348

Monthly Averages

YEAR	00060, Discharge, cubic feet per second, Monthly mean in cfs (Calculation Period: 2000-12-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000												1,405
2001	1,545			835.9		1,400		974.2	679.4		855.8	999.5
2002	1,353	1,002	1,258	1,092	1,166	928.5	962.9	1,037	1,475	1,465	1,644	1,873
2003	1,401	2,366	4,466	2,414	5,579	4,355	4,636	2,775	1,836	1,633	2,281	2,277
2004	2,469	2,046	1,505	1,106	1,094	1,500	2,080	1,873	4,367	2,662	2,180	4,371
2005	2,469	2,722	3,338	3,481	2,184	3,250	3,933	3,526	1,922	1,431	1,481	2,419
2006	2,925	2,299	1,868	1,960	2,133	1,572	1,146	1,365	1,375	1,369	1,468	1,271
2007	1,453	1,248	1,311	1,095	1,146	1,645	1,416	1,289	1,461			
Mean of monthly Discharge	1,950	1,950	2,290	1,710	2,220	2,090	2,360	1,830	1,870	1,710	1,650	2,090

YEAR	00065, Gage height, feet, Monthly mean in ft (Calculation Period: 2000-11-01 -> 2008-01-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000											812.028	811.658
2001	811.678	811.081		810.977	811.343	811.551	811.520	811.154	810.784		810.678	
2002		810.762	811.041	810.853	811.192	810.981	811.092	811.260	811.896		811.961	812.035
2003	811.422	812.282	813.889	812.305	814.668	813.777	814.016		811.921			812.808
2004	812.847	812.298	811.705	811.238			812.650		814.540		812.321	814.160
2005		812.682	813.315	813.432	812.116	813.182		813.760	812.399	811.773	811.832	812.989
2006	813.500	812.860	812.308	812.423	812.633	812.088	811.662	812.038		811.981		
2007		811.564	811.620	811.386	811.588	812.476	812.335	812.208		812.728	813.028	
2008	811.292											
Mean of monthly Gage height	812.15	811.93	812.31	811.80	812.26	812.34	812.21	812.08	812.31	812.16	811.97	812.73

USGS 02334480 RICHLAND CREEK AT SUWANEE DAM ROAD, NEAR BUFORD, GA

Annual Averages

Water Year	00065, Gage height, feet	00060, Discharge, cubic feet per second
1996		21.0
2002		10.8
2003		23.3
2004	0.580	15.8
2005		23.4
2006		17.8
2007		13.5

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1995-10-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995										39.3	23.8	13.3
1996	28.5	25.5	45.1	25.5	14.1	10.4	8.16	8.04	10.7	6.35	9.27	12.5
2001						16.6	28.4	21.2	6.64	5.88	5.94	7.89
2002	23.7	14.1	19.4	11.6	16.0	6.11	5.25	3.51	9.63	13.4	23.4	30.9
2003	14.4	22.9	26.5	17.8	29.5	36.6	32.9	17.7	13.5	10.5	21.0	15.2
2004	15.0	21.4	12.2	12.1	10.4	17.3	16.6	10.1	28.3	11.1	18.6	23.7
2005	14.8	31.9	29.8	24.5	13.8	24.6	57.9	20.5	9.96	12.8	11.0	21.6
2006	26.3	24.7	21.6	20.9	19.2	18.7	14.0	10.9	12.4	14.6	15.6	10.6
2007	17.8	16.6	21.1	12.2	11.2	9.76	14.6	8.94	8.39			
Mean of monthly Discharge	20	22	25	18	16	18	22	13	12	14	16	17

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 1995-10-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995										0.667	0.621	0.534
1996				0.652	0.500							0.459
2001									0.381	0.379	0.390	
2002			0.587	0.483	0.536	0.387		0.310	0.424	0.497	0.679	0.725
2003	0.558	0.677	0.801	0.615	0.747		0.777	0.602	0.517	0.510	0.626	0.593
2004	0.583	0.684	0.543	0.530	0.498	0.589	0.570	0.488	0.764	0.540	0.608	
2005		0.790	0.804	0.696	0.523	0.709	0.932	0.752		0.631	0.619	
2006			0.813	0.775	0.722	0.696	0.623	0.575	0.599	0.646		
2007	0.687	0.671	0.724	0.609	0.587	0.528		0.543	0.532			
Mean of monthly Gage height	0.61	0.71	0.71	0.62	0.59	0.58	0.73	0.55	0.54	0.55	0.59	0.58

USGS 02334578 LEVEL CREEK AT SUWANEE DAM ROAD, NEAR SUWANEE, GA

Annual Averages

Water Year	00065, Gage height, feet	00060, Discharge, cubic feet per second
2003		13.0
2004		8.15
2005	3.615	10.6
2006		6.52
2007		4.54

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 2001-06-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001						5.73			3.01	2.51	3.23	4.34
2002		6.08	9.93	5.78		2.25	2.44	0.891	5.94	9.50	14.2	18.1
2003	6.77	11.8	14.9	7.72	21.1	26.4	13.1	6.60	5.43	4.05	12.4	7.67
2004	7.98	11.4	6.56	5.66	5.13	7.70	6.98	3.53	19.4	4.88	12.4	14.4
2005	6.31	18.2	16.7	9.43	4.26	9.41	18.5	9.87	3.87	6.01	5.12	10.4
2006	13.8	12.0	9.15	6.85	4.71	4.51	2.27	1.33	2.37	3.75	6.46	4.79
2007	8.41	7.07	9.98	4.09	2.59	2.15	2.78	1.51	1.01			
Mean of monthly Discharge	8.7	11	11	6.6	7.6	8.3	7.7	4.0	5.9	5.1	9.0	9.9

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 2001-06-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001						3.436		3.579	3.493	3.494	3.513	3.526
2002	3.660	3.577		3.557	3.600	3.479	3.474	3.428	3.521	3.581	3.684	3.726
2003	3.595	3.670	3.707	3.616	3.751			3.585	3.541	3.534		
2004	3.591	3.653	3.576	3.542	3.519	3.532	3.532	3.475	3.705	3.524	3.618	3.663
2005	3.558	3.725	3.709	3.639	3.538	3.609	3.692	3.604		3.528	3.521	3.608
2006		3.651				3.505	3.468	3.446	3.456	3.495	3.539	
2007	3.588	3.564	3.589	3.503	3.462	3.447	3.461	3.431	3.422			
Mean of monthly Gage height	3.60	3.64	3.65	3.57	3.57	3.50	3.53	3.51	3.52	3.53	3.58	3.63

USGS 02334620 DICK CREEK – Old Atlanta Road near Suwanee

Annual Averages

Water Year	00065, Gage height, feet	00060, Discharge, cubic feet per second
2005		17.0
2006	2.079	8.70
2007	1.985	6.80

Monthly Averages

YEAR	00060, Discharge, cubic feet per second, Monthly mean in cfs (Calculation Period: 2004-01-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	20.5	21.3	9.56	6.37	5.75	9.82	12.3	4.59	34.1	5.82	17.5	21.0
2005	9.02	23.9	24.1	16.4	6.26	15.1	33.9	25.9	5.50	8.90	7.33	14.2
2006	15.4	14.3	12.2	8.99	5.80	5.39	3.05	4.17	4.88	5.82	12.0	7.86
2007	13.4	10.7	11.3	5.76	3.20	2.58	4.79	2.73	1.60			
Mean of monthly Discharge	15	18	14	9.4	5.3	8.2	14	9.3	12	6.8	12	14

YEAR	00065, Gage height, feet, Monthly mean in ft (Calculation Period: 2004-01-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	2.389	2.384	2.165	2.086	2.038	2.117	2.178	1.975	2.441	2.142	2.319	2.387
2005	2.194	2.425	2.431	2.334	2.093	2.236		2.405		2.098	2.056	2.222
2006	2.249	2.250	2.181	2.097	2.007	1.956	1.923	1.949	1.973	1.996		2.034
2007	2.135	2.085	2.078	1.980	1.910	1.871	1.937	1.858	1.862			
Mean of monthly Gage height	2.24	2.29	2.21	2.12	2.01	2.04	2.01	2.05	2.09	2.08	2.19	2.21

USGS 02334885 SUWANEE CREEK AT SUWANEE, GA

Annual Averages

Water Year	00060, Discharge, cubic feet per second	00065, Gage height, feet
1985	53.5	
1986	31.7	
1987	60.5	
1988	30.0	
1989	57.2	
1990	98.2	
1991	66.1	
1992	55.5	
1993	102.8	
1994	65.7	
1995	68.2	
1996	109.2	
1997	73.3	
1998	111.2	
1999	37.1	
2000	42.9	1.547
2001	57.9	1.747
2002	47.1	
2003	131.9	
2004	77.7	
2005	108.3	
2006	66.8	
2007	42.6	

USGS 02334885 SUWANEE CREEK AT SUWANEE, GA

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1984-10-01 -> 2008-05-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984										25.3	35.4	55.5
1985	48.2	114.2	50.0	44.8	44.1	25.7	93.4	78.8	30.0	37.4	52.4	59.0
1986	37.1	38.3	60.0	35.2	23.8	10.0	4.20	4.23	18.7	61.2	97.1	79.4
1987	120.2	96.8	122.7	61.9	31.8	27.6	16.3	7.43	6.19	5.35	14.6	23.8
1988	68.9	74.8	34.7	60.3	20.4	6.20	4.32	11.3	38.4	31.7	27.2	26.5
1989	38.0	47.1	60.4	60.3	43.5	98.7	130.4	41.7	81.2	135.6	85.7	88.6
1990	169.2	213.7	232.8	86.9	57.1	28.7	27.6	26.7	31.6	38.2	32.5	51.2
1991	76.4	74.3	120.3	97.5	124.0	48.9	52.2	48.3	28.0	19.6	32.4	43.8
1992	65.8	87.1	89.2	48.6	30.6	61.4	48.0	64.2	77.7	78.1	195.8	175.0
1993	172.0	137.8	170.9	98.9	95.7	49.4	27.2	21.4	12.8	22.6	55.1	50.2
1994	76.6	80.2	100.5	78.0	44.5	55.4	79.1	96.8	50.4	76.7	55.7	60.1
1995	69.8	214.8	127.3	57.4	43.4	40.1	22.1	36.0	26.1	204.2	142.9	67.3
1996	178.1	167.7	213.2	105.2	74.4	57.7	32.6	32.2	35.3	24.4	43.2	54.4
1997	91.6	155.5	123.0	89.2	75.2	67.2	56.3	28.2	79.2	80.9	75.4	82.1
1998	116.1	238.6	184.1	206.2	142.5	65.0	33.3	95.1	25.4	20.8	31.8	40.8
1999	69.7	88.9	49.6	37.8	36.3	28.5	24.2	11.8	8.93	33.1	47.4	40.4
2000	56.0	50.4	64.4	74.7	27.9	21.4	21.4	35.5	43.6	14.1	34.4	31.5
2001	52.7	62.3	145.3	65.3	36.5	91.2	87.1	49.9	24.5	17.8	22.9	37.4
2002	106.3	52.6	89.1	52.2	74.7	27.6	22.7	12.2	49.5	69.7	124.4	153.0
2003	70.8	135.7	180.2	80.6	194.5	235.5	213.3	80.5	43.7	33.6	93.3	67.4
2004	70.6	110.8	58.0	53.7	47.6	60.0	62.2	52.0	229.8	39.9	121.4	150.8
2005	62.3	163.6	159.3	118.5	53.8	116.2	180.5	107.5	29.5	77.0	43.1	99.5
2006	141.6	118.1	88.1	69.4	42.9	34.4	35.4	23.5	30.1	37.0	67.2	34.7
2007	88.5	72.0	92.6	36.1	21.0	16.3	29.5	8.93	8.12	7.00	17.5	43.3
2008	37.7	96.1	59.5	53.3	35.4							
Mean of monthly Discharge	87	112	111	74	59	55	57	42	44	50	65	67

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 1999-10-01 -> 2008-05-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999										1.433	1.596	1.531
2000	1.865	1.791	1.906	1.940	1.259	1.095	1.047	1.457	1.662	1.238	1.500	1.485
2001	1.749	1.872	2.633	1.908	1.542	2.123	1.908	1.664	1.345	1.258	1.350	1.555
2002	2.191	1.763		1.754	1.936		1.269	1.035	1.583	1.859		2.582
2003	1.923	2.380	2.623	2.013	2.740	2.990	2.724	1.990		1.510	1.964	1.875
2004	1.889	2.209		1.665		1.630	1.666	1.542	2.583			2.389
2005	1.797	2.528	2.466	2.210	1.665	2.116		2.103		1.712	1.471	
2006	2.306	2.155	1.914	1.754	1.494	1.297	1.305	1.181	1.260	1.277	1.626	1.376
2007	1.882	1.746	1.848	1.405	1.173	1.061	1.260		0.850	0.830	0.990	1.290
2008	1.326	1.838	1.548	1.475	1.275							
Mean of monthly Gage height	1.88	2.03	2.13	1.79	1.64	1.76	1.60	1.57	1.55	1.39	1.50	1.76

USGS 02335350 CROOKED CREEK NEAR NORCROSS, GA

Annual Averages

Water Year	00060, Discharge, cubic feet per second
2002	13.7
2003	24.2
2004	17.0
2005	23.3
2006	13.1
2007	10.6

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 2001-04-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001				12.9	12.3	15.1	17.2	7.26	12.8	5.60	5.82	10.3
2002	31.9	9.57	27.2	10.9	23.0	10.1	5.29	6.32	17.2	27.3	27.0	30.7
2003	13.3	22.2	24.1	16.7	44.8	39.0	26.0	10.5	8.25	11.7	21.3	15.2
2004	17.2	23.2	11.0	11.2	11.5	14.8	14.0	10.3	43.9	8.46	37.6	29.2
2005	12.3	36.6	37.7	18.8	9.11	12.9	37.0	35.5	5.15	11.7	8.53	17.4
2006	31.6	25.1	15.0	11.0	7.03	6.96	4.94	9.00	9.45	9.17	15.1	8.97
2007	16.5	11.2	17.9	8.03	3.50	7.26	17.7	8.55	3.60			
Mean of monthly Discharge	20	21	22	13	16	15	17	12	14	12	19	19

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 2001-04-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001				3.963	3.903	3.958	3.971	3.976	4.004	3.841	4.031	3.987
2002			4.242	4.016	3.852	3.770	3.665	3.674	3.943	4.159	4.208	4.208
2003	3.874	4.058			4.474			3.827	3.746	3.748		3.906
2004	3.904	4.058	3.808	3.814	3.844	3.986		3.790	4.330	3.527		4.144
2005		3.996	4.023	3.829		3.831				3.686	3.654	3.846
2006	3.987	3.922	3.735	3.655	3.567	3.484	3.459		3.613	3.553		
2007			3.719	3.579			3.791	3.599	3.535			
Mean of monthly Gage height	3.92	4.01	3.91	3.81	3.93	3.81	3.72	3.77	3.86	3.75	3.96	4.02

USGS 02335700 BIG CREEK NEAR ALPHARETTA, GA

Annual Averages

Water Year	00060, Discharge, cubic feet per second	00065 Gage height feet
1961	125.3	
1962	125.9	
1963	126.2	
1964	166.2	
1965	106.5	
1966	105.1	
1967	124.9	
1968	121.8	
1969	103.5	
1970	72.1	
1971	94.9	
1972	110.3	
1973	155.3	
1974	110.5	
1975	125.0	
1976	137.1	
1977	96.5	
1978	121.0	
1979	116.2	
1980	141.4	
1981	55.0	
1982	110.8	
1983	117.5	
1984	167.7	
1985	74.4	
1986	45.5	
1987	100.3	
1988	54.3	
1989	81.3	
1990	158.5	
1991	127.9	
1992	105.8	
1993	164.6	
1994	107.2	

Water Year	00060, Discharge, cubic feet per second	00065 Gage height feet
1995	95.1	
1996	152.3	
1997	130.9	
1998	192.2	3.040
1999	65.8	2.030
2000	67.6	
2001	96.0	2.354
2002	71.5	
2003	186.5	3.197
2004	123.6	2.589
2005	170.4	
2006	88.9	
2007	66.4	2.065

USGS 02335700 BIG CREEK NEAR ALPHARETTA, GA

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 1960-05-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960					69.5	41.8	29.5	30.1	35.1	61.6	40.4	46.5
1961	62.9	502.4	206.8	182.9	114.1	110.9	102.0	65.3	40.3	24.8	41.5	473.9
1962	128.2	249.5	163.2	203.9	66.9	47.3	56.9	28.8	31.8	63.1	105.8	86.4
1963	140.7	113.8	321.9	166.2	165.5	159.1	92.7	44.3	52.9	42.3	58.0	137.2
1964	290.5	175.1	421.2	402.8	196.7	90.5	81.9	60.4	36.0	115.1	70.0	177.5
1965	142.9	164.3	157.8	148.7	87.4	108.2	48.3	34.4	27.2	45.9	42.1	40.5
1966	110.4	320.9	249.5	138.1	147.4	64.4	46.5	45.4	26.0	108.7	97.6	92.7
1967	150.9	133.1	121.0	105.2	117.1	169.3	170.8	165.7	65.9	56.2	138.8	201.4
1968	261.8	109.6	193.3	169.0	131.5	76.9	46.5	38.2	36.2	28.3	87.5	105.6
1969	160.7	152.9	139.6	186.0	115.6	46.6	25.2	138.4	59.1	37.5	60.5	76.5
1970	88.3	81.0	169.2	100.6	76.2	89.9	35.5	31.4	18.8	41.7	49.8	47.3
1971	96.7	179.5	223.7	115.8	84.5	49.4	99.7	76.3	80.2	42.0	53.0	142.6
1972	339.5	152.7	137.8	106.2	130.8	76.2	55.2	47.0	38.1	46.7	80.4	182.1
1973	203.3	196.5	256.8	306.9	230.5	144.8	99.9	49.5	69.6	58.9	58.8	91.1
1974	299.2	173.2	132.5	194.7	95.2	74.4	50.3	67.2	34.2	27.4	47.7	113.7
1975	193.6	223.7	293.1	119.3	175.1	101.8	57.8	89.1	62.4	93.1	88.1	100.2
1976	228.8	126.9	371.1	210.1	189.8	99.7	71.2	37.5	24.5	36.1	51.9	101.4
1977	162.9	107.0	310.3	205.1	59.3	34.1	26.9	28.2	33.5	129.7	191.7	105.3
1978	346.0	116.5	155.3	97.0	100.5	48.8	31.1	104.3	21.7	20.1	28.6	55.7
1979	117.7	205.7	164.4	414.8	119.3	97.4	65.6	50.6	67.8	64.8	101.8	58.8
1980	200.7	116.5	512.5	214.8	186.3	118.9	47.6	29.3	40.8	51.8	50.4	43.6
1981	40.1	172.1	78.7	71.0	65.2	43.9	20.1	20.5	12.9	13.8	19.2	53.7
1982	159.0	389.6	109.1	231.6	79.3	58.3	104.6	102.7	32.6	82.9	65.5	203.7
1983	118.8	187.5	217.6	215.4	136.4	70.8	45.7	22.3	47.2	35.8	147.6	495.4
1984	180.9	192.9	177.4	199.7	218.0	72.2	119.3	127.8	40.2	35.4	54.4	85.5
1985	74.0	219.1	80.3	70.8	91.9	36.9	60.0	66.4	28.7	67.7	52.7	73.8
1986	48.7	54.4	73.5	37.2	38.3	19.1	10.5	12.3	58.6	118.4	101.2	118.9
1987	205.2	135.2	227.7	113.1	57.0	59.0	32.3	18.2	17.5	15.2	32.7	53.4
1988	119.3	90.0	60.0	97.0	31.3	10.5	15.3	13.8	117.4	59.5	44.0	33.1
1989	91.9	106.5	127.8	95.0	62.5	145.1	86.7	51.9	74.7	230.7	106.4	116.9
1990	257.5	331.6	451.1	119.8	90.5	46.6	39.2	42.2	77.3	101.1	61.2	105.6
1991	150.8	158.3	189.8	154.3	180.2	95.7	112.4	128.5	96.3	43.4	91.6	119.8
1992	144.3	223.8	160.2	90.6	60.0	79.1	64.0	113.0	84.7	84.1	241.5	299.5
1993	452.5	192.7	251.7	159.4	126.6	72.9	37.5	35.7	18.8	39.5	92.8	88.1
1994	116.5	170.4	231.2	136.6	73.9	90.7	98.5	102.6	50.2	66.6	66.3	69.6
1995	87.1	299.5	242.9	92.5	63.0	68.8	23.4	40.2	37.3	190.1	205.6	99.4
1996	285.0	247.0	343.8	165.2	93.3	67.4	33.6	44.5	54.7	41.8	81.2	109.4
1997	185.9	210.7	254.2	151.9	135.2	152.4	111.6	51.4	91.4	201.0	94.8	124.6
1998	224.2	419.7	341.3	398.3	251.7	109.1	54.5	73.3	31.8	27.0	61.2	75.8
1999	125.8	148.0	86.1	58.1	55.4	43.8	83.5	17.8	11.8	49.6	70.0	50.6
2000	98.7	71.9	124.7	100.0	32.7	28.9	23.2	38.6	124.4	24.8	89.1	64.3

USGS 02335700 BIG CREEK NEAR ALPHARETTA, GA

Monthly Averages (cont'd.)

YEAR	00060, Discharge, cubic feet per second, Monthly mean in cfs (Calculation Period: 1960-05-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	98.7	71.9	124.7	100.0	32.7	28.9	23.2	38.6	124.4	24.8	89.1	64.3
2001	152.0	114.6	236.8	108.1	62.2	107.6	88.5	63.3	40.6	27.7	28.9	53.0
2002	178.3	74.1	149.4	103.3	115.2	30.8	19.4	9.45	66.7	96.4	218.6	301.9
2003	104.8	210.7	262.2	132.2	272.1	216.0	242.8	113.1	65.6	65.9	171.2	113.0
2004	114.2	176.7	85.2	74.8	72.9	80.8	88.7	67.0	382.6	63.3	156.9	192.5
2005	90.3	252.0	235.3	197.3	82.6	138.9	402.8	184.9	52.0	70.3	80.2	138.5
2006	168.1	172.4	153.0	97.4	59.0	46.8	28.2	23.4	34.4	57.1	145.4	58.8
2007	145.9	95.5	97.7	57.4	36.8	35.6	37.8	16.5	14.0			
Mean of monthly Discharge	167	185	207	156	110	81	71	60	56	66	88	123

YEAR	00065, Gage height, feet, Monthly mean in ft (Calculation Period: 1997-10-01 -> 2007-09-30) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997										2.648	2.683	2.865
1998	3.587	4.324	3.938	4.515	3.650	2.617	1.963	2.166	1.628	1.613	2.095	2.277
1999	2.732	2.909	2.356	2.005	1.911	1.725	2.200	1.338	1.257	1.756	2.030	1.897
2000	2.490	2.230	2.615	2.384	1.598				2.413	1.612	2.347	2.190
2001	2.807	2.682	3.562	2.610	2.034	2.457	2.261	1.990	1.725	1.630	1.693	2.084
2002	2.995	2.398	2.891		2.611	1.682	1.439	1.160	1.952	2.443	3.537	3.967
2003	2.779	3.620	3.531	2.920	3.826	3.472	3.542	2.674	2.062	2.153	2.943	2.832
2004	2.747	3.282	2.436	2.267	2.210	2.281	2.341	2.064	3.583	2.307	3.036	3.390
2005	2.644	3.705	3.725	3.479		2.998	4.266	3.238	2.006	2.255	2.391	3.017
2006	3.257	3.279	3.004	2.708	2.225	1.879	1.661		1.739	1.965	2.630	2.187
2007	3.010	2.599	2.536	2.135	1.760	1.690	1.778	1.295	1.231			
Mean of monthly Gage height	2.90	3.10	3.06	2.78	2.43	2.31	2.38	1.99	1.96	2.04	2.54	2.67

USGS 02335757 BIG CREEK BELOW HOG WALLOW CREEK AT ROSWELL, GA

Annual Averages

Water Year	00065, Gage height, feet	00060, Discharge, cubic feet per second
2005		236.4
2006	2.890	134.8
2007		86.0

Monthly Averages

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in cfs (Calculation Period: 2004-04-01 -> 2007-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004				93.1	97.8	140.8	130.0	92.9	547.2	94.2	243.0	234.3
2005	106.1	353.6	337.6	287.1	105.1	212.0	531.3	278.5	61.3	98.4	113.0	196.8
2006	248.8	268.3	217.9	161.1	89.4	77.9	47.0	48.5	59.2	77.2	165.5	71.9
2007	186.3	130.6	133.2	81.2	51.0	48.1	54.2	21.0	14.6			
Mean of monthly Discharge	180	251	230	156	86	120	191	110	171	90	174	168

00065, Gage height, feet,												
YEAR	Monthly mean in ft (Calculation Period: 2004-04-01 -> 2007-08-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004				2.864	2.845	2.982	2.934	2.745	3.986		3.288	3.415
2005		3.743	3.696	3.567	2.968	3.319	4.093	3.450	2.647	2.780	2.850	3.218
2006	3.402	3.484	3.288	3.066	2.750	2.554	2.404	2.407	2.518	2.553	2.936	2.665
2007	3.166	2.971	2.949	2.706	2.440	2.381	2.463	2.095				
Mean of monthly Gage height	3.28	3.40	3.31	3.05	2.75	2.81	2.97	2.67	3.05	2.67	3.02	3.10

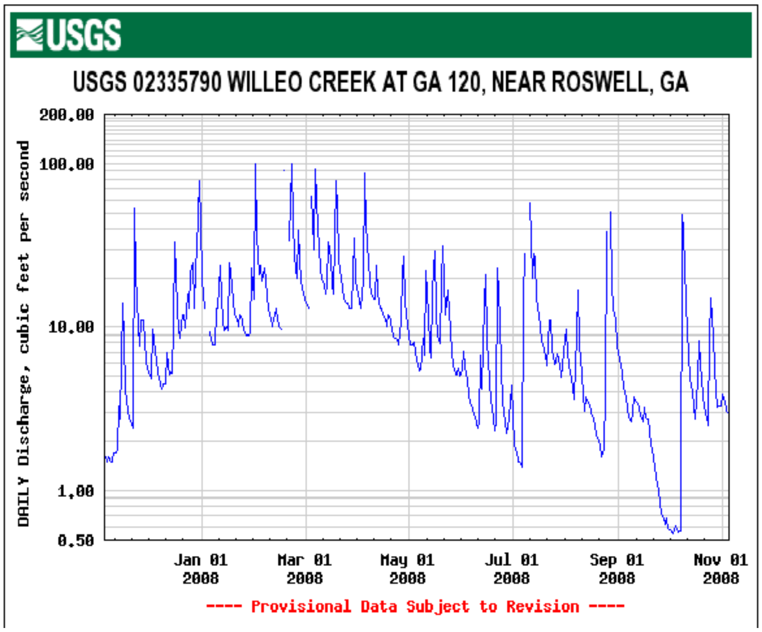
USGS 02335870 SOPE CREEK NEAR MARIETTA, GA

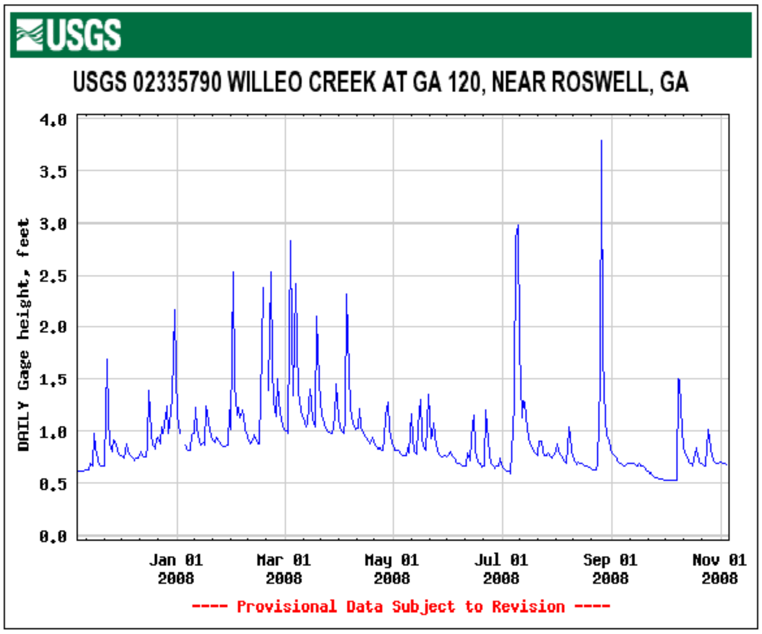
Annual Averages

Water Year	00060, Discharge, cubic feet per second	00065, Gage height, feet
1985	43.2	
1986	21.8	
1987	48.5	
1988	28.6	
1989	58.0	
1990	70.5	
1991	56.6	
1992	45.8	
1993	65.8	
1994	53.6	
1995	48.3	
1996	65.8	
1997	58.4	
1998	68.7	
1999	27.7	2.066
2000	29.7	1.987
2001	46.8	
2002	32.7	
2003	73.8	
2004	69.1	
2005	75.2	
2006	32.9	
2007	23.1	

USGS 02335790 WILLEO CREEK AT GA 120, NEAR ROSWELL, GA

(data available for 11 May 07 – 4 Nov 08)





Appendix 2. Available data for water quality conditions at or near the park over the past ~decade, also indicating unacceptable conditions.

In these tables, nd ≡ not detectable; sv ≡ single value. Underline and bold ≡ data in violation of state standard (GA DNR 2008d), except for fecal coliforms. This Appendix considers all fecal coliform and Escherichia coli data collectively, whereas Appendix 3 considers data amenable to calculation of geometric means. Since only some of the bacterial data were collected with sufficient frequency to enable calculation of geometric means – which are used for the state standards – the data here were evaluated as follows: Values underlined suggest degraded conditions. These samples exceeded the FC water quality standard values for geometric means (> 200 mpn/100 mL, May - Oct; > 1,000 mpn/100 mL, Nov - Apr); or they exceeded the U.S. EPA standard (>235 mpn/100 mL). The fecal bacterial data were also evaluated at the 400 mpn/100 mL level, which is the criterion recommended by the U.S. EPA (2003) for data collected too infrequently for calculation of geometric means by the state's criteria (at least 4 samples collected within a 30-day period). Fecal coliform densities were assessed by the multiple-tube procedure (EC medium) or the membrane filter (MF) technique (M-FC medium). E. coli densities were assessed by the multiple-tube procedure (EC-MUG medium), the membrane filter technique (m-TEC MF or modified m-TEC MF) or by the enzyme substrate test using IDEXX Quanti-Trays (American Public Health Association 1992). For other parameters, blue and bold ≡ can support noxious algal blooms (NO3-+NO2- – see Mallin 2000), or data exceeded recommended values to protect aquatic life (BOD5 – see Mallin 2006). Bold shaded ≡ data exceeded recommended values for acceptable water quality (U.S. EPA 2000: for TSS, 25 mg/L maximum, and < 10 mg/L increase from a sudden spike; for heavy metals (Al, Cu, Hg, Pb, Ni, Zn), see Table 20). Note that the U.S. EPA (2002) recommends that pH be maintained within the range 6.5-9, but this Report follows Georgia regulations (pH > 6.0).

Table A2-1. Water quality data for source water and Park Section I (Units 1-3).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
<u>**Source Water – Lake Lanier**</u>					
<u>**GA DNR 12040001** (Upstream of Buford Dam Forebay, Gwinnett Co.; latitude 34.1628, longitude -84.0671)</u>					
Turbidity (NTU)	Oct 01 - Oct 04	22	nd - 1.4[b]	1	----
Spec. cond. (µmhos/cm)	Oct 01 - Oct 04	6	47.5 (43 - 52)	48	----
pH	Oct 01 - Oct 04	22	7.0 (6.4 - 7.5)	7	----
$NO_3^-N+NO_2^-N$ (µg/L)	Oct 01 - Oct 04	22	**139** (40 - **240**)	**145**	**14**
NH_4^+N (µg/L)	Oct 01 - Oct 04	22	nd - 30[b]	----	----
TKN (µg/L)	Oct 01 - Aug 04	20	194 (nd - 320)	205	----
SRP (µg/L)	Oct 01 - Oct 04	22	all nd[b]	----	----
TP (µg/L)	Oct 01 - Aug 04	20	nd - 20[b]	----	----
TOC (mg/L)	Oct 01 - Oct 04	22	2.7 (1.6 - 4.0)	2.5	----
TSS (mg/L)	Oct 01 - Oct 04	22	1.5 (nd - 4.8)	1.0	----
BOD_5 (mg/L)	Oct 01 - Oct 04	21	all nd[b]	----	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Oct 01 - Oct 04	22	11.5 (9 - 13)	12	----
Hardness, Ca+Mg (mg/L)	Oct 01 - Oct 04	22	14 (8 - 36)	12	----
Fecal coliforms, EC (mpn/100 mL)	Oct 01 - Oct 04	18	nd - 20[b]	----	----
<u>**SECTION I**</u>					
<u>**Gwinnett County / USGS 02334480** (Park Unit 1, Bowmans Island – Richland Creek at Suwanee Dam Road near Buford; latitude 34.1325, longitude –84.0700) – presently in operation</u>					
Fecal coliforms, EC&M-FC (mpn/100 mL)	Jul 01 - Apr 08	112	<u>715</u> (brl - <u>36,800</u>)	164	<u>37</u> (33% >200, 1000) <u>26</u> (23% > 400)

Table A2-1. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
USGS 02334480 (Park Unit 1, Bowmans Island – Richland Creek; selected parameters[c])					
Turbidity (NTU)	Jul 01 - Aug 03	28	**500** (3.9 - **6,500**)	**71**	**14**
Temperature (°C)	Jul 01 - Feb 08	72	15.1 (4.1 - 23.3)	14.8	----
Spec. cond. (µmhos/cm)	Jul 01 - Feb 08	72	76 (17 - 144)	78	----
DO (mg/L)	Jul 01 - Feb 08	72	9.8 (6.9 - 16.2)	9.4	----
pH	Jul 01 - Feb 08	71	6.8 (**5.8** - 7.3)	6.8	**2**
$NO_3^-N+NO_2^-N$ (µg/L)	Jul 01 - Aug 08	84	**543** (270 - **1,200**)	**540**	**84**
NH_4^+N (µg/L), filtered	Jul 01 - Jun 08	67	**118** (10 - **420**)	**100**	**32**
TKN (µg/L)	Jul 01 - Aug 08	84	895 (100 - 5,300)	415	----
TN (µg/L)	Jul 01 - Aug 08	62	1,680 (750 - 5,800)	1,300	----
TP (µg/L)	Jul 01 - Aug 08	85	**275** (10 - **3,000**)	82	**39**
TDP (µg/L)	Jul 01 - Aug 08	85	24 (5 - 440) **	20	----
TSS (mg/L)	Jul 01 - Aug 08	85	**586** (0.05 - **6,900**)	**120**	**45**
TDS (mg/L)	Jul 01 - Aug 08	85	70 (19 - 300)	58	----
TOC (mg/L)	Jul 01 - Aug 08	84	2.7 (0.4 - 8.8)	1.9	----
BOD_5 (mg/L)	Jul 04 - Aug 08	48	**4.0** (0.8 - **13**)	2.4	**23**
COD (mg/L)	Jul 04 - Aug 08	49	12 (4.1 - 30)	10	----
Chloride, total (mg/L)	2 Aug 07	2	3.55 (3.4 - 3.7)	----	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	17 Apr 08	1	[sv 30]	----	----
Hardness, Ca+Mg (mg/L)	Jul 04 - Oct 07	39	26.6 (7.0 - 93.0)	23	----
Calcium (mg/L)	Aug 04 - Aug 08	49	8.0 (2.6 - 17.0)	7.3	----
Magnesium (mg/L)	Aug 04 - Aug 08	49	4.9 (1.1 - 30.0)	2.1	----
Fecal coliforms, M-FC MF (colonies/100 mL)	Jul 01 - Jul 08	80	4,851 (14 - 58,000)	460	48 (60% > 200, 1000) 42 (53% > 400)
Cadmium, total (µg/L)	Jul 04 - Aug 08	50	**2.0** (0.09 - < **5**)[b]	**2.5**	uncertain[d]
Chromium, total (µg/L)	Jul 04 - Oct 07	39	28.2 (1 - 170)[b]	5	uncertain[d]
Copper, total (µg/L)	Jul 04 - Aug 08	48	**15.3** (0.8 - **90**)[b]	7.5	at least **19**; uncertain[d]
Lead, total (µg/L)	Jul 04 - Aug 08	39	**9.3** (0.2 - **66**)[b]	**4.5**	at least **16**; uncertain[d]
Manganese, total (µg/L)	Jul 04 - Oct 07	39	793 (65 - 3,600)	390	----
Zinc, total (µg/L)	Jul 04 - Aug 08	45	85 (1.7 - **780**)	36	**12**
USGS 02334500 (Park Units 1/2, Bowmans Island / Orrs Ferry – Chattahoochee River, State Road 20 near Buford, Forsyth Co.; latitude 34.1261, longitude –84.0936; selected parameters[c])					
Temperature (°C)	Jan - Dec 00	20	9.5 (7.3 - 11.8)	9.6	----
Turbidity (NTU)	Jan - Dec 00	12	2.7 (0.4 - 8)	1.9	----
Spec. cond. (µmhos/cm)	Jan - Dec 00	20	48 (43 - 58)	47	----
DO (mg/L)	Jan - Dec 00	20	9.1 (5.4 - 11.6)	9.4	----
pH	Jan - Dec 00	20	7.0 (6.5 - 7.5)	7.0	----
$NO_3^-N+NO_2^-N$ (µg/L)	Jan - Dec 00	12	**239** (70 - **420**)	**210**	**10**
NH_4^+N (µg/L)	Jan - Dec 00	12	**122** (40 - **400**)	**75**	**5**
TP (µg/L)	Jan - Dec 00	12	all < or = 20	----	----
TSS (mg/L)	Jan - Dec 00	12	1.9 (nd - 4)	2	----
BOD_5 (mg/L)	Jan - Dec 00	12	0.6 (0.4 - 0.9)	0.6	----
TOC (mg/L)	Jan - Dec 00	12	1.5 (0.9 - 2.3)	1.4	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	15.9 (14 - 18)	16	----

Table A2-1. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
USGS 02334500 (Park Units 1/2, Bowmans Island / Orrs Ferry – Chattahoochee River, cont'd.)					
Fecal coliforms, FC (mpn/100 mL)	Jan - Oct 00	16	40.6 (10 - 330)[b]	10	1 (6% > 200,1000) 0 (0% > 400)
Water	23 Mar 00		7 Aug 00 (n = 2; all toxic except Ca, Mg)		
Calcium (Ca)	2.8 mg/L		2.9 mg/L		----
Magnesium (Mg)	1.2 mg/L		1.2 mg/L		----
Antimony, total	< 1 µg/L		< 1 µg/L		----
Arsenic, total	< 2 µg/L		< 2 µg/L		----
Cadmium, total	< 0.5 µg/L		< 0.5 µg/L		uncertain[d]
Chromium, total	< 1 µg/L		< 1 µg/L		----
Copper, total	< 1 µg/L		< 1 µg/L		----
Lead, total	< 1 µg/L		1 µg/L		----
Mercury, total	< 0.1 µg/L		< 0.1 µg/L		----
Nickel, total	< 1 µg/L		< 1 µg/L		----
Selenium, diss'd.	2 µg/L		< 2 µg/L		----
Thallium, total	< 2 µg/L		< 2 µg/L		----
Zinc, total	2 µg/L		4 µg/L		----
Forsyth County JSF-1 (Park Unit 2, Orrs Ferry - James Creek, James Burgess Road; latitude 34.1523, longitude –84.10305)					
Temperature (°C)	May 05 - Aug 08	69	16.9 (4.9 - 28.1)	17.1	----
Turbidity (NTU)	May 05 - Aug 08	69	96.3 (1.3 - **1,061**)	9.7	**16**
Spec. cond. (µmhos/cm)	May 05 - Aug 08	69	89 (2 - 266)	79	----
DO (mg/L)	May 05 - Aug 08	69	9.6 (**0.2** - 13.8)	9.9	**1**
pH	May 05 - Aug 08	69	7.4 (6.4 - 8.0)	7.3	----
$NO_3^-N+NO_2^-N$ (µg/L)	May 05 - Aug 08	42	**1,002** (**232 - 4,500**)	**728**	**42**
TP (µg/L)	May 05 - Aug 08	42	**136** (brl - **550**)	**100**	**15**
TOC (mg/L)	May 05 - Aug 08	42	3.3 (1.0 - 9.0)	3.0	----
TSS (mg/L)	May 05 - Aug 08	42	137.7 (2 - **2,200**)	14.0	**18**
Fecal coliforms, M-FC MF (mpn/100 mL)	May 05 - Aug 08	60	3,146 (brl - 140,000)	210	21 (35% >200, 1000) 19 (32% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Aug 07 - Aug 08	20	400 (28 - 2,800)	150	7 (35% > 235) 4 (20% > 400)
Copper, dissolved (µg/L)	May 05 - Aug 08	42	5.8 (brl - **25**)[b]	----	**1**
Gwinnett County / USGS 02334578 (Park Unit 3, Settles Bridge – Level Creek at Suwanee Dam Road, near Suwanee, GA; latitude 34.0964, longitude –84.0797)					
Fecal coliforms, EC&M-FC (mpn or colonies/100 mL)	Jul 01 - Apr 08	112	583 (15 - 9,000)	249	43 (38% > 200, 1000) 32 (29% > 400)
USGS 02334578 (Park Unit 3, Settles Bridge – Level Creek at Suwanee Dam Road; selected parameters[c])					
Temperature (°C)	Jul 01 - Feb 08	70	15.2 (3.9 - 24.2)	15.1	----
Turbidity (NTU)	Jul 01 - Sep 03	26	**321** (4 - **2,100**)	**55**	**13**
Spec. cond. (µmhos/cm)	Jul 01 - Feb 08	74	64 (26 - 87)	70	----

Table A2-1. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
USGS 02334578 (Park Unit 3, Settles Bridge – Level Creek, cont'd.)					
DO (mg/L)	Jul 01 - Feb 08	70	9.4 (6.7 - 14.6)	8.9	----
pH	Jul 01 - Feb 08	74	6.6 (**5.2** - 7.4)	6.8	**6**
$NO_3^-N+NO_2^-N$ (µg/L)	Jul 01 - Aug 08	86	**351** (10 - **690**)	**345**	**83**
NH_4^+N (µg/L), filtered	Dec 01 - Aug 08	67	**139** (30 - **490**)	**110**	**34**
TKN (µg/L)	Jul 01 - Aug 08	86	810 (100 - 3,800)	440	----
TN (µg/L)	Jul 01 - Aug 08	62	1,500 (450 - 4,200)	1,200	----
TP (µg/L)	Jul 01 - Aug 08	85	**144** (10 - **780**)	45	**29**
TDP (µg/L)	Jul 01 - Aug 08	86	25 (4 - 110)[b]	20	----
TSS (mg/L)	Jul 01 - Aug 08	86	**201** (1 - **1,800**)	**29**	**44**
TDS (mg/L)	Jul 01 - Aug 08	86	56 (25 - 120)	55	----
COD (mg/L)	Jul 04 - Aug 08	51	13 (2.5 - 56)[b]	10	----
TOC (mg/L)	Jul 01 - Aug 08	84	3.4 (0.5 - 22)	2.4	----
BOD_5 (mg/L)	Jul 04 - Aug 08	50	**3.2** (0.7 - **11**)	2.7	**21**
COD (mg/L)	Jul 04 - Aug 08	51	13 (2.5 - 56)	10	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	17 Apr 08	1	[sv 32]	----	----
Hardness, Ca+Mg (mg/L)	Jul 04 - Oct 07	41	20 (8 - 86)	20	----
Chloride, total (mg/L)	2 dates in 07-08	2	4.0 (3.8-4.2)	----	----
Sulfate (mg/L)	2 dates in 07-08	2	1.8 (1.5-2.1)	----	----
Fecal coliforms, M-FC MF (colonies/100 mL)	Jul 01 - Jul 08	81	5,617 (18 - 58,000)	535	490 (60% > 200, 1000) 43 (53% > 400)
Calcium (mg/L)	Aug 04 - Aug 08	50	5.8 (4.2 – 8.4)	5.9	----
Magnesium (mg/L)	Aug 04 - Aug 08	50	1.9 (1.3 - 5.9)	1.7	----
Cadmium, total (µg/L)	Jul 04 - Aug 08	52	**2.0** (0.05 - < **5**)[b]	**2.5**	uncertain[d]
Chromium, total (µg/L)	Jul 04 - Oct 07	41	8.7 (<1 - 50)[b]	5	uncertain[d]
Copper, total (µg/L)	Jul 04 - Aug 08	52	7.1 (0.3 - **48**)[b]	5	**≥ 6**
Lead, total (µg/L)	Jul 04 - Aug 08	52	**4.8** (0.1 - **33**)[b]	**2.9**	**≥ 12**
Manganese, total (µg/L)	Jul 04 - Oct 07	41	381 (120 - 1,500)	240	----
Zinc, total (µg/L)	Jul 04 - Aug 08	47	44 (2.9 - **470**)	18	**5**
Forsyth County DKF-1 (Park Unit 3, Settles Bridge – Dick Creek at Old Atlanta Road; latitude 34.0719, longitude –84.1300)					
Temperature (°C)	May 05 - Aug 08	69	17.4 (4.7 - 27.5)	18.0	----
Turbidity (NTU)	May 05 - Aug 08	69	64.4 (3.9 - **949**)	13.3	**17**
Spec. cond. (µmhos/cm)	May 05 - Aug 08	69	110 (52 - 279)	97	----
DO (mg/L)	May 05 - Aug 08	69	9.6 (5.2 - 13.3)	9.5	----
pH	May 05 - Aug 08	69	7.3 (6.3 - 12.4)	7.3	----
$NO_3\,N+NO_2\,N$ (µg/L)	May 05 - Aug 08	42	**524** (79 - **1,300**)	**461**	**41**
TP (µg/L)	May 05 - Aug 08	42	**129** (15 - **430**)	**100**	**14**
TOC (mg/L)	May 05 - Aug 08	42	3.3 (1.0 - 6.0)	3.1	----
TSS (mg/L)	May 05 - Aug 08	42	65.4 (3 - **470**)	10.5	**17**
Fecal coliforms, M-FC MF (mpn/100 mL)	May 05 - Aug 08	60	1,349 (brl - 22,000)	245	27 (45% > 200,1000) 22 (37% > 400)

Table A2-1. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
Forsyth County DKF-1 (Park Unit 3, Settles Bridge – Dick Creek, cont'd.)					
Escherichia coli, Quanti-Tray (mpn/100 mL)	Aug 07 - Aug 08	20	350 (41 - 1,600)	225	10 (50% > 235) 4 (20% > 400)
Copper, diss'd. (µg/L)	May 05 - Aug 08	42	brl - 3.1[b]	----	----

[a] All values reported less than the level of detection or less than the reporting limit were replaced with ½ the value, following Ellis and Gilbert (1980) and Zirschky et al. (1985).

[b] More than 50% of the samples were below detection or below reporting limits (brl) with the analytical technique used; thus, statistical interpretation was not attempted.

[c] Selected parameters included those most commonly considered in water quality assessment; most of those that were not included here also had been sampled infrequently (1 or a few dates).

[d] Values were reported as "less than" a range of values that include the CCC; or, for chromium, the species was not designated.

Table A2-2. Water quality data for Park Section II (Units 4-8).[a]

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12048001 (Park Unit 4, McGinnis Ferry – Chattahoochee River, McGinnis Ferry Road, Fulton Co.; latitude 34.0506, longitude –84.0977)					
Turbidity (NTU)	Mar 01 - Dec 04	47	4.3 (nd - 24)	2.8	----
Spec. cond. (µmhos/cm)	Mar 01 - Dec 04	47	54 (45 - 82)	52	----
pH	Mar 01 - Dec 04	47	6.7 (6.2 - 7.4)	6.7	----
$NO_3^-N+NO_2^-N$ (µg/L)	Mar 01 - Dec 04	47	**292** (98 - **620**)	**280**	**45**
NH_4^+N (µg/L)	Mar 01 - Dec 04	47	53 (nd - **260**)	30	**4**
TP (µg/L)	Mar 01 - Aug 04	43	nd – 82[b]	----	----
TOC (mg/L)	Mar 01 - Dec 04	47	1.9 (nd - 4.2)	1.8	----
TSS (mg/L)	Mar 01 - Dec 04	47	6.7 (nd - **48**)	2	**3**
BOD_5 (mg/L)	Mar 01 - Dec 04	47	all nd[b]	----	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Nov 01 - Dec 03	25	13 (11 - 20)	13	----
Hardness, Ca+Mg (mg/L)	Mar 01 - Dec 04	47	15 (10 - 42)	14	----
Fecal coliforms, EC (mpn/100 mL)	Mar 01 - Jun 04	54	276 (nd - 10,000[c])	20	6 (11% > 200,1000) 3 (6% > 400)
Escherichia coli, EC-MUG (mpn/100 mL)	Jan 02 - Jun 04	37	224 (nd - 5,794)	32	4 (11% > 235) 2 (5% > 400)
Forsyth County CHF-1 (Park Unit 4, McGinnis Ferry – Chattahoochee River, McGinnis Ferry Road; latitude 34.0506, longitude –84.0977)					
Temperature (°C)	May 05 - Aug 08	69	12.0 (4.7 - 21.6)	12.0	----
Turbidity (NTU)	May 05 - Aug 08	69	15.2 (0 - **149.5**)	4.0	**6**
Spec. cond. (µmhos/cm)	May 05 - Aug 08	69	54 (35 - 470)	42	----
DO (mg/L)	May 05 - Aug 08	69	10.1 (**4.8** - 12.9)	10.1	**1**
pH	May 05 - Aug 08	69	7.5 (6.6 - 8.3)	7.6	----
$NO_3^-N+NO_2^-N$ (µg/L)	May 05 - Aug 08	42	**322** (64 - **1,600**)	**280**	**37**
TP (µg/L)	May 05 - Aug 08	42	73 (8 - **190**)	**91**	**3**
TOC (mg/L)	May 05 - Aug 08	42	1.7 (0.7 - 3.8)	1.5	----
TSS (mg/L)	May 05 - Aug 08	42	17.1 (1 - **110**)	5	**7**
Fecal coliforms, M-FC MF (mpn/100 mL)	May 05 - Aug 08	60	1,155 (nd - 48,000)	35	7 (12% > 200,1000) 7 (12% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Aug 07 - Aug 08	20	40 (brl - 120)	23	----
Copper, diss'd. (µg/L)	May 05 - Aug 08	42	brl - 3.1[b]	0.4	----
Gwinnett County USGS 02334885 (Park Unit 5, Suwanee Creek – Suwanee Creek, Buford Hwy; latitude 34.0322, longitude –84.0894)					
Fecal coliforms EC&M-FC (mpn or colonies/100 mL)	Jul 01 - Apr 08	112	715 (bdl - 36,800)	164	37 (33% > 200,1000) 26 (23% > 400)
USGS 02334885 (Park Unit 5, Suwanee Creek – Suwanee Creek at Buford Highway, Gwinnett Co.; latitude 34.0322, longitude –84.0894 – selected parameters[d])					
Temperature (°C)	Jan 98 - Mar 08	131	15.8 (2 - 24.8)	17	----
Turbidity (NTU)	Mar 98 - Aug 03	66	133.6 (2.9 – **1,000**)	18	**25**

Table A2-2. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
USGS 02334885 (Park Unit 5, Suwanee Creek – Suwanee Creek, cont'd.)					
Spec. cond. (µmhos/cm)	Jan 98 - Mar 08	141	105.6 (39 - 259)	102	----
DO (mg/L)	Jan 98 - Mar 08	127	8.5 (**4.3** - 13.9)	8.0	**1**
pH	Jan 98 - Mar 08	141	6.9 (**5.8** - 8.1)	6.9	**2**
$NO_3^-N+NO_2^-N$ (µg/L)	Jan 98 - Aug 08	128	**771** (50 - **4,200**)	**675**	**127**
TKN (µg/L)	Jan 98 - Aug 08	121	625 (100 - 2,300)	430	----
NH_4^+N (µg/L)	Jan - Dec 00	12	**300** (90 - **950**)	**200**	**11**
TN (µg/L)	Jan 98 - Aug 08	106	1,435 (590 - 4,800)	1,300	----
TP (µg/L)	Jan 98 - Aug 08	134	**115** (4 - **790**)	35	**42**
TDP (µg/L)	Jan 98 - Aug 08	118	18.5 (2 - 370)[b]	10	----
TSS (mg/L)	Jan 98 - Aug 08	130	**120** (1.2 - **870**)	20	**60**
TOC (mg/L)	Jan 00 - Aug 08	58	2.8 (9.6 - 7.0)	2.4	----
BOD_5 (mg/L)	Jan 98 - Aug 08	126	2.6 (0.05 - **8.6**)	1.9	**47**
COD (mg/L)	Jan 98 - Aug 08	115	9.8 (2.5 - 32)	10	----
Chloride, total (mg/L)	1 Aug 07	1	[sv 6.7]	----	----
Chloride, diss'd. (mg/L)	Nov 02 - Sep 03	6	4.8 (3.7 - 6.3)	4.8	----
Sulfate, total (mg/L)	1 Aug 07	1	[sv 16]	----	----
Sulfur, diss'd. (mg/L)	Nov 02 - Sep 03	6	7.1 (5.1 - 9.1)	7.0	----
Fecal coliforms, M-FC MF (colonies/100 mL)	Jan 98 - Aug 00	22	1,513 (23 - 12,000)	440	12 (55% >200,1000) 11 (50% > 400)
Fecal coliforms, EC (mpn/100 mL)	Jan - Oct 00	16	933 (10 - 9,200)	280	9 (56% >200,1000) 6 (38% >400)
Escherichia coli, M-TEC MF (colonies/100 mL)	Jun 99 - Apr 00	4	1,715 (320 - 3,100)	1,720	4 (100%>235) 3 (75% > 400)
Calcium (mg/L)	Jan 98 - Aug 08	78	8.8 (2.9 - 70)	7.9	----
Iron, total (µg/L)	Jun 99 - Mar 01	15	7,331 (968 - 19,800)	2,600	----
Iron, diss'd. (µg/L)	Jan 01 - Feb 03	4	186 (144 - 271)	164	----
Magnesium (mg/L)	Jan 98 - Aug 08	78	9.6 (0.9 - 560)	2	----
Cadmium, total (µg/L)	Jan 98 - Aug 08	120	**1.03** (0.04 - **<5.0**)[b]	**0.25**	uncertain[e]
Chromium, total (µg/L)	Jan 98 - Aug 08	110	5.8 (0.5 - 26)[b]	5	----
Copper, total (µg/L)	Jan 98 - Aug 08	111	5.5 (0.5 - **28**)[b]	5	**19**
Lead, total (µg/L)	Jan 98 - Aug 08	109	**5.0** (0.19 - **28**)[b]	3	**57**
Manganese, total (µg/L)	Jun 99 - Oct 07	96	548 (190 - 1,950)	435	----
Zinc, total (µg/L)	Jan 98 - Aug 08	116	29.4 (2 - **720**)	15	**5**
Cadmium, diss'd. (µg/L)	Jan 01 - Oct 02	24	< 0.5[b]	----	uncertain[e]
Chromium, diss'd. (µg/L)	Jan 01 - Oct 02	24	< 1.0[b]	----	----
Copper, diss'd. (µg/L)	Jan 01 - Oct 02	24	(< 2.0, 3)[b]	----	----
Lead, diss'd. (µg/L)	Jan 01 - Oct 02	24	< 2.0[b]	----	----
Manganese, diss'd. (µg/L)	Jan 01 - Oct 02	24	281 (110 - 556)	265	----
Zinc, diss'd. (µg/L)	Jan 01 - Oct 02	24	2.1 (1.0 - 5.0)	2	----
Atrazine (µg/L)	Nov 02 - Mar 08	17	0.043 (< 0.007-0.213)	0.019	----
Simazine (µg/L)	Nov 02 - Mar 08	17	0.445 (0.008 - 5.04)	0.067	----
GA DNR 12050301 (Park Unit 5, Suwanee Creek – Suwanee Creek, U.S. Hwy 23 near Suwanee, Gwinnett Co.; latitude 34.0326, longitude –84.0895)					
Temperature (°C)	Jan 99 - Sep 03	66	16.0 (2 - 24.6)	17.5	----
Turbidity (NTU)	Jan 99 - Aug 03	49	125 (2.9 - **930**)	19	**19**

Table A2-2. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12050301 (Park Unit 5, Suwanee Creek – Suwanee Creek, cont'd.)					
Spec. cond. (µmhos/cm)	Jan 99 - Sep 03	87	105 (39 - 223)	97	----
DO (mg/L)	Jan 99 - Sep 03	64	8.4 (5.2 - 13.9)	7.8	----
DO (% saturation)	Jan 99 - Feb 03	17	86 (62 - 106)	87	----
pH	Jan 99 - Sep 03	87	6.9 (**5.8** - 7.7)	6.9	**1**
$NO_3^-N+NO_2^-N$ (µg/L)	Jan 99 - Aug 03	49	**714** (**320** - **4,200**)	**640**	**49**
NH_4^+N (µg/L)	Jan 00 - Dec 00	12	**300** (90 - **950**)	**200**	**11**
TKN (µg/L)	Jan 99 - Sep 03	42	738 (140 - 2,300)	490	----
TP (µg/L)	Jan 99 - Sep 03	55	**134** (17 - **790**)	40	**18**
TDP (µg/L)	Jan 99 - Aug 03	37	22 (20 - 40)	20	----
SRP (µg/L)	Nov 02 - Sep 03	6	47 (20 - **180**)	20	**1**
TOC (mg/L)	Jan - Dec 00	12	2.4 (1.7 - 3.7)	2.4	----
TSS (mg/L)	Jan 99 - Aug 03	107	88 (1 - **870**)	44	**67**
BOD_5 (mg/L)	Jan 99 - Aug 03	49	2.3 (0.3 - **8.6**)	1.3	**17**
COD (mg/L)	Jan 99 - Aug 03	38	9.3 (5 - 28)	6.5	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	29 (18 - 45)	26	----
Chloride (mg/L)	Nov 02 - Sep 03	6	4.8 (3.7 - 6.3)	4.8	----
Sulfur, diss'd. (mg/L)	Nov 02 - Sep 03	6	7.1 (5.1 - 9.1)	7.1	----
Calcium (mg/L)	Jan 99 - Aug 00	19	8.8 (5,1 - 13.0)	8.6	----
Magnesium (mg/L)	Jan - Aug 00	19	2.0 (1.6 - 3.0)	1.9	----
Iron, total (mg/L)	Jan 99 - Aug 00	13	6.49 (9.68 - 19.80)	2.50	----
Iron, diss'd. (µg/L)	10 Dec 02	2	164 (144 - 183)	----	----
Cadmium, total (µg/L)	Jan 99 - Aug 03	39	all 0.5	----	**39**
Chromium, total (µg/L)	Jan 99 - Aug 03	39	5.3 (1 - 25)	2	----
Copper, total (µg/L)	Jan 99 - Aug 03	39	5.3 (1 - **28**)	2	**7**
Lead, total (µg/L)	Jan 99 - Aug 03	39	**6.0** (1 - **28**)	3	**20**
Manganese, total (µg/L)	Jun 99 - Aug 03	31	586 (210 - 1,930)	420	----
Zinc, total (µg/L)	Jan 99 - Aug 03	39	23.5 (3.0 - **104.0**)	11	**1**
Cadmium, diss'd. (µg/L)	Feb - Oct 02	9	all 0.5	0.5	**9**
Chromium, diss'd. (µg/L)	Feb - Oct 02	9	all 1.0	----	----
Copper, diss'd. (µg/L)	Feb - Oct 02	9	2.1 (2 - 3)	2	----
Lead, diss'd. (µg/L)	Feb - Oct 02	9	all 2.0	----	----
Manganese, diss'd. (µg/L)	Feb - Oct 02	9	302 (191 - 556)	300	----
Zinc, diss'd. (µg/L)	Feb - Oct 02	9	2.4 (2.0 - 4.0)	2	----
Other WC Data	23 Mar 00		7 Aug 00 (n = 2; toxic substances)		
Antimony, total	1 µg/L		1 µg/L		----
Arsenic, total	2 µg/L		2 µg/L		----
Mercury, total	0.1 µg/L		0.1 µg/L		----
Nickel, total	1 µg/L		2 µg/L		----
Selenium, diss'd.	2 µg/L		2 µg/L		----
Thallium, total	2 µg/L		2 µg/L		----
Fulton County CC-2 (Park Unit 6, Abbotts Bridge – Cauley Creek, downstream of discharge; latitude 34.0379, longitude –84.1483)					
$NO_3^-N + NO_2^-N$ (µg/L)	Apr 07 - Apr 08	5	49 (brl - **106**)[b]	----	**1**

Table A2-2. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
Fulton County CC-2 (Park Unit 6, Cauley Creek, cont'd.)					
TKN (µg/L)	Apr 07 - Apr 08	5	520 (brl - 800)	600	----
NH_4^+N (µg/L)	Apr 07 - Apr 08	5	all brl = 200[b]	----	----
TP (µg/L)	Apr 07 - Apr 08	5	brl - 79[b]	----	----
TDP (µg/L)	Apr 07 - Apr 08	5	all brl = 50[b]	----	----
SRP (µg/L)	Apr 07 - Apr 08	5	9 (brl - 14)	11	----
TSS (mg/L)	Apr 07 - Apr 08	5	brl - 13[b]	----	----
TDS (mg/L)	Apr 07 - Apr 08	5	68.2 (58 - 76)	71	----
BOD_5 (mg/L)	Apr 07 - Apr 08	5	all brl = 5[b]	----	----
COD (mg/L)	Apr 07 - Apr 08	5	brl - 20[b]	----	----
Fecal coliforms, M-FC MF (mpn/100 mL)	Mar 07 - Nov 07	17	571 (30 - 2,100)	330	8 (47% > 200, 1000) 7 (41% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Mar 07 - Nov 07	17	378 (20 - 1,100)	260	10 (59% > 235) 5 (29% > 400)
Hardness, Ca+Mg (mg/L)	Apr 07 - Apr 08	4	27 (24 - 31)	26	----
Cadmium, total (µg/L)	Apr 07 - Apr 08	4	all brl = 0.7[b]	----	uncertain[e]
Copper, total (µg/L)	Apr 07 - Apr 08	4	brl - **16.8**[b]	----	**1**
Lead, total (µg/L)	Apr 07 - Apr 08	4	all brl = 1.0[b]	----	----
Zinc, total (µg/L)	Apr 07 - Apr 08	4	(brl - 14.5)[b]	----	----
USGS 02335000 (Park Unit 7, Medlock Bridge - Chattahoochee River near Norcross; latitude 33.9972, longitude −84.2019; selected parameters[d])					
Temperature (°C)	Jul 02, Feb 05 - Sep 07	262	13.0 (6.3 - 23.2)	12	----
Spec. cond. (µmhos/cm)	Jul 02, Feb 05 - Sep 07	262	52 (36 - 94)	48	----
DO (mg/L)	Jul 29 02	1	[sv 9.1]	----	----
pH	Jul 29 02	1	[sv 6.5]	----	----
Fecal coliforms, M-FC MF (colonies/100 mL)	Nov 00 - Aug 01	18	141 (0 - 1,500)	38	2 (11% > 200,1000) 2 (11% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Oct 00 - Nov 07	1,312	313 (nd - 18,000)	56	203 (15% > 235) 139 (11% > 400)
Atrazine (µg/L)	Apr - May 01	3	0.015 (0.006 - 0.032)	0.006	----
Simazine (µg/L)	Apr - May 01	3	0.03 (<0.005 - 10.056)	0.03	----
NPS BacteriALERT Site #1 (Park Unit 7, Medlock Bridge - Chattahoochee River; latitude 33.9972, longitude −84.2019)					
Escherichia coli, Quanti-Tray (mpn/100 mL)	Oct 00 - Nov 08	1,405	289 (1 - 18,452)	56	200 (14% > 235) 139 (10% > 400)
Fulton County JO-1 (Park Unit 8, Jones Bridge – Johns Creek; latitude 34.0142, longitude –84.2076)					
$NO_3^-N + NO_2^-N$ (µg/L)	Sep 06 - Apr 08	6	**136** (BRL - **220**)	**139**	**3**
TKN (µg/L)	Sep 06 - Apr 08	6	BRL - 1,400[b]	----	----
NH_4^+N (µg/L)	Apr 07 - Apr 08	5	all BRL = 200[b]	----	----
TP (µg/L)	Sep 06 - Apr 08	6	brl - 58[b]	----	----

Table A2-2. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
Fulton County JO-1 (Park Unit 8, Jones Bridge, cont'd.)					
TDP (µg/L)	Sep 06 - Apr 08	4	all brl = 50 [b]	----	----
SRP (µg/L)	Apr 07 - Apr 08	5	brl - 11[b]	----	----
TSS (mg/L)	Sep 06 - Apr 08	6	5.4 (brl - 13)	3.8	----
TDS (mg/L)	Sep 06 - Apr 08	6	58.3 (40 - 72)	58.5	----
BOD_5 (mg/L)	Sep 06 - Apr 08	6	all brl = 5[b]	----	----
COD (mg/L)	Sep 06 - Apr 08	6	all brl = 10[b]	----	----
Hardness, Ca+Mg (mg/L)	Sep 06 - Apr 08	5	27 (26 - 29)	26	----
Fecal coliforms, M-FC MF (mpn/100 mL)	Jun 06 - Feb 08	20	571 (40 - 2,800)	275	7 (35% > 200, 1000) 7 (35% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Jun 06 - Feb 08	20	429 (31 - 1,700)	230	9 (45% > 200,1000) 6 (30% > 400)
Cadmium, total (µg/L)	Sep 06 - Apr 08	5	all brl = 0.7[b]	----	uncertain[e]
Copper, total (µg/L)	Sep 06 - Apr 08	5	all brl = 2.0[b]	----	----
Lead, total (µg/L)	Sep 06 - Apr 08	5	all brl = 1.0[b]	----	----
Zinc, total (µg/L)	Sep 06 - Apr 08	5	all brl = 10[b]	----	----
GA DNR 12054401 (Park Unit 8, Jones Bridge – Johns Creek, Old Alabama Road near Alpharetta, Fulton Co.; latitude 34.0111, longitude –84.2197)					
Temperature (°C)	Jan - Dec 00	20	16.6 (5.5 - 25.1)	18.1	----
Turbidity (NTU)	Jan - Dec 00	17	6.1 (2 - 17)	4.0	----
Spec. cond. (µmhos/cm)	Jan - Dec 00	20	78 (56 - 86)	80	----
DO (mg/L)	Jan - Dec 00	20	8.8 (7.0 - 11.8)	8.4	----
pH	Jan - Dec 00	20	7.3 (7.0 - 7.5)	7.3	----
$NO_3^-N+NO_2^-N$ (µg/L)	Jan - Dec 00	12	**249** (20 - **500**)	**225**	**11**
NH_4^+N (µg/L)	Jan - Dec 00	12	51 (30 - 80)	45	----
TP (µg/L)	Jan - Dec 00	12	all = 20	----	----
TOC (mg/L)	Jan - Dec 00	12	2.2 (1.3 - 7.2)	1.7	----
TSS (mg/L)	Jan - Dec 00	12	5.5 (2 – 17)	3.5	----
BOD_5 (mg/L)	Jan - Dec 00	12	0.9 (0.4 - 2.0)	0.9	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	30 (23 - 37)	32	----
Calcium (mg/L)	2 dates in 00	2	6.4 (5.5 - 7.2)	----	----
Magnesium (mg/L)	2 dates in 00	2	1.7 (1.5 - 1.9)	----	----

Other WQ Data	23 Mar 00	7 Aug 00 (n = 2; toxic substances)	
Antimony, total	1 µg/L	1 µg/L	----
Arsenic, total	2 µg/L	2 µg/L	----
Cadmium, total	**0.5** µg/L	**0.5** µg/L	**2**
Chromium, total	1 µg/L	1 µg/L	----
Copper, total	1 µg/L	1 µg/L	----
Lead, total	1 µg/L	1 µg/L	----
Mercury, total	0.1 µg/L	0.1 µg/L	----
Nickel, total	1 µg/L	1 µg/L	----
Selenium, diss'd.	2 µg/L	2 µg/L	----
Thallium, total	2 µg/L	2 µg/L	----

Table A2-2. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12054401 (Park Unit 8, Jones Bridge – Johns Creek, cont'd.)					
Other WQ Data	23 Mar 00		7 Aug 00 (n = 2; toxic substances, cont'd.)		
Zinc, total	3 µg/L		2 µg/L		----

[a] All values reported less than the level of detection or less than the reporting limit were replaced with ½ the value, following Ellis and Gilbert (1980) and Zirschky et al. (1985).

[b] More than 50% of the samples were below detection or below the reporting limit with the analytical technique used; thus, statistical interpretation was not attempted.

[c] Sample value in STORET for fecal coliforms (GA DNR 12048001) was noted as "*present > QL", with upper quantification limit equal to 10,000. Therefore, the value 10,000 was used for statistical computation.

[d] Selected parameters included those most commonly considered in water quality assessment; most of those that were not included here also had been sampled infrequently (1 or a few dates).

[e] Values were reported as "less than" a range of values that include the CCC.

Table A2-3. Water quality data for Park Section III (Units 9-13).[a]

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12055001 (Park Unit 9, Holcomb Bridge – Chattahoochee River, Dekalb Co. Water Intake, Fulton Co.; latitude 33.9731, longitude –84.2631)					
Turbidity (NTU)	Mar 01 - Dec 04	47	12.7 (nd - **240**)	4.4	**1**
Spec. cond. (µmhos/cm)	Mar 01 - Dec 04	47	54 (45 - 75)	53	----
pH	Mar 01 - Dec 04	47	6.8 (6.4 - 7.4)	6.8	----
NO_3 N+NO_2 N (µg/L)	Mar 01 - Dec 04	47	**303** (90 - **490**)	**300**	**46**
NH_4^+N (µg/L)	Mar 01 - Dec 04	47	40 (nd - **220**)	30	**4**
TP (µg/L)	Mar 01 - Aug 04	43	16 (nd - 50)	20	----
TOC (mg/L)	Mar 01 - Dec 04	47	2.0 (nd - 4.7)	2	----
TSS (mg/L)	Mar 01 - Dec 04	47	13.2 (nd - 100)	4	**6**
BOD_5 (mg/L)	Mar 01 - Dec 04	47	all nd[b]		
Fecal coliforms, EC (mpn/100 mL)	Mar 01 - Jun 04	52	437 (nd - 9,000)	50	11 (21% > 200, 1000) 7 (13% > 400)
Escherichia coli, EC-MUG (mpn/100 mL)	Jan 02 - Jun 04	37	244 (nd - 3,130)	52	9 (24% > 235) 3 (8% > 400)
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Nov 01 - Dec 03	25	13.8 (10 - 20)	13	----
Hardness, Ca+Mg (mg/L)	Mar 01 - Dec 04	47	16 (10 - 28)	16	----
DeKalb Co. - Scott Candler WTP (Park Unit 9, Holcomb Bridge, intake at same location as GA DNR 12055001)					
Fecal coliforms, M-FC MF (cfu/100 mL)	Jan 05 - Jul 06	404	576 (1-26,000)	61	72 (18% >200, 1000) 63 (16% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Aug 06 - Mar 09	661	158 (1-7,940)	55	78(12% >235) 45 (7% > 400)
GA DNR 12055361 (Park Unit 9, Holcomb Bridge – Crooked Creek, Spalding Drive near Norcross, Gwinnett Co.; latitude 33.965, longitude –84.2647)					
Temperature (°C)	Feb 99 - Sep 03	64	17.5 (4.8 - 27)	19.7	----
Turbidity (NTU)	Jan 99 - Sep 03	48	109 (2.3 - **980**)	9.5	**15**
Spec. cond. (µmhos/cm)	Feb 99 - Sep 03	83	86 (25 - 175)	93	----
DO (mg/L)	Feb 99 - Sep 03	64	8.3 (**0** - 12.4)	8.3	**3**
DO (% saturation)	Feb 99 - May 03	15	87 (76 - 98)	88	----
pH	Feb 99 - Sep 03	84	6.9 (**5.8** - 7.8)	6.9	**2**
NO_3^-N+NO_2^-N (µg/L)	Jan 99 - Aug 03	51	**346** (**100** - **1,100**)	**320**	**51**
NH_4^+N (µg/L)	Jan - Dec 00	12	89 (40 - **270**)	60	**3**
TKN (µg/L)	Jan 99 - Sep 03	39	851 (200 - 2,500)	770	----
TP (µg/L)	Jan 99 - Sep 03	51	**117** (20 - **640**)	30	**18**
TDP (µg/L)	Jan 99 - Sep 03	39	25 (20 - 90)	20	----
TOC (mg/L)	Jan - Dec 00	11	2.6 (1.6 - 7.1)	2.0	----
TSS (mg/L)	Jan 99 - Sep 03	109	110 (1 - **1,810**)	41	**66**
BOD_5 (mg/L)	Jan 99 - Sep 03	49	2.8 (0.4 - **8.9**)	1.4	**17**
COD (mg/L)	Jan 99 - Sep 03	40	12.4 (5 - 38)	10	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	36 (23 - 47)	40	----
Calcium (mg/L)	Jan 99 - Sep 00	19	7.5 (3.9 - 10.0)	8.3	----
Magnesium (mg/L)	Jan 99 - Sep 00	19	2.2 (1.7 - 3.9)	2.1	----
Iron, total (µg/L)	Jun 99 - Sep 00	14	4.84 (0.88 - 16.60)	3.85	----

Table A2-3. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12055361 (Park Unit 9, Holcomb Bridge – Crooked Creek, cont'd.)					
Cadmium, total (µg/L)	Jan 99 - Sep 03	40	0.5 (0.5 - **0.7**)	0.5	**40**
Chromium, total (µg/L)	Jan 99 - Sep 03	40	5.0 (1.0 - 30.0)	2	----
Copper, total (µg/L)	Jan 99 - Sep 03	40	6.9 (1 - **37**)	4	**11**
Lead, total (µg/L)	Jan 99 - Sep 03	40	**7.5** (1 - **40**)	**3.5**	**21**
Manganese, total (µg/L)	Jun 99 - Sep 03	34	496 (150 - 1,820)	345	----
Zinc, total (µg/L)	Jan 99 - Sep 03	40	50 (4 - **241**)	36	**9**
Cadmium, diss'd. (µg/L)	Feb - Oct 02	10	all = **0.5**	**0.5**	**10**
Copper, diss'd. (µg/L)	Feb - Oct 02	10	all = 2.0	2	----
Chromium, diss'd. (µg/L)	Feb - Oct 02	10	all = 1.0	1.0	----
Lead, diss'd. (µg/L)	Feb - Oct 02	10	all = 2.0	2.0	----
Manganese, diss'd. (µg/L)	Feb - Oct 02	10	155 (48 - 340)	131	----
Zinc, diss'd. (µg/L)	Feb - Oct 02	10	7.6 (3 - 14)	8	----
Other WQ Data	23 Mar 00		7 Aug 00 (n = 2; toxic substances)		
Antimony, total	1 µg/L		1 µg/L		----
Arsenic, total	2 µg/L		2 µg/L		----
Mercury, total	0.1 µg/L		0.1 µg/L		----
Nickel, total	1 µg/L		1 µg/L		----
Selenium, diss'd.	2 µg/L		2 µg/L		----
Thallium, total	2 µg/L		2 µg/L		----

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
Gwinnett County USGS 02335350 (Park Unit 9, Holcomb Bridge – Crooked Creek at Spalding Drive; latitude 33.9650, longitude -84.2650)					
Fecal coliforms, EC&M-FC (mpn or colonies/100 mL)	Jul 01 - Apr 08	112	809 (20 - 20,800)	180	39 (35% > 200, 1000) 33 (29% > 400)
USGS 02335350 (Park Unit 9, Holcomb Bridge – Crooked Creek at Spalding Drive; latitude 34.9650, longitude –84.2650 selected parameters[c])					
Temperature (^{o}C)	Jan 98 - Feb 08	109	17.0 (4.8 - 27.0)	17.8	----
Turbidity (NTU)	Apr 98 - Sep 03	68	133 (2.3 - **2,100**)	11.5	**23**
Spec. cond. (µmhos/cm)	Jan 98 - Feb 08	157	88 (21 - 239)	93	----
DO (mg/L)	Jan 98 - Feb 08	109	8.7 (**0** - 14.3)	8.4	**1**
pH	Jan 98 - Feb 08	156	6.8 (**5.2** - 8.5)	6.9	**4**
$NO_3^-N+NO_2^-N$ (µg/L)	Jan 98 - Aug 08	129	**343** (74 – **1,100**)	**330**	**127**
TKN (µg/L)	Jan 98 - Aug 08	117	765 (100 - 3,800)	520	----
NH_4^+N (µg/L)	Jan - Dec 00	12	89 (40 - **270**)	60	**3**
TN (µg/L)	Apr 98 - Aug 08	90	1,310 (380 - 4,100)	1,100	----
TP (µg/L)	Jan 98 - Aug 08	129	**118** (6 - **820**)	30	**44**
TDP (µg/L)	Jan 98 - Aug 08	118	19 (3 - 280) [b]	10	----
TSS (mg/L)	Jan 98 - Aug 08	129	**232** (nd - **3,120**)	11	**59**
TDS (mg/L)	Jan 98 - Aug 08	117	58 (14 - 136)	62	----

Table A2-3. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
USGS 02335350 (Park Unit 9, Holcomb Bridge – Crooked Creek, cont'd.)					
TOC (mg/L)	Jan 00 - Aug 08	60	3.0 (0.5 - 13.0)	2.1	----
BOD_5 (mg/L)	Jan 98 - Aug 08	121	**3.2** (0.05 - **17**)	1.6	**50**
COD (mg/L)	Jan 98 - Aug 08	115	13 (2.5 - 72)	10	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	36 (23 - 47)	40	----
Hardness, Ca+Mg (mg/L)	Mar 01 - Oct 07	83	25.5 (6 - 38)	29	----
Calcium (mg/L)	Jan 98 - Aug 08	77	7.6 (3.9 - 11)	8.4	----
Magnesium (mg/L)	Jan 98 - Aug 08	78	2.4 (1.4 - 7)	2.3	----
Chloride, total	2 dates in 00	2	5.8 (4.7 - 6.9)	----	----
Sulfate, total	2 dates in 00	2	4.2 (3.6 - 4.8)	----	----
Iron, total (µg/L)	Jun 99 - Apr 01	18	4,642 (875 - 16,600)	3,850	----
Iron, diss'd. (µg/L)	Mar - Apr 01	4	185 (145 - 260)	165	----
Fecal coliforms, M-FC MF (colonies/100 mL)	Jan 98 - Jul 01	23	5,094 (3 - 43,000)	500	15 (65% > 200,1000) 12 (52% > 400)
Fecal coliforms, EC (mpn/100 mL)	Jan - Oct 00	16	1,488 (20 - 17,000)	225	8 (50% > 200,1000) 6 (38% > 400)
Escherichia coli, m-TEC MF (colonies/100 mL)	8 Sep 99	1	[sv 240]	----	1 (100% > 235) 0 (0% > 400)
Cadmium, total (µg/L)	Jan 98 - Aug 08	119	**1.0** (0.07 - <**5.0**)[b]	**0.25**	uncertain[d]
Chromium, total (µg/L)	Jan 98 - Oct 07	110	6.5 (<1 - **78**)[b]	5	uncertain[d]
Copper, total (µg/L)	Jan 98 - Aug 08	116	8.6 (<1 - **95**)[b]	5	**≥ 34**
Lead, total (µg/L)	Jan 98 - Aug 08	108	**7.7** (0.1 - **120**)[b]	**3.5**	**≥ 43**
Manganese, total (µg/L)	Jun 99 - Oct 07	97	540 (131 - 3,800)	320	----
Zinc, total (µg/L)	Jan 98 - Aug 08	116	57.9 (4 - **710**)	28	**26**
Cadmium, diss'd. (µg/L)	Mar 01 - Oct 02	25	all < 0.5[b]	----	uncertain[c]
Chromium, diss'd. (µg/L)	Mar 01 - Oct 02	25	all < 1.0[b]	----	----
Copper, diss'd. (µg/L)	Mar 01 - Oct 02	24	(<2.0 - 2)[b]	----	----
Lead, diss'd. (µg/L)	Mar 01 - Oct 02	25	all < 2.0[b]	----	----
Manganese, diss'd. (µg/L)	Mar 01 - Oct 02	24	164 (46 - 340)	151	----
Zinc, diss'd. (µg/L)	Mar 01 - Oct 02	25	7.4 (3 - 17)	7	----
Other WQ Data	23 Mar 00		7 Aug 00 (n = 2; toxic substances)		
Antimony, total	< 1 µg/L		< 1 µg/L		----
Arsenic, total	< 2 µg/L		< 2 µg/L		----
Mercury, total	< 0.1 µg/L		< 0.1 µg/L		----
Nickel, total	< 1 µg/L		< 1 µg/L		----
Selenium, diss'd.	2 µg/L		< 2 µg/L		----
Thallium, total	< 2 µg/L		< 2 µg/L		----
Fulton County CK-1 (Park Unit 10, Island Ford – Ball Mill Creek near Chattahoochee River.; latitude 33.9827, longitude –84.3182)					
$NO_3^-N + NO_2^-N$ (µg/L)	Sep 06 - Apr 08	6	**420** (**291** - **498**)	**454**	**6**
TKN (µg/L)	Sep 06 - Apr 08	6	442 (brl - 700)	375	----
NH_4^+N (µg/L)	Apr 07 - Apr 08	5	all brl = 200[b]	----	----
TP (µg/L)	Sep 06 - Apr 08	6	all brl = 50[b]	----	----
TDP (µg/L)	Sep 06 - Apr 08	4	all brl = 50[b]	----	----

Table A2-3. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
Fulton County CK-1 (Park Unit 10, Island Ford – Ball Mill Creek, cont'd.)					
SRP (µg/L)	Apr 07 - Apr 08	5	brl - 23[b]	----	**----**
TSS (mg/L)	Sep 06 - Apr 08	6	brl - 8[b]	----	**----**
TDS (mg/L)	Sep 06 - Apr 08	6	73.8 (68 - 81)	73	----
BOD_5 (mg/L)	Sep 06 - Apr 08	6	all brl = 5[b]	**----**	**----**
COD (mg/L)	Sep 06 - Apr 08	6	brl - 16[b]	----	**----**
Hardness, Ca+Mg (mg/L)	Sep 06 - Apr 08	6	34 (31 - 38)	33	----
Fecal coliforms, M-FC MF (mpn/100 mL)	Jun 06 - Nov 07	20	668 (50 - 3,100)	220	9 (45% > 200, 1000) 7 (35% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Jun 06 - Nov 07	20	482 (31 - 1,800)	160	9 (45% > 235) 7 (35% > 400)
Cadmium, total (µg/L)	Sep 06 - Apr 08	6	all brl = 0.7[b]	**----**	uncertain[d]
Copper, total (µg/L)	Sep 06 - Apr 08	6	all brl = 2.0[b]	**----**	**----**
Lead, total (µg/L)	Sep 06 - Apr 08	6	all brl = 1.0[b]	----	----
Zinc, total (µg/L)	Sep 06 - Apr 08	6	all brl = 10[b]	**----**	**----**
City of Alpharetta (Park Unit 11, Vickery Creek – Big Creek site #47 at Mansell Road; latitude 34.0374, longitude; −84.3032)					
Temperature (°C)	Jun 99 - Feb 09	85	15.4 (5.6 - 27.8)	15	**----**
Turbidity (NTU)	Jun 99 - Feb 09	87	25 (4.3 - **669**)	10.3	**4**
Spec. cond. (µmhos/cm)	Jun 99 - Feb 09	85	117 (29 - 450)	94	----
DO (mg/L)	Jun 99 - Feb 09	73	7.7 (**2.5** - 11.6)	7.5	**6**
pH	Jun 99 - Feb 09	82	6.9 (6.0 - 7.8)	6.9	----
Nitrate (µg/L)	Jun 99 - Feb 02	3	**1,700** (0 - **3,000**)	**2,000**	**2**
Ammonium (µg/L)	Sep 99 - Feb 09	77	109 (0 - **1,100**)	80	**26**
Phosphate (µg/L)	Jun 99 - Feb 09	83	**280** (0 - **2,000**)	100	**41**
TDS (mg/L)	Jun 99 - Feb 09	80	85 (30 - 290)	70	----
Fecal coliforms, M-FC MF (cfu/100 mL)	Jun 99 - Feb 09	87	1,494 (0 - 19,400)	120	30 (34%>200, 1000) 30 (34% > 400)
Fecal streptococci (cfu/100 mL)	Jun 99 - Feb 09	83	635 (0 - 12,630)	160	25 (30%>200, 1000) 23 (28%>400)
Copper, total (µg/L)	Feb 02 - Feb 09	32	76 (0 - 397)	16	17
Chloride (ppm)	Feb 02, Apr 05	2	25 (0 - 50)	----	----
Fluoride (µg/L)	Jun 00 - Aug 06	9	16 (0 – 1,000)	0	----
GA DNR 12060001 (Park Unit 11, Vickery Creek – Big Creek, Roswell Water Intake near Roswell, Fulton Co.; latitude 34.0042, longitude –84.3514)					
Turbidity (NTU)	Mar 01 - Dec 04	47	16.8 (5 - **80**)	11	**2**
Spec. cond. (µmhos/cm)	Mar 01 - Dec 04	47	115.8 (50 - 280)	110	----
pH	Mar 01 - Dec 04	47	7.0 (6.4 - 7.5)	7	----
$NO_3^-N + NO_2^-N$ (µg/L)	Mar 01 - Dec 04	47	**1,025** (**410** - **4,200**)	**910**	**47**
NH_4^+N (µg/L)	Mar 01 - Dec 04	47	42 (nd - **170**)	30	**1**
TP (µg/L)	Mar 01 - Aug 04	43	**151** (nd - **660**)	**130**	**25**
TOC (mg/L)	Mar 01 - Dec 04	47	3.2 (nd - 6.5)	3.1	----
TSS (mg/L)	Mar 01 - Dec 04	47	14.2 (2 - **84**)	8	**6**
BOD_5 (mg/L)	Mar 01 - Dec 04	46	all nd [b]	----	----

Table A2-3. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12060001 (Park Unit 11, Vickery Creek – Big Creek					
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Nov 01 - Dec 03	25	26 (4.9 - 42)	25	----
Hardness, Ca+Mg (mg/L)	Mar 01 - Dec 04	47	33 (12 - 60)	32	----
Fecal coliforms, EC (mpn/100 mL)	Mar 01 - Jun 04	52	1,086 (40 - 9,000)	260	23 (44% > 200, 1000) 21 (40 > 400)
Escherichia coli, EC-MUG (mpn /100 mL)	Jan 02 - Jun 04	37	748 (20 - 7,701)	212	17 (46% > 235) 12 (32% > 400)
Cobb County WL4 (Park Unit 12, Gold Branch - Willeo Creek at Willeo Creek Point; latitude 33.9948, longitude –84.3901)					
Temperature (°C)	Feb 98 - Mar 08	35	15.8 (3.5 - 25.5)	16.0	----
Turbidity (NTU)	Feb 98 - Mar 08	35	6.5 (1.2 - 18)	5.5	----
Spec. cond. (µmhos/cm)	Feb 98 - Mar 08	34	86 (62 - 135)	82	----
DO (mg/L)	Feb 98 - Mar 08	35	8.1 (**4.2** - 12.2)	7.7	**3** (9% < 5)
pH	Feb 98 - Mar 08	32	6.9 (6.4 - 8.6)	6.9	----
$NO_3^-N+NO_2^-N$ (µg/L)	Feb 98 - Mar 08	35	**251** (25 - **480**)	**220**	**34**
TKN (µg/L)	Feb 98 - Mar 08	35	600 (50 - 1,810)	500	----
TP (µg/L)	Feb 98 - Mar 08	35	59 (5 - **150**)	50	**6**
BOD_5 (mg/L)	Feb 98 - Mar 08	35	1.3 (0.5 - 2.9)	1.0	----
COD (mg/L)	Feb 98 - Mar 08	34	all < 20.0[b]	----	----
Chlorides (mg/L)	Feb 98 - Nov 07	34	4.8 (2.4 - 7.8)	4.7	----
TSS (mg/L)	Feb 98 - Mar 08	35	3.8 (1.6 - 6.4)	3.4	----
Fecal coliforms, M-FC MF (cfu/100 mL)	Feb 98 - Mar 08	35	434 (10 - 3,000[c])	200	12 (34% > 200, 1000) 10 (29% > 400)
Calcium (mg/L)	Nov 07, Mar 08	2	5.8 (5.3 - 6.3)	----	----
Magnesium (mg/L)	Nov 07, Mar 08	2	1.9 (1.8 - 2.1)	----	----
Barium, total (µg/L)	Nov 07, Mar 08	2	24.8 (22.9 - 26.7)	----	----
Cadmium, total (µg/L)	Feb 98 - Mar 08	35	all < 0.7[b]	----	uncertain[d]
Copper, total (µg/L)	Feb 98 - Mar 08	35	2.9 (2.5 - **17.8**)	2.5	**1**
Iron, total (µg/L)	Nov 07, Mar 08	2	1,651 (1,009-2293)		
Lead, total (µg/L)	Feb 98 - Mar 08	35	1.1 (0.5 - **17.6**)	0.5	**1**
Potassium (mg/L)	Nov 07, Mar 08	2	2.0 (1.7 - 2.3)	----	----
Sodium (mg/L)	Nov 07, Mar 08	2	4.1 (3.6 - 4.5)	----	----
Zinc, total (µg/L)	Feb 98 - Mar 08	35	6.5 (5.0 - 17.3)	5.0	----
GA DNR 12064001 (Park Unit 12, Gold Branch – Willeo Creek at State Road 120 near Roswell in Cobb Co.; latitude 33.9922, longitude –84.3867)					
Temperature (°C)	Jun 99 - Dec 00	24	15.0 (2.5 - 25.3)	16.5	----
Turbidity (NTU)	Jan - Dec 00	12	6.1 (2.6 - 13)	4.8	----
Spec. cond. (µmhos/cm)	Jun 99 - Dec 00	25	80 (54 - 93)	80	----
DO (mg/L)	Jun 99 - Dec 00	25	8.5 (**4.6** - 12.6)	8.2	**2**
pH	Jun 99 - Dec 00	25	7.0 (6.5 - 7.6)	6.9	----
$NO_3^-N+NO_2^-N$ (µg/L)	Jan - Dec 00	12	**209** (20 - **360**)	**210**	**11**
NH_4^+N (µg/L)	Jan - Dec 00	12	79 (10 - **160**)	70	**3**
TP (µg/L)	Jan - Dec 00	12	24 (20 - 50)	20	----
TOC (mg/L)	Jan - Dec 00	12	2.1 (1.0 - 2.8)	2.1	----

Table A2-3. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12064001 (Park Unit 12, Gold Branch – Willeo Creek, cont'd.)					
TSS (mg/L)	Jan - Dec 00	11	6.4 (2 - 17)	6	----
BOD_5 (mg/L)	Jan - Dec 00	12	1.1 (0.3 - **3.4**)	1.0	**1**
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	29 (23 - 36)	31	----
Calcium (mg/L)	2 dates in 00	2	6.9 (5.8 - 7.9)	----	----
Magnesium (mg/L)	2 dates in 00	2	2.2 (1.9 - 2.4)	----	----
Other WQ Data	27 Apr 00		6 Nov 00 (n = 2; toxic substances)		
Antimony, total	1 µg/L		1 µg/L		----
Arsenic, total	2 µg/L		4 µg/L		----
Cadmium, total	0.5 µg/L		0.5 µg/L		**2**
Chromium, total	1 µg/L		1 µg/L		----
Copper, total	1 µg/L		2 µg/L		----
Lead, total	1 µg/L		2 µg/L		----
Mercury, total	0.1 µg/L		0.1 µg/L		----
Nickel, total	1 µg/L		1 µg/L		----
Selenium, diss'd.	2 µg/L		4 µg/L		----
Thallium, total	2 µg/L		2 µg/L		----
Zinc, total	2 µg/L		2 µg/L		----
Fulton County MA-1 (Park Unit 13, Johnson Ferry – Marsh Creek at Brandon Mill Road; latitude 33.9653, longitude –84.3729)					
$NO_3^-N + NO_2^-N$ (µg/L)	Sep 06 - Apr 08	6	**321** (**114** - **600**)	**313**	**6**
TKN (µg/L)	Sep 06 - Apr 08	6	brl - 500[b]	----	----
NH_4^+N (µg/L)	Apr 07 - Apr 08	5	all brl = 200[b]	----	----
TP (µg/L)	Sep 06 - Apr 08	6	all brl = 50[b]	----	----
TDP (µg/L)	Sep 06 - Apr 08	4	all brl = 50[b]	----	----
SRP (µg/L)	Apr 07 - Apr 08	5	brl - 16[b]	----	----
TSS (mg/L)	Sep 06 - Apr 08	6	brl - 8[b]	----	----
TDS (mg/L)	Sep 06 - Apr 08	6	82.3 (72 - 91)	83.5	----
BOD_5 (mg/L)	Sep 06 - Apr 08	6	all brl = 5[b]	----	----
COD (mg/L)	Sep 06 - Apr 08	6	brl - 27[b]	----	----
Hardness, Ca+Mg (mg/L)	Sep 06 - Apr 08	6	37.5 (30 - 44)	39	----
Fecal coliforms, M-FC MF (mpn/100 mL)	Jun 06 - Nov 07	20	759 (20 - 2,600)	305	11 (55% > 200, 1000) 9 (45% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Jun 06 - Nov 07	20	767 (20 - 2,700)	340	12 (60% > 235) 9 (45% > 400)
Cadmium, total (µg/L)	Sep 06 - Apr 08	6	all brl = 0.7[b]	----	uncertain[d]
Copper, total (µg/L)	Sep 06 - Apr 08	6	all brl = 2.0[b]	----	----
Lead, total (µg/L)	Sep 06 - Apr 08	6	all brl = 1.0[b]	----	----
Zinc, total (µg/L)	Sep 06 - Apr 08	6	all brl = 10[b]	----	----

Table A2-3. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12070001 (Park Unit 13, Johnson Ferry – Chattahoochee River, Fulton Co.; by intake of Cobb Co. WTP, just upstream from Johnson Ferry Road bridge, right bank (latitude 33.9444, longitude –84.4053)					
Turbidity (NTU)	Mar 01 - Dec 04	47	14 (nd - **90**)	9	**1**
Spec. cond. (µmhos/cm)	Mar 01 - Dec 04	47	83.1 (52 - 160)	80	----
pH	Mar 01 - Dec 04	45	7.1 (6.7 - 7.6)	7	----
$NO_3^-N+NO_2^-N$ (µg/L)	Mar 01 - Aug 04	47	**822** (**280** - **1,400**)	**780**	**47**
NH_4^+N (µg/L)	Mar 01 - Aug 04	47	61 (nd - **460**)	40	**6**
TP (µg/L)	Mar 01 - Aug 04	43	45 (nd - **110**)	40	**1**
TOC (mg/L)	Mar 01 - Dec 04	47	2.6 (nd - 6.1)	2.5	----
TSS (mg/L)	Mar 01 - Dec 04	46	18.5 (nd - **120**)	9.2	**11**
BOD_5 (mg/L)	Mar 01 - Dec 04	46	2.9 (nd - **4.6**)[b]	----	**1**
Fecal coliforms, EC (mpn/100 mL)	Mar 01 - Jun 04	52	276 (nd - 2,400)	110	13 (25% > 200, 1000) 11 (21% > 400)
Escherichia coli, EC-MUG (mpn/100 mL)	Jan 02 - Jun 04	36	326 (nd - 6,131)	95	10 (28% > 235) 4 (11% > 400)
Alkalinity, Carbonate as $CaCO_3$ (mg/L)	Nov 01 - Dec 03	25	21 (12 - 45)	20	----
Hardness, Ca+Mg (mg/L)	Mar 01 - Dec 04	46	23 (14 - 50)	20	----
MWA, Cobb County (Park Unit 13, Johnson Ferry - J.E. Quarles Water Treatment Plant's raw water intake – Chattahoochee River; latitude 33.9444, longitude -84.4053					
Escherichia coli, Quanti-Tray (mpn/100 mL)	Sep 07 - Mar 09	554	159 (brl – 7,820)	25	61 (11% >235) 41 (7% > 400)
NPS BacteriALERT Site 2 (Park Unit 13, Johnson Ferry – Chattahoochee River; latitude 33.9433, longitude –84.4047)					
Escherichia coli, quanti-tray (mpn/100 mL)	Oct 01 - Nov 02	406	234 (3 - 8,259)	49	59 (15% > 235) 43 (11% > 400)
USGS 02335830 (Park Unit 13, Johnson Ferry – Chattahoochee River at Johnson Ferry Rd.; latitude 33.9433, longitude −84.4047; selected parameters[c])					
Temperature (°C)	Mar 99 - Dec 00	81	14.9 (4.0 - 23.0)	16	----
Turbidity (NTU)	Jan - Dec 00	11	29.3 (2.6 - **200**)	5	**2**
Spec. cond. (µmhos/cm)	Mar 99 - Dec 00	81	66 (43 - 89)	65	----
DO (mg/L)	Mar 99 - Dec 00	81	9.2 (6.8 - 11.8)	9.1	----
pH	Mar 99 - Dec 00	81	6.9 (**5.9** - 8.1)	6.9	**1**
$NO_3^-N+NO_2^-N$ (µg/L)	Jan - Dec 00	12	**651** (**540** - **850**)	**610**	**12**
NH_4^+N (µg/L)	Jan - Dec 00	12	**154** (15 - **620**)	**135**	**7**
TP (µg/L)	Jan - Dec 00	12	**136** (30 - **550**)	55	**3**
TSS (mg/L)	Jan - Dec 00	11	22.1 (nd - **150**)	6	**2**
TOC (mg/L)	Jan - Dec 00	12	2.0 (1.4 - 2.8)	1.9	----
BOD_5 (mg/L)	Jan - Dec 00	11	1.1 (0.5 - 2.3)	0.9	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	19.4 (15 - 22)	19.5	----

Table A2-3. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
USGS 02335830 (Park Unit 13, Johnson Ferry – Chattahoochee River, cont'd.)					
Fecal coliforms, M-FC MF (colonies/100 mL)	Mar 99 - Apr 00	60	628 (6 - 15,000)	60	11 (18% > 200,1000) 13 (22% > 400)
Fecal coliforms, EC (mpn/100 mL)	Jan - Dec 00	16	447 (10 - 5,400)	80	2 (13% > 200,1000) 2 (13% > 400)
Escherichia coli, m-TEC MF (colonies/100 mL)	Mar 99 - Apr 00	56	494 (nd - 10,000)	52	12 (21% >200,1000) 11 (20% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Oct 01 - Nov 02	405	230 (3 - 8,300)	49	59 (15% >200, 1000) 42 (10% > 400)
Calcium (mg/L)	2 dates in 00	2	4.75 (4.4 - 5.1)	----	**----**
Magnesium (mg/L)	2 dates in 00	2	1.45 (1.4 - 1.5)	----	**----**

Other WQ Data	27 Apr 00	6 Nov 00 (n = 2; toxic substances)	
Antimony, total	< 1 µg/L	< 1 µg/L	----
Arsenic, total	< 2 µg/L	< 4 µg/L	----
Cadmium, total	< **0.5** µg/L	< **0.5** µg/L	uncertain[e]
Chromium, total	< 1 µg/L	< 1 µg/L	----
Copper, total	< 1 µg/L	< 2 µg/L	----
Lead, total	< 1 µg/L	< 2 µg/L	----
Mercury, total	< 0.1 µg/L	< 0.1 µg/L	----
Nickel, total	< 1 µg/L	< 1 µg/L	----
Selenium, diss'd.	< 2 µg/L	< 4 µg/L	----
Thallium, total	< 2 µg/L	< 2 µg/L	----
Zinc, total	4 µg/L	4 µg/L	----

[a] All values reported less than the level of detection or less than the reporting limit were replaced with ½ the value, following Ellis and Gilbert (1980) and Zirschky et al. (1985).

[b] More than 50% of the samples were below detection or below the reporting limit with the analytical technique used; thus, statistical interpretation was not attempted.

[c] Selected parameters included those most commonly considered in water quality assessment; most of those that were not included here also had been sampled infrequently (1 or a few dates).

[d] Values were reported as "less than" a range of values that include the CCC.

Table A2-4. Water quality data for Park Section IV (Units 14-16).[a]

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
USGS 02335870 (Park Unit 14, Cochran Shoals – Sope Creek near Marietta; latitude 33.9539, longitude −84.4433 selected parameters[b])					
Temperature (°C)	Apr 98 - Oct 08	157	17.0 (2.8 – 29.5)	17.8	----
Turbidity (NTU)	Apr 98	1	sv 17	----	----
Spec. cond. (µmhos/cm)	Apr 98 - Oct 08	163	104 (43 - 471)	98	----
DO (mg/L)	Apr 98 - Oct 08	152	8.8 (**4.2** - 13.5)	8.6	**1**
pH	Apr 98 - Oct 08	157	6.9 (**5.5** - 7.8)	7.0	**1**
$NO_3^-N + NO_2^-N$ (µg/L)	Apr 98 - Sep 08	142	**479** (4 – **2,950**)	**470**	**139**
TKN (µg/L)	Apr 98 - Sep 03	87	347 (50 - 3,100)	190	----
TN (µg/L)	Apr 98 - Sep 03	84	852 (190 - 3,700)	685	----
TP (µg/L)	Apr 98 - Sep 08	143	45 (5 - **810**)	15	**10**
TDP (µg/L)	Apr 98 - Sep 01	42	7.9 (3 - 36)	4.5	----
TDS (mg/L)	Apr 98 - Oct 02	41	77 (39 - 259)	72	----
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Apr 98 - Jul 99	8	29 (20 - 34)	30	----
Hardness, Ca+Mg (mg/L)	Apr 98 - Oct 02	41	31 (20 - 54)	31	----
Fecal coliforms, M-FC MF (colonies/100 mL)	Jun 99 - Apr 00	4	4,205 (71 - 13,000)	1,875	2 (50% > 200,1000) 2 (50% > 400)
Escherichia coli, m-TEC MF (colonies/100 mL)	Jun 99 - Mar 02	5	3,118 (100 - 9,300)	2,000	3 (60% > 235) 3 (60% > 400)
Escherichia coli, modified m-TEC MF(colonies/ 100 mL)	Nov 02 - Jul 03	5	1,978 (11 - 9,000)	150	2 (40% > 235) 2 (40% > 400)
Aluminum, diss'd. (µg/L)	Nov 01 - Oct 02	4	2.1 (1.6 - 2.3)	2.2	----
Antimony, diss'd. (µg/L)	Nov 01 - Oct 02	4	0.09 (0.06 – < 3)	0.06	----
Arsenic, diss'd. (µg/L)	Apr 98 - Oct 02	5	(< 1 - < 2) [c]	----	----
Barium, diss'd. (µg/L)	Nov 01 - Oct 02	4	28 (26 - 31)	27	----
Iron, diss'd. (µg/L)	Apr 98 - Oct 02	42	121 (13 - 430)	103	----
Cadmium, diss'd. (µg/L)	Nov 01 - Oct 02	4	all < 0.04 [c]	----	----
Chromium, diss'd. (µg/L)	Nov 01 - Oct 02	4	all < 0.8 [c]	----	----
Cobalt, diss'd. (µg/L)	Nov 01 - Oct 02	4	0.36 (0.297 - 0.522)	0.31	----
Copper, diss'd. (µg/L)	Nov 01 - Oct 02	4	1.1 (0.7 - 1.6)	1.1	----
Lead, diss'd. (µg/L)	Nov 01 - Oct 02	4	(<0.08 - 0.12) [c]	----	----
Manganese, diss'd. (µg/L)	Apr 98 - Oct 02	41	159 (22.1 - 397)	150	----
Nickel, diss'd. (µg/L)	Nov 01 - Oct 02	4	0.3 (0.23 - 0.39)	0.3	----
Selenium, diss'd. (µg/L)	Nov 01 - Oct 02	4	(1 - < 3) [c]	----	----
Zinc, diss'd. (µg/L)	Nov 01 - Oct 02	4	3.2 (2.1 - 5.1)	2.9	----
Atrazine (µg/L)	Apr 98 - Aug 08	132	0.03 (<0.001 - 0.537)	0.014	----
Simazine (µg/L)	Apr 98 - Aug 08	131	0.37 (<0.005 - 8.7)	0.083	?
Cobb County SP6 (Park Unit 14, Cochran Shoals – Sope Creek, Paper Mill Road; latitude 33.9409, longitude –84.4376)					
Temperature (°C)	Mar 98 - Jan 08	32	15.8 (5.0 - 26.4)	16.0	----
Turbidity (NTU)	Mar 98 - Jan 08	33	5.0 (1.6 - 12.5)	4.2	----
Spec. cond. (µmhos/cm)	Mar 98 - Jan 08	32	115 (85 - 282)	106	----
DO (mg/L)	Mar 98 - Jan 08	33	9.7 (7.4 - 12.5)	9.4	----
pH	Mar 98 - Jan 08	33	7.3 (6.8 - 7.9)	7.3	----

Table A2-4. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
<u>**Cobb County SP6** (Park Unit 14, Cochran Shoals – Sope Creek, cont'd.)</u>					
$NO_3^-N + NO_2^-N$ (µg/L)	Mar 98 - Jan 08	33	**481** (**200** - **780**)	**470**	**33**
TKN (µg/L)	Mar 98 - Jan 08	33	574 (140 - 1,470)	390	----
TP (µg/L)	Mar 98 - Jan 08	33	51 (5 - **150**)	50	**4**
BOD_5 (mg/L)	Mar 98 - Jan 08	33	1.0 (0.5 - 1.7)	1.0	----
COD (mg/L)	Mar 98 - Jan 08	33	11 (10 - 30)	10.0	----
Chloride (mg/L)	Mar 98 - Oct 07	32	10.2 (1.2 - 69)	7.4	----
TSS (mg/L)	Mar 98 - Jan 08	33	3.4 (1.2 - 10.8)	2.6	----
Fecal coliforms, M-FC MF (cfu/100 mL)	Mar 98 - Jan 08	33	<u>294</u> (40 - <u>1,350</u>)	<u>200</u>	<u>9</u> (27% > 200, 1000) <u>7</u> (21% > 400)
Calcium (mg/L)	Jan 08	1	[sv 8.2]	----	----
Magnesium (mg/L)	Jan 08	1	[sv 2.3]	----	----
Barium (µg/L)	Jan 08	1	[sv 27.1]	----	----
Potassium (mg/L)	Jan 08	1	[sv 2.1]	----	----
Sodium (mg/L)	Jan 08	1	[sv 6.3]	----	----
Iron, total (µg/L)	Jan 08	1	[sv 557.5]	----	----
Aluminum, total (µg/L)	Jan 08	1	[sv 61.2]	----	----
Cadmium, total (µg/L)	Mar 98 - Jan 08	32	all < 0.7[c]	----	uncertain[d]
Copper, total (µg/L)	Mar 98 - Jan 08	32	all < 5.0[c]	----	----
Lead, total (µg/L)	Mar 98 - Jan 08	32	0.7 (0.5 - **3.7**)	0.5	**1**
Manganese, total (µg/L)	Jan 08	1	[sv 139.5]	----	----
Zinc, total (µg/L)	Mar 98 - Jan 08	32	9.3 (5.0 - 52.7)	5.0	----
<u>**GA DNR 12072101** (Park Unit 14, Cochran Shoals – Sope Creek, Columns Drive near Marietta, GA – latitude 33.9264, longitude –84.4303)</u>					
Temperature (^oC)	Jan - Dec 00	20	14.9 (2.5 - 25.4)	16.4	----
Turbidity (NTU)	Jan - Dec 00	12	10.9 (0.9 - **92**)	3	**1**
Spec. cond. (µmhos/cm)	Jan - Dec 00	20	109 (59 - 151)	109	----
DO (mg/L)	Jan - Dec 00	20	9.4 (6.3 - 13.3)	8.7	----
pH	Jan - Dec 00	20	7.4 (7.0 - 7.7)	7.4	----
$NO_3^-N + NO_2^-N$ (µg/L)	Jan - Dec 00	11	**424** (60 - **690**)	**420**	**10**
NH_4^+N (µg/L)	Jan - Dec 00	11	91 (10 - **210**)	80	**4**
TP (µg/L)	Jan - Dec 00	11	31 (20 - **120**)	20	**1**
TOC (mg/L)	Jan - Dec 00	11	2.1 (1.2 - 3.4)	2.1	----
TSS (mg/L)	Jan - Dec 00	11	10 (2 - **77**)	3	**1**
BOD_5 (mg/L)	Jan - Dec 00	11	1.3 (0.3 - **3.8**)	0.9	**1**
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	11	32 (15 - 41)	35	----
Calcium (mg/L)	2 dates in 00	2	9.75 (8.5 - 11.0)	----	----
Magnesium (mg/L)	2 dates in 00	2	2.4 (2.2 - 2.6)	----	----

<u>Other WC Data</u>	<u>27 Apr 00</u>	<u>6 Nov 00</u>	(n = 2; toxic substances)
Antimony, total	1 µg/L	1 µg/L	----
Arsenic, total	2 µg/L	4 µg/L	----
Cadmium, total	**0.5** µg/L	**0.5** µg/L	**2**
Chromium, total	1 µg/L	1 µg/L	----
Copper, total	1 µg/L	2 µg/L	----

Table A2-4. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12072101 (Park Unit 14, Cochran Shoals – Sope Creek cont'd.)					
Other WC Data	27 Apr 00		6 Nov 00 (n = 2; toxic substances)		
Lead, total	1 µg/L		2 µg/L		----
Mercury, total	0.1 µg/L		0.1 µg/L		----
Nickel, total	1 µg/L		1 µg/L		----
Selenium, diss'd.	2 µg/L		4 µg/L		----
Thallium, total	2 µg/L		2 µg/L		----
Zinc, total	4 µg/L		4 µg/L		----

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
Fulton County LI-2 (Park Unit 15, Palisades – Long Island Creek at Northside Drive; latitude 33.8914, longitude –84.4222)					
$NO_3^-N + NO_2^-N$ (µg/L)	Sep 06 - Apr 08	6	**395** (**215** - **569**)	**396**	**6**
TKN (µg/L)	Sep 06 - Apr 08	6	442 (brl - 700)	375	----
NH_4^+N (µg/L)	Apr 07 - Apr 08	5	all brl = 200[c]	----	**----**
TP (µg/L)	Sep 06 - Apr 08	6	all brl = 50[c]	----	**----**
TDP (µg/L)	Sep 06 - Apr 08	4	all brl = 50[c]	----	**----**
SRP (µg/L)	Apr 07 - Apr 08	5	brl - 14[c]	----	**----**
TSS (mg/L)	Sep 06 - Apr 08	6	brl - 8[c]	**----**	**----**
TDS (mg/L)	Sep 06 - Apr 08	6	71.3 (53 - 91)	73.5	----
BOD_5 (mg/L)	Sep 06 - Apr 08	6	all brl = 5[c]	**----**	**----**
COD (mg/L)	Sep 06 - Apr 08	6	brl - 10[c]	----	**----**
Fecal coliforms, M-FC MF (mpn/100 mL)	Jun 06 - Nov 07	20	<u>1,761</u> (70 - <u>9,000</u>)	299	<u>9</u> (45% > 200, 1000) <u>9</u> (45% > 400)
Escherichia coli, Quanti-Tray (mpn/100 mL)	Jun 06 - Nov 07	20	<u>1,643</u> (96 - <u>9,800</u>)	<u>453</u>	<u>11</u> (55% > 235) <u>10</u> (50% > 400)
Hardness, Ca+Mg (mg/L)	Sep 06 - Apr 08	6	33.5 (30 - 41)	32	----
Cadmium, total (µg/L)	Sep 06 - Apr 08	6	all brl = 0.7[c]	**----**	uncertain[d]
Copper, total (µg/L)	Sep 06 - Apr 08	6	all brl = 2.0[c]	**----**	**----**
Lead, total (µg/L)	Sep 06 - Apr 08	6	all brl = 1.0[c]	**----**	**----**
Zinc, total (µg/L)	Sep 06 - Apr 08	6	brl - 10.4[c]	----	**----**
GA DNR 12073201 (Park Unit 15, Palisades – Long Island Creek at Northside Drive in Fulton Co. near Atlanta; latitude 33.8861, long. –84.4267)					
Temperature (°C)	Jan - Dec 00	20	15.0 (3 - 23.8)	16.5	----
Turbidity (NTU)	Jan - Dec 00	12	5.2 (1 - 30)	2.7	----
Spec. cond. (µmhos/cm)	Jan - Dec 00	20	126 (82 - 163)	124.5	----
DO (mg/L)	Jan - Dec 00	20	8.9 (<u>**4.9**</u> - 12.6)	8.5	<u>**1**</u>
pH	Jan - Dec 00	20	7.3 (6.8 - 7.7)	7.3	----
$NO_3^-N + NO_2^-N$ (µg/L)	Jan - Dec 00	12	**428** (**130** - **700**)	**440**	**12**
NH_4^+N (µg/L)	Jan - Dec 00	12	**107** (30 - **440**)	60	**3**

Table A2-4. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12073201 (Park Unit 15, Palisades – Long Island Creek, cont'd.)					
TP (µg/L)	Jan - Dec 00	12	30 (20 - 60)	20	----
TOC (mg/L)	Jan - Dec 00	11	2.7 (1.1 - 5.3)	2.4	----
TSS (mg/L)	Jan - Dec 00	11	6.4 (1 - 16)	4	----
BOD_5 (mg/L)	Jan - Dec 00	12	1.6 (0.5 - **3.5**)	1.3	**1**
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	38 (22 - 48)	41	----
Calcium (mg/L)	2 dates in 00	2	11.5 (10.0 - 13.0)	----	----
Magnesium (mg/L)	2 dates in 00	2	2.7 (2.5 - 2.9)	----	----
Other WC Data	27 Apr 00		6 Nov 00 (n = 2; toxic substances)		
Antimony, total	1 µg/L		1 µg/L		----
Arsenic, total	2 µg/L		4 µg/L		----
Cadmium, total	**0.5** µg/L		**0.5** µg/L		**2**
Chromium, total	1 µg/L		1 µg/L		----
Copper, total	1 µg/L		2 µg/L		----
Lead, total	1 µg/L		2 µg/L		----
Mercury, total	0.1 µg/L		0.1 µg/L		----
Nickel, total	1 µg/L		1 µg/L		----
Selenium, diss'd.	2 µg/L		4 µg/L		----
Thallium, total	2 µg/L		2 µg/L		----
Zinc, total	4 µg/L		4 µg/L		----

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
Cobb County RT5 (Park Unit 15, Palisades – Rottenwood Creek, Akers Mill Road; latitude 33.8898, longitude –84.4570)					
Temperature (°C)	Jan 98 - Dec 07	34	14.7 (1.0 - 26.0)	13.5	----
Turbidity (NTU)	Jan 98 - Dec 07	35	6.1 (0.7 - 32)	4.6	----
Spec. cond. (µmhos/cm)	Jan 98 - Dec 07	33	106 (80 - 149)	107	----
DO (mg/L)	Jan 98 - Dec 07	35	9.9 (7.4 - 13.2)	9.8	----
pH	Jan 98 - Dec 07	35	7.2 (6.6 - 7.7)	7.2	----
$NO_3^-N + NO_2^-N$ (µg/L)	Jan 98 - Dec 07	35	**556** (**200** - **1,060**)	**540**	**35**
TKN (µg/L)	Jan 98 - Dec 07	35	689 (110 - 2,920)	600	----
TP (µg/L)	Jan 98 - Dec 07	35	62 (5 - **150**)	50	**6**
BOD_5 (mg/L)	Jan 98 - Dec 07	35	1.3 (0.5 - 3.0)	1.1	----
COD (mg/L)	Jan 98 - Dec 07	34	all < 20.0[b]	----	----
Chloride (mg/L)	Jan 98 - Aug 07	34	5.4 (2.8 - 7.1)	5.7	----
TSS (mg/L)	Jan 98 - Dec 07	35	4.1 (0.5 - **28.2**)	2.2	**1**
Fecal coliforms, M-FC MF (cfu/100 mL)	Jan 98 - Dec 07	35	548 (40 - 3,250)	200	14 (40% > 200, 1000) 12 (34% > 400)
Cadmium, total (µg/L)	Jan 98 - Aug 07	34	all < 0.7[c]	----	uncertain[d]
Copper, total (µg/L)	Jan 98 - Aug 07	34	2.7 (2.5 - **10.4**)	2.5	**1**
Lead, total (µg/L)	Jan 98 - Aug 07	34	**3.6** (0.5 - **94.7**)	0.5	**3**
Zinc, total (µg/L)	Jan 98 - Aug 07	34	14.2 (5.0 – 33)	13.2	----

Table A2-4. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12073901 (Park Unit 15, Palisades – White Water Creek, Harris Trail Road, Cobb Co.; latitude 33.8824, longitude –84.4511)					
Temperature (°C)	Jun 99 - Sep 03	32	16.4 (3 - 24.9)	17.4	----
Turbidity (NTU)	Jan - Dec 00	12	13.8 (1.9 - **77**)	4	**1**
Spec. cond. (µmhos/cm)	Jun 99 - Sep 03	32	101 (28 - 129)	105.5	----
DO (mg/L)	Jun 99 - Sep 03	32	9.4 (5.9 - 12.9)	8.75	----
pH	Jun 99 - Sep 03	32	7.3 (6.6 - 7.7)	7.3	----
$NO_3^-N+NO_2^-N$ (µg/L)	Jan - Dec 00	12	**531** (**190** - **830**)	**545**	**12**
NH_4^+N (µg/L)	Jan - Dec 00	12	**96** (20 - **280**)	68	**3**
TKN (µg/L)	Feb 02 - Sep 03	5	234 (90 - 690)	140	----
TP (µg/L)	Jan 00 - Sep 03	17	30 (11 - **110**)	20	**1**
SRP (µg/L)	Feb 02 - Sep 03	5	20 (20 - 20)	20	----
TOC (mg/L)	Jan - Dec 00	12	2.3 (1.1 - 3.2)	2.3	----
TSS (mg/L)	Jan 00 - May 02	13	23.8 (1 - **82**)	5	**4**
BOD_5 (mg/L)	Jan - Dec 00	12	1.5 (0.6 - **4.2**)	1.3	**1**
Alkalinity, carbonate as $CaCO_3$ (mg/L)	Jan - Dec 00	12	31 (14 - 38)	34	----
Calcium (mg/L)	2 dates in 00	2	10.0 - 11.0)	----	----
Magnesium (mg/L)	2 dates in 02	2	2.25 (2.10 - 2.40)	----	----
Barium, diss'd. (µg/L)	2 dates in 02	2	26 (23 - 29)	----	----
Iron, diss'd. (µg/L)	2 dates in 02	2	150 (119 - 181)	----	----
Chloride (mg/L)	2 dates in 02, 03	4	5.59 (5.36 - 5.70)	5.36	----
Sulfur	2 dates in 02, 03	4	8.03 (6.90 - 9.70)	7.75	----

Other (Toxics)	27 Apr 00	6 Nov 00	15 Feb 02	29 May 02	14 Mar 03	17 Sep 03
Antimony, total	1 µg/L	1 µg/L	----	----	----	----
Arsenic, total	2 µg/L	4 µg/L	----	----	----	----
Cadmium, total	**0.5** µg/L	**0.5** µg/L	----	----	----	----
Chromium, total	1 µg/L	1 µg/L	----	----	----	----
Copper, total	1 µg/L	2 µg/L	----	----	----	----
Lead, total	1 µg/L	2 µg/L	----	----	----	----
Mercury, total	0.1 µg/L	0.1 µg/L	----	----	----	----
Nickel, total	1 µg/L	1 µg/L	----	----	----	----
Thallium, total	2 µg/L	2 µg/L	----	----	----	----
Zinc, total	9 µg/L	12 µg/L	----	----	----	----
Aluminum, diss'd.	----	----	8 µg/L	6 µg/L	----	----
Antimony, diss'd.	----	----	0.11 µg/L	0.31 µg/L	----	----
Arsenic, diss'd.	----	----	2 µg/L	2 µg/L	----	----
Beryllium, diss'd.	----	----	0.06 µg/L	0.06 µg/L	----	----
Cadmium, diss'd.	----	----	0.04 µg/L	0.04 µg/L	----	----
Chromium, diss'd.	----	----	0.8 µg/L	0.8 µg/L	----	----
Cobalt, diss'.d	----	----	0.37 µg/L	0.16 µg/L	----	----
Copper, diss'd.	----	----	0.8 µg/L	1.7 µg/L	----	----
Lead, diss'd.	----	----	0.08 µg/L	0.05 µg/L	----	----
Manganese, diss'd.	----	----	69.1 µg/L	32.8 µg/L	----	----
Molybdenum, diss'd.	----	----	0.6 µg/L	1.1 µg/L	----	----
Nickel, diss'd.	----	----	0.6 µg/L	0.38 µg/L	----	----

Table A2-4. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
GA DNR 12073901 (Park Unit 15, Palisades – White Water Creek, cont'd.)					

Other (Toxics)	27 Apr 00	6 Nov 00	15 Feb 02	29 May 02	14 Mar 03	17 Sep 03
Selenium, diss'd.	2 µg/L	4 µg/L	2 µg/L	2 µg/L	----	----
Silver, diss'd.	----	----	1 µg/L	1 µg/L	----	----
Zinc, diss'd.	----	----	7 µg/L	4 µg/L	----	----

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
NPS BacteriALERT Site 3 (Park Unit 16, Paces Mill – Chattahoochee River, Paces Ferry; latitude 33.8592, Longitude –84.4544)					
Escherichia coli, quanti-tray (mpn/100 mL)	Oct 00 - Nov 08	1,399	493 (7 - 28,000)	110	418 (30% > 235) 292 (21% > 400)
Cobb County NA1 (Park Unit 16, Paces Mill – Little Nancy Creek, Stillhouse Road; latitude 33.8713, longitude –84.4617)					
Temperature (^{o}C)	Jun 00 - Mar 08	32	17.2 (4.3 - 25.5)	17.8	----
Turbidity (NTU)	Jun 00 - Mar 08	33	10.0 (1.8 - **90**)	5.3	**1**
Spec. cond. (µmhos/cm)	Jun 00 - Mar 08	32	88 (53 - 143)	87	----
DO (mg/L)	Jun 00 - Mar 08	33	8.1 (5.8 - 11.7)	7.8	----
pH	Jun 00 - Mar 08	32	7.0 (6.6 - 7.9)	6.9	----
$NO_3^-N+NO_2^-N$ (µg/L)	Jun 00 - Mar 08	33	**402** (**200** - **660**)	**390**	**33**
TKN (µg/L)	Jun 00 - Mar 08	33	854 (250 - 1,980)	740	----
TP (µg/L)	Jun 00 - Mar 08	33	65 (5 - **770**)	50	**1**
BOD_5 (mg/L)	Jun 00 - Mar 08	33	1.4 (0.5 - 2.7)	1.2	----
COD (mg/L)	Jun 00 - Mar 08	33	all < 20.0[c]	----	----
Chloride (mg/L)	Jun 00 - Sep 07	31	4.5 (3.3 - 6.0)	4.4	----
TSS (mg/L)	Jun 00 - Mar 08	33	5.0 (0.5 - 10.2)	4.4	----
Fecal coliforms, M-FC MF (cfu/100 mL)	Jun 00 - Mar 08	33	135 (10 - 510)	50	5 (15% > 200, 1000) 2 (6% > 400)
Calcium (mg/L)	Jan 08, Mar 08	2	5.9 (5.6 - 6.2)	----	----
Magnesium (mg/L)	Jan 08, Mar 08	2	1.4 (1.4 - 1.4)	----	----
Barium, total (µg/L)	Jan 08, Mar 08	2	20.9 (20.7 - 21.1)	----	----
Iron, total (µg/L)	Jan 08, Mar 08	2	551 (1.3 - 1,100)	----	----
Potassium (mg/L)	Jan 08, Mar 08	2	1.9 (1.7 - 2.0)	----	----
Sodium (mg/L)	Jan 08, Mar 08	2	3.0 (2.8 - 3.2)	----	----
Aluminum, total (µg/L)	Jan 08, Mar 08	2	**137.4** (**127.3** - **147.4**)	----	**2**
Cadmium, total (µg/L)	Jun 00 - Mar 08	33	all < 0.7[c]	----	uncertain[d]
Copper, total (µg/L)	Jun 00 - Mar 08	33	2.6 (2.5 - 5.4)	2.5	----
Lead, total (µg/L)	Jun 00 - Mar 08	33	0.7 (0.5 - 2.4)	0.5	----
Manganese, total (µg/L)	Jan 08, Mar 08	2	210 (157 - 263)	----	----
Zinc, total (µg/L)	Jun 00 - Mar 08	33	12.0 (5.0 - 38.6)	11.2	----

Table A2-4. (Continued).

Parameter	Date	n	Mean (range)	Median	Number Unacceptable
<u>**Cobb County NA2**</u> <u>(Park Unit 16, Paces Mill – Little Nancy Creek, Paces Mill Road; latitude 33.8703, longitude –84.4575)</u>					
Temperature (°C)	Jun 02 - Mar 08	24	16.6 (4.0 - 24.0)	16.8	----
Turbidity (NTU)	Jun 02 - Mar 08	24	4.0 (1.1 - 14.1)	3.4	----
Spec. cond. (µmhos/cm)	Jun 02 - Mar 08	23	82 (3.3 - 139)	82.5	----
DO (mg/L)	Jun 02 - Mar 08	24	9.0 (7.1 - 12.0)	8.8	----
pH	Jun 02 - Mar 08	24	6.9 (6.7 - 7.4)	6.9	----
$NO_3^-N+NO_2^-N$ (µg/L)	Jun 02 - Mar 08	24	**566** (**390 - 940**)	**580**	**24**
TKN (µg/L)	Jun 02 - Mar 08	24	483 (170 - 1,150)	365	----
TP (µg/L)	Jun 02 - Mar 08	24	84 (5 - **500**)	50	**3**
BOD_5 (mg/L)	Jun 02 - Mar 08	24	1.2 (0.5 - 2.2)	1.0	----
COD (mg/L)	Jun 02 - Mar 08	24	all < 20.0[c]	----	----
Chloride (mg/L)	Jun 02 - Sep 07	22	4.9 (3.3 - 6.2)	4.8	----
TSS (mg/L)	Jun 02 - Mar 08	24	2.4 (0.5 - 5.8)	1.8	----
Fecal coliforms, M-FC MF (cfu/100 mL)	Jun 02 - Mar 08	24	162 (40 - <u>500</u>)	95	<u>4</u> (17% > 200, 1000) <u>3</u> (13% > 400)
Calcium (mg/L)	Jan 08, Mar 08	2	6.0 (5.8 - 6.2)	----	----
Magnesium (mg/L)	Jan 08, Mar 08	2	1.5 (1.5 - 1.6)	----	----
Barium, total (µg/L)	Jan 08, Mar 08	2	16.9 (16.7 - 17.0)	----	----
Potassium (mg/L)	Jan 08, Mar 08	2	1.9 (1.8 - 2.0)	----	----
Sodium (mg/L)	Jan 08, Mar 08	2	3.4 (3.2 – 3.6)	----	----
Iron, total (µg/L)	Jan 08, Mar 08	2	301 (0.7 - 601)	----	----
Aluminum, total (µg/L)	Jan 08, Mar 08	2	114.4 (79.3 - **149.4**)	----	**1**
Cadmium, total (µg/L)	Jun 02 - Mar 08	24	all < 0.7[c]	----	uncertain[d]
Copper, total (µg/L)	Jun 02 - Mar 08	24	all < 5.0[c]	----	----
Lead, total (µg/L)	Jun 02 - Mar 08	24	0.6 (0.5 - 1.3)	0.5	----
Manganese, total (µg/L)	Jan 08, Mar 08	2	41 (32.6 - 50.1)	----	----
Zinc, total (µg/L)	Jun 02 - Mar 08	24	7.2 (5.0 – 28.4)	5.0	----

[a] All values reported less than the level of detection or less than the reporting limit were replaced with ½ the value, following Ellis and Gilbert (1980) and Zirschky et al. (1985).
[b] Selected parameters included those most commonly considered in water quality assessment; most of those that were not included here also had been sampled infrequently (1 or a few dates).

[c] More than 50% of the samples were below detection or below the reporting limit with the analytical technique used; thus, statistical interpretation was not attempted.

[d] Values were reported as “less than” a range of values that include the CCC.

Appendix 3. Fecal coliform data – geometric means (gms).

Table A3-1. Fecal coliform (FC) and Escherichia coli (EC) data sampled with sufficient frequency to calculate gms (units, mpn or colonies or cfu/100 mL – see Appendix 2). Values that exceed the state standards (FC) or the U.S. EPA standard (EC) are in blue+bold. Numbers in parentheses ≡ the percentage of samples that were in violation of the state standards (FC) or U.S. EPA standard (EC).a

Date	FC	*E. coli*	Date	FC	*E. coli*
Section I					
Gwinnett County – Richland Creek (at USGS 02334480) (39% FC)					
Jul 01	**1,316**	----	Jan 05	158	----
Oct 01	134	----	Apr 05	222	----
Jan 02	334	----	May 05	**270**	----
Apr 02	226	----	Oct 05	**267**	----
May 02	**270**	----	Jan 06	74	----
Oct 02	**285**	----	Apr 06	55	----
Jan 03	16	----	May 06	**207**	----
Apr 03	204	----	Oct 06	**1,076**	----
May 03	**1,434**	----	Jan 07	109	----
Oct 03	**350**	----	Apr 07	68	----
Jan 04	180	----	May 07	128	----
Apr 04	182	----	Oct 07	**279**	----
May 04	**394**	----	Jan 08	149	----
Oct 04	139	----	Apr 08	87	----
USGS 20334500 – Chattahoochee River, Bowman's Island					
Jan/Feb 00	15	----	Jul/Aug	18	----
May/Jun 00	10	----	Sep/Oct	55	----
Forsyth County JSF-1 – James Creek (33% FC)					
Jun/Jul 06	174	----	Nov/Dec 07	558	----
Sep 06	**548**	----	Feb/Mar 08	372	----
Oct/Nov 06	**980**	----	May 08	151	----
Nov/Dec 06	188	----	Aug 08	100	----
Aug/Sep 07	**228**	----			
Gwinnett County – Level Creek (at USGS 02334578) (43% FC)					
Jul 01	**1,393**	----	Jan 05	49	----
Oct 01	**395**	----	Apr 05	179	----
Jan 02	226	----	May 05	**243**	----
Apr 02	220	----	Oct 05	**388**	----
May 02	**330**	----	Jan 06	131	----
Oct 02	**395**	----	Apr 06	278	----
Jan 03	110	----	May 06	**323**	----
Apr 03	155	----	Oct 06	191	----
May 03	**2,830**	----	Jan 07	268	----
Oct 03	**331**	----	Apr 07	195	----
Jan 04	106	----	May 07	**204**	----
Apr 04	269	----	Oct 07	**426**	----
May 04	**496**	----	Jan 08	114	----
Oct 04	173	----	Apr 08	362	----

Table A3-1. (Continued).

Date	FC	*E. coli*	Date	FC	*E. coli*
Forsyth County DKF-1 – Dick Creek (44% FC)					
Jun/Jul 06	187	----	Nov/Dec 07	427	----
Sep 06	**513**	----	Feb/Mar 08	190	----
Oct/Nov 06	**403**	----	May 08	**373**	----
Nov/Dec 06	134	----	Aug 08	**347**	----
Aug/Sep 07	157	----			
Section II					
GA DNR 12048001 – Chattahoochee River (8% FC)					
Apr 01	15	----	Jul 02	40	----
Jun 01	122	----	Oct 02	**214**	----
Jul 01	67	----	Jan 03	2	----
Oct 01	2	----	Apr 03	34	----
Jan 02	49	----	Jul 03	63	----
Apr 02	7	----	Oct 03	2	----
Forsyth County CHF-1 – Chattahoochee River					
Jun/Jul 06	7	----	Nov/Dec 07	26	----
Sep 06	13	----	Feb/Mar 08	79	----
Oct/Nov 06	89	----	May 08	52	----
Nov/Dec 06	14	----	Aug 08	52	----
Aug/Sep 07	15	----			
USGS 02334885 – Suwanee Creek (67% FC)					
May/Jun 00	192	----	Sep/Oct 00	**1,169**	----
Jul/Aug 00	**369**	----			
Gwinnett County – Suwanee Creek (at USGS 02334885) (39% FC)					
Jul 01	**1,346**	----	Jan 05	107	----
Oct 01	197	----	Apr 05	152	----
Jan 02	207	----	May 05	**202**	----
Apr 02	216	----	Oct 05	**311**	----
May 02	**368**	----	Jan 06	74	----
Oct 02	**447**	----	Apr 06	98	----
Jan 03	92	----	May 06	169	----
Apr 03	225	----	Oct 06	**262**	----
May 03	**1,749**	----	Jan 07	324	----
Oct 03	**344**	----	Apr 07	116	----
Jan 04	159	----	May 07	128	----
Apr 04	212	----	Oct 07	**524**	----
May 04	**528**	----	Jan 08	97	----
Oct 04	**305**	----	Apr 08	79	----
Fulton County CC-2 – Cauley Creek (50% FC)					
Jun 07	**601**	----	Nov 07	251	----
Aug 07	**780**	----	Feb 08	110	----

Table A3-1. (Continued).

Date	FC	*E. coli*	Date	FC	*E. coli*
USGS 2335000 – Chattahoochee River (19% EC)					
Oct 00	----	34	Dec 00	----	31
Nov 00	----	45	Jan 01	---	33
Feb 01	----	43	Jul 04	----	68
Mar 01	----	98	Aug 04	----	57
Apr 01	----	62	Sep 04	----	**161**
May 01	----	72	Oct 04	----	27
Jun 01	----	113	Nov 04	----	111
Jul 01	143	**215**	Dec 04	----	68
Aug 01	----	103	Jan 04	----	67
Sep 01	----	80	Feb 05	----	**181**
Oct 01	----	41	Mar 05	----	**128**
Nov 01	----	30	Apr 05	----	43
Dec 01	----	62	May 05	----	63
Jan 02	----	86	Jun 05	----	**223**
Feb 02	----	40	Jul 05	----	**519**
Mar 02	----	89	Aug 05	----	**271**
Apr 02	----	77	Sep 05	----	64
May 02	----	**155**	Oct 05	----	90
Jun 02	----	87	Nov 05	----	99
Jul 02	----	79	Dec 05	----	116
Aug 02	----	57	Jan 06	----	90
Sep 02	----	**166**	Feb 06	----	35
Oct 02	----	**178**	Mar 06	----	31
Nov 02	----	114	Apr 06	----	30
Dec 02	----	100	May 06	----	46
Jan 03	----	36	Jun 06	----	53
Feb 03	----	48	Jul 06	----	71
Mar 03	----	33	Aug 06	----	107
Apr 03	----	58	Sep 06	----	98
May 03	----	108	Oct 06	----	61
Jun 03	----	**209**	Nov 06	----	48
Jul 03	----	**374**	Dec 06	----	23
Aug 03	----	**164**	Jan 07	----	106
Sep 03	----	83	Feb 07	----	68
Oct 03	----	64	Mar 07	----	40
Nov 03	----	**133**	Apr 07	----	29
Dec 03	----	85	May 07	----	37
Jan 04	----	57	Jun 07	----	44
Feb 04	----	60	Jul 07	----	**172**
Mar 04	----	29	Aug 07	----	69
Apr 04	----	74	Sep 07	----	41
May 04	----	95	Oct 07	----	56
Jun 04	----	**195**	Nov 07	----	35
BacteriALERT Site 1, Chattahoochee River (17% EC)					
Oct 00	----	34	Apr 01	----	62
Nov 00	----	45	May 01	----	72
Dec 00	----	33	Jun 01	----	113

Table A3-1. (Continued).

Date	FC	*E. coli*	Date	FC	*E. coli*
BacteriALERT Site 1, Chattahoochee River (cont'd.)					
Jan 01	----	32	Feb 05	----	**199**
Feb 01	----	43	Mar 05	----	**126**
Mar 01	----	98	Apr 05	----	48
Jul 01	----	**215**	May 05	----	63
Aug 01	----	103	Jun 05	----	**239**
Sep 01	----	80	Jul 05	----	**281**
Oct 01	----	41	Aug 05	----	**272**
Nov 01	----	31	Sep 05	----	66
Dec 01	----	62	Oct 05	----	90
Jan 02	----	86	Nov 05	----	99
Feb 02	----	40	Dec 05	----	116
Mar 02	----	89	Jan 06	----	90
Apr 02	----	77	Feb 06	----	35
May 02	----	**148**	Mar 06	----	30
Jun 02	----	87	Apr 06	----	30
Jul 02	----	71	May 06	----	46
Aug 02	----	61	Jun 06	----	53
Sep 02	----	**166**	Jul 06	----	73
Oct 02	----	**178**	Aug 06	----	107
Nov 02	----	114	Sep 06	----	114
Dec 02	----	101	Oct 06	----	47
Jan 03	----	36	Nov 06	----	48
Feb 03	----	48	Dec 06	----	23
Mar 03	----	33	Jan 07	----	68
Apr 03	----	59	Feb 07	----	76
May 03	----	111	Mar 07	----	34
Jun 03	----	**209**	Apr 07	----	25
Jul 03	----	**373**	May 07	----	42
Aug 03	----	**147**	Jun 07	----	51
Sep 03	----	84	Jul 07	----	**172**
Oct 03	----	64	Aug 07	----	69
Nov 03	----	**135**	Sep 07	----	40
Dec 03	----	85	Oct 07	----	56
Jan 04	----	63	Nov 07	----	35
Feb 04	----	64	Dec 07	----	90
Mar 04	----	29	Jan 08	----	26
Apr 04	----	74	Feb 08	----	33
May 04	----	96	Mar 08	----	41
Jun 04	----	**196**	Apr 08	----	40
Jul 04	----	69	May 08	----	44
Aug 04	----	57	Jun 08	----	88
Sep 04	----	**130**	Jul 08	----	**142**
Oct 04	----	24	Aug 08	----	74
Nov 04	----	112	Sep 08	----	63
Dec 04	----	71	Oct 08	----	55
Jan 05	----	63	Nov 08	----	34

Table A3-1. (Continued).

Date	FC	*E. coli*	Date	FC	*E. coli*
Section III					
Fulton County JO-1 (50% FC)					
Jan 07	**560**	----	Nov 07	206	----
Aug 07	**335**	----	Feb 08	292	----
GA DNR 12055001 – Chattahoochee River (18% FC)					
Apr 01	8	----	Oct 02	**220**	----
Jul 01	87	----	Jan 03	7	----
Oct 01	13	----	Apr 03	25	----
Jan 02	89	----	Jul 03	**464**	----
Apr 02	88	----	Oct 03	112	----
Jul 02	72	----			
DeKalb Co. – Scott Candler WTP, Chattahoochee River (16% FC, 3% EC)					
Jan 05	43	----	Mar 07	----	42
Feb 05	117	----	Apr 07	----	36
Mar 05	90	----	May 07	----	40
Apr 05	57	----	Jun 07	----	36
May 05	61	----	Jul 07	----	91
Jun 05	**227**	----	Aug 07	----	42
Jul 05	**721**	----	Sep 07	----	24
Aug 05	**598**	----	Oct 07	----	55
Sep 05	69	----	Nov 07	----	18
Oct 05	166	----	Dec 07	----	25
Nov 05	141	----	Jan 08	----	42
Dec 05	44	----	Feb 08	----	40
Jan 06	35	----	Mar 08	----	38
Feb 06	30	----	Apr 08	----	45
Mar 06	32	----	May 08	----	82
Apr 06	39	----	Jun 08	----	104
May 06	47	----	Jul 08	----	125
Jun 06	60	----	Aug 08	----	108
Jul 06	93	----	Sep 08	----	98
Aug 06	----	**223**	Oct 08	----	59
Sep 06	----	99	Nov 08	----	33
Oct 06	----	81	Dec 08	----	48
Nov 06	----	37	Jan 09	----	63
Dec 06	----	30	Feb 09	----	25
Jan 07	----	50	Mar 09	----	92
Feb 07	----	36			
USGS 02335350 – Crooked Creek (75% FC)					
Jan/Feb 00	96	----	Jul/Aug 00	**343**	----
May/Jun 00	**865**	----	Sep/Oct 00	**237**	----
Gwinnett County – Crooked Creek (at USGS 02335350) (43% FC)					
Jul 01	**891**	----	Apr 02	193	----
Oct 01	107	----	May 02	**216**	----
Jan 02	71	----	Oct 02	**424**	----

Table A3-1. (Continued).

Date	FC	*E. coli*	Date	FC	*E. coli*
Section III (cont'd.)					
USGS 02335350 (Crooked Creek, cont'd.)					
Jan 03	43	----	Oct 05	**495**	----
Apr 03	**1,636**	----	Apr 06	224	----
May 03	**1,699**	----	May 06	**255**	----
Oct 03	191	----	Oct 06	150	----
Jan 04	76	----	Jan 07	89	----
Apr 04	**1,263**	----	Apr 07	112	----
May 04	**1,484**	----	May 07	**276**	----
Oct 04	162	----	Oct 07	**371**	----
Jan 05	99	----	Jan 08	151	----
Apr 05	270	----	Apr 08	73	----
May 05	**709**	----			
Fulton County CK-1 – Ball Mill Creek (25% FC)					
Jun 07	**524**	----	Nov 07	96	----
Aug 07	179	----	Feb 08	807	----
City of Alpharetta – Big Creek (100% FC)					
Oct-Nov 05	**1,936**	----			
GA DNR 12060001, Chatthoochee River (45% FC)					
Apr 01	115	----	Oct 02	**1,387**	----
Jul 01	**1,185**	----	Jan 03	81	----
Oct 01	160	----	Apr 03	377	----
Jan 02	342	----	Jul 03	**405**	----
Apr 02	324	----	Oct 03	**742**	----
Jul 02	**660**	----			
Fulton County MA-1, Marsh Creek (75% FC)					
Jun 07	**350**	----			
Aug 07	**333**	----			
Nov 07	138	----			
Feb 08	**1,084**	----			
GA DNR 12070001, Chattahoochee River (27% FC)					
Apr 01	26	----	Oct 02	**255**	----
Jul 01	**223**	----	Jan 03	30	----
Oct 01	107	----	Apr 03	154	----
Jan 02	28	----	Jul 03	**415**	----
Apr 02	15	----	Oct 03	147	----
Jul 02	35	----			
MWA, Cobb County (J.E. Quarles WTP water intake, Chattahoochee River)[b]					
Sep 07	----	31	Mar 08	----	32
Oct 07	----	38	Apr 08	----	23
Nov 07	----	22	May 08	----	25
Dec 07	----	46	Jun 08	----	32

Jan 08	----	27	Jul 08	----	26
Feb 08	----	35	Aug 08	----	38

Table A3-1. (Continued).

Date	FC	*E. coli*	Date	FC	*E. coli*
Section III (cont'd.)					
MWA, Cobb County (cont'd.)					
Sep 08	----	21	Jan 09	----	50
Oct 08	----	32	Feb 09	----	16
Nov 08	----	36	Mar 09	----	76
Dec 08	----	82			
BacteriALERT Site 2 – Chattahoochee River, Johnson Ferry (21% EC)					
Oct 01	----	61	May 02	----	51
Nov 01	----	28	Jun 02	----	25
Dec 01	----	61	Jul 02	----	41
Jan 02	----	107	Aug 02	----	67
Feb 02	----	29	Sep 02	----	**137**
Mar 02	----	46	Oct 02	----	**207**
Apr 02	----	47	Nov 02	----	**219**
USGS 2335830 – Chattahoochee River, Johnson Ferry (21% FC, 26% EC)					
Apr 99	78	57	Oct 01	----	61
May 99	81	30	Nov 01	----	28
Jun 99	**267**	**391**	Dec 01	----	61
Jul 99	85	92	Jan 02	----	107
Aug 99	**200**	**166**	Feb 02	----	29
Sep 99	58	47	Mar 02	----	46
Oct 99	**257**	----	Apr 02	----	47
Nov 99	55	----	May 02	----	51
Dec 99	53	57	Jun 02	----	25
Jan/Feb 00	39, 87[c]	38	Jul 02	----	39
Mar/Apr 00	316	**281**	Aug 02	----	67
May/Jun 00	103	----	Sep 02	----	**137**
Jul/Aug 00	132	----	Oct 02	----	**191**
Sep/Oct 00	40	----	Nov 02	----	**240**
Section IV					
Fulton County LI-2, Long Island Creek (50% FC)					
Jun 07	**835**	----	Nov 07	255	----
Aug 07	**464**	----	Feb 08	531	----
NPS Site 3, Chattahoochee River, Paces Ferry (55% EC)					
Oct 00	----	39	Aug 01	----	**260**
Nov 00	----	66	Sep 01	----	**153**
Dec 00	----	56	Oct 01	----	100
Jan 01	----	85	Nov 01	----	70
Feb 01	----	**163**	Dec 01	----	**126**
Mar 01	----	**322**	Jan 02	----	**127**

Apr 01	----	70	Feb 02	----	73
May 01	----	**155**	Mar 02	----	**139**
Jun 01	----	**277**	Apr 02	----	120
Jul 01	----	**349**	May 02	----	**203**

Table A3-1. (Continued).

Date	FC	*E. coli*	Date	FC	*E. coli*
NPS Site 3, Chattahoochee River, Paces Ferry (cont'd.)					
Jun 02	----	**153**	Sep 05	----	**134**
Jul 02	----	**210**	Oct 05	----	**194**
Aug 02	----	97	Nov 05	----	**309**
Sep 02	----	**259**	Dec 05	----	**127**
Oct 02	----	**304**	Jan 06	----	**136**
Nov 02	----	**353**	Feb 06	----	66
Dec 02	----	**307**	Mar 06	----	67
Jan 03	----	63	Apr 06	----	111
Feb 03	----	103	May 06	----	98
Mar 03	----	105	Jun 06	----	114
Apr 03	----	**153**	Jul 06	----	**127**
May 03	----	**471**	Aug 06	----	**363**
Jun 03	----	**519**	Sep 06	----	**494**
Jul 03	----	**465**	Oct 06	----	**126**
Aug 03	----	**462**	Nov 06	----	122
Sep 03	----	**341**	Dec 06	----	27
Oct 03	----	**239**	Jan 07	----	111
Nov 03	----	**322**	Feb 07	----	116
Dec 03	----	**141**	Mar 07	----	31
Jan 04	----	99	Apr 07	----	92
Feb 04	----	117	May 07	----	78
Mar 04	----	51	Jun 07	----	98
Apr 04	----	79	Jul 07	----	**208**
May 04	----	**162**	Aug 07	----	**141**
Jun 04	----	**349**	Sep 07	----	113
Jul 04	----	**423**	Oct 07	----	117
Aug 04	----	**161**	Nov 07	----	57
Sep 04	----	**359**	Dec 07	----	80
Oct 04	----	114	Jan 08	----	101
Nov 04	----	**332**	Feb 08	----	**155**
Dec 04	----	**207**	Mar 08	----	**136**
Jan 05	----	92	Apr 08	----	103
Feb 05	----	**265**	May 08	----	**188**
Mar 05	----	**243**	Jun 08	----	110
Apr 05	----	118	Jul 08	----	**243**
May 05	----	107	Aug 08	----	115
Jun 05	----	**773**	Sep 08	----	90
Jul 05	----	**547**	Oct 08	----	86
Aug 05	----	**579**	Nov 08	----	**136**

[a] State standards for fecal coliforms: gm of at least 4 samples taken within 30 days should not exceed 200 mpn/100 mL from April through October, or 1,000 mpn/100 mL from November through March (mpn, colonies, and cfu units considered interchangeably). U.S. EPA standard for *Escherichia coli*: gm of at least 5

samples taken within 30 days should not exceed 126 cells or cfu per 100 mL.
[b] For this station, monthly gms are reported for data taken daily.
[c] Considering two different methods (see *Appendix 2*).

Appendix 4. Available WQ data (past ~decade) and percentage of samples indicating unacceptable conditions, evaluated using the criteria from Appendix 1.

Table A4-1. Sampling duration/frequency for water quality stations in and near CHATT, and number/ percent of samples indicating unacceptable water quality conditions as follows: DO and pH were in violation of the state standards (GA DNR 2008d); fecal coliforms indicated degraded water quality (see *Table 29* and *Appendix 2*; *Appendix 4* considers all fecal coliform and *Escherichia coli* data); nutrients exceeded concentrations known to support noxious algal blooms (Mallin 2000 – note that "nitrate" here ≡ $NO_3^-N + NO_2^-N$); BOD_5 exceeded 3 mg/L (Mallin 2006); and other parameters exceeded recommended values for acceptable water quality (U.S. EPA 2000) including TSS (> 25 mg/L maximum) and heavy metals (Al, Cu, Hg, Pb, Ni, Zn – see *Table 20*). The U.S. EPA (2002) recommends that pH be maintained within the range 6.5-9, but this report follows Georgia regulations (pH $\geq$ 6.0).[a] Percentages are rounded to the nearest integer.

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Source - Lake Lanier (near outfall)			
<u>GA DNR 12040001</u>			
Lake Lanier			
13 general WQ parameters (n = 6-22)	Oct 01 - Oct 04	Nitrate, 14 of 22	64%
Fecal coliforms (n = 18)	Oct 01 - Oct 04	----	----
Section I (Bowmans Island to Settles Bridge)			
<u>Gwinnett County USGS 2334480</u>			
Bowmans Island – Richland Creek			
Fecal coliforms (n = 112)	Jul 01 - Apr 08	FC, 37 or 26	33% or 23%
<u>USGS 2334480</u>			
Bowmans Island – Richland Creek			
1 general WQ parameter (n = 28)	Jul 01 - Aug 03	Turbidity, 14 of 28	50%
4 general WQ parameters (n = 71-72)	Jul 01 - Feb 08	pH, 2 of 71	3%
1 general WQ parameter (n = 67)	Jul 01 - Jun 08	Ammonium, 32 of 67	48%
8 general WQ parameters (n = 84-85)	Jul 01 - Aug 08	TSS, 45 of 85	53%
		TP, 39 of 85	46%
		Nitrate, 84 of 84	100%
1 general WQ parameter (n = 390)	Jul 04 - Oct 07	----	----
2 general WQ parameters (n = 48-49)	Jul 04 - Aug 08	BOD_5, 23 of 48	48%
3 general WQ parameters (n = 1-2)	1-2 dates in 08	----	----
Fecal coliforms (n = 80)	Jul 01 - Jul 08	FC, 48 or 42	60% or 53%
2 nontoxic metals[c] (n = 49)	Aug 04 - Aug 08	----	----
2 toxic metals (n = 39)	Jul 04 - Oct 07	Total Cr, uncertain[d]	?
4 toxic metals (total; n = 39-50)	Jul 04 - Aug 08	Total Cd, uncertain[d]	?
		Cu, $\geq$ 19 of 48[e]	$\geq$ 40%
		Pb, $\geq$ 16 of 39[e]	$\geq$ 67%
		Zn, 12 of 45	27%
<u>USGS 02334500</u>			
Bowmans Island / Orrs Ferry – Chattahoochee River near Buford, GA (selected parameters)[f]			
12 general WQ parameters (n = 12-20)	Jan - Dec 00	Ammonium, 5 of 12	42%
		Nitrate, 10 of 12	83%
Fecal coliforms (n = 16)	Jan - Dec 00	FC, 1 or 0	6% or 0%

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section I (Bowmans Island to Settles Bridge, cont'd.)			
USGS 02334500, Bowmans Island / Orrs Ferry – Chattahoochee River (cont'd.)			
2 nontoxic metals[c]	2 dates in 00	----	----
11 toxic metals	2 dates in 00	Total Cd, uncertain[d]	?
Forsyth County JSF-1			
Orrs Ferry – James Creek			
9 general WQ parameters (n =20-69)	May 05 - Aug 08	Turbidity, 16 of 69	23%
		TSS, 18 of 42	43%
		DO, 1 of 69	1%
		TP, 15 of 42	36%
		Nitrate, 42 of 42	100%
Fecal coliforms (n = 60)	May 05 - Aug 08	FC, 21 or 19	35% or 32%
Escherichia coli (n = 20)	May 05 - Aug 08	*E. coli*, 7 or 4	35% or 20%
1 toxic metal (n = 42)	May 05 - Aug 08	Cu, 1	2%
Gwinnett County USGS 2334578			
Settles Bridge – Level Creek			
Fecal coliforms (n = 112)	Jul 01 - Apr 08	FC, 43 or 32	38% or 29%
USGS 2334578			
Settles Bridge – Level Creek			
4 general WQ parameters (n = 70-74)	Jul 01 - Feb 08	pH, 6 of 74	8%
9 general WQ parameters (n = 67-86)	Jul (Dec) 01 - Aug 08	TSS, 44 of 86	51%
		TP, 29 of 85	34%
		Nitrate, 83 of 86	97%
		Ammonium, 34 of 67	51%
1 general WQ parameter (n = 26)	Jul 01 - Sep 03	Turbidity, 13 of 26	50%
1 general WQ parameter (n = 41)	Jul 04 - Oct 07	----	----
2 general WQ parameters (n = 50-51)	Jul 04 - Aug 08	BOD_5, 21 of 50	42%
2 general WQ parameters (n = 2)	2 dates in 07-08	----	----
1 general WQ parameter (n = 1)	1 date in 08	----	----
Fecal coliforms (n = 82)	Jul 01 - Jul 08	FC, 50 or 44	61% or 54%
2 nontoxic metals[c] (n = 50)	Aug 04 - Aug 08	----	----
2 toxic metals (n = 41)	Jul 04 - Oct 07	Total Cr, uncertain[d]	?
4 toxic metals (n = 40-52)	Jul 04 - Aug 08	Total Cd, uncertain[d]	?
		Total Cu, $\geq$ 6 of 52[e]	$\geq$ 12%
		Total Pb, $\geq$ 12 of 52[e]	$\geq$ 23%
		Total Zn, 5 of 47	11%
Forsyth County DKF-1			
Settles Bridge – Dick Creek			
9 general WQ parameters (n = 20-69)	May 05 - Aug 08	Turbidity, 17 of 69	25%
		TSS, 17 of 42	40%
		TP, 14 of 42	33%

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section I (Bowmans Island to Settles Bridge, cont'd.)			
Forsyth County DKF-1, Settles Bridge – Dick Creek (cont'd.)			
9 general WQ parameters (n = 20-69) (cont'd.)		Nitrate, 41 of 42	98%
Fecal coliforms (n = 60)	May 05 - Aug 08	FC, 27 or 22	45% or 37%
Escherichia coli (n = 20)	Aug 07 - Aug 08	*E. coli*, 10 or 4	50% or 20%
1 toxic metal (Cu, dissolved; n = 42)	May 05 - Aug 08	----	----
Section II (McGinnis Ferry to Jones Bridge)			
GA DNR 12048001 McGinnis Ferry – Chattahoochee River			
10 general WQ parameters (n = 25-47)	Mar 01 - Dec (Aug) 04	TSS, 3 of 47 Nitrate, 45 of 47 Ammonium, 4 of 47	6% 96% 9%
1 general WQ parameter (n = 25)	Nov 01 - Dec 03	----	----
Fecal coliforms (n = 54)	Mar 01 - Jun 04	FC, 6 or 3	11% or 6%
Escherichia coli (n = 37)	Jan 02 - Jun 04	*E. coli*, 4 or 2	11% or 5%
Forsyth County CHF-1 McGinnis Ferry – Chattahoochee River			
9 general WQ parameters (n = 20-69)	May 05 - Aug 08	Turbidity, 6 of 69 TSS, 7 of 42 DO, 1 of 69 TP, 3 of 42 Nitrate, 37 of 42	9% 17% 1% 7% 88%
Fecal coliforms (n = 60)	May 05 - Aug 08	FC, 7 or 7	12%
Escherichia coli (n = 20)	Aug 07- Aug 08	----	----
1 toxic metal (Cu, dissolved; n = 42)	May 05 - Aug 08	----	----
Gwinnett County USGS 02334885 Suwannee Creek – Suwanee Creek			
Fecal coliforms (n = 112)	Jul 01 - Apr 08	FC, 37 or 26	33% or 23%
USGS 02334885 Suwanee Creek – Suwanee Creek at Buford Highway (selected parameters)[f]			
1 general WQ parameter (n = 66)	Mar 98 - Aug 03	Turbidity, 25	38%
12 general WQ parameters (n = 106-141)	Jan 98 - Aug 08	TSS, 60 of 130 pH, 2 of 141 DO, 1 of 127 TP, 42 of 134 Nitrate, 127of 128 BOD_5, 47 of 126	46% 1% 1% 31% 99% 37%
2 general WQ parameters (n = 12)	Jan - Dec 00	Ammonium, 11 of 12	92%
2 general WQ parameters (n = 58-85)	Jan 00 - Aug 08, Jan 01 - Oct 07	----	----

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section II (McGinnis Ferry to Jones Bridge, cont'd.)			
USGS 02334885, Suwanee Creek (cont'd.)			
2 general WQ parameters (n = 6)	Nov 02 - Sep 03	----	----
2 general WQ parameters (n = 1)	1 date in 07	----	----
Fecal coliforms, 1st method (n = 22)	Jan 98 - Aug 00	FC, 12 or 11	55% or 50%
Fecal coliforms, 2nd method (n = 16)	Jan - Oct 00	FC, 9 or 6	56% or 38%
Escherichia coli (n = 4)	Jun 99 - Apr 00	*E. coli*, 4 or 3	100% or 75%
3 nontoxic metals[c] (n = 4-78) (Fe, both total and dissolved)	Jan 98 - Aug 08, Jan 99 - Mar 01, Jan 01 - Feb 03	----	----
6 toxic metals (total; n = 96-120) n = 24-120)	Jan 98 - Aug 08	Cd, uncertain[d]	?
		Cu, 19 of 111	17%
		Pb, 57 of 109	52%
		Zn, 5 of 116	4%
6 toxic metals (dissolved; n = 24)	Jan 01 - Oct 02	----	----
2 pesticides (n = 17)	Nov 02 - Mar 08	----	----
GA DNR 12050301[b] Suwanee Creek – Suwanee Creek			
12 general WQ parameters (n = 37-107)	Jan 99 - Aug/ Sep 03	Turbidity, 19 of 49	39%
		TSS, 67 of 107	63%
		pH, 1of 87	1%
		TP, 18 of 55	33%
		Nitrate, 49 of 49	100%
		BOD_5, 17 of 49	35%
3 general WQ parameters (n = 12)	Jan - Dec 00	Ammonium, 11 of 12	92%
3 general WQ parameters (n = 6)	Nov 02 - Sep 03	SRP, 1 of 6	17%
3 nontoxic metals[c] (n = 2-19) (Fe, both total and dissolved)	Jan 99 - Aug 00 (or diss'd. Fe, 1 date in 02, 03)	----	----
6 toxic metals (total; n = 31-39)	Jan 99 - Aug 03	Total Cd, 39 of 39	100%
		Total Cu, 7 of 39	18%
		Total Pb, 20 of 39	51%
		Total Zn, 1 of 39	3%
5 toxic metals (dissolved; n = 9)	Feb - Oct 02	Diss'd. Cd, 9 of 9	100%
6 toxic metals (all but 1, total; n = 2)	2 dates in 00	----	----
Fulton County CC-2 Abbotts Bridge – Chattahoochee River			
11 general WQ parameters (n = 4-5)	Apr 07 - Apr 08	Nitrate, 1 of 5	20%
Fecal coliforms (n = 17)	Mar - Nov 07	FC, 8 or 7	47% or 41%
Escherichia coli (n = 17)	Mar - Nov 07	*E. coli*, 10 or 5	59% or 29%
4 toxic metals (n = 4)	Apr 07 - Apr 08	Total Cd, uncertain[d]	?
		Total Cu, 1 of 4	25%

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section II (McGinnis Ferry to Jones Bridge, cont'd.)			
USGS 02335000			
Chattahoochee River near Norcross (selected parameters)[f]			
2 general WQ parameters (n = 262)	Jul 02, Feb 05 - Sep 07	----	----
2 general WQ parameters (n = 1)	1 date in 02	----	----
Fecal coliforms (n = 18)	Nov 00 - Aug 01	FC, 2 or 2	11%
Escherichia coli (n = 1,312)	Oct 00 - Nov 07	*E. coli*, 203 or 139	15% or 11%
2 pesticides (n = 3)	3 dates in 01	----	----
BacteriALERT Site 1			
Medlock Bridge – Chattahoochee River			
Escherichia coli (n = 1,405)	Oct 00 - Nov 08	*E. coli*, 200 or 139	14% or 10%
Fulton County JO-1			
Jones Bridge – Johns Creek			
9 general WQ parameters (n = 4-6)	Sep 06 - Apr 08	Nitrate, 3 of 6	50%
2 general WQ parameters (n = 5)	Apr 07 - Apr 08	----	----
Fecal coliforms (n = 20)	Jun 06 - Feb 08	FC, 7 or 7	35%
Escherichia coli (n = 20)		*E. coli*, 9 or 6	45% or 30%
4 toxic metals (n = 5)	Sep 06 - Apr 08	Total Cd, uncertain[d]	?
GA DNR 12054401 [b]			
Jones Bridge – Johns Creek			
12 general WQ parameters (n = 12-20)	Jan - Dec 00	Nitrate, 11of 12	92%
2 nontoxic metals (n = 2)	2 dates in 00	----	----
11 toxic metals, 2 nontoxic metals (n = 2)	2 dates in 00	Total Cd, 2	100%
Section III (Holcomb Bridge to Johnson Ferry)			
GA DNR 10255001			
Holcomb Bridge - Chattahoochee River			
1 general WQ parameter (n = 43)	Mar 01 - Aug 04	----	----
1 general WQ parameter (n = 25)	Nov 01 - Dec 03	----	----
9 general WQ parameters (n = 47)	Mar 01 - Dec 04	Turbidity, 1 of 47	2%
		TSS, 6 of 47	13%
		Ammonium, 4 of 47	9%
		Nitrate, 46 of 47	98%
Fecal coliforms (n = 52)	Mar 01 - Jun 04	11 or 7	21% or 13%
Escherichia coli (n = 37)	Jan 02 - Jun 04	9 or 3	24% or 8%
DeKalb Co. - Scott Candler WTP			
Holcomb Bridge - Chattahoochee R.			
Fecal coliforms (n = 404)	Jan 05 - Jul 06	72 or 63	18% or 16%
Escherichia coli (n = 661)	Aug 06 - Mar 09	78 or 45	12% or 7%

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section III (Holcomb Bridge to Johnson Ferry, cont'd.)			
GA DNR 12055361[b]			
Holcomb Bridge - Crooked Creek			
12 general WQ parameters (n = 39-109)	Feb (Jan) 99 - Sep (May) 03	Turbidity, 15 of 48	31%
		DO, 3 of 64	5%
		Turbidity, 15 of 48	31%
		DO, 3 of 64	5%
		pH, 2 of 84	2%
		TP, 18 of 51	35%
		Nitrate, 51 of 51	100%
		BOD_5, 17 of 49	35%
3 general WQ parameters (n = 11-12)	Jan - Dec 00	Ammonium, 3 of 12	25%
3 nontoxic metals[c] (n = 14-19)	Jan (Jun) 99 - Sep 00	----	----
5 toxic metals (total; n = 40)	Jan 99 - Sep 03	Cd, 40 of 40	100%
		Cu, 11 of 40	28%
		Pb, 21 of 40	53%
		Zn, 9 of 40	23%
5 toxic metals (dissolved; n = 10)	Feb - Oct 02	Cd, 10 of 10	100%
6 toxic metals (n = 2)	2 dates in 00	----	----
Gwinnett County USGS 02335350			
Holcomb Bridge - Crooked Creek			
Fecal coliforms (n = 112)	Jul 01 - Apr 08	FC, 39 or 33	35% or 29%
USGS 02335350			
Holcomb Bridge - Crooked Creek			
12 general WQ parameters (n = 90-157)	Jan (Apr) 98 - Feb (Aug) 08	TSS, 59 of 129	46%
		DO, 1 of 109	1%
		pH, 4 of 156	3%
		TP, 44 of 129	34%
		Nitrate, 127 of 129	98%
		BOD_5, 50 of 121	41%
1 general WQ parameter (n = 68)	Apr 98 - Sep 03	Turbidity, 23 of 68	34%
2 general WQ parameters (n = 12)	Jan - Dec 00	Ammonium, 3 of 12	25%
1 general WQ parameter (n = 60)	Jan 00 - Aug 08	----	----
2 general WQ parameters (n = 2)	1 date each, 07, 08	----	----
1 general WQ parameter (n = 83)	Mar 01 - Oct 07	----	----
Fecal coliforms, 1st method (n = 23)	Jan 98 - Jul 01	FC, 15 or 12	65% or 52%
Fecal coliforms, 2nd method (n = 16)	Jan - Oct 00	FC, 8 or 6	50% or 38%
Escherichia coli (n = 1)	8 Sep 99	*E. coli*, 1	100%
2 nontoxic metals[c] (n = 77-78)	Jan 98 - Aug 08	----	----
1 nontoxic metal (Fe, total n = 18;	Jan 99 - Apr 01	----	----
dissolved, n = 4)	Mar - Apr 01	----	----

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section III (Holcomb Bridge to Johnson Ferry, cont'd.)			
USGS 02335350 (Holcomb Bridge - Crooked Creek, cont'd.)			
6 toxic metals (total; n = 97-119)	Jan 98 (Jun 99) - Oct 07 or Aug 08	Total Cd, uncertain	?
		Diss'd. Cd, uncertain	?
		Total Cr, uncertain	?
		Cu, $\geq$ 34 of 116[e]	$\geq$ 29%
		Pb, $\geq$ 43 of 108[e]	$\geq$ 40%
		Pb, $\geq$ 43 of 108[e]	$\geq$ 40%
		Zn, 26 of 116	22%
6 other toxic metals (n = 2)	2 dates in 00	----	----
6 toxic metals (dissolved; n = 24-25)	Mar 01 - Oct 02	----	----
Fulton County CK-1			
Island Ford - Ball Mill Creek			
9 general WQ parameters (n = 4-6)	Sep 06 - Apr 08	Nitrate, 6 of 6	100%
2 general WQ parameters (n = 5)	Apr 07 - Apr 08	----	----
Fecal coliforms (n = 20)	Jun 06 - Nov 07	FC, 9 or 7	45% or 35%
Escherichia coli (n = 20)	Jun 06 - Nov 07	*E. coli*, 9 or 7	45% or 35%
4 toxic metals (n = 6)	Sep 06 - Apr 08	----	----
City of Alpharetta – Big Creek			
11 general WQ parameters (n = 3-87)	Jun - Feb 09	Turbidity, 4 of 87	5%
		DO, 6 of 73	8%
		Ammonium, 26 of 77	34%
		Phosphate, 41 of 83	49%
	Jun 99 - Feb 02	Nitrate, 2 of 3	67%
Fecal coliforms (n = 87)	Jun 99 - Feb 09	FC, 30 or 30	34%
Fecal streptococci (n = 83)	Jun 99 - Feb 09	Fecal strep, 25 or 23	30% or 28%
1 toxic metal (n = 32)	Feb 02 - Feb 09	Total Cu, 17 of 32	53%
GA DNR 12060001			
Vickery Creek - Big Creek			
10 general WQ parameters (n = 43-47)	Mar 01 - Dec (Aug) 04	Turbidity, 2 of 47	4%
		TSS, 6 of 47	13%
		TP, 25 of 43	58%
		Ammonium, 1 of 47	2%
		Nitrate, 47 of 47	100%
Fecal coliforms (n = 52)	Mar 01 - Jun 04	FC, 23 or 21	44% or 40%
Escherichia coli (n = 37)	Jan 02 - Jun 04	*E. coli*, 17 or 12	46% or 32%
Cobb County WL4			
Gold Branch - Willeo Creek			
13 general WQ parameters (n = 32-35)	Feb 98 - Mar 08	DO, 3 of 35	9%
		Nitrate, 34 of 35	97%

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section III (Holcomb Bridge to Johnson Ferry, cont'd.)			
Cobb County WL4 (Gold Branch - Willeo Creek, cont'd.)			
Gold Branch - Willeo Creek			
	Feb 98 - Mar 08	TP, 6 of 35	17%
Fecal coliforms (n = 35)	Feb 98 - Mar 08	FC, 12 or 10	34% or 29%
6 nontoxic metals (n = 2)	Nov 07, Mar 08	----	----
4 toxic metals (n = 35)	Feb 98 - Mar 08	Cu, 1	3%
		Pb, 1	3%
GA DNR 12064001[b]			
Gold Branch - Willeo Creek			
4 general WQ parameters (n = 24-25)	Jun 99 - Dec 00	DO, 2 of 25	8%
8 general WQ parameters (n = 11-12)	Jan - Dec 00	Ammonium, 3 of 12	25%
	Jan - Dec 00	Nitrate, 11 of 12	92%
		BOD_5, 1 of 12	9%
2 nontoxic metals[c] (n = 2)	2 dates in 00	----	----
11 toxic metals (n = 2)	2 dates in 00	Total Cd, 2	100%
Fulton County MA-1			
Johnson Ferry – March (Marsh) Creek			
9 general WQ parameters (n = 4-6)	Sep 06 - Apr 08	Nitrate, 6 of 6	100%
2 general WQ parameters (n = 5)	Apr 07 - Apr 08	----	----
Fecal coliforms (n = 20)	Jun 06 - Nov 07	FC, 11 or 9	55% or 45%
Escherichia coli (n = 20)	Jun 06 - Nov 07	*E. coli*, 12 or 9	60% or 45%
4 toxic metals (n = 6)	Sep 06 - Apr 08	----	
GA DNR 12070001			
Johnson Ferry – Chattahoochee River			
10 general WQ parameters (n = 43-47)	Mar 01 - Dec	Turbidity, 1 of 47	2%
	(Aug) 04	TSS, 11 of 46	24%
		TP, 1 of 43	2%
		Ammonium, 6 of 47	13%
		Nitrate, 47 of 47	100%
		BOD_5, 1 of 46	2%
1 general WQ parameter (n = 25)	Nov 01 - Dec 03	----	----
Fecal coliforms (n = 52)	Mar 01 - Jun 04	FC, 13 or 11	25% or 21%
Escherichia coli (n = 36)	Jan 02 - Jun 04	*E. coli*, 10 or 4	28% or 11%
Quarles WTP raw water intake			
Escherichia coli (n = 554)	Sep 07 - Mar 09	*E. coli*, 61 or 41	11% or 7%
BacteriALERT Site 2			
Johnson Ferry – Chattahoochee River			
Escherichia coli (n = 406)	Oct 01 - Nov 02	*E. coli*, 59 or 43	15% or 11%

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section III (Holcomb Bridge to Johnson Ferry, cont'd.)			
USGS 02335830			
Chattahoochee River, Johnson Ferry Rd.			
4 general WQ parameters (n = 81)	Mar 99 - Dec 00	pH, 1	1%
8 general WQ parameters (n = 11-12)	Jan - Dec 00	Turbidity, 2 of 11	18%
		TSS, 2 of 11	18%
		TP, 3 of 12	25%
		Ammonium, 7 of 12	58%
		Nitrate, 12 of 12	100%
Fecal coliforms, 1st method (n = 60)	Mar 99 - Apr 00	FC, 11 or 13	18% or 22%
Fecal coliforms, 2nd method (n = 16)	Jan - Dec 00	FC, 2 or 2	13%
Escherichia coli, 1st method (n = 56)	Mar 99 - Apr 00	*E. coli*, 12 or 11	21% or 20%
Escherichia coli, 2nd method (n = 49)	Jan - Dec 00	*E. coli*, 59 or 42	15% or 10%
2 nontoxic metals[c] (n = 2)	2 dates in 00	Total Cd, uncertain	?
11 toxic metals (n = 2)			
Section IV (Cochran Shoals to Paces Mill)			
USGS 02335870			
Sope Creek near Marietta, GA			
1 general WQ parameter (n = 1)	Apr 98	----	----
1 general WQ parameter (n = 8)	Apr 98 - Jul 99	----	----
1 general WQ parameter (n = 42)	Apr 98 - Sep 01	----	----
2 general WQ parameters (n = 41)	Apr 98 - Oct 02	----	----
2 general WQ parameters (n = 84-87)	Apr 98 - Sep 03	----	----
5 general WQ parameters (n = 143-163)	Apr 98 - Oct	pH, 1 of 157	1%
	(Sep) 08	DO, 1 of 152	1%
		TP, 10 of 143	7%
Fecal coliforms (n = 4)	Jun 99 - Apr 00	FC, 2 or 2	50%
Escherichia coli, 1st method (n = 5)	Jun 99 - Mar 02	*E. coli*, 3 or 3	60%
Escherichia coli, 2nd method (n = 5)	Nov 02 - Jul 03	*E. coli*, 2 or 2	40%
Cobb County SP6			
Cochran Shoals – Sope Creek			
12 general WQ parameters (n = 32-33)	Mar 98 - Jan 08	Nitrate, 33 of 33	100%
	(or Oct 07)	TP, 4 of 33	12%
Fecal coliforms (n = 33)	Mar 98 - Jan 08	FC, 9 or 7	27% or 21%
Fecal streptococci (mpn/100 mL; n = 1)	1 date in Dec 00	FS, 1	100%
6 nontoxic metals[c] (n = 1)	1 date in Jan 08	----	----
4 toxic metals (n = 1 for Al, Mn; or n = 32)	1 date (Jan 08);	Total Cd, uncertain[d]	?
	or Mar 98 - Jan 08	Pb, 1 of 32	3%
GA DNR 12072101[b]			
Cochran Shoals - Sope Creek			
12 general WQ parameters (11-20)	Jan - Dec 00	Turbidity, 1 of 12	8%
		TSS, 1 of 11	9%

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section IV (Cochran Shoals to Paces Mill, cont'd.)			
GA DNR 12072101 (Cochran Shoals - Sope Creek, cont'd.)			
	Jan - Dec 00	TP, 1 of 11	9%
		Ammonium, 4 of 11	36%
		Nitrate, 10 of 11	91%
		BOD_5, 1 of 11	9%
2 nontoxic metals[c] (n = 2)	2 dates in 00	----	----
11 metals (toxic, nontoxic) (n = 2)	2 dates in 00	Total Cd, 2	100%
Fulton County LI-2			
Palisades - Long Island Creek			
9 general WQ parameters (n = 4-6)	Sep 06 - Apr 08	Nitrate, 6 of 6	100%
2 general WQ parameters (n = 5)	Apr 07 - Apr 08	----	----
Fecal coliforms (n = 20)	Jun 06 - Nov 07	FC, 9 or 9	45%
Escherichia coli (n = 20)	Jun 06 - Nov 07	*E.coli*, 11 or 10	55% or 50%
4 toxic metals (n = 6)	Sep 06 - Apr 08	Total Cd, uncertain[d]	?
GA DNR 12073201[b]			
Palisades - Long Island Creek			
12 general WQ parameters (n = 11-20)	Jan - Dec 00	DO, 1 of 20	5%
		Ammonium, 3 of 12	25%
		Nitrate, 12 of 12	100%
		BOD_5, 1 of 12	8%
2 nontoxic metals (n = 2)	2 dates in 00	----	
11 toxic metals (n = 2)	2 dates in 00	Total Cd, 2	100%
Cobb County RT5			
Palisades - Rottenwood Creek			
12 general WQ parameters (33-35)	Jan 98 - Dec 07	TSS, 1 of 35	3%
		TP, 6 of 35	17%
		Nitrate, 35 of 35	100%
Fecal coliforms (n = 35)	Jan 98 - Dec 07	FC, 14 or 12	40% or 34%
4 toxic metals (n = 34)	Jan 98 - Aug 07	Total Cd, uncertain[d]	?
		Total Cu, 1	3%
		Total Pb, 3	9%
GA DNR 12073901 [b]			
Palisades - White Water Creek			
4 general WQ parameters (n = 32)	Jun 99 - Sep 03	----	----
6 general WQ parameters (n = 12)	Jan - Dec 00	Turbidity, 1 of 12	8%
		Ammonium, 3	25%
		Nitrate, 12	100%
		BOD_5, 1	8%
1 general WQ parameter (n = 13)	Jan 00 - May 02	TSS, 4	31%
1 general WQ parameter (n = 17)	Jan 00 - Sep 03	TP, 1	6%
2 general WQ parameters (n = 5)	Feb 02 - Sep 03	----	----

Table A4-1. (Continued).

Station / Location (Parameters)	Data Available	Parameter, Number Unacceptable	Percent of Total
Section IV (Cochran Shoals to Paces Mill, cont'd.)			
GA DNR 12073901 (Palisades - White Water Creek, cont'd.)			
4 nontoxic metals[c] (n = 2)	Apr 00 - May 02	----	----
10 toxic metals (total; n = 2)	2 dates in 00	Total Cd, 2	100%
15 toxic metals (dissolved; n = 2-4)	Apr 00 - May 02	----	----
BacteriALERT Site 3 Johnson Ferry - Chattahoochee River			
Escherichia coli (n = 1,399)	Oct 00 - Nov 08	*E. coli*, 418 or 292	30% or 21%
Cobb County NA1 Paces Mill - Little Nancy Creek			
12 general WQ parameters (n = 31-33)	Jun 00 - Mar 08 (or Sep 07)	Turbidity, 1 of 33 TP, 1 of 33 Nitrate, 33 of 33	3% 3% 100%
Fecal coliforms (n = 33)	Jun 00 - Mar 08	FC, 5 or 2	15% or 6%
6 nontoxic metals[c] (n = 2)	2 dates in 08	----	----
4 toxic metals (n = 33)	Jun 00 - Mar 08	Total Cd, uncertain[d]	?
2 toxic metals (n = 2)	2 dates in 08	Al, 2	100%
Cobb County NA2 Paces Mill - Little Nancy Creek			
7 general WQ parameters (n = 22-24)	Jun 02 - Mar 08	TP, 3 of 24 Nitrate, 24 of 24	13% 100%
Fecal coliforms (n = 24)	Jun 02 - Mar 08	FC, 4 or 3	17% or 13%
6 nontoxic metals[c] (n = 2)	2 dates in 08	----	----
4 toxic metals (n = 24)	Jun 02 - Mar 08	Total Cd, uncertain[d]	?
2 toxic metals (n = 2)	2 dates in 08	Al, 1	50%

[a] Nitrate here refers to nitrate+nitrite. Fecal coliform bacteria (FC) are evaluated based upon GA DNR's regulation ($\leq$ 200 mpn/100 mL as the gm of 4 samples taken consecutively within 30 days; and $\leq$ 400 mpn/10 mL, the standard for samples taken less frequently – GA DNR 2008d, US EPA 2003). Thus, the record "FC, 31 or 19 of 60" would mean that either 31 of 60 samples (or 52% of samples, using the value of $\leq$ 200 mpn/100 mL) or 19 of 60 samples (or 32% of samples, using the value of $\leq$ 400 mpn/100 mL) had densities of fecal coliform bacteria suggestive of unacceptable conditions. *Escherichia coli* bacterial densities are evaluated using only the value of $\leq$ 400 mpn/100/mL.

[b] Fecal coliform bacteria were not measured.

[c] Nontoxic metals ≡ barium (Ba), calcium (Ca), iron (Fe), magnesium (Mg), potassium (K), and sodium (Na).

[d] Values were reported as less than a range of values that include the CCC.

[e] Some values were reported as less than a range of values that include the CCC.

[f] Selected parameters included those most commonly considered in water quality assessment; most of the others had been sampled infrequently (1 or a few dates).

Appendix 5. Georgia Water Quality Standards for all Waters: Toxic Substances

TABLE 3-3
GEORGIA INSTREAM WATER QUALITY STANDARDS FOR ALL WATERS: TOXIC SUBSTANCES

(Excerpt from Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03 - Water Use Classifications and Water Quality Standards)

(i) Instream concentrations of the following chemical constituents which are considered to be other toxic pollutants of concern in the State of Georgia shall not exceed the criteria indicated below under 7-day, 10-year minimum flow (7Q10) or higher stream flow conditions except within established mixing zones:

1. 2,4-Dichlorophenoxyacetic acid (2,4-D)	70 µg/l
2. Methoxychlor	0.03 µg/l*
3. 2,4,5-Trichlorophenoxy propionic acid (TP Silvex)	50 µg/l

(ii) Instream concentrations of the following chemical constituents listed by the U.S. Environmental Protection Agency as toxic priority pollutants pursuant to Section 307(a)(1) of the Federal Clean Water Act (as amended) shall not exceed the acute criteria indicated below under 1-day, 10-year minimum flow (1Q10) or higher stream flow conditions and shall not exceed the chronic criteria indicated below under 7-day, 10-year minimum flow (7Q10) or higher stream flow conditions except within established mixing zones or in accordance with site specific effluent limitations developed in accordance with procedures presented in 391-3-6-.06. Unless otherwise specified, the criteria below are listed in their total recoverable form. Because most of the numeric criteria for the metals below are listed as the dissolved form, total recoverable concentrations of metals that are measured instream will need to be translated to the dissolved form in order to compare the instream data with the numeric criteria. This translation will be performed using guidance found in "Guidance Document of Dynamic Modeling and Translators August 1993" found in Appendix J of EPA's Water Quality Standards Handbook: Second Edition, EPA-823-B-94-005a or by using other appropriate guidance from EPA.

		Acute	Chronic
1.	Arsenic		
	(a) Freshwater	340 µg/l [1]	150 µg/l [1]
	(b) Coastal and Marine Estuarine Waters	69 µg/l [1]	36 µg/l [1]
2.	Cadmium		
	(a) Freshwater	2.0 µg/l [1,3]	1.3 µg/l [1,3]
	(b) Coastal and Marine Estuarine Waters	42 µg/l [1]	9.3 µg/l [1]
3.	Chromium III		
	(a) Freshwater	320 µg/l [1,3]	42 µg/l [1,3]
	(b) Coastal and Marine Estuarine Waters	--	--
4.	Chromium VI		
	(a) Freshwater	16 µg/l [1]	11 µg/l [1]
	(b) Coastal and Marine Estuarine Waters	1,100 µg/l [1]	50 µg/l [1]
5.	Copper		
	(a) Freshwater	7.0 µg/l [1,2*,3]	5.0 µg/l [1,2*,3]
	(b) Coastal and Marine Estuarine Waters	4.8 µg/l [1,2]	3.1 µg/l [1,2]
6.	Lead		
	(a) Freshwater	30 µg/l [1,3]	1.2 µg/l [1,2*,3]
	(b) Coastal and Marine Estuarine Waters	210 µg/l [1]	8.1 µg/l [1]
7.	Mercury		
	(a) Freshwater	1.4 µg/l	0.012 µg/l [2]
	(b) Coastal and Marine Estuarine Waters	1.8 µg/l	0.025 µg/l [2]
8.	Nickel		
	(a) Freshwater	260 µg/l [1,3]	29 µg/l [1,3]
	(b) Coastal and Marine Estuarine Waters	74 µg/l [1]	8.2 µg/l [1]
9.	Selenium		
	(a) Freshwater	--	5.0 µg/l
	(b) Coastal and Marine Estuarine Waters	290µg/l [1]	71 µg/l [1]

10.	Silver	--[4]	--[4]
11.	Zinc		
	(a) Freshwater	65 µg/l [1,3]	65 µg/l [1,3]
	(b) Coastal and Marine Estuarine Waters	90 µg/l [1]	81 µg/l [1]
12.	Lindane [Hexachlorocyclohexane (g-BHC-Gamma)]		
	(a) Freshwater	0.95 µg/l	
	(b) Coastal and Marine Estuarine Waters	0.16 µg/l	

[1] The in-stream criterion is expressed in terms of the dissolved fraction in the water column. Conversion factors used to calculate dissolved criteria are found in the EPA document – National Recommended Water Quality Criteria – Correction, EPA 822-Z-99-001, April 1999.

[2] The in-stream criterion is lower than the EPD laboratory detection limits (A "*" indicates that the criterion may be higher than or lower than EPD laboratory detection limits depending upon the hardness of the water).

[3] The aquatic life criteria for these metals are expressed as a function of total hardness (mg/l) in a water body. Values in the table above assume a hardness of 50 mg/l $CaCO_3$. For other hardness values, the following equations from the EPA document – National Recommended Water Quality Criteria – Correction; EPA 822-Z-99-001, April 1999 should be used. The minimum hardness allowed for use in these equations shall not be less than 25 mg/l, as calcium carbonate and the maximum shall not be greater than 400 mg/l as calcium carbonate.

Cadmium
acute criteria = $(e^{(1.128[\ln(hardness)] - 3.6867)})(1.136672-[(\ln hardness)(0.041838)]$ µg/l
chronic criteria = $(e^{(0.7852[\ln(hardness)] - 2.715)})(1.101672-[(\ln hardness)(0.041838)]$ µg/l

Chromium III
acute criteria = $(e^{(0.8190[\ln(hardness)] + 3.7256)}(0.316)$ µg/l
chronic criteria = $(e^{(0.8190[\ln(hardness)] + 0.6848)})(0.860)$ µg/l

Copper
acute criteria = $(e^{(0.9422[\ln(hardness)] - 1.700)})(0.96)$ µg/l
chronic criteria = $(e^{(0.8545[\ln(hardness)] - 1.702)})(0.96)$ µg/l

Lead
acute criteria = $(e^{(1.273[\ln(hardness) - 1.460)})(1.46203 - [(\ln hardness)(0.145712)])$ µg/l
chronic criteria = $(e^{(1.273[\ln(hardness) - 4.705)})(1.46203 - [(\ln hardness)(0.145712)])$ µg/l

Nickel
acute criteria = $(e^{(0.8460[\ln(hardness)] + 2.255)})(.998)$ µg/l
chronic criteria = $(e^{(0.8460[\ln(hardness)] + 0.0584)})(.997)$ µg/l

Zinc
acute criteria = $(e^{(0.8473[\ln(hardness)] + 0.884)})(0.978)$ µg/l
chronic criteria = $(e^{(0.8473[\ln(hardness)] + 0.884)})(0.986)$ µg/l

[4] This pollutant is addressed in 391-3-6-.06.

(iii) Instream concentrations of the following chemical constituents listed by the U.S. Environmental Protection Agency as toxic priority pollutants pursuant to Section 307(a)(1) of the Federal Clean Water Act (as amended) shall not exceed criteria indicated below under 7-day, 10-year minimum flow (7Q10) or higher stream flow conditions except within established mixing zones or in accordance with site specific effluent limitations developed in accordance with procedures presented in 391-3-6-.06.

1.	Chlordane	
	(a) Freshwater	0.0043 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.004 µg/l*
2.	Cyanide	
	(a) Freshwater	5.2 µg/l*
	(b) Coastal and Marine Estuarine Waters	1.0 µg/l*
3.	Dieldrin	
	(a) Freshwater	0.056 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.0019 µg/l*
4.	4,4'-DDT	0.001 µg/l*
5.	a-Endosulfan	
	(a) Freshwater	0.056 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.0087 µg/l*
6.	b-Endosulfan	
	(a) Freshwater	0.056 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.0087 µg/l*

7.	Endrin	
	(a) Freshwater	0.036 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.0023 µg/l*
8.	Heptachlor	
	(a) Freshwater	0.0038 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.0036µg/l*
9.	Heptachlor Epoxide	
	(a) Freshwater	0.0038 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.0036 µg/l*
10	Pentachlorophenol	
	(a) Freshwater	2.1 µg/l*
	(b) Coastal and Marine Estuarine Waters	7.9 µg/l*
11.	PCBs	
	(a) Freshwater	0.014 µg/l*
	(b) Coastal and Marine Estuarine Waters	0.03 µg/l*
12.	Phenol	300 µg/l
13.	Toxaphene	0.0002 µg/l*

*The in-stream criterion is lower than the EPD laboratory detection limits.

(iv) Instream concentrations of the following chemical constituents listed by the U. S. Environmental Protection Agency as toxic priority pollutants pursuant to Section 307(a)(1) of the Federal Clean Water Act (as amended) shall not exceed criteria indicated below under annual average or higher stream flow conditions:

1.	Acenaphthene	2700 µg/l	
2.	Acenaphthylene	**	
3.	Acrolein	780 µg/l	
4.	Acrylonitrile	0.66 µg/l	
5.	Aldrin	0.00014 µg/l	
6.	Anthracene	110000 µg/l	
7.	Antimony	4300 µg/l	
8.	Arsenic	50 µg/l	
9.	Benzidine	0.00054 µg/l	
10.	Benzo(a)Anthracene	0.049µg/l	
11.	Benzo(a)Pyrene	0.049µg/l	
12.	3,4-Benzofluoranthene	0.049µg/l	
13.	Benzene	71 µg/l	
14.	Benzo(ghi)Perylene	**	
15.	Benzo(k)Fluoranthene	0.049µg/l	
16.	Beryllium	**	
17.	a-BHC-Alpha	0.013 µg/l	
18.	b-BHC-Beta	0.046 µg/l	
19.	Bis(2-Chloroethyl)Ether	1.4 µg/l	
20.	Bis(2-Chloroisopropyl)Ether	170000 µg/l	
21.	Bis(2-Ethylhexyl)Phthalate	5.9 µg/l	
22.	Bromoform (Tribromomethane)	360 µg/l	
23.	Butylbenzyl Phthalate	5200	
24.	Carbon Tetrachloride	4.4 µg/l	
25.	Chlorobenzene	21000 µg/l	
26.	Chlorodibromomethane	34 µg/l	
27.	2-Chloroethylvinyl Ether	**	
28.	Chlordane	0.0022 µg/l	
29.	Chloroform (Trichloromethane)	470 µg/l	
30.	2-Chloronaphthalene	4300 µg/l	
31.	2-Chlorophenol	400 µg/l	
32.	Chrysene	0.049 µg/l	
33.	Dibenzo(a,h)Anthracene	0.049 µg/l	
34.	Dichlorobromomethane	46 µg/l	
35.	1,2-Dichloroethane	99 µg/l	eded basis through toxic
36.	1,1-Dichloroethylene	3.2 µg/l	ce of the pollutant at levels
37	1,2 – Dichloropropane	39 µg/l	
38.	1,3-Dichloropropylene	1700 µg/l	
39.	2,4-Dichlorophenol	790 µg/l	
40.	1,2-Dichlorobenzene	17000 µg/l	d 0.0000012 ug/l under
41.	1,3-Dichlorobenzene	2600 µg/l	

(f) Applicable State and Federal requirements and regulations for the discharge of radioactive substances shall be met at all times.

Appendix 6. Criteria for classification of major lakes and tributaries as meeting or not meeting their designated uses.

Substantial changes have been made to the format of Georgia's 2008 305(b)/303(d) List of Waters assessed from earlier listing years. The USEPA has required States to move to a five-part categorization of their waters. The GAEPD adopted the five-part categorization method with

TABLE 3-4
WATER QUALITY STANDARDS FOR MAJOR LAKES

(16) **Specific Criteria for Lakes and Major Lake Tributaries.** In addition to the general criteria, the following lake specific criteria are deemed necessary and shall be required for the specific water usage as shown:

in previous 305(b)/303(d) lists.

Lake Sidney Lanier: Those waters impounded by Buford Dam and upstream to Belton Bridge Road on the Chattahoochee River, 0.6 miles downstream from State Road 400 on the Chestatee River, as well as other impounded tributaries to an elevation of 1070 feet mean sea level corresponding to the normal pool elevation of Lake Sidney Lanier.

(i) Chlorophyll a: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed the chlorophyll a concentrations at the locations listed below:

1.Upstream from the Buford Dam forebay	5 ug/l
2.Upstream from the Flowery Branch confluence	5 ug/
3.At Browns Bridge Road (State Road 369)	5 ug/l
4.At Bolling Bridge (State Road 53) on Chestatee River	10 ug/l
5.At Lanier Bridge (State Road 53) on Chattahoochee River	10 ug/l

(ii) pH: Within the range of 6.0-9.5 standard units.
(iii) Total Nitrogen: Not to exceed 4 mg/l as nitrogen in the photic zone.
(iv) Phosphorous: Total lake loading shall not exceed 0.25 pounds per acre-foot of lake volume per year.
(v) Fecal Coliform: Fecal coliform bacteria shall not exceed the Recreation criterion as presented in 391-3-6-.03(6)(b)(I).
(vi) Dissolved Oxygen: A daily average of 5.0 mg/l and no less than 4.0 mg/l at all times at the depth specified in 391-3--6-.03(5)(g).
(vii) Temperature: Water temperature shall not exceed the Recreation criterion as presented in 391-3-6-.03(6)(b)(iv).
(viii) Major Lake Tributaries: For the following major tributaries, the annual total phosphorous loading to Lake Sidney Lanier shall not exceed the following:

1. Chattahoochee River at Belton Bridge Road	178,000 pounds
2. Chestatee River at Georgia Highway 400	118,000 pounds
3. Flat Creek at McEver Road	14,400 pounds

(f) Carters Lake: Those waters impounded by Carters Dam and upstream on the Coosawattee River as well as other impounded tributaries to an elevation of 1072 feet mean sea level corresponding to the normal pool elevation of Carters Lake.

(i) Chlorophyll a: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed the chlorophyll a concentrations at the locations listed below:

1. Carters Lake upstream from Woodring Branch	5 ug/l
2. Carters Lake at Coosawattee River embayment mouth	10 ug/l

(ii) pH: within the range of 6.0 – 9.5 standard units.
(iii) Total Nitrogen: Not to exceed 4.0 mg/l as nitrogen in the photic zone.
(iv)Phosphorous: Total lake loading shall not exceed 172,500 pounds or 0.46 pounds per acre-foot of lake volume per year.
(v) Fecal Coliform: Fecal coliform bacteria shall not exceed the Recreation criterion as presented in 391-3-6-.03(6)(b)(i).
(vi) Dissolved Oxygen: A daily average of 5.0 mg/l and no less than 4.0 mg/l at all times at the depth specified in 391-3-6-.03(5)(g).
(vii) Temperature: Water temperature shall not exceed the Recreation criterion as presented in 391-3-6-.03(6)(b)(iv).

(viii) Major Lake Tributaries: For the following major tributaries, the annual total phosphorous loading at the compliance monitoring location shall not exceed the following:

1. Coosawattee River at Old Highway 5	151,500 pounds
2. Mountaintown Creek at U.S. Highway 76	8,000 pounds

nnelized)

TMDL(s) need to be completed for one or more pollutants. In previous 305(b)/ 303(d) lists, a water body that was determined not to be supporting its use and for which a TMDL still needed to be completed was indicated by the presence of an "x" in the 303(d) column of the report.

In accordance with Section 303(d) of the Clean Water Act, the 303(d) list is a list of waters not meeting their uses and for which TMDL(s) have not been completed for the parameter(s) of concern. Once the TMDL is completed, the water may still not be supporting its use; however, it is no longer on the 303(d) list. In the new 5-part categorization method, waters that are assessed as "not supporting" their uses will either be placed in Category 4a, 4b, 4c or 5. Only those waters in Category 5 make up the federally mandated 303(d) list.

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