Chapter 2

LANDUSE AND WATER QUALITY IN GEORIGA

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Nonpoint Source Pollution: The Nation's Largest Water Quality Problem

The United States has made tremendous advances in the past 30 years to clean up the aquatic environment by controlling **point source** pollution coming from industries and sewage treatment plants.

Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water.

These pollutants include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;

- Oil, grease, and toxic chemicals from urban runoff and energy production;

- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks;

- Salt from irrigation practices and acid drainage from abandoned mines;

- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

Atmospheric deposition and modifications to natural vegetation, stream shape and flow are also sources of nonpoint source pollution.

Georgia Urban Development Trends

**From Land Development Provisions To Protect Georgia Water Quality*

Early urban development

A hundred years ago, trains and streetcars supported downtown business districts by bringing shoppers and workers from all over the urban regions. Development in the suburbs was kept within walking distance of streetcar lines. Land use combinations evolved within the constraints of daily walking distances. City streets were paved with cobblestones, which were permeable to small amounts of rainfall and runoff. Minor residential streets had no curbs; instead they were usually flanked by swales or ditches that kept streets passable during moderate rainfalls.

Auto-oriented development

Since the automobile was developed in the early years of this century, its use has been subsidized with public investment and land use regulation. Local governments spent million of dollars to widen the cobbled streets and repave them with asphalt. The Federal government began subsidizing auto use in 1916 and 1921 with Federal Road Acts to construct and improve auto roads, support the formation and operation of state highway departments, and link state highways into national networks. To enable Georgia to participate in the new program, the General Assembly created a State Highway Board in August 1916. In 1925, federal highway spending topped $1 billion per year. In 1956, the federal government began the Interstate system, which added 41,000 miles of connecting and beltway expressways and subsidized the widening of local roads to collect auto traffic onto them. By the early 1970s paving was referred to as "the nation's biggest endowed business" (Sorvig, 1993). Each year, in the United States, we are paving or repaving half a million acres (Ferguson, 1996).

The new highways opened up rural areas to suburban development. Georgia's citizens moved from farms to urban areas, and from the central sections of cities to the fringes. Sewer and water lines were extended into low-density suburbs. City development was refitted to accommodate the car. Zoning codes, originally devised to protect residential neighborhoods from incompatible industries, grew to segregate every detailed category of land use. They imposed exclusive reliance on cars for daily transportation by requiring homogeneous, low-density residential development across large areas. Street pavement widths increased by more than 50 percent to favor rapid, unobstructed automobile traffic. Parking lots became essential adjuncts to suburban stores and offices that had once fronted on city sidewalks. As land uses spread farther apart with only auto roads as connectors, more cars were needed to link them back together, and more asphalt and concrete were needed to maintain the connectors.

Effects of impervious surfaces

- Development requirements increase the dimensions of streets, driveways and parking lots causing an increase in impervious pavement, which generate runoff. Curbs make structural channels accelerate it.

- Almost any contemporary land use produces impervious coverage over 10 percent. Even residences dispersed on 2-acre lots produce impervious cover of 12 percent.

- Industrial and office uses and shopping centers can produce nearly 100 percent impervious coverage.

- Of all the impervious areas, the pavements of the roads and parking lots make up the major portion.

- Impervious surfaces seal over the soil pores, depriving the root zone of water and air. They deflect rainwater into surface channels, where it concentrates into downstream floods.

- Storm water runoff carries oils from cars, parking lots, maintenance yards, and storage areas, metals from construction materials, and herbicides, pesticides, and nutrients from over-maintained landscapes.

- Streets and parking lots are the impervious surfaces with the greatest area and highest pollutant loads. Automobiles drop hydrocarbons from oil, and metals from the wearing of brake pads and tires; all are washed off of pavements and into streams by runoff.

- In the days or weeks between rainstorms, oils and sediments accumulate on pavements. When the first rain falls on pavements, it flushes the accumulated pollutants into streams. As the rain continues, growing volumes of runoff erode stream banks, destroying habitats and producing further sediment pollution.

- Stream and wetland health decline with overall impervious coverage. Significant impacts begin at 10 percent coverage. At impervious coverage over 30 percent, impacts on streams and wetlands become severe and degradation is almost unavoidable (Arnold and Gibbons, 1996).

Impervious coverage	Stream health
<10%	"Protected"
10 to <30%	"Impacted" if not mitigated
>30%	"Degraded" if not mitigated

Effects of development on peak discharges and runoff volumes

A storm hydrograph is a tool used to show how storm water discharge changes with time. The portion of the hydrograph that lies to the left of the peak is called the rising limb, which shows how long it takes the stream to peak following a rain event. The portion of the curve to the right of the peak is called the recession limb.

Storm runoff moves more rapidly over smooth, hard pavement than over natural vegetation (figure 2.1). As a result, the rising limbs hydrographs become steeper and higher in urbanized areas. Recession limbs also decline more steeply in urban streams.

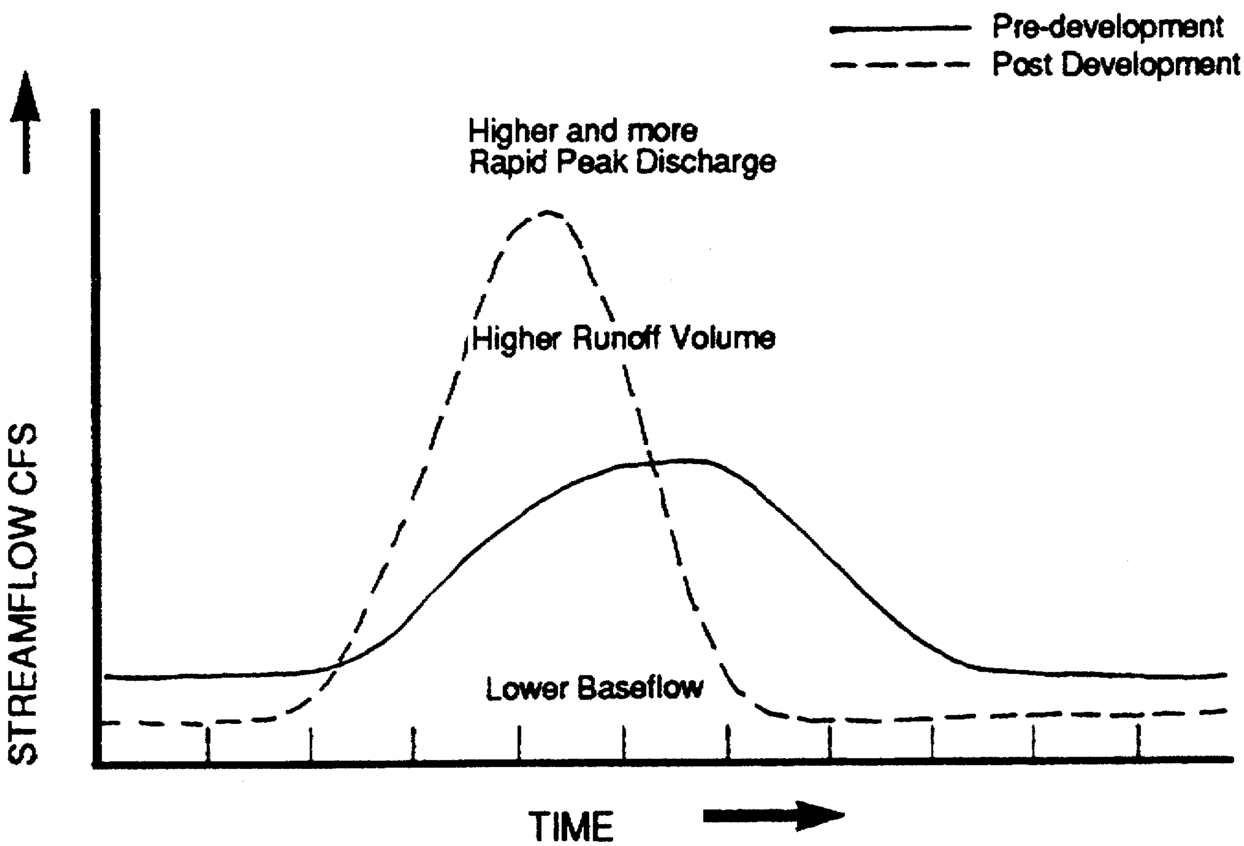

Figure 2.1 Effects of development on stream flow

What Are Erosion and Sedimentation?

Erosion is the breaking away and movement of soil or rock fragments by water, wind, ice, or gravity. Once the soil or rock is detached, it becomes known as sediment. The sediment can move by wind or, most commonly, water onto adjoining land or into our streams and rivers. This movement into rivers and streams is Georgia’s number one source of water pollution. If erosion is controlled, sediment does not travel. Therefore, by controlling erosion we can greatly improve the quality of our water.

Erosion is a natural process and its natural occurrence creates mountains, flatlands, and coastal regions. Natural erosion occurs slowly and in a uniform manner. However, human activity can result in "accelerated erosion." Accelerated erosion causes too much sediment to enter our rivers and streams.

Humans, through land-disturbing activities, accelerate erosion. A land-disturbing activity is "any activity which may result in soil erosion from water or wind and the movement of sediments into State water or onto lands within the State." Examples include clearing, grading, dredging, filling, transporting and excavating.

When excessive eroded soil enters a stream, the stream becomes sedimented. This means that the stream is overloaded with silt and clay, giving the water a murky, cloudy look. Georgia's infamous red clay contributes the orange-red coloration that characterizes many of Georgia’s rivers.

The suspended sediment may contain a mixture varying from fine silt to larger gravel. As the stream flows downhill, it usually widens and slows. As the stream's pace decreases, the sediment settles out to the stream bed. Heavier sediment like pebbles will settle out first. Fine sediment such as silt and clay particles take much longer to settle out. Unfortunately, the rate at which eroded soil enters the stream along its banks may exceed the rate at which fine sediment settles out. The result is permanently muddy water.

An Overview of Georgia's Regions and Waters

This information was taken from a series of sources, including *The Natural Environments of Georgia* by Charles H. Wharton, DNR Bulletin 114. Combining the available chemical, physical, biological and watershed data, a description of the major watersheds in Georgia has been developed.

North Georgia Mountains
Four mountain rivers, Chatooga, Chattahoochee, Etowah and Hiawassee, possess similar water chemistry. Their acidity is moderate (6.4 – 6.9) and their phosphorus and nitrogen levels low. Blue Ridge mountain streams are low in calcium, manganese and iron and are not especially rich in other minerals. Cold, well-oxygenated water coursing over a rocky substrate is the picture of a typical mountain stream. The headwater streams tend to be highly oxygenated, but lack organic nutrients. Most nutrients come from leaves and other organic debris that fall into the water. Algae on rocks is the dominant primary producer in North Georgia mountain streams. Macroinvertebrates adapted to living among the rocks of these streams include stoneflies, mayflies, caddisflies, black fly larvae, water pennies and dobsonflies.

The Piedmont
The Upper Piedmont region is drained by the Chattahoochee River and its tributaries and by small portions of the Coosa and Savannah. The Lower Piedmont region contains the Chattahoochee, Flint, Altamaha, Savannah and small portions of the Ogeechee River. Piedmont streams are more basic (pH 6.9 – 7.2), contain slightly more organic matter, and are more turbid (44 NTU) than mountain streams. As these waters move downstream, they gradually gain more organic matter and more species (as the temperature also climbs). A familiar characteristic of this region is the red clay subsoil, which is exposed when most of the topsoil has been eroded away during heavy development and agricultural practices. The rock and gravel substrate in the Piedmont streams is typically embedded in sand and silt.

Coastal Plains
The Coastal Plain streams can be divided into three groups on the basis of water chemistry. The large rivers originating in the Piedmont are weakly acid (average pH 6.8) and have moderate amounts of organic matter, turbidity (15 NTU), and hardness (average 17), with fairly high phosphorus (.07) and nitrogen (.24) levels. Two examples are the Oconee and Ocmulgee Rivers. They carry heavy runoff, coming from the steeper slopes of the Piedmont, and form extensive floodplains – four miles wide – as they drop below the Fall Line. These rivers carry significant loads of silt, clay and sand all the way to the sea.

Rocky Creek (Laurens Co.) and Ichawaynochaway (Baker Co.) exemplify the second group of Coastal Plain streams. These streams have a basic pH (7.25), are low in organics, moderately turbid (15.5 NTU), very hard (28), and have moderate loads of nutrients. The hardness and pH of these streams are probably due to passing through the basic limestone in the aquifer recharge zone. Many of the streams running through this area of Georgia (called the Dougherty Plain) are intermittent.

The third group consists of the lower Coastal Plain streams and is exemplified by the Little, Alapaha, Satilla, St. Marys, and Suwannee. These are referred to as blackwater river systems. Except for the large rivers that drain the Piedmont, almost all Coastal Plain rivers fall into this category. The water appears black when deep and tea-colored when shallow. The color comes from the organic acids leached from plant matter by the slow-moving waters of the swamps through which the tributaries flow.

These rivers and streams have a high content of organic matter and low levels of inorganic matter, such as sand, silt and clay. The high percentage of organic material plays a big role in the chemistry of these waters. These streams are relatively acidic (pH 4.59). Both the Little and the Alapaha are slightly less acidic, probably due to their contact with the basic limestone in the vicinity of Valdosta. The ultimate acidity is shown by the Suwannee (pH 4.3), deriving its acid from the Okefenokee peat and the cypress-tupelo floodplain along its upper portion. Hardness is low, approaching that of mountain streams, and phosphorus and nitrogen are quite low. Oxygen levels are lower than those of the North Georgia and Piedmont area due to the warmer, slower-moving waters. The common macroinvertebrates found in these blackwater systems are stoneflies, mayflies, dragonflies, beetles, dobsonflies, caddisflies, midges, and black flies.

The Coastal Marsh

Some of our volunteers located on the coast monitor tidal creeks, rivers or canals. These are defined as the network of channels that drain the salt marshes. The salt marsh "boundaries" lie between the coastal barrier islands and the high tide line and extend up tidal creeks and rivers, where its upper boundary is generally marked by the black rush (Juncus roemerianus). Salinity levels range from 1 to 28 parts per thousand (ppt). Temperature and dissolved oxygen levels can also have great fluctuations. These factors will depend on the tidal influence and the source and amount of freshwater entering the creeks. Coastal Georgia Adopt-A-Stream provides biological protocols and indices for these systems.

Georgia's Wetlands

Various assessments of Georgia's wetlands have identified from 4.9 to 7.7 million acres, including more than 600,000 acres of open water habitat found in estuarine, riverine, palustrine, and lacustrine environments. Estimates of wetland losses since colonial settlement beginning in 1733 and expanding over the next two and one-half centuries are between 20-25% of the original wetland acreage.

Georgia has approximately 100 miles of shoreline along the Atlantic, with extensive tidal marshes separating the barrier islands from the mainland. Georgia's coastline and tidal marshes are well preserved compared to other South Atlantic states.

Georgia's interior ranges in elevation from sea level to 4,788 feet in the Blue Ridge Mountain Province. At the higher elevations, significant pristine cool water streams originate and flow down steep to moderate gradients until they encounter lower elevations of the Piedmont Province. Many of the major tributaries originating in the mountains and Piedmont have been impounded for hydropower and water supply reservoirs. These man-made lakes constitute significant recreational resources and valuable fishery habitat. Palustrine wetlands in floodplains and beaver ponds are found in Piedmont river corridors. At the fall line, streams flowing southeasterly to the Atlantic Ocean or south-southwesterly to the Gulf of Mexico have formed large floodplains as each encounters the soft sediments of the upper Coastal Plain (Figure 4-1).

Other significant wetlands found in the state are associated with blackwater streams originating in the Coastal Plain, lime sinkholes, spring heads, Carolina bays, and the Okefenokee Swamp, a bog-swamp measuring approximately one-half million acres in south Georgia.

In the flatwoods of the lower Coastal Plain, seven tidal rivers originate in the ancient shoreline terraces and sediments of Pleistocene age. Scattered throughout the flatwoods are isolated depressional wetlands and drainages dominated by needle-leaved and broad-leaved tree species adapted to long hydroperiods.

Due to considerable variation in the landscape in topography, hydrology, geology, soils, and climatic regime, the state has one of the highest levels of biodiversity in the eastern United States. The state provides a diversity of habitats for nearly 4,000 vascular plant species and slightly less than 1,000 vertebrate species. Numerous plant and animal species are endemic to the state. Many of the rarer species are dependent upon wetlands for survival.