BIG CREEK WATERSHED VOLUNTEER MONITORING & EDUCATION PROGRAM: FOCUS ON WET WEATHER SEDIMENT & TURBIDITY LEVELS

Glynn Forrest Groszmann

AUTHOR: Environmental Consultant and Principal, Groszmann Environmental Services, 160 Thompson Place, Roswell, Georgia 30075.
REFERENCE: Proceedings of the 1997 Georgia Water Resources Conference, held March 20-22, 1997, at The University of Georgia, Kathryn J. Hatcher, Editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. The project, a one-year study of sediment loads in the Big Creek watershed in north Fulton and Forsyth Counties, involved the collection of water samples during rain events when suspended sediment levels are at their highest. The goal of the project is to determine the actual magnitude of peak sediment loads that occur in this waterway as a result of rain events, and to show that this type of evaluation can be accomplished with simple, inexpensive equipment and non-technical personnel with limited training. Conditions within the watershed were evaluated to determine what factors might contribute to sediment loads, with a focus on land-use patterns and erosion and sediment control practices on construction sites. Data produced from analysis of water samples shows extremely high peak and average values of sediment loads for most of the rain events monitored, and observations of construction sites revealed a lack of effective erosion and sediment controls throughout the watershed.

INTRODUCTION

In 1996, the Director of Georgia's Environmental Protection Division stated that in Georgia's streams that do not meet water quality standards, 75% of in-stream pollutants come not from the "point source" discharges of industrial pipes but from "non-point source" pollution flushed by rainfall from the land's surfaces into waterways. The watershed's land area is the source of many pollutants that are carried by stormwater into waterways, including soil particles that are eroded from land areas and carried into Georgia's streams and lakes as sediment.

The negative impacts of soil sediment on natural aquatic ecosystems and the value of waterways to mankind can be enormous. Not only does the sediment itself cause many problems, many toxic pollutants enter waterways attached to soil particles. When water flows are high, eroded soils are carried as suspended sediment, causing the earthy color and cloudy, turbid appearance of the water. Suspended sediment damages the gills of fish, blocks sunlight from aquatic plants, and affects the public's enjoyment of natural waters. A 1995 report from the Georgia Board of Regent's Scientific Panel stated that damage to fish populations begins at turbidity levels as low as 25 NTU (nephelometric turbidity units). Suspended soil particles increase damage to turbine blades in hydro-power plants and increase the cost of drinking water treatment. When rainfall ends and flow velocities decrease, soil particles are deposited in streams, lakes and reservoirs, decreasing their storage capacities and increasing the frequency and severity of floods. Sediment deposits destroy essential aquatic habitat, by filling-in stream pool areas and smothering fish spawning beds and aquatic insect habitat in stream bottoms.

Although soil erosion and sedimentation is a natural process, the rate is greatly increased by man's logging, farming, mining and land development activities. The problem is most acute in urbanizing watersheds as large land areas are stripped bare and the soil is moved during the construction process. Although some research has been done to determine sediment loads in waterways, there is little data to show how these loads change as conditions in the watershed change. There is also a lack of understanding of the damaging effects of sediment by the public, the developers who work the land, and even many of the agencies that regulate these activities.

The Project: The Upper Chattahoochee Riverkeeper, a nonprofit environmental organization, and environmental consultant Glynn Groszmann teamed-up with corporate sponsor Scientific Games and federal, state and local agencies to address the lack of awareness of these issues and collect data that would illustrate the magnitude of the problem. The project, funded in part by a grant from EPA's Urban Resource Partnership, is a one-year study of the Big Creek watershed in north Fulton and Forsyth Counties, and involves the collection of water samples during rain events when suspended sediment levels are at the highest levels. Volunteers were educated about the adverse impacts and causes of sedimentation, and trained to collect water samples and rain data, and to observe watershed and stream channel conditions. Water samples were analyzed to determine total suspended sediment and turbidity levels, and this data was compiled and charted to illustrate conditions and trends. This data was compared to information about conditions in the watershed, including land use patterns, construction activities, soil types and natural features. Project data was also compared to a study performed by the U. S. Geological Survey of the Big Creek basin in the mid-1970's, when the watershed was primarily rural.

Project goals:
1) Determine peak turbidity and sediment loads in Big Creek by collecting samples during rain events.
2) Relate sediment data to watershed meteorological, topographical, soil and land use conditions.
3) Involve private citizens, corporations and government agencies in data collection and evaluation.
4) Raise public awareness about the effects of sedimentation through workshops and project participation.
4) Evaluate effectiveness of erosion control methods and best management practices in the watershed.
5) Compare today's urbanizing Big Creek watershed to a USGS study when the watershed was more rural.
6) Compile data into a usable format and provide it to interested agencies, citizens and policy makers.

METHODS

The goals of collecting water samples during rain events and obtaining representative samples at various locations along the creek are difficult to achieve with experienced, professional staff, and they presented serious challenges for this project staffed by volunteers.

Equipment: A key to the success of this project is the Automatic Rising-Stage Sampler Stand (see Figure 1), adapted from devices designed by the U.S. Geological Survey and modified by Dr. Todd Rasmussen of the University of Georgia. This device, once installed in the creek, automatically fills sample bottles with water as the stage of the creek rises in response to rain events. The sampler stand takes-in water samples from mid-depth for each one-foot rise in stage, filling up to six sample bottles. The design is comprised of a ten-foot 4X4 post with six bottles sitting on metal brackets and attached with Velcro, and tubing that allows water to flow into the bottles and air to flow out. Each stand is installed in a post-hole at the edge of the creek (at low flow) and supported by braces to withstand the forces of deep fast-moving water that result from large storms. The eight sampler stands, which were constructed and installed with the help of volunteers, worked perfectly throughout the project, even withstanding the seven inches of rain associated with Hurricane Opal.

Test stations: Four test station locations were chosen, with a sampler stand installed on each creek bank and a pair of rain gauges for each station. The criteria for test station locations were: 1) location within the watershed - the sites are uniformly distributed throughout the watershed; 2) stream channel geometry - sites were selected where the channel has a trapezoidal cross-section with banks at least six feet high; 3) The sites had to be "volunteer friendly", with safe off-road parking and safe, easy access to the sampling stands.

Volunteers: Public awareness and volunteer participation were key aspects of this project. Workshops conducted by Alpharetta Environmental Services educated seventy-nine participants on the causes and effects of erosion and sedimentation. Many of these participants were able to pass-along and apply this information to their local Adopt-A-Stream programs. Twenty-four volunteers also received training to participate in this project, after which they divided into teams and selected team captains. Each team received a cooler to store and transport samples, along with replacement bottles and safety equipment. The sampler stand design allows volunteers to wait until rain events end and flows recede before venturing out to the creek to retrieve samples (and replace filled bottles with empties). In addition to collecting filled sample bottles, each team was also responsible for reading a pair of rain gauges and noting observations of conditions in the watershed that contribute to sediment loads. Feedback from the volunteers played a crucial role in making this project a success; procedures were streamlined in response to their

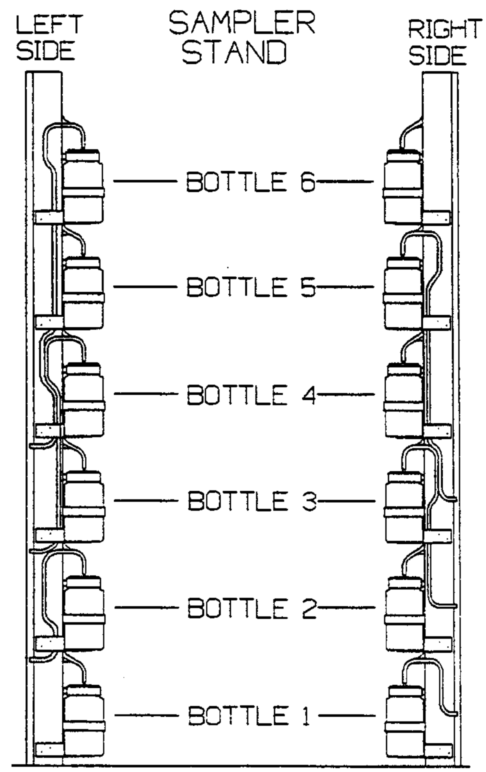

Figure 1: Automatic rising stage sampler stand

suggestions, and rain gages and a sampler stand were relocated to safer and more accessible locations based on volunteer suggestions.

Procedures: Weather forecasts were monitored by the project manager, who notified each team captain of impending rain events. Captains would make sure that their team checked their field equipment (sampler stands and rain gauges) in preparation for the event. After the rainfall, teams would check their sites to determine when water levels had dropped enough to safely access the sampler stands. Each filled bottle was collected and placed in the team's cooler, and replaced on the stand with an empty bottle. All bottles were marked with their installed location (station number, left or right stand, and position on the stand), and each group had two complete sets of bottles. Rain gauges were read and emptied, with the readings recorded on data sheets along with observations of conditions in the watershed. Coolers with water samples and data sheets were then delivered to drop-off points, where they were collected by the project manager and taken to the lab for analysis.

Testing: Water samples were analyzed in two ways: 1) turbidity analysis, which is an optical measurement of how much light is scattered by soil particles, which is most often specified in state law and scientific evaluations of biological impacts; and 2) total suspended sediment analysis, the weight of soil per volume of water, which is used by engineers and agricultural scientists to determine the weight and volume of soil lost from land areas and deposited in reservoirs. A goal of the project is to compare how these values correlate to each other and how the relationship varies with changing conditions.

Water samples were analyzed by the project manager using laboratory space provided by corporate sponsor Scientific Games, Inc., who also made key lab equipment available to the project, provided computers and programmers for data processing, and made a significant financial contribution to the project. Turbidity analysis was performed using a Hach 2100P turbidimeter (calibrated to the manufacturer's specifications) to the requirements of Standard Methods procedure 2130B. Total suspended sediment analysis was performed using a vacuum filtration system, precision balance and oven provided by Scientific Games, and was in accordance with Standard Methods procedure 2540D. Results that appeared excessive or unusual were re-analyzed for verification.

TEST RESULTS

A total of (144) water samples were collected during eight rain events in 1995. Measured values showed that rainfall events routinely cause sediment levels in Big Creek to become extremely high, as evidenced by levels above 400 NTU measured at at least one station during seven of the eight events sampled. Severe erosion and sediment transport is evidenced by the number of exceedingly high turbidity measurements - (24) samples in six rain events exceeded 1000 NTU, (3) samples exceeded 3000 NTU. Station #4 (at Bethelview Road in Forsyth County), which had the most samples measuring over 1000 NTU (12), had measurements as high as 7000 mg/l and 5000 NTU. Typical values at all stations were in the range of 300 to 800 (NTU and mg/l), and over 90 percent of the samples had turbidity levels above 80 NTU (see Figure 2).

Evaluation of the data does not reveal a consistent pattern of values, which is not surprising with the variety of conditions in the watershed and numerous sources of sediment. Whereas a simple system might be expected to show rising sediment levels with increasing water flow energy (which can be determined by analysis of the creek's hydrograph for each event), this set of data shows many spikes in measured values (due to slugs of sediment reaching the samplers) and often the highest values were at the lowest flows (probably due to loose soils at disturbed areas that were moved in the early stages of rain events).

In most cases, there was close correlation of data at each station between the left and right stands at the same stages, with exception of occasional data spikes that were most likely from either streambank failure or a slug of sediment entering from a tributary. Comparison of turbidity and total suspended sediment analysis showed a fairly consistent correlation of these values, with a nearly 1-to-1 slope of the logarithmic plot of these measurements.

WATERSHED CONDITIONS

Precipitation: Total precipitation in 1995, measured by NOAA near Cumming at the headwaters of the watershed, was about average at 57-inches. One notable precipitation event was Hurricane Opal, which arrived on October 5 depositing two-inches of rain on top of five-inches that fell throughout the previous day. Analysis of samples shows that sediment levels were not directly related to precipitation, i.e. higher rainfalls did not necessarily produce higher sediment

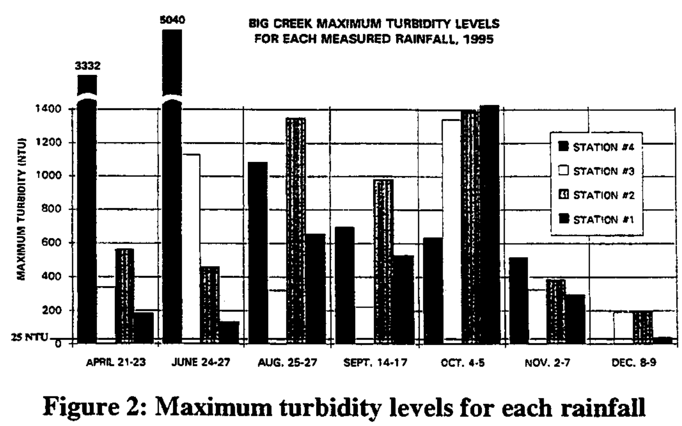

Figure 2: Maximum turbidity levels for each rainfall

levels. Factors that probably had a greater impact on sediment levels are rainfall intensity (which is not known for these events) and the size and condition of areas of land-disturbing activities (see below).

Soils and slopes: Although the types of soils in the Big Creek watershed are classified as highly erodable, the steepness and length of slopes are very low compared to other areas in the upper Chattahoochee River watershed. The product of these two factors indicates that the land in the Big Creek watershed is less susceptible to soil erosion than other land in the area.

Land Use: The Big Creek watershed has undergone significant transformation over the previous two decades, changing from predominantly agriculture and forest to significantly more urban and residential land use. Agriculture and forest areas decreased by about 6,700 acres between 1971-75 and 1990, with a corresponding increase in commercial, industrial, transportation, residential and other highly developed urban and suburban areas. The five years since 1990 have seen an explosive increase in development activities in the watershed, including the massive development of the Northpoint Mall area and a jump in construction in southern Forsyth county. 1990 data shows a 400% increase in transitional acreage (land under development) over 1971-75 data, and it is likely that the amount of disturbed land in the watershed was even higher during this study. This is likely the single most significant factor affecting the sediment levels measured in Big Creek.

CONCLUSIONS & RECOMMENDATIONS

Monitor and evaluate watershed conditions:
The collection of (144) water samples at four sites during eight rain events using simple, inexpensive equipment and non-technical volunteer labor shows that monitoring of waterways and sites of land disturbance activities for sediment discharges can be accomplished accurately with minimal cost and effort. As part of an effective National Pollution Discharge Elimination System program, Georgia's Environmental Protection Division should require sediment monitoring using these or similar methods as a requirement for NPDES permits.

The results of analysis of the water samples collected indicates that the prevailing methods and practices of erosion and sedimentation control are not effectively protecting aquatic systems in Big Creek. A basin-wide evaluation of sediment sources and best management practices employed during farming, logging and development activities by a panel of the agencies responsible for overseeing each of these activities should be conducted.

Severe erosion and sediment transport is evidenced by the number of exceedingly high turbidity measurements - (24) samples in six rain events exceeded 1000 NTU, (3) samples exceeded 3000 NTU. The sources of these sediment loads should be identified and stabilized.

Employ watershed-based planning:
Daily turbidity measurements taken at the Roswell water treatment plant show very low to moderate protection of aquatic systems as a result of sediment levels in Big Creek. The 25 NTU instream limit recommended by the Regent's Scientific Panel was exceeded in over 41% of the measurements in 1995, and over 10% of the measurements exceeded the 80 NTU limit of moderate protection. The recommendations contained in the Panel's 1995 report should be reviewed by the Georgia Department of Natural Resources and implemented in the Big Creek Watershed. This would include defining instream turbidity standards for Big Creek and its tributaries, monitoring these waterways to determine which stream segments fail to meet these standards, and employing increased monitoring and enforcement of applicable laws on non-attainment segments (including placing limits on land-disturbing activities, if necessary) to bring these waterways into compliance.

Strengthen oversight and enforcement:
Lack of enforcement of erosion and sedimentation control laws by local issuing authorities appears to be the primary factor behind the extremely high sediment levels measured in Big Creek during this study. It is important to note that this problem is not unique to the Big Creek watershed; similar results can be expected if similar studies are performed in other developing watersheds in the metro-Atlanta area. Observations at development sites determined that best management practices to minimize erosion and retain sediment on sites were often not effectively designed, implemented or maintained.

Most local issuing authorities do not have adequate staff to properly monitor development sites in their jurisdiction, and often much of the staff is poorly trained or inexperienced. The project manager's interaction with issuing authorities in the watershed determined that review of sites was sparse, and inadequate or improper measures were often approved or sometimes even recommended by the issuing authorities' personnel. The Georgia Soil and Water Conservation Commission must develop more effective methods of evaluating local programs, determining any weaknesses that may exist in these programs, and requiring that local personnel vigorously enforce applicable erosion and sediment control laws.

LITERATURE CITED

Seabrook, Charles and Soto, Lucy, March 28, 1996. *Urban runoff cited in state's pollution woes - The Atlanta Constitution, Atlanta, Georgia.*

Faye, R.E., Carey, W.P., Stamer, J.K., and Kleckner, R.L., 1980. *Erosion, Sediment Discharge, and Channel Morphology in the Upper Chattahoochee River Basin, Georgia*, U.S. Geological Survey, Washington D.C.

Schmidt, Denise, February 1996. *ARC Land Use/Cover Digital Database Documentation,* plus map and computer data of 1990 conditions, Atlanta Regional Commission, Atlanta, Georgia.

NOAA, 1996. Record of River and Climatological Observations - Cumming, Georgia, 1995. National Climatic Data Center, Asheville, North Carolina.

USGS, 1996. Discharge data - Big Creek near Alpharetta, Georgia, 1995. U.S. Geological Survey, Atlanta, GA.

Georgia Board of Regents' Scientific Panel on Evaluating the Erosion Measurement Standard Defined by the Georgia Erosion and Sedimentation Act, 1995. *Erosion and Sedimentation: Scientific and Regulatory Issues.* Report developed for the Georgia Board of Natural Resources.