ISIS ECOSYSTEM RESTORATION FEASIBILITY STUDY

Julie Kaplan[1], Jamie Childers[1], and E. Dean Trawick[2]

AUTHORS: [1]Tetra Tech, 2110 Powers Ferry Rd. SE, Atlanta, Georgia 30339, julie.kaplan@tetratech.com. [2]USACE Mobile District, 109 St. Joseph St., Mobile, AL 36604

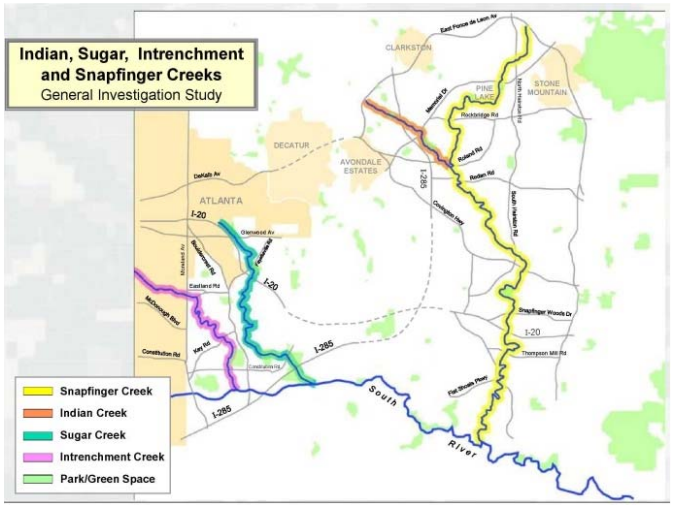
REFERENCE: *Proceedings of the 2013 Georgia Water Resources Conference*, held April 10–11, 2013, at the University of Georgia

Abstract. Tetra Tech is supporting the United States Army Corps of Engineers (USACE) Mobile District and DeKalb County in a feasibility study for ecosystem restoration in the Sugar and Snapfinger Creek watersheds in DeKalb County, Georgia. Flashy hydrology, resulting from urban development, has caused excess bank erosion and sedimentation in the streams. The feasibility phase of this study involved baseline biological monitoring, hydrologic modeling, selection of potential management measures, and analysis of project alternatives. Over 100 potential management measures were evaluated, and selected measures were strategically combined into alternative plans. Environmental benefits of alternative plans were evaluated using the Ecosystem Response Model which was developed in a collaborative effort by North Georgia Water Resource Agencies (NGWRA) to quantify environmental quality for USACE studies around North Georgia. The proposed measures were selected to reduce peak flows, improve physical habitat conditions and biotic communities in the stream systems, and improve riparian and floodplain functions. The process of evaluating alternatives for this study revealed that the greatest benefit to the overall watershed was provided by measures placed in the headwaters and by large flow attenuation features that can significantly reduce peak flows.

INTRODUCTION

A feasibility phase investigation was conducted to determine if there is a continued federal interest in providing aquatic ecosystem restoration to the Indian, Sugar, Intrenchment, and Snapfinger Creek (ISIS) watersheds. The ISIS watersheds are in and adjacent to the urban center of Atlanta, Georgia, within the political boundaries of DeKalb and Fulton Counties and the City of Atlanta. These watersheds all drain to the South River. Planning objectives for this study are to 1) Improve Georgia's Fish Index of Biotic Integrity (FIBI) and benthic multimetric index (BMI) scores, 2) Improve physical habitat conditions (as defined by Georgia's Habitat Assessment), 3) Reduce peak flows, and 4) Improve riparian and floodplain functions .

Degraded aquatic habitat and biological conditions in the ISIS watersheds can generally be attributed to urbanization. Land use changes have increased the percentage of impervious surface in these watersheds and altered the natural hydrologic regime. Flashy hydrology has triggered excess sedimentation, which degrades aquatic habitat and biota.



Indian, Sugar, Intrenchment, and Snapfinger Creeks

BASELINE BIOLOGICAL MONITORING

Baseline monitoring was conducted at sampling stations in the ISIS watersheds to define conditions in 2005. Georgia Environmental Protection Division (GAEPD) protocols (Gore et al. 2005) were used to score habitat conditions at each site. Fish community data were analyzed using the FIBI criteria developed by the Georgia Department of Natural Resources (GADNR 2005). Benthic macroinvertebrate community data were analyzed using a benthic multi-metric index (BMI) that is specific to the Southern Outer Piedmont region (subecoregion 45b) of Georgia (Gore et al. 2005, Griffith et al. 2001).

Baseline monitoring found that stream habitat ranged from "marginal" to "optimal". The majority of the sites had a rating of "fair" for the fish community based on FIBI scores. The benthic macroinvertebrate index rated most sites as "poor". Baseline monitoring also found various positive indicators that degraded conditions could be improved. Fish sampling in lower Snapfinger Creek, for example, found the state threatened Altamaha shiner.

HYDROLOGIC MODELING

Hydrologic models ─including Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), HEC's River Analysis System (HEC-RAS), Sediment Tool in the Watershed Characterization Model, and HEC-RAS Sediment Impact Analysis Methods ─ were used to establish instream peak flows, peak velocities, and a sediment budget in future without–project and future with–project scenarios over a 50-year planning period. The percent change from existing conditions for the future without–project and future with–project conditions were used to determine changes to the physical habitat, fish, and macroinvertebrate scores at each of the monitored sites.

THE ECOSYSTEM RESPONSE MODEL

USACE policies require that potential outcomes of environmental restoration be forecast into the future to support decision-making related to restoration/rehabilitation in North Georgia. Consequently, USACE realized that some technique for modeling potential outcomes was required, and worked with the NGWRA to develop an Ecosystem Response Model (ERM). The ERM is a spreadsheet model that that derives estimates of stream health from physical habitat scores, fish community (FIBI) scores, and macroinvertebrate community (BMI) scores. Scores from these three assessments are normalized to a 100-point scale, and then combined based on a weighting of 40 percent FIBI, 40 percent BMI, and 20 percent habitat score. The weighted scores are summed to calculate the *combined stream health*. As a final step in the ERM, the combined stream health is multiplied by an area factor to establish *habitat units* ─ a numerical representation of stream health. Results from the baseline (existing conditions) ERM are used to evaluate habitat units in a future without-project scenario and future with-project scenarios.

FORMULATION AND ANALYSIS OF PROJECT ALTERNATIVES

The most significant factor contributing to the degradation and loss of aquatic and riparian habitat in the ISIS watersheds is altered hydrology. Accordingly, the majority of management measures focused on reducing peak flows.
In the first phase of plan formulation, previous work was used to locate management measures throughout the watersheds. Over 280 sites were identified where impervious areas were directly connected to stream corridors through storm drains and parking lots where flow attenuation measures could be implemented. On the basis of field observations, measures were eliminated from further consideration if they were not feasible to construct because of roadways, other utilities, or inadequate drainage to sustain features. As a result of this screening, 128 measures on the ISIS creeks were considered for further evaluation.

Measures were grouped into alternatives on the basis of their location in the watershed for hydraulic modeling and analysis in the ERM. Modeling was used to determine the change in peak flows, velocities, and sediment that would be expected from alternatives. The modeled results were input into the ERM to quantify the environmental benefits. For the ISIS project, modeled changes in peak flows, peak velocities, and sediment were used to predict changes in physical habitat scores for each project alternative. Next, regional data was used to develop relationships between habitat scores and biological index scores (both for fish and benthic macroinvertebrates), and these relationships were used to forecast FIBI and BMI scores for each project alternative. The ERM then uses the future-condition habitat, FIBI, and BMI scores to calculate the environmental benefit of each alternative plan in terms of *average annual habitat units*.

The results of implementing the Phase 1 alternatives did not substantially improve annual average habitat units over the future without-project condition. In the second phase of plan formulation, many measures were eliminated based on input from the County or based on an inability to reduce peak flows. Management measures that attenuated the 2 year peak flow by at least 5 cfs were carried forward, and six additional flow attenuation measures were added in the Snapfinger Creek watershed. Measures were grouped into additional alternatives based on the new set of measures.

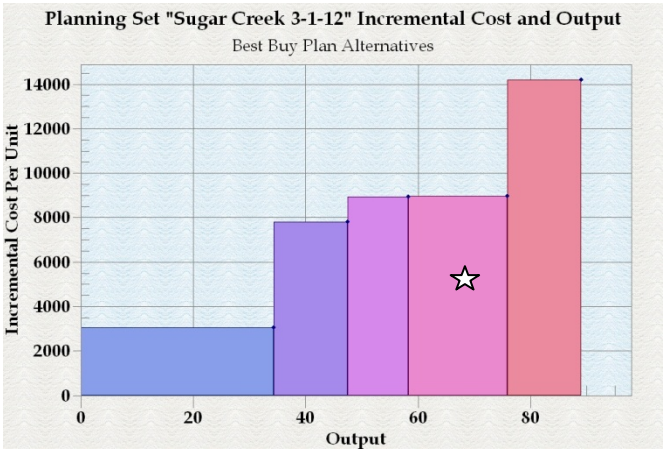
Alternative formulation in Phase 3 carried alternatives forward from Phase 2 and focused additional alternatives on meeting planning opportunities to

- restore habitat and riparian conditions,
- stabilize streambanks,
- restore connectivity between the stream and floodplain, and
- remove and control invasive plants.

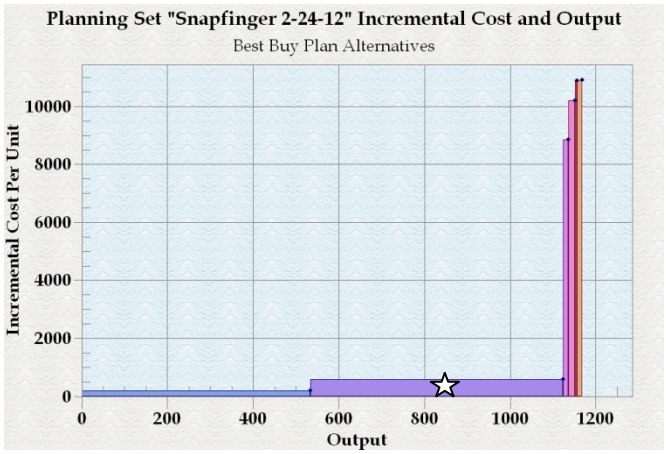
Four stream restoration reaches were added for consideration in each of the Sugar and Snapfinger Creek watersheds. During this phase, consideration was also given to updating a weir in Snapfinger Creek upstream of Pine Lake, Georgia. Environmental benefits for stream restoration were calculated based on the physical habitat conditions expected following restoration, and FIBI and BMI scores calculated using the regional habitat/biologic relationships. These benefits were scaled to the length of each restoration reach.

Many assumptions are made in the process of forecasting future conditions at the monitoring stations. Many other assumptions are made in translating conditions at individual monitoring stations to overall watershed health. The results of the ERM are meant to show general trends that can be expected over the planning period of the project, and to show relative comparisons between different alternative plans. The average annualized habitat units can be used, in conjunction with the costs associated with each alternative, to identify which alternatives are most cost effective.

The three phases of planning resulted in a total of 39 alternatives in the Sugar Creek watershed and 173 alternatives in the Snapfinger Creek watershed. Alternatives were evaluated and compared with each other using the IWR Planning Suite, a tool that determines if the environmental benefits, or *habitat units*, generated for an alternative are a best buy compared to other alternatives. Six Best Buy Plans were identified in the Sugar Creek watershed and seven Best Buy Plans were identified in the Snapfinger Creek watershed. A tentatively selected plan was selected in each watershed based on the results of this cost-benefit analysis, in consideration of positive and negative effects of various alternatives. The Incremental costs are plotted against the environmental benefits (output) in the figures below. The tentatively selected plan is identified by the star.

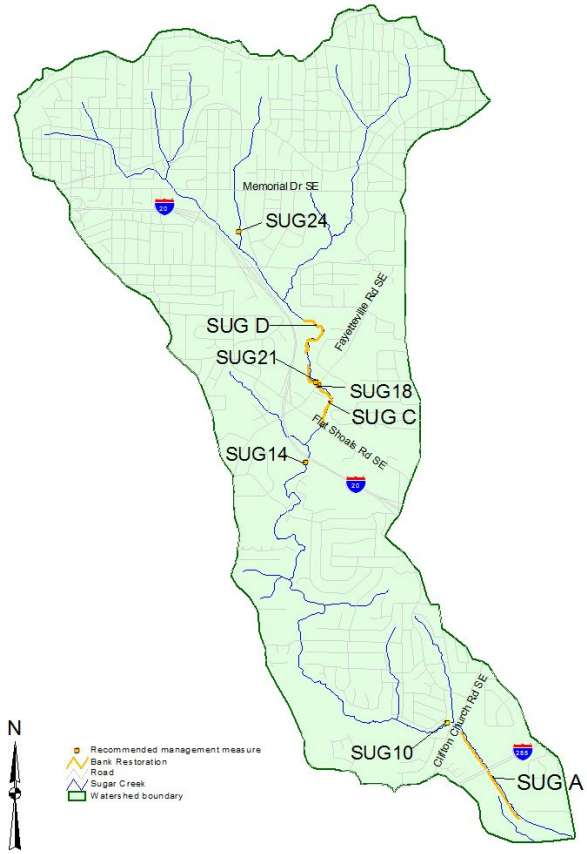


Display of best buy alternatives for Sugar Creek



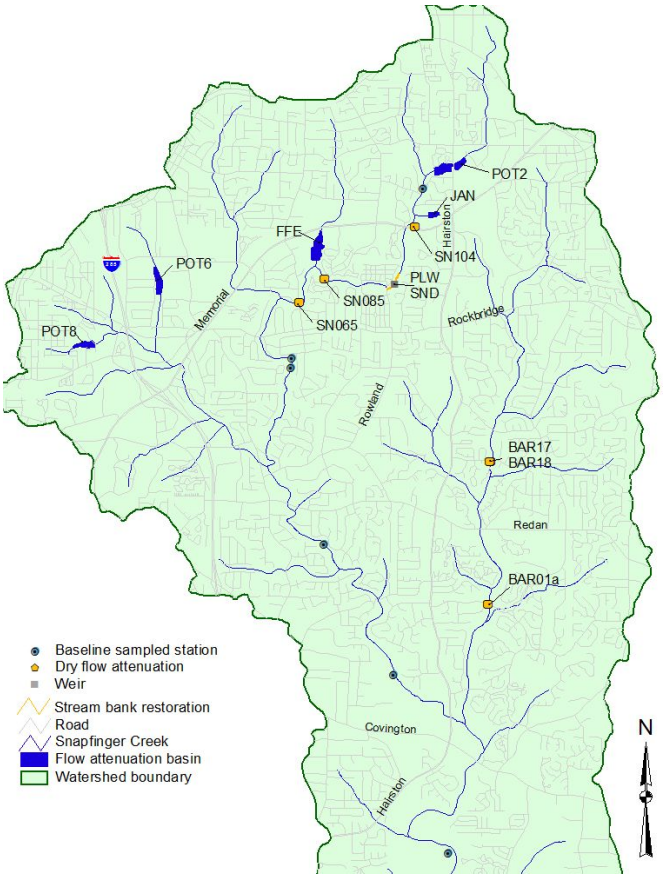
Display of best buy alternatives for Snapfinger Creek

The tentatively selected plan for the Sugar Creek watershed includes a combination of flow attenuation and stream restoration management measures. Five dry flow attenuation measures and three stream restoration reaches totaling 8,613 feet are proposed for restoration.



Sugar Creek Tentatively Selected Plan

The tentatively selected plan for the Snapfinger Creek watershed includes a combination of flow attenuation and stream restoration management measures. Five flow attenuation basins, six dry flow attenuation features, one stream reach totaling 1,048 feet, and a weir are proposed to be restored in the Snapfinger Creek and Indian Creek watersheds.



Snapfinger Creek Tentatively Selected Plan

CONCLUSION

The tentatively selected plans for the Sugar and Snapfinger Creek watersheds sufficiently meet the objectives of the feasibility study. The process of evaluating alternatives for this study revealed that the greatest benefit to the overall watershed was provided by measures placed in the headwaters and by large flow attenuation features that can significantly reduce peak flows.