WATERSHED IMPROVEMENT PLANNING GWINNETT COUNTY, GEORGIA

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Abstract. Developing Watershed Improvement Plans (WIPs) to improve conditions in streams and watersheds has been a challenging activity. The goal has been to create an objective, quantifiable, defensible, performance based system that would be applicable to all watersheds and conditions. Issues encountered along the way have included: data collection and defining the scope and extent of stream walks, selecting sound, defensible project evaluation criteria and procedures, identifying the source of Total Suspended Solids (TSS), and developing a reliable water quality / total suspended solids (TSS) model to evaluate existing condition and impacts of project implementation. The evaluation process required determining project benefits for stream restoration and upland best management practices (BMPs) based on water quality and habitat improvements. Potential projects are required to be evaluated and prioritized based on watershed benefits and then screened with regard to implementation issues and factors such as ownership, service requests, and permitting. An objective has been to develop an interactive, "live" WIP that can be easily updated as projects are implemented and evolve with new data, technology, regulatory issues and requirements, and other programs.

INTRODUCTION

In order to meet EPD requirements for a wastewater NPDES discharge permit, Gwinnett County completed a Watershed Impact Assessment and Watershed Protection Plan (WWP) in 2000. The WPP recognized the need to mitigate: the changes to hydrology as a result of development, to protect stream riparian corridors, and reduce the amount of pollutants released to streams via storm water runoff. To achieve these objectives the Watershed Protection Plan included 3 key recommendations to control runoff, reduce pollution, and protect streams:

- new development requirements to address water quality and changes in hydrology,
- improve affected areas, or areas adversely impact by development, and
- activities to promote and improve watershed stewardship.

To improve “affected areas”, or watersheds where the biotic integrity has been compromised. Gwinnett County initiated a Watershed Improvement Planning program in January 2001. Since then, Watershed Improvement Planning has been performed in approximately 290 squares mile of the 437 square miles in Gwinnett County. The objective of the Watershed Improvement Plans is to develop Capital Improvement Plans (CIPs) to improve and protect water quality and habitat and the aquatic integrity in streams. The challenge has been to create Watershed Improvement Plans (WIPs) that accurately evaluates watershed conditions and needs and produces a CIP based on a performance system that is objective, quantifiable, realistic, defensible, and applicable to all watersheds.

WATERSHED CONDITION INVENTORY

To evaluate conditions in watersheds and streams it is essential to have good topographic, land use, and parcel mapping. Our earliest efforts at Watershed Improvement Planning were somewhat hampered by the age, quality, and accuracy of mapping. Land use data only provide approximate values for the percent imperviousness and parcel information was difficult to acquire and often inaccurate. Gwinnett County has since re-flown the County and updated aerial photography and, using LIDAR technology, Digital Elevation Model (DEM) and topographic maps have been created. In addition,

polygons of impervious areas have been created providing for the accurate calculation of impervious area. Parcel data is now also easily accessed. All of this information is available in Gwinnett County's GIS and has been used to create sophisticated GIS models for watershed evaluation.

Data Collection

Having good procedures in place to collect and record data in the field is essential. Mapping, GIS and office evaluation is used to efficiently plan field and stream reconnaissance strategies to locate and document impairments and potential improvement projects. Initially data collection and documentation were primarily performed by hand using paper maps and note pads. Now hand held GPS units are used that are connected to Pocket PCs running GIS software allowing data to be collected and exported directly into a desktop GIS in shape file format.

Stream Walks Assessment

One of the most important aspects in Water Improvement Planning is performing stream walks or reconnaissance to observe and document conditions along the streams and locations and degree of impairments. Over the course of our planning efforts there have been changes in the procedures for performing stream walks such as the manner data is collected and the extent and scope of the assessments.

Initially, the location and extent of stream walks were based on stream hydrology coverage developed during the Watershed Impact Assessment. This coverage did not always extend to the upper reaches of the watersheds. Now streams walks extend to the 25-acre drainage point providing valuable information regarding watershed conditions and potential implementation opportunities. This is also consistent with recommendations of the Metropolitan North Georgia Water Planning District.

Initially the same procedures and scope for data collection were performed on all streams that were walked. Now, in order to collect more useful data more efficiently, stream walks and data collection are performed at 2 levels of inventory. Level 1 inventory is to collect information for the County's MS4 permit, fecal coliform TMDLs, and stream bank erosion. Data collected includes information on pipes, illicit discharges, outfalls, ditches and bank erosion. Level 2 inventory includes: percentage and length of stream bank erosion, stream buffer condition and length, channel alteration-manmade and hydrologic, water quality issues- point and non-point source discharges, maintenance issues, existing or potential BMP locations along stream margins, and other issues such as beaver dams, wetlands, and water withdrawals. In addition at key locations, or representative reach sites, cross section measurements, habitat assessments, and Rosgen based stream morphological evaluation are performed. Habitat assessments are performed based on GA DNR *Standards Operating Procedures-Freshwater Macroinvertebrate Biological Assessment* protocols. Habitat conditions and Rosgen stream classifications are performed on representative stream reaches each time there is a noticeable change in conditions or form.

It should be noted that, at times, applying habitat assessment protocols on some smaller streams indicated poor conditions when stream were actually in good condition. It has, therefore, been suggested that, generally, habitat protocol be used on streams in watershed with areas greater than 100 acres.

PROJECT EVALUATION

To objectively evaluate potential BMP and stream projects, sound evaluation criteria needs to be established. Initially potential improvement projects were evaluated and scored with respect to 15 issues in 6 major categories: water quality benefits, hydrologic controls, property protection, improvements to habitat, implementation, and benefit/cost for both TSS removal and habitat improvements. Each issue was given a score from 0 to 5, then weighted depending on its importance toward achieving WWP goals, and the projects were scored and prioritized, or ranked, based on the accumulative scores of all issues. Although each of the evaluation issues has merit and could impact implementation, some of the issues are difficult to objectively evaluate at the conceptual plan stage and are therefore believed to be better evaluated as projects move closer toward implementation. Although all 15 issues are still evaluated and scored, potential Capital Improvement Projects are now evaluated based on watershed benefits and cost and are prioritized on benefit/cost ratios for both TSS removal and habitat improvements.

Capital Improvement Plan Development

The goal established in the WPP is to improve and protect the biotic integrity in streams. Potential projects need to be evaluated based on the ability to improve and protect water quality, habitat, and, ultimately, biotic integrity in streams. The performance measure established in the WPP for water quality is to maintain TSS loads below 1600 lbs/acre/year. For habitat, the goal established is to improve aquatic habitat scores to acceptable levels based on Georgia DNR biological assessment protocols. The targeted habitat goal is a score of 150 out of 200 based on a reference stream reach.

In developing a performance based project evaluation system it was considered important that BMP and stream improvement projects be evaluated on the ability meet TSS and habitat goals. BMP and stream improvement projects can both improve water quality and habitat, but they do so in different manners. BMPs improve WQ by preventing pollutants from entering stream and, through hydrologic control, prevent erosion downstream. They improve aquatic habitat by preventing pollutants from entering streams and stabilizing hydrology and flow regimes. Stream Projects improve water quality by stabilizing eroding channels and reconnecting flood plain to remove pollutants locally, and to improve hydrology down stream. They improve habitat by providing morphologically stable channels in form, cross section, pattern and profile.

The evaluation of BMP performance in the WIPs is based on procedures that have been adopted in the Gwinnett Storm Water Regulations and are described in the *Gwinnett County Storm Water Design Manual.* For TSS removal, projects are evaluated on the ability to provide "water quality protection" and down stream "channel protection" volumes. Water quality protection is evaluated based on the ability to provide 24 hour extended detention of the runoff from the first 1.2 inches of rainfall from the contributing drainage area. Channel protection is evaluated based on the ability to provide 24 hour extended for the 1-year frequency storm. Credit for habitat improvement is given for the ability to reduce downstream flows from the more frequent storm. Improvements are assumed to be realized in the length downstream where flow is reduced a minimum of a 50%. This length is determined using the GIS hydrology model.

The evaluation of stream project performance is based on the ability to stabilize stream bank and improve habitat. For TSS, projects are evaluated base on the ability to reduce TSS production from the project area. For habitat, credit is given based on the ability to improve habitat scores. A score of 150 is believed to be the highest score that could be achieved immediately after implementation.

TSS Source

To evaluate BMP and stream projects with regard to TSS removal it is most important to have an idea of the source of TSS. Is it from wash off or from the stream? A comparison of loads developed in the Gwinnett County WPP, that includes the wash off and channel contributions, to TSS loads developed in neighboring jurisdictions, that include only wash off, suggests that the of the split should be about 15% wash off to 85% channel. This split is believed to reasonably reflect the impacts altered hydrology has on stream morphology and the degradation observed in highly developed watersheds in Gwinnett County. This wash off to channel split has been used in earlier WIPs, now however procedures have been developed for estimating channel contributions based on in-stream erosion data and GIS analysis. Wash off contribution is still based on 15% of WPP loads for the various land coverage.

TSS production for various land coverage established in the WPP, including wash off and channel contributions, are:

- Impervious- 4000 lbs/acre/year
- Disturbed Pervious Areas- 1200 lbs/acre/year
- Undisturbed Upland Areas- 500 lbs/acre/year
- Undisturbed Stream Buffers- 100 lbs/acre/year

The method to calculate the channel contribution uses stream bank erosion data collected during stream walks to evaluate in-stream TSS contributions based on *erodibility* and *ersosivity*. Erodibility is characterized by a standard erosion rate per square foot of bare, non-vegetated stream bank under rural flow conditions. Bank erodibilty is inversely related to the percent of vegetated cover. A bank with no vegetated cover has an erodibility factor of 1.0. Preliminary estimates indicate a square foot of bare bank in Gwinnett County produces, on average, 12 lbs/acre/year. Erosivity relates to the degree urbanization in a watershed and is characterized by the change in hydrology of the 1-year rainfall event from rural to urban conditions. This is referred to as the urban-rural discharge ratio. Erosivity is calculated as the urban-rural flow ratio to the 1.5 power.

Erosion per square foot of stream bank is calculated as:

*Bank Erosion = (12 lbs/ac/yr) * erodibilty * erosivity*:

Total TSS production along a stream is calculated as:

TSS Production = Bank Erosion Bank Height* Bank Length*

A major assumption made here is that the stream TSS generated is the result of bank erosion and not bed erosion, implying that streams have reached vertical equilibrium and are no longer down-cutting or aggrading.

In effort to better determine TSS production in streams, Gwinnett County has begun a channel-monitoring program. Fifty monitoring station have been established to measure actual bank erosion and to provide data to estimate the stream contribution. When data is available

it will be used to calculate TSS production and will be incorporated into the water quality model that has been developed as part of the WIP program.

Water Quality Modeling

Developing a reliable Water Quality / TSS Model has been one of the biggest challenges. The model must be able to evaluate existing conditions and the impacts of potential improvements projects. It must also be flexible and easily modified to reflect changes in watersheds and the potential improvements. The model developed is a GIS, grid-based model using a DEM developed from point LIDAR data from aerial photography, impervious surface polygons, and lakes from GIS hydrography data. Model output includes: drainage areas, 25 acre stream network, percent upstream imperviousness, 1-year and 25-year rural and urban flows, water quality and channel protection volumes, urban/rural flow ratios, stream bank TSS erosion, TSS production rates, and TSS loads and yields.

This model enables the determination of conditions at any point along a stream network and allows the evaluation of impacts of BMP and stream project implementation at any location in the watershed.

The model is interactive in that various project implementation scenarios can be entered to determine anticipated impact in the watershed or along a specific stream segments. It also can be easily updated when projects are implemented and enables the tracking of the performance of our overall Watershed Improvement Planning efforts.

CONCLUSION

There are many issues to be encountered in developing a performance based Watershed Improvement Plan. Conditions in watersheds and streams must be collected and documented and objective, realistic project evaluation criteria and procedures must be in place. GIS has greatly enhanced the ability to manage the information collected and evaluate conditions in the watershed and impacts of potential improvements. In the future there will be new challenges and opportunities to improve on current procedures. The challenge now is the implementation of recommended Capital Improvement Plans to satisfy regulatory programs and protect and improve conditions of our natural resources and the quality of our urban environment.

Literature Cited

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Gwinnett County Storm Water Design Manual

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