MANAGEMENT OPTIONS FOR CONTROLLING NONPOINT SOURCE POLLUTION IN HENRY COUNTY, GEORGIA

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REFERENCE: Proceedings of the 2003 Georgia Water Resources Conference, held April 23-24, 2003, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. Water quality in much of Georgia is threatened by nonpoint source pollution due to urban development and increased stormwater runoff. Recent watershed modeling for seven watersheds in Henry County, Georgia has projected increases in nutrient loads caused by nonpoint sources. The GWLF model was used to explore management strategies that may mitigate these increases.

Projected increases in TN and TP loads from nonpoint sources in Henry County's jurisdictional areas are expected to increase by 48% and 3%, respectively, over the next 20 years. Two out of four management options considered were capable of reducing future TP loads to existing levels, but none were predicted to reduce TN to existing levels.

INTRODUCTION

Many communities in Georgia are facing numerous challenges, including expanding drinking water supplies and wastewater treatment capacity to meet the needs of a growing population, maintaining water quality in streams, and minimizing flooding risks. To protect its water resources, Henry County is developing a watershed management plan that will guide future growth. The goal is to mitigate the impacts of development and additional wastewater discharge where feasible. Total phosphorus loading is the highest priority for the County because of the recent regulations protecting Lake Jackson. This paper discusses ways that the County may reduce future total phosphorus (TP) loads to existing levels, and minimize increases in total nitrogen (TN) load in each basin.

Water quality modeling is required to estimate pollutant loads for both the existing and future landuse conditions, and to evaluate potential management alternatives to include in the watershed management plan. The Generalized Watershed Loading Function or GWLF model (Haith et al., 1992) was chosen as the primary watershed-modeling tool based on its ability to simulate hydrology, runoff, and pollutant loads from both urban and rural landuses. GWLF considers landuse parameters, weather data, soil types, pollutant concentrations in runoff, and build up washoff rates to simulate pollutant loads. A complete description of the GWLF model is presented in the recently completed Henry County, Georgia, Watershed Modeling Baseline Analysis (Tetra Tech, 2002a).

GWLF modeling provided the means for the County to predict and evaluate the effects of future landuse conversion and alternative management practices. Insight was gained regarding the trade-off between nutrient loading from agricultural land and redevelopment of these lands in suburban and commercial use. Additionally, modeling was used to demonstrate the relative effectiveness of requirements for enhanced stormwater controls being applied to developments with greater than 25 percent imperviousness versus controls on all new development. The relative effectiveness of riparian buffers and education of septic tank owners for proper operation and maintenance techniques was also analyzed. These four management techniques are compared based on their relative impacts on nonpoint source, nutrient pollution.

BACKGROUND AND RELATED WORK

The baseline analysis for the county revealed that phosphorus, nitrogen, sediment, runoff volume, and fecal coliform pose the greatest risk to future water quality protection. Wastewater treatment facilities, septic systems, and runoff from new development are expected to be the greatest sources of additional nutrient loads.

Specific goals for the parameters of concern are: (1) maintain year 2000 levels of phosphorus loading in each basin, (2) mitigate increases in TN loading where feasible and cost-effective, (3) mitigate sediment from disturbed sites, new development, unpaved roads, and remaining agriculture, and (4) take reasonable measures to control runoff and protect instream biology and streambank stability.

Effective stormwater management is viewed as critical for achieving the County's goals. The State of Georgia and the Atlanta Regional Commission have invested considerable resources in developing the Georgia Stormwater Management Design Manual (ARC, 2001). The Henry County project team has recommended that the County's Watershed Management Plan be consistent with the Design Manual. Among the more common management options promoted in the Atlanta Metropolitan area, based on the Design Manual, are stormwater wet detention ponds (designed for water quality treatment and enhanced peak flow control) and 100-ft riparian buffers. Tetra Tech was therefore asked to evaluate the effectiveness of these two management options using the watershed model set up for Henry County. Additionally, given the extensive reliance on septic tanks for wastewater treatment in many parts of the County, Tetra Tech was asked to estimate the impact of improved septic tank maintenance throughout the watershed.

The GWLF model was used to evaluate these management alternatives. The parameters emphasized in the modeling analysis are TP and TN. Sediment is not evaluated because the GWLF model accounts for post-construction upland runoff, but not sediment attributed to the construction (land disturbance) phase of new development or instream erosion due to changes in hydrology. These two sources affect the sediment balance more strongly than post-construction development and require alternative methods for predicting overall impacts. Other tools and information that supplement the GWLF output for sediment loading are presented in the Baseline Analysis (Tetra Tech, 2002a), but are not included in this report due to brevity requirements.

Similarly, impacts on stream flow volume are not evaluated using the GWLF model. Although the model demonstrates effects on annual flow volumes, management measures such as wet detention ponds and buffers act on flows over a much shorter time frame. Therefore, other means of evaluation such as application of the Site Evaluation Tool (Tetra Tech, 2002b) are needed to adequately evaluate effectiveness at controlling stormwater runoff volume.

The modeling results for phosphorus and nitrogen provide a good starting point for determining whether one or all of these options would be effective for Henry County, and whether other management options might be needed to achieve the County's management goals.

MODELING SCENARIOS

Existing and future modeling scenarios were already developed and processed during the Baseline Analysis. Four additional modeling scenarios were analyzed to evaluate the impacts of the proposed management options on TP and TN. The first two evaluate the use of extended wet detention ponds in various types of development. Both the Henry County Zoning Ordinance (2001) and the Georgia Stormwater Manual (ARC, 2001) suggest that at a minimum, extended wet detention ponds should be used to protect water quality. These ponds are designed to remove 80% of total suspended solids, 50% of TP, and 30% of TN from the runoff they receive. Future Scenario 1 assumes that extended wet detention ponds are constructed in all new developments with a percent imperviousness greater than 25%. Future Scenario 2 assumes that stormwater ponds are constructed in all new development, regardless of percent imperviousness.

The third scenario evaluates the effects of educating septic system owners on proper operation and maintenance techniques. The Baseline Analysis assumed that 10% of septic systems fail under dry conditions and 20% fail under wet conditions. These assumptions were based on communication with Glenda Croft at the Henry County Environmental Health Department (2001). To model the impacts of education, it was assumed that failure rates could be cut in half with improved owner maintenance.

The fourth scenario assumes that 100-foot buffers will be preserved on all perennial streams in new developments. This width was chosen to coincide with the suggested width for channel protection in the Georgia Stormwater Manual. Only the non-water supply watersheds benefit because the Henry County Water Supply Watershed Protection Ordinance already requires that water supply basins maintain 100-foot buffers on perennial streams. Maximum removal efficiencies for TSS, TN, and TP are 75%, 40%, and 50%, respectively (Schueler, 1995). Width factors reported by Desbonnet (1994) were used to adjust the removal efficiency to the width of the buffer.

MODELING RESULTS

Increases in nutrient loads are a result of additional wastewater treatment facilities (and expansions) and nonpoint sources. The management options discussed in this document are only capable of addressing nonpoint source loads. In order to assess their effectiveness, the following results do not include loads from land application sites and direct discharge facilities. However, the nutrient loads from these sources are significant, and in order to achieve existing levels of TP, further treatment at these sources will be required.

Modeling results are presented for nonpoint source TP and TN loads at two scales: 1) the seven major watersheds (Big Cotton Indian Creek, Walnut Creek, Honey/Mackey Creek, Tussahaw Creek, Indian Creek, Towaliga River, and Bear Creek), and 2) the three major basins (Flint River, Ocmulgee River, and the portion of the Ocmulgee River basin draining to Lake Jackson).

Nonpoint sources of TP include urban and rural landuses and groundwater discharges. Septic systems contribute a relatively small amount of TP. Nonpoint sources of TN include urban and rural landuses, groundwater discharges, and septic systems.

Total Phosphorus

At the watershed scale, the nonpoint source phosphorus load is predicted to increase in four out of seven watersheds: Walnut Creek, Big Cotton Indian Creek, Tussahaw Creek, and Bear Creek. In the Honey/Mackey Creek Watershed, the load is not predicted to change under future conditions. In the Indian Creek and Towaliga River Watersheds, the cumulative loss of agricultural land use causes a net reduction in TP loads from nonpoint sources.

Fortunately, in two of the watersheds where increases are expected (Walnut Creek and Big Cotton Indian Creek), Mgt 1 and 2 (extended wet detention ponds) and Mgt 3 (reduction in septic tank failures) are each capable of reducing TP loads to existing conditions. Mgt 4 (100-ft buffers) is not as effective.

In the Tussahaw Creek and Bear Creek watersheds, TP loads are not controlled to existing levels by the four management options studied. Other options or combinations of options will be required.

In all three basins, nonpoint source TP loads are predicted to increase under future conditions. In the Flint River Basin, none of the four management scenarios reduce TP loads to existing levels. Sixty-three percent of this basin is expected to be developed as commercial land, and the management options are not capable of offsetting the associated increase.

In the Lake Jackson drainage basin, use of extended wet stormwater detention ponds (Mgt 1 and 2) or reduced septic system failure rates (Mgt 3) would be expected to result in TP loads below existing levels. In the entire Ocmulgee River Basin drainage for Henry County, all four management options achieve existing nonpoint source phosphorus loads.

Total Nitrogen

None of the management options reduce future TN loads to existing conditions. Septic systems and groundwater pathways contribute the majority of the TN load in each watershed. The groundwater component is not addressed by any of these four management scenarios, and the education of septic system owners does not decrease TN loads because septic systems are not efficient in nitrogen removal even when they are properly functioning.

CONCLUSIONS

Under projected growth and development plans in Henry County, nonpoint source nutrient loads are expected to increase. The majority of the existing nonpoint source TP load from Henry County is due to loads generated by agricultural lands. As these areas are converted to urbanized uses, decreases in total phosphorus load are seen in some watersheds without further management. In 2 of the 4 watersheds that are expected to have increases in TP, management options discussed in this paper are capable of reducing the nonpoint source load to existing conditions.

Total nitrogen is not managed effectively by the options studied here. Septic systems comprise the majority of the nonpoint source TN loads, and none of the management options studied here are effective in reducing these loads. In addition as the County develops, more septic systems will be added for onsite wastewater disposal.

Mgt 1 assumes that extended wet detention ponds treat runoff from any new development with a percent imperviousness greater than 25%. This option reduces TP loads to existing levels in 2 out of 4 watersheds and 2 out of 3 basins.

Mgt 2 extends the use of extended wet detention ponds to all new development, regardless of percent imperviousness. Nutrient loads are further reduced in each watershed and basin, but the number of drainages that meet existing levels does not increase.

Mgt 3 assumes that the number of failing septic systems can be reduced by one half through education and improved maintenance. When aggregated to the watershed scale, 2 of the 4 watersheds are expected to meet existing levels of phosphorus loading under Mgt 3. Those sub-basins with extensive loss of agricultural land help to offset phosphorus loads from other sub-basins. This loss combined with improved maintenance of septic systems is predicted to reduce phosphorus loading to existing levels. The cumulative effect is also evident at the basin scale, where 2 of 3 basins meet existing levels.

Mgt 4 assumes preservation of 100 ft buffers along all perennial streams in new development. Buffers are only able to treat a small percentage of adjoining land, and these effects are masked in large drainage areas. At the watershed scale, Mgt 4 does not reduce TP loads to existing levels in the 4 watersheds that have a projected increase. At the basin scale, when the cumulative effects of all watersheds are considered, Mgt 4 does achieve existing levels in one basin.

At this time, it is not required for Henry County to achieve existing levels of TN in the three basins. Of the options studied in this memo, extended wet detention ponds are the most efficient in TN removal (30%). However, even Mgt 2, which assumes ponds in all new development, cannot reduce loads to near existing levels. Each basin has at least a 47% increase in TN under Mgt 2.

DISCUSSION

TP and TN loads from nonpoint sources in Henry County are expected to increase over the next 20 years. Of the four management options studied here, extended wet detention ponds offer the greatest reductions for both nutrients. However, wet detention ponds are costly to install and maintain, and cause nuisances such as mosquito habitation and poor aesthetics.

Education of septic system owners on proper maintenance is a low cost management tool that is capable of reducing TP loads to existing levels in several watersheds; the TN load is not significantly affected.

Preservation of 100-ft buffers has little effect on nutrient loads at the watershed or basin scale because the land treated is a small percentage of the drainage area. Though buffers are not capable of reducing nutrient loads in Henry County to existing levels, they are essential for the preservation of streambanks and riparian areas. Stable, vegetated streambanks provide habitat, flood protection, stream shading, aesthetic value, and protection against scouring and erosion. As Henry County continues to develop, and more impervious surfaces reduce infiltration capacity, the volume and velocity of runoff will also increase. These changes result in high-energy flows that scour and erode sediment from the sides and bottom of downstream channels. Protection from these hydrologic changes may be the County's best defense against degradation of water quality.

In recent years, other management techniques have been applied to new and existing developments in an attempt to regulate water quality in ways that preserve ecological function (e.g. Low Impact Design – LID). As assessment tools are developed to compare these methods to traditional techniques, informed decisions that incorporate water quality impacts, ecological function, and cost benefits will guide watershed management in a holistic approach.

ACKNOWLEDGEMENTS

Both the Georgia EPD and Arcadis Consultants were instrumental in providing data and supplemental information for the watershed modeling setup. Management strategies were developed by the Henry County Stakeholder Committee, which included developers, county officials, citizens, and consultants.

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