EVALUATION OF PHOSPHATE, AND ESCHERICHIA COLI CONCENTRATIONS DURING A SPRING STORM IN THE NORTH OCONEE RIVER, ATHENS, GEORGIA

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Abstract. Samples were taken at two sites on the North Oconee River in Athens, Georgia, during a storm event of almost 3 inches, to evaluate changes in soluble reactive phosphorous (SRP) and *Escherichia coli* (*E. coli*) concentrations. The objective of the study was to assess the effects on these constituents from storm water runoff and to measure the impact from a waste water treatment plant. While the down stream site generally had higher concentrations of phosphate, both sites showed a spike in SRP approximately 12 hours after the beginning of the storm. This increase most likely reflected the first flush of storm water runoff. Later during the storm, as discharge peaked, the SRP at both sites decreased, probably due to dilution. The storm event also produced an increase in *E. coli* levels at both sites about 23 hours into the storm. However, only the down stream site showed a marked increased *E. coli* during peak discharge. This pattern may be explained by several causes, which this study cannot resolve.

INTRODUCTION

A number of environmental studies have shown concern about increasing nutrient loads (primarily phosphate and nitrate) and growing bacteria concentrations (fecal coliform) in waterways in the United States (EPA, 2000; EPA(a), 2003; EPA(b), 2003; USGS, 2000).

Increased nutrient loading into lakes and streams is important because it can lead to cultural (or nutrient-accelerated) eutrophication (Horne and Goldman, 1994). This occurs when the concentration of inorganic nutrients in a system increases and produces extensive algal growth. Cultural eutrophication has many negative impacts on humans such as decreasing the amenity value of lakes as navigation is impeded and fishing and swimming are hindered (Mason, 2002). In addition, swarms of hatching insects and the odor of decaying plant material do not produce a pleasant environment for humans (Horne and Goldman, 1994).

Coliform bacteria is a commonly used indicator of fecal contamination (Mason, 2002). However, because not all types of coliform bacteria require the gut of a warm blooded animal and some can grow in unpolluted water, *Escherichia coli (E. coli)* is a better indicator of fecal contamination (Mason, 2002). In addition, it is recognized that there is a strong correlation between *E. coli* levels and both pathogenic organisms and gastrointestinal illnesses (Mason, 2002).

Understanding variations in nutrient and bacteria levels during a storm event is becoming increasingly important with added attention being given to storm water runoff issues. In order to study such changes during a single storm event, soluble reactive phosphorous (SRP) and *E. coli* were examined on suites of samples collected from two sites, Dudley Park and Whitehall Road, along the North Oconee River on March 5-9, 2003 (Figure 1). These two sites lie upstream and downstream, respectively, of the Bailey Street waste water treatment plant. This plant is known to discharge relatively high amounts of phosphorous into the North Oconee River (UOWN, 2001; EPA, 2003). One of the major objectives

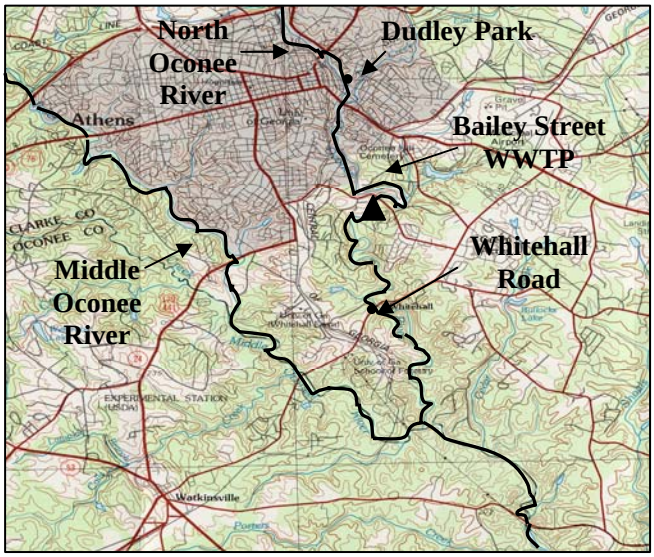


Figure 1. Map of Oconee River at Athens, Georgia. Approximate sample sites are labled. The triangle represents the USGS North Oconee gauging station 02217770.

of this study is to try and understand the relative contribution of both non point sources and point sources of phosphorous and bacteria during a storm event.

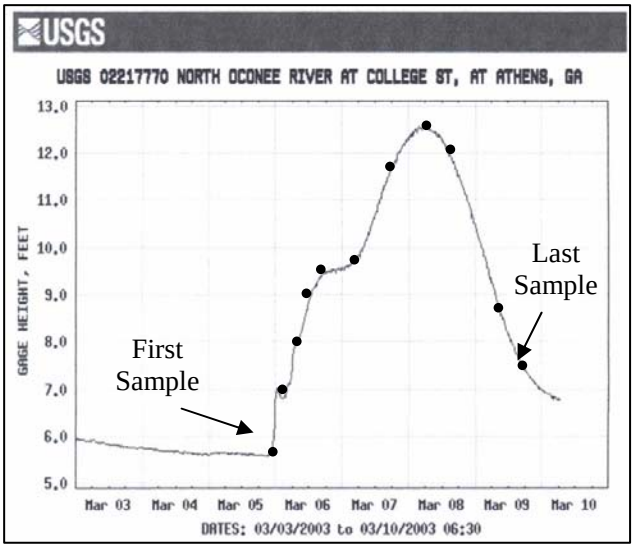
METHODS

On eleven occasions throughout the March 5-9, 2003 storm, river water grab samples were collected at both Dudley Park and Whitehall Road. The sampling was done to cover both the rise and fall of discharge by this single storm event.

Soluble reactive phosphate concentrations were measured using the molybdate blue method with HACH AccuVacAmpules and a HACH DR/890 Colorimeter. Prior to measurement, samples were passed through a 0.45µm filter. Phosphate standards were analyzed and 11% of all samples were duplicated for quality control. Recovery of all phosphate standards ranged between 97% and 107%. The measured standard deviation of the duplicate samples ranged from 0 to 0.01 mg/L.

E. coli was measured on a separate suite of samples collected at the same time as the phosphate samples using the IDEXX method. Duplicate samples and blanks were analyzed. Standard deviations of duplicate samples ranged from 122 to 455 MPN/100mL.

Information about precipitation, river discharge, and gauge height was obtained from the United States Geological Survey gauging station about 1 mile upstream of Dudley Park (Figure 1) (USGS, 2003). Since the USGS gauging station was not calibrated for discharge greater than 800 cfs at the time of this study, which this storm exceeded, the gauge height is used in conjunction with the phosphate and *E. coli* data shown in Figures 2 and 3.



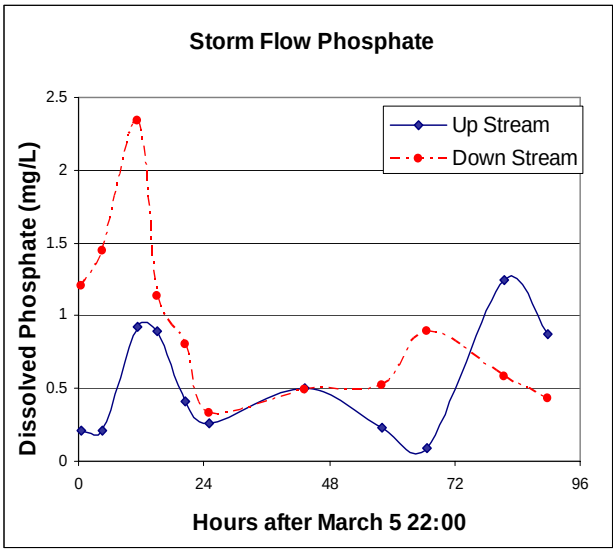


Figure 2. Soluble reactive phosphate at two sites along the North Oconee River during a spring storm.

DISCUSSION

Soluble Reactive Phosphate

The SRP concentrations were quite variable (Figure 2). Generally, phosphate concentrations at the downstream site on Whitehall Road were higher than the upstream site. This is most likely due to phosphate being added to the river from the Bailey Street waste water treatment plant. The NPDES records (EPA (c), 2003) show that the average phosphate concentration discharged by this waste water treatment plant for March of 2003 was 23.3 mg/L (reported as PO_4).

The highest concentrations of SRP at both sites occurred approximately 12 hours after the storm began. This most likely reflects the first flush of storm water from impervious surfaces within the watershed. These peaks dissipated very quickly as the volume of water in the river increased.

At peak discharge, both sites had relatively low levels of SRP, probably because of dilution. Later in the storm, the concentration increased at both sites because the amount of phosphate in the river did not decrease as much as the volume of water.

Escherichia coli

The levels of *E. coli* fluctuated greatly during the storm (Figure 3). Immediately prior to the storm, elevated *E. coli* concentrations were measured at the Dudley site, probably due to old, leaky sewer lines in the area. Increased dilution with storm water lowered the

concentration of *E. coli* at Dudley Park until a spike occurred 23 hours after the storm began. This peak may have been from the additional input of shallow groundwater contaminated by leaky sewer lines. Leaking sewer lines have been a recurrent problem in this area (UOWN, 2001). As the volume of water in the river increased, the concentration of *E. coli* decreased due to dilution.

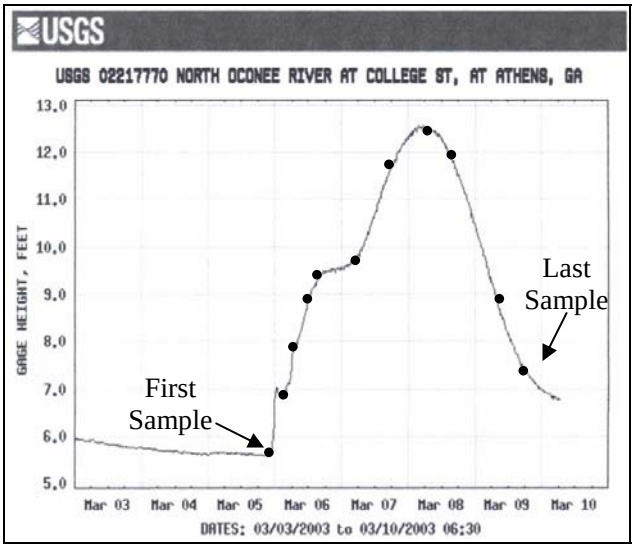
Prior to the storm, the Whitehall site contained low levels of *E. coli*, most likely because of addition of treated water from the Bailey Street wastewater treatment plant. However, after about 24 hours, the concentrations of *E. coli* increased with increasing river discharge. Clearly significant additions of bacteria occurred despite dilution. Although this study cannot provide a single definitive explanation of this observation, several possibilities might include the following.

- Tributaries delivering high bacteria levels to the river during storm water runoff.
- High turbulence due to increased river discharge may have caused bacteria in the sediment (preserved by the cold water) to become suspended in the water column.
- Discharge of incompletely treated waste water by the Bailey Street water treatment plant due to increased volume of water entering the plant.

CONCLUSIONS

Several conclusions seem warranted from the pattern of changes observed in phosphate and *E. coli* concentrations in the North Oconee River during a single storm event:

- Concentrations of SRP were generally higher at the downstream site likely due to discharge from the wastewater treatment plant.
- Early in the storm event, SRP sharply increased corresponding to the rising hydrograph. This observation seems to be associated with first flush storm water runoff from impervious surfaces in urbanized parts of the watershed.
- As river discharge increased, SRP at both sites decreased because of dilution from the increased volume of water in the river.
- Prior to the storm, upstream *E. coli* concentrations were elevated, but like SRP, the high concentrations were diluted as the volume of water in the river increased.
- Conversely, initial downstream *E. coli* concentrations were low because of dilution by treated waters from the waste water treatment plant.
- The E. coli concentrations at the downstream site increased and mirrored the increased discharge. There is no definitive explanation for this, but several possibilities are advanced.



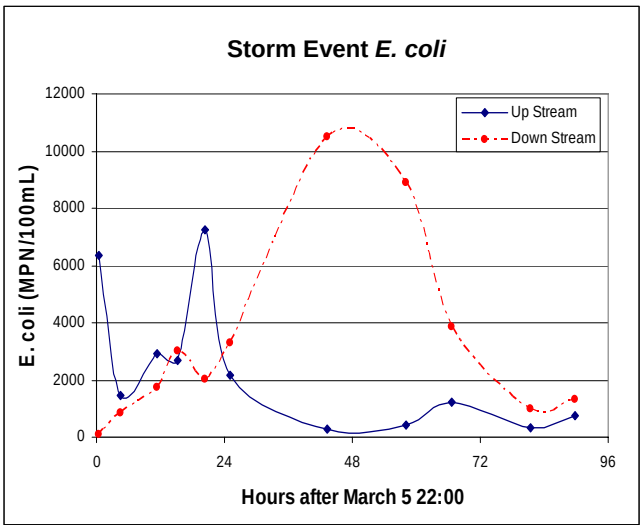


Figure 3. *E. coli* concentrations at two sites along the North Oconee River during a spring storm.

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