Effects of Storm Water Runoff and Overland Flow on Retention Ponds at Georgia Southern University
Matthew C. Harris and James S. Reichard, Department of Geology and Geography, Georgia Southern University, Statesboro, Georgia, 30460

Abstract
This study examines the effects of parking lot overland flow and roof runoff inputs on the water chemistry of two retention ponds located near the Recreational Activity Center on the Georgia Southern University campus. The primary input to the ponds was calcium-bicarbonate groundwater pumped from both ponds during the summer and fall of 2010. Samples of overland flow and roof runoff were collected during storm events. Temperature, dissolved oxygen, and specific electrical conductivity were measured onsite; samples were taken to a campus lab and analyzed for major cations and anions using an ion chromatograph. Precipitation data were obtained from a weather station located approximately 13 km from the ponds.

The overland flow and runoff were characterized as having relatively low specific conductivity (15-133 µS/cm), acidic pH (4.5 to 6.4), and high, unseen saturated dissolved oxygen content (69-60%). The storm inputs were in marked contrast to the pond water itself, which had relatively high specific conductivity (107-249 µS/cm), alkaline pH (7.7-9.2), and dissolved oxygen content that ranged from undersaturated to supersaturated (58-157%). Trilinear Piper diagrams show that the ponds contain calcium bicarbonate type water, and while the dominant species in the overland flow and runoff are calcium and bicarbonate, the ponds contain calcium bicarbonate type water, and while the dominate species in the overland flow and runoff are calcium and bicarbonate, the ponds contain calcium bicarbonate type water. The overland flow and runoff also contained elevated levels of ammonium, nitrate, and phosphate relative to the ponds. Because the storm water originated from asphalt surfaces, its water chemistry is believed to largely be influenced by atmospheric fallout. Temporal variations in the general chemistry of the ponds do not appear to be influenced by storm water inputs. This can be explained by the relatively small volume of storm water compared to the pond volume, and by the general chemistry of the storm water being similar to the groundwater.

The objectives of this study are as follows:

- Determine general chemistry using ion chromatography.
- Determine lead content and nutrients of runoff.
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- Most of the storm water inputs had only a negligible effect on pond chemistry due to the relatively large pond volumes and the rapid replenishment of the ponds via pumping of groundwater from the upper Floridan aquifer.
- Nutrients from the storm water did have a measurable impact on pond chemistry, and may help explain the observed algae growth and variable dissolved oxygen levels.

Study Location
The study was located at the Recreation Activity Center (RAC) on the Georgia Southern University (GSU) campus, in Bulloch County, Georgia. Photos show the north (top) and south (bottom) retention ponds at the RAC.

Methodology

- Pond samples were collected twice a month, from May through October, 2010.
- Temperature, pH, electrical conductivity, and dissolved oxygen were measured in the field using electronic meters.
- Samples were collected from the parking lot and roof during four rainfall events that generated overland flow.
- Alkalinity was determined by using titration techniques in the hydrogeochemistry lab.
- General chemistry (major cations and anions) was determined using an ion chromatograph in the lab (Fig. 4).
- Lead (Pb) content of select samples was measured using an anodic stripping voltammetry instrument in GSU Chemistry Department.
- Rainfall data was obtained from a weather station within the Georgia Automated Environmental Monitoring Network (Fig. 6).

Results

- Temperature (Fig. 7) shows that parking lot runoff could be a source of thermal pollution during the summer.
- The salinity and pH of the ponds are relatively high due to groundwater inputs.
- Dissolved oxygen content of ponds (Fig. 8) varies with biological activity, whereas storm water is naturally saturated and groundwater under saturated.
- Storm water is elevated in both nitrate (NO₃⁻) and ammonium (NH₄⁺), causing nitrogen spikes in the south pond.
- Phosphate (PO₄³⁻) is much higher in the parking lot overland flow than in the roof runoff (Fig. 9).
- Chloride (Cl⁻) is present in ponds is higher than the makeup water by 0.7 ppm; possibly due to evaporation.
- Calcium (Ca²⁺) in the south pond is lower than the makeup water; possibly due to dissolution of lead by oxidation-reduction reactions in ponds.

Conclusions

- The objectives of this study are as follows:
- Collect water samples from ponds, overland flow from parking lot, and runoff from RAC roof.
- Determine general chemistry using ion chromatography.
- Determine lead content and nutrients of runoff.

Table 1. Lead concentrations determined from anodic stripping voltammetry instrument.

<table>
<thead>
<tr>
<th>Location</th>
<th>Lead Concentration (ppb)</th>
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<tbody>
<tr>
<td>Parking Lot</td>
<td>0.6</td>
</tr>
<tr>
<td>Roof</td>
<td>0.1</td>
</tr>
<tr>
<td>South Pond</td>
<td>0.4</td>
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<tr>
<td>North Pond</td>
<td>1.0</td>
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<tr>
<td>South Pond runoff</td>
<td>6.6</td>
</tr>
</tbody>
</table>

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