Nutrient Export from a Green Roof: A Comparison to Other Land Use Types
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Abstract
Recent studies on green roof effluent have indicated that extensive green roofs are a source of phosphorus and occasionally a source of nitrogen as compared to conventional roofing systems. In this study, green roof effluent was compared to runoff quality from other vegetated areas, and to other stormwater control measures. Data were graphed against EPA recommended criteria for unaffected waterways. Results indicated that in terms of nutrient retention, the green roof performed similarly to other vegetated sites, and was outperformed by a rain garden and wetland. It is suggested that, if space is available, green roof effluent be diverted to other systems designed for nutrient removal.

Introduction & Background

Green roofs (GRs) are proven effective stormwater control measures (SCMs), providing benefits of runoff volume reduction through hydrologic mechanisms, which include plant evapotranspiration and infiltration via growth media. However, recent studies suggest that GR effluent may contribute to non-point source nutrient loading. Phosphorus (P) and nitrogen (N) export are of concern due to their ecological impacts on stream and wetland health. Studies have generally compared GR systems to conventional roofs, although few have compared GRs to other vegetated land uses.

Procedure

For this study, a GR was compared to several vegetated sites which are common contributors to nutrient loading in waterways and to SCMs which are designed for pollutant retention. The two-phase comparison study is summarized in Table 1.

Table 1: Summary of vegetated site comparison and SCM comparison.

<table>
<thead>
<tr>
<th>Land Use Comparison I: Vegetated Sites</th>
<th>Land Use Comparison II: SCMs</th>
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<tbody>
<tr>
<td>Precipitation (GR P)</td>
<td>Constructed stormwater wetland outflow (AS OUTLETs, OUTLET)</td>
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<tr>
<td>Green Roof (GR OUT 1, GR OUT 2)</td>
<td>Rain garden outflow (OVER)</td>
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<td>Wooded area first flush (FFW)</td>
<td>Green roof outflow (GR OUT 1, GR OUT 2)</td>
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<td>Grassy lawn first flush (FFG)</td>
<td>Parking lot/roof first flush (FF02)</td>
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<td>Parking lot/roof first flush (FF02)</td>
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Results & Discussion

Using boxplot groupings, a relative comparison of data from the GR versus other sampling sites was performed for each nutrient parameter. Comparisons for TN and TPK are provided in Figures 3-6.

Figure 3: Land Use Comparison I for TN. Median TN concentrations from the GR first flush (GR OUT 1) and whole-storm composite (GR OUT 2) were similar to those of background vegetated sites.

Ongoing Research

A mass export analysis is currently being conducted to determine the portion of fertilizer applied to the green roof that is taken up by the plants as compared to the portion that is washed off during higher-volume storms. A preliminary graph is provided in Figure 7.

Figure 7: Nutrient mass export for the green roof versus quantities of fertilizer applied annually.

Conclusions
Comparisons of GRs to other vegetated sites would suggest that GRs perform similarly to traditional urban sources of nutrient loading. Figures 4 and 6 suggest the GR is outperformed by the wetland and rain garden, two types of SCMs which are specifically designed for and proven effective at removing nutrients from stormwater. It is suggested that GRs be implemented in series with other SCMs, which are designed for nutrient removal. This is a practical solution where space for multiple SCMs is available.

References

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