Assessing Water Treatment Residuals as a Filtration Media for Phosphorus Removal at Wapato Lake - Tacoma, WA

Brian Hite
Center for Urban Waters, hiteb@uw.edu

Megan Hintz
Center for Urban Waters

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Assessing Water Treatment Residuals as a Filtration Media for Phosphorus Removal at Wapato Lake, Tacoma, WA

Brian Hite

Research Assistant
Center for Urban Waters
BS - Environmental Science - UWT
Civil / Environmental Engineering - UW
Acknowledgements

Dr. Joel Baker
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Alex Gipe
Megan Hintz

City of Tacoma Environmental Services Division

Department of Ecology
Overview

• History of Algae Problems
  • Background on Wapato’s history

• Scope of Work
  • Design low cost stormwater filtration media
  • Compare to proprietary stormwater filtration media

• Current Progress
  • Results and Future Plans
Background of Wapato Lake

- **History of Problems**
  - Urban Lake
  - Stormwater P Loading
  - Toxic Algae Closures

- **Diversion into 2 Lakes**
  - Retention Time ≈ 8.5 years
  - ≈ 1.5 m deep
  - Stagnant Lake
Wapato Lake Plan

- City of Tacoma wants to investigate introduction of filtered stormwater into South Wapato Lake

- Reduce Retention Time, Reduce Phosphorus and Reduce Toxic Algal Blooms
Water Treatment Residuals (WTR)

- 25 – 50 % Aluminum Sulfate or Ferric Chloride (additive)
- 15 – 25 % Organic Matter (source water)
- 35 – 50 % Clay / Silt (source water)
WTR – Types Tested

Seattle – WTR
Ferric Chloride

Everett – WTR
Aluminum Sulfate

- Compared to Proprietary Media
Prop A
Prop B
Prop C
Initial Media Testing

- Dissolved Metals Analysis
- Kinetics of Phosphorus Adsorption
- Batch Adsorption Isotherms
# Initial Media Conclusions

<table>
<thead>
<tr>
<th>Test</th>
<th>WTR-Seattle</th>
<th>WTR-Everett</th>
<th>Prop Media</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute-Chronic Toxicity</strong></td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Kinetics 1 mg/L 50% Adsorption</td>
<td>-</td>
<td>≈ 0.25 hrs</td>
<td>2 – 16 hrs</td>
</tr>
<tr>
<td>Batch Max Adsorption</td>
<td>-</td>
<td>&gt; 8000 mg P</td>
<td>&gt;4000 mg P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kg WTR</td>
<td>kg Media</td>
</tr>
</tbody>
</table>
28 Loading Events
Table of Total Phosphorus (ug/L):

<table>
<thead>
<tr>
<th>Condition</th>
<th>Total P (ug/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent</td>
<td>100</td>
</tr>
<tr>
<td>25% WTR</td>
<td>80</td>
</tr>
<tr>
<td>35% WTR</td>
<td>60</td>
</tr>
<tr>
<td>Prop A</td>
<td>40</td>
</tr>
<tr>
<td>Prop B</td>
<td>33</td>
</tr>
<tr>
<td>Prop C</td>
<td>40</td>
</tr>
<tr>
<td>C-33 Sand</td>
<td>80</td>
</tr>
</tbody>
</table>
Our Future Plans

• Set-up Field Site
• Test WTR’s from Across State
WTR Procurement
Conclusion

Phosphorus Removed

<table>
<thead>
<tr>
<th></th>
<th>Everett WTR</th>
<th>Prop Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total P</td>
<td>≈48%</td>
<td>≈39-44 %</td>
</tr>
<tr>
<td>Ortho-P</td>
<td>≈86%</td>
<td>≈44-83%</td>
</tr>
</tbody>
</table>

Toxicity Screening Needed

More WTR Needed
Questions?

Brian Hite
E-mail – Hiteb@uw.edu
Kinetic Adsorption Method

- Determines Contact Time Necessary for ortho-P removal

- Methods
  - 1.8 mL of media
  - 45mL of 1 mg/L P solution
  - Shaken at various intervals
  - 1, 2, 5, 10, 15, 30 min, 1, 2, 4, 6, and 24 hr
  - Filtered & Analyzed using Westco Nutrient Analyzer
Kinetics of Phosphorus Adsorption

% P Adsorbed vs. Time (h:mm)

- WTR Everett
- Prop B
- Prop A
Kinetics of Phosphorus Adsorption

% P Adsorbed vs Time (h:mm)

- WTR Everett
- Prop B
- Prop A
Preliminary Treatment Sizing

Conclusions

Assumptions

100 gal/min flow rate

Treating 52 million gallons / year

<table>
<thead>
<tr>
<th>Infiltration Rate</th>
<th>30 in / hr</th>
<th>50 in / hr</th>
<th>70 in / hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Sizing</td>
<td>300 ft²</td>
<td>200 ft²</td>
<td>150 ft²</td>
</tr>
<tr>
<td>Contact Time</td>
<td>34 min</td>
<td>22 min</td>
<td>17 min</td>
</tr>
</tbody>
</table>
Wapato Lake samples: March 2009 to December 2010
P Loading Reduction Needed

Current State

Reduced Residence Time
( Added 100 Gal / min )

P Loading Reduction Needed

Phosphorus Loading (g P / m² yr)

Mean Depth / Residence Time (m / year)

Eutrophic Zone

Excessive Loading

Permissible Loading

Oligotrophic Zone

Current Depth 1.5 m / Current Residence Time 8.5 years

Current Depth 1.5 m / Target Residence Time 0.7 years
Why is Algae a Problem at Wapato

- Eutrophication
  - Is the accelerated growth of nuisance cyanobacteria blooms and phytoplankton

- Eutrophication occurs at concentrations
  - > 0.05 mg / L of total P

- Average total P in South Wapato
  - ≈ 0.05 mg / L of total P