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

Follow this and additional works at: https://cedar.wwu.edu/ssec

Part of the Terrestrial and Aquatic Ecology Commons
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
Dr. Andy James
Kurt Marx
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><strong>Kinetics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 mg/L 50% Adsorption</td>
<td>-</td>
<td>≈ 0.25 hrs</td>
<td>2 – 16 hrs</td>
</tr>
<tr>
<td><strong>Batch Max Adsorption</strong></td>
<td>-</td>
<td>&gt; 8000 mg P/kg WTR</td>
<td>500 - &gt;4000 mg P/kg Media</td>
</tr>
</tbody>
</table>
28 Loading Events
Total Phosphorus

Influent 25% WTR 35% WTR Prop A Prop B Prop C C-33 Sand

Total P (µg/L)

0 20 40 60 80 100
Our Future Plans

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

- WTR Everett
- Prop B
- Prop A

% P Adsorbed vs. Time (h:mm)
Kinetics of Phosphorus Adsorption

- **WTR Everett**
- **Prop B**
- **Prop A**

Graph showing the percentage of phosphorus adsorbed over time (h:mm) for different materials.
### 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

Mean Depth / Residence Time (m/year)

Current State

Reduced Residence Time
(Added 100 Gal/min)

Target Zone
Reduced P Loading

Eutrophic Zone

Excessive Loading
Permissible Loading

Oligotrophic Zone

Phosphorus Loading (g P/m² yr)

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