STORMWATER RUNOFF CONTROL FROM A WATER QUALITY PERSPECTIVE

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PART 1:
LONG-TERM PERFORMANCE OF A BIOINFILTRATION RAIN GARDEN WITH RESPECT TO NUTRIENT AND METALS REMOVAL

PART 2:
WATER TREATMENT PLANT RESIDUALS AS AN AMENDMENT TO STORMWATER CONTROL MEASURES (SCMS)

Stormwater Runoff
Nutrient (Nitrogen and Phosphorus) Pollution

Sources:

- Fertilizer applied to lawns and golf courses
- Leaking septic tanks
- Agricultural runoff
- Detergents used to wash cars in street
- Pet waste

VUSP
VILLANOVA URBAN STORMWATER PARTNERSHIP
Stormwater Runoff - Metals Pollution

Source of metals in stormwater runoff:

- Vehicle exhaust
- Brake linings
- Tire and engine wear
- Roof material

Some Metals of Concern:

- Lead
- Cadmium
- Chromium
- Copper
- Zinc

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PART 1:
LONG-TERM PERFORMANCE OF A BIOINFILTRATION RAIN GARDEN WITH RESPECT TO NUTRIENT AND METALS REMOVAL

John Komlos
Robert Traver
Volume Reduction per Storm (n=364 storms)

Volume reduction = Pollutant reduction

n=27
n=41
n=29
n=267

Percent Volume Reduction Per Storm Event

Phosphate (PO$_4^{3-}$) Mass Balance

PO$_4^{3-}$ that entered rain garden but did not leave between 2001 and 2010 (1.9 kg)

PO$_4^{3-}$ that was unaccounted for = 0.3 kg (or 16%)

Metals Accumulation on Raingarden Soil

![Diagram of Raingarden Soil](image)

Metals Accumulation on Raingarden Soil

![Bar chart showing metals accumulation](chart)

- 2009
- 2013

Copper (µg/g)

- end
- middle
- control
Long-term Impact of Metals Accumulation

<table>
<thead>
<tr>
<th></th>
<th>Range of concentrations measured in active ponding zone (μg/g)</th>
<th>PADEP clean fill limits (μg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>2.4 – 18.9</td>
<td>1080</td>
</tr>
<tr>
<td>Chromium</td>
<td>1.9 – 38.3</td>
<td>94</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.01 – 1.9</td>
<td>38</td>
</tr>
<tr>
<td>Lead</td>
<td>1.4 – 21.5</td>
<td>450</td>
</tr>
<tr>
<td>Zinc</td>
<td>13 - 134</td>
<td>1200</td>
</tr>
</tbody>
</table>

- The raingarden soil matrix has not exceeded PADEP limits after 12 years of operation.
- Copper sorption isotherms indicate that the soil can hold 63 – 364 μg/g of copper (maximum) when in equilibrium with the median ponded copper concentration (10.8 μg/L).
- Therefore, under these conditions, the clean fill standard will never be exceeded for copper.

STORMWATER RUNOFF CONTROL FROM A WATER QUALITY PERSPECTIVE

PART 2: WATER TREATMENT PLANT RESIDUALS AS AN AMENDMENT TO STORMWATER CONTROL MEASURES (SCMS)

John Komlos
Robert Traver
Andrea Welker
Vito Punzi
Bridget Wadzuk
Kaitlin Vacca

Scope

• The residuals used for this study were from a water treatment plant that uses alum coagulation.

• Water treatment plant residuals (WTRs) containing alum have potential to improve SCM performance due to their phosphate removal ability.

• Investigations are needed to determine if WTRs will be an effective infiltration material.

• It is also important to determine the extent of aluminum leaching that may occur.

• In addition, how will the WTR-amended soil perform in more field-scale (i.e. flowing) system?

Residuals Modification
Aluminum Leaching Experiment

Copper Removal by Residuals
Lead Removal by Residuals

Zinc Removal by Residuals

(Solid Horizontal Line = Detection Limit)
Arsenic Removal by Residuals

(Komlos, Welker, Punzi, Traver (2013) J. Env. Eng. 139:1237-1245)

WATER TREATMENT RESIDUALS (WTRs) AS A SOIL AMENDMENT IN CONSTRUCTED STORMWATER WETLAND MESOCOSMS

- Control
- 2% WTR
- 5% WTR
- 8% WTR

Kaitlin Vacca
John Komlos
Bridget Wadzuk
PHOSPHATE SORPTION CAPACITY OF WTR-AMENDED SOIL (FROM BATCH EXPERIMENTS)

PHOSPHATE REMOVAL IN EACH MESOCOSM OVER 4 WEEKS
SURFACE VS SUBSURFACE FLOW THROUGH THE MESOCOSMS

Surface Flowrate - $1.18 \pm 0.07 \text{ mL/s (n=234)}$

Subsurface Flowrate - $0.23 \pm 0.02 \text{ mL/s (n=234)}$

Even though water infiltrated into the subsurface (and phosphate removal did occur), only a small % of the flow was subsurface flow.

Vacca, K., Komlos, J., and Wadzuk, B.M. *Water Environment Research* (to be submitted soon)

SPATIAL DISTRIBUTION OF PHOSPHATE RETENTION IN A CONSTRUCTED STORMWATER WETLAND

Above ground soil: $50 \pm 17 \text{ mg/kg (n=6 locations)}$

Submerged Soil: $401 \pm 160 \text{ mg/kg (n=9 locations)}$

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Water Treatment Residuals as an amendment to SCMs

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