Phosphorus Pollution from Urban Stormwater Ponds

John S. Gulliver, Ph.D.
Professor
Department of Civil, Environmental and Geo-Engineering
University of Minnesota

Collaborators

• Jacques Finlay, PhD
  – Professor, Ecology and Behavioral Biology
• Tyler A. Olsen
  – Recent M.S. Graduate
• Vini Taguchi
  – Ph. D. student
• Ben Janke, PhD
  – Research Associate
• Poornima S. Natarajan, PhD
  – Research Associate
• Heinz Stefan, PhD
  – Professor Emeritus
Phosphorus Pollution from Urban Stormwater Ponds

Outline
1. Why is phosphorus important?
2. Assumptions about ponds.
3. Are ponds a phosphorus source?
4. Why does phosphorus release happen?
5. How can we stop phosphorus release?
6. Take away messages

Why is Phosphorus Important?

• Limiting nutrient in freshwater bodies
• Add phosphorus => algae bloom
• Blue Green algae => releases toxins
• Results in soupy water body

Photo: Andy Erickson
Stormwater Ponds should retain Phosphorus

- Capture solids and associated phosphorus
- ~ 30 years old

Assumptions about Stormwater Ponds

1. Ponds are shallow => not stratified
2. => High DO over sediments
3. => No phosphate release from sediments
Are Ponds a Phosphorus Source?  
Stormwater Pond and Wetland Phosphorus  
Riley Purgatory Bluff Creek Watershed District

Why does Phosphorus Release Happen?
Iron-Bound P in Sediments

Oxic Conditions
≥1 mg/L Dissolved Oxygen (DO)
Phosphate is adsorbed by iron in sediments

Anoxic Conditions
<1 mg/L DO
Phosphate is released from iron minerals in sediments

Field Sampling
Field Study Sites

A

B

C

D

E

Pond E Field Data – Temperature

ST. ANTHONY FALLS LABORATORY

University of Minnesota
Driven to Discover™
Many Ponds are Stratified!

Surface Layer
Exposed to Atmosphere
High Dissolved Oxygen

Bottom Layer
Not Exposed to Atmosphere
Low Dissolved Oxygen (DO)

Why?
- Sheltering
- Chloride inflow in spring
Pond E - Sheltering

Pond E Field Data – Conductivity
How can we stop P release from stormwater ponds?

Some concepts:

1. Alum Treatment (developed for lakes, requires expertise and equipment)
2. Iron Filings (current research – 8 ponds)
3. Pond Mixing (aerators, needs research)
4. Low Level Withdrawal (needs research)
5. Dredging to Pre-Pond Soil (can be successful with load reduction)
1. Aluminum Sulfate (Alum) Treatment

http://www.flatwatergroup.com

2. Iron Filings Treatment

Courtesy Rush Lake Improvement Association
3. Pond Mixing (Aerators)

4. Low Level Withdrawal

odfw.forestry.oregonstate.edu/willamettesalmonidrme/cougar-reservoir-temperature-control
5. Dredging to Pre-Pond Soil

Take Away Messages

1. ~32% of ponds => Higher P concentration than expected => Internal P release?
   - Low DO => Internal P release
   - Ponds are stratified by sheltering and chloride => Low DO
2. We document stratification, low DO, and P release in 4 of 5 ponds
3. Need to develop remediation technology for P release
Stormwater UPDATES Newsletter

Iron Enhanced Sand Filtration for Agricultural Tile Drainage

Iron Enhanced Sand Filtration (ESF) has been shown to be effective in reducing phosphorus loads, as evidenced by a study in Minnesota in 2007-2008. This system, however, has not been tested for agricultural tile drainage. The efficacy of ESF in agricultural settings is not well-known. In order to help fill this gap, a study was conducted to evaluate the performance of ESF in an agricultural setting at an ESF that receives agricultural runoff in Minnesota.

Past Newsletters
August 2018: Lessons Learned from Pond-Perimeter Filter Trenches

Rain gardens or bioretention practices are another effective strategy for reducing phosphorus concentrations in the leachate. Rain gardens, which are shallow basins covered with a layer of vegetative cover, can help reduce phosphorus concentrations in agricultural runoff. Bioretention practices, on the other hand, are more effective at removing nutrients from urban runoff. However, the effectiveness of these practices is highly dependent on site-specific factors such as climate, soil type, and vegetation.

Past Articles
July 2016: Enhanced Effluent Treatment for Pond-Perimeter Filter Trenches

Contact Information
St. Anthony Falls Laboratory
University of Minnesota
Driven to Discover

Signup at http://stormwater.safl.umn.edu/