Shallow Lakes and Alum

White Bear Lake City Council Meeting
5/11/2021

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Objectives

- Shallow lake ecology and management
- Background on sediment P release in shallow lakes
- Alum as a management tool in shallow lakes
  - What is alum and how does it work?
  - Does it work?
  - Is it cost effective compared to other management actions?
  - How long does it last?
  - Is it safe?

Turbid and Clearwater States
Competing Equilibria in Shallow Lakes

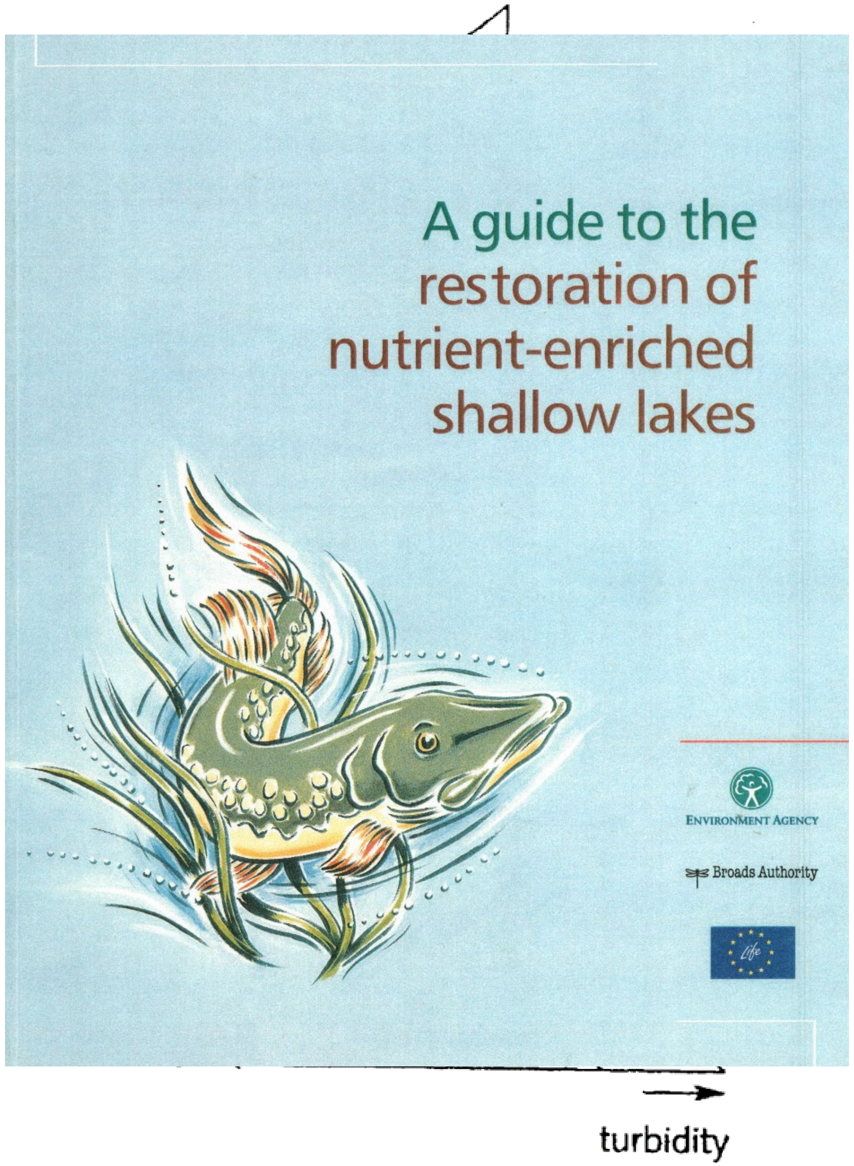
Clearwater State

- Large aquatic plant community
- Low algal productivity
- Large grazer population

Turbid State

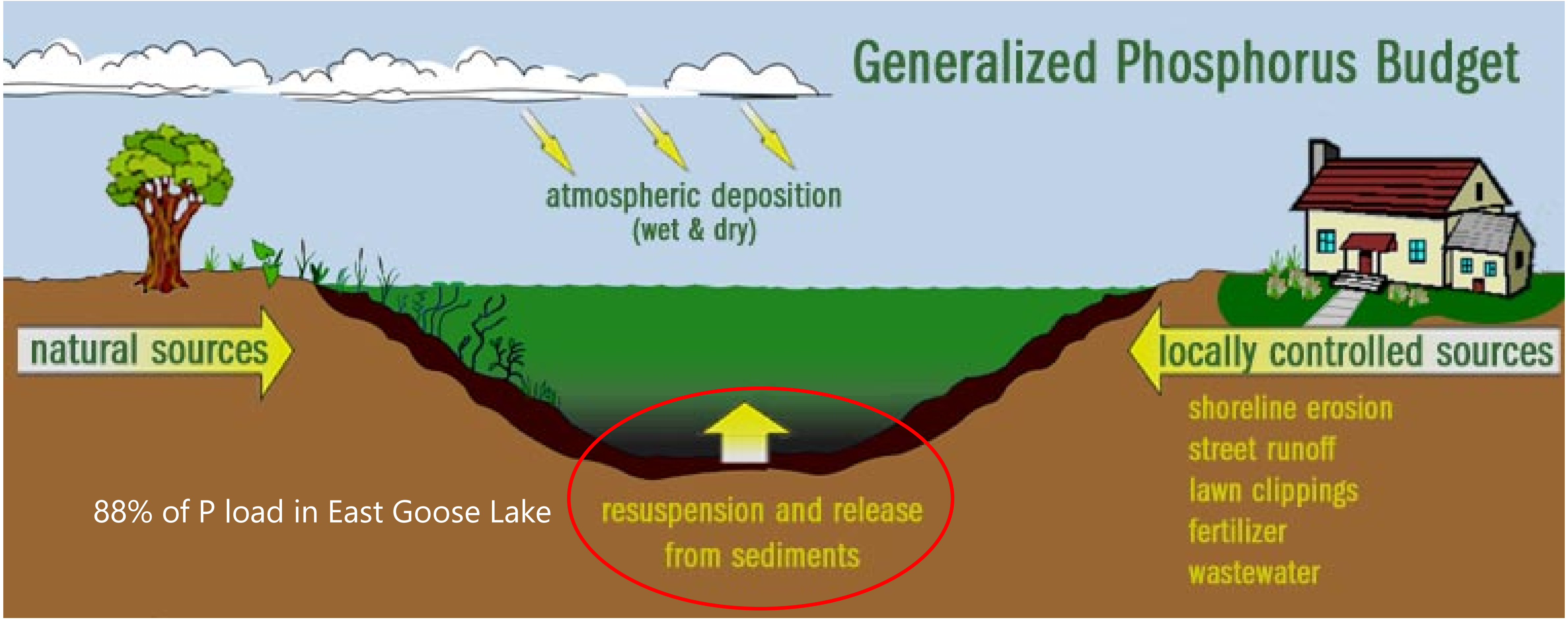
- High algal productivity
- Low aquatic plant productivity
- Low grazer (zooplankton) productivity

Strategy for Restoring Shallow Eutrophic Lakes



- Driver detection and removal
- External and internal nutrient control
- Biomanipulation
- Plant establishment
- Stabilizing and managing restored system

Lake Watershed Phosphorus Loading

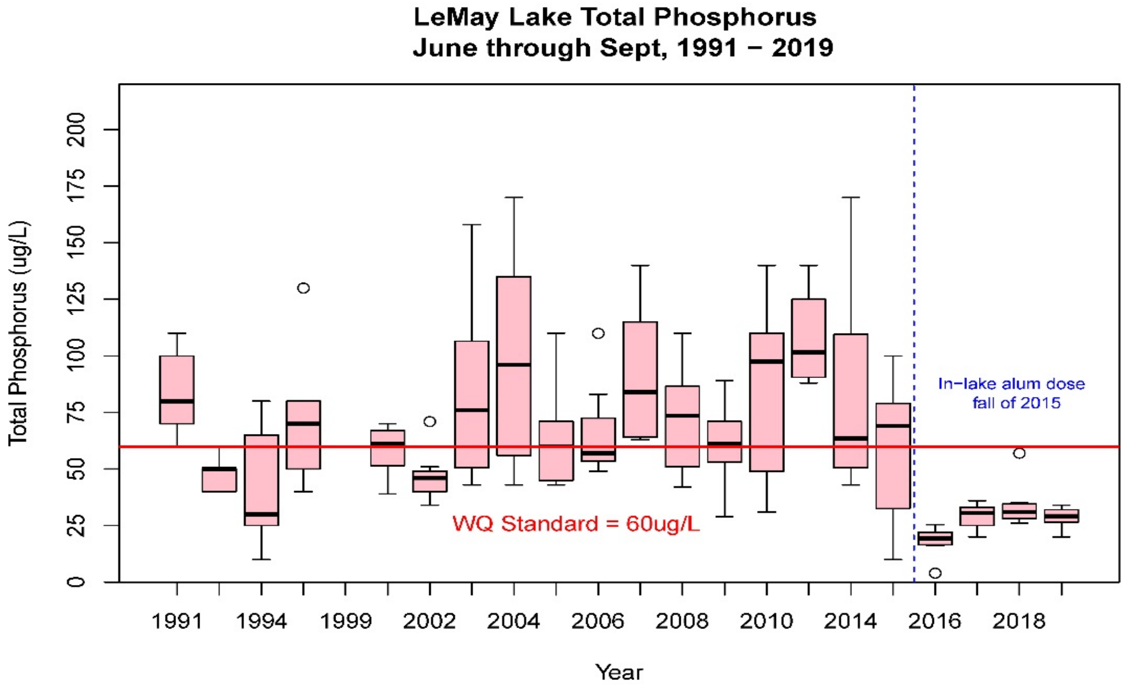


What is Alum?

- Aluminum Sulfate (liquid)
  - Dissolves in water to form aluminum hydroxide and sulfate
  - Aluminum hydroxide is a white solid that settles out of the water column
- Permanently binds phosphorus in the sediments
- Aluminum phosphate complexation ($Al(OH)_3PO_4$)
  - Very stable in the environment
  - Not sensitive to anoxia (low oxygen)

Shallow Lake Alum Treatment Examples – City of Eagan

Does it work?



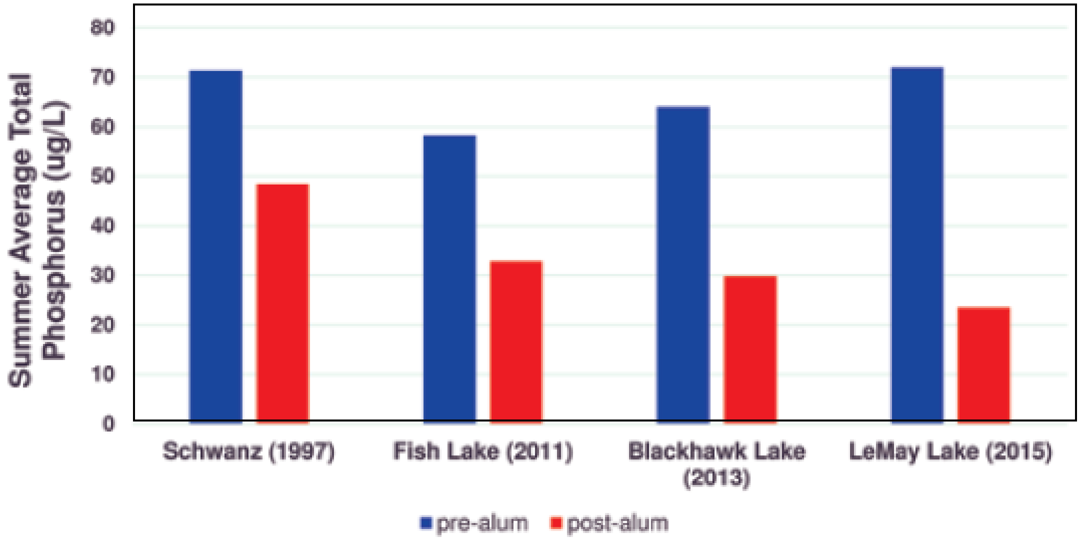


Figure 7. Total phosphorus concentrations before and after alum treatments for four lakes in Eagan.

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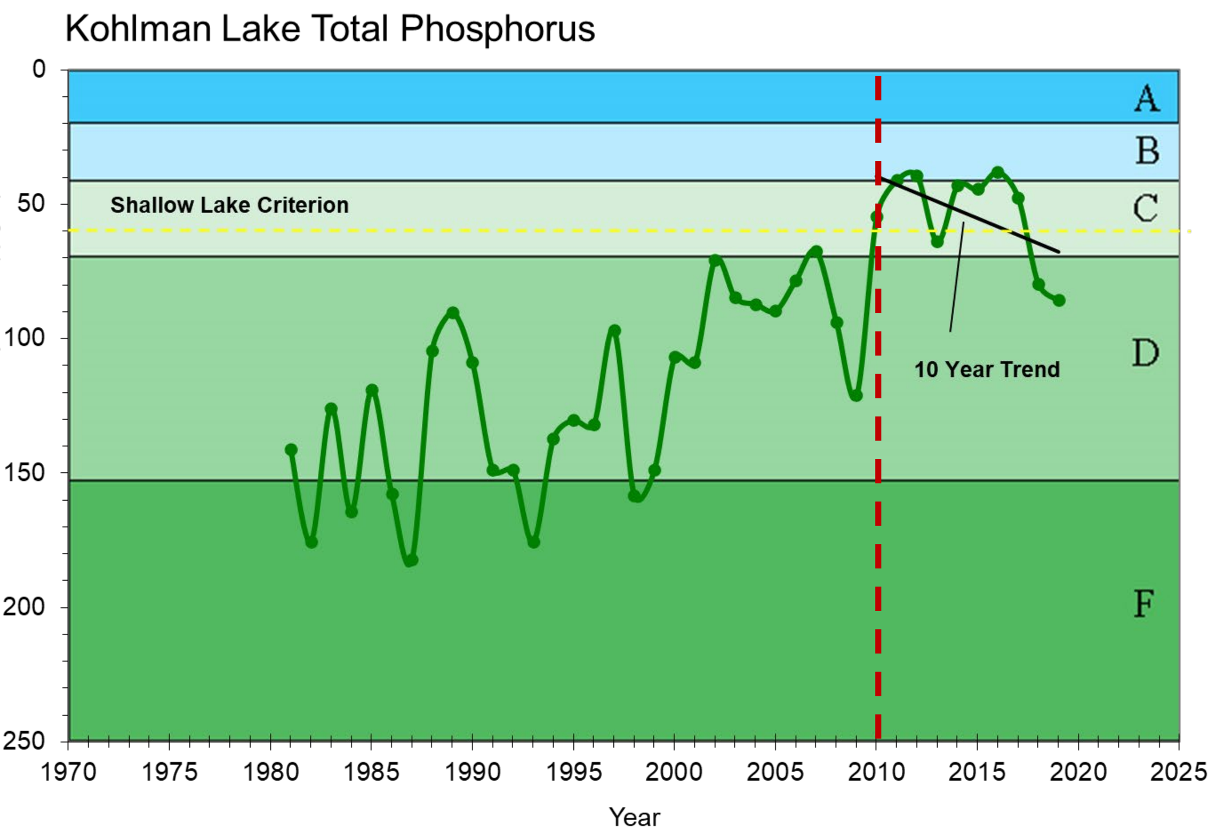
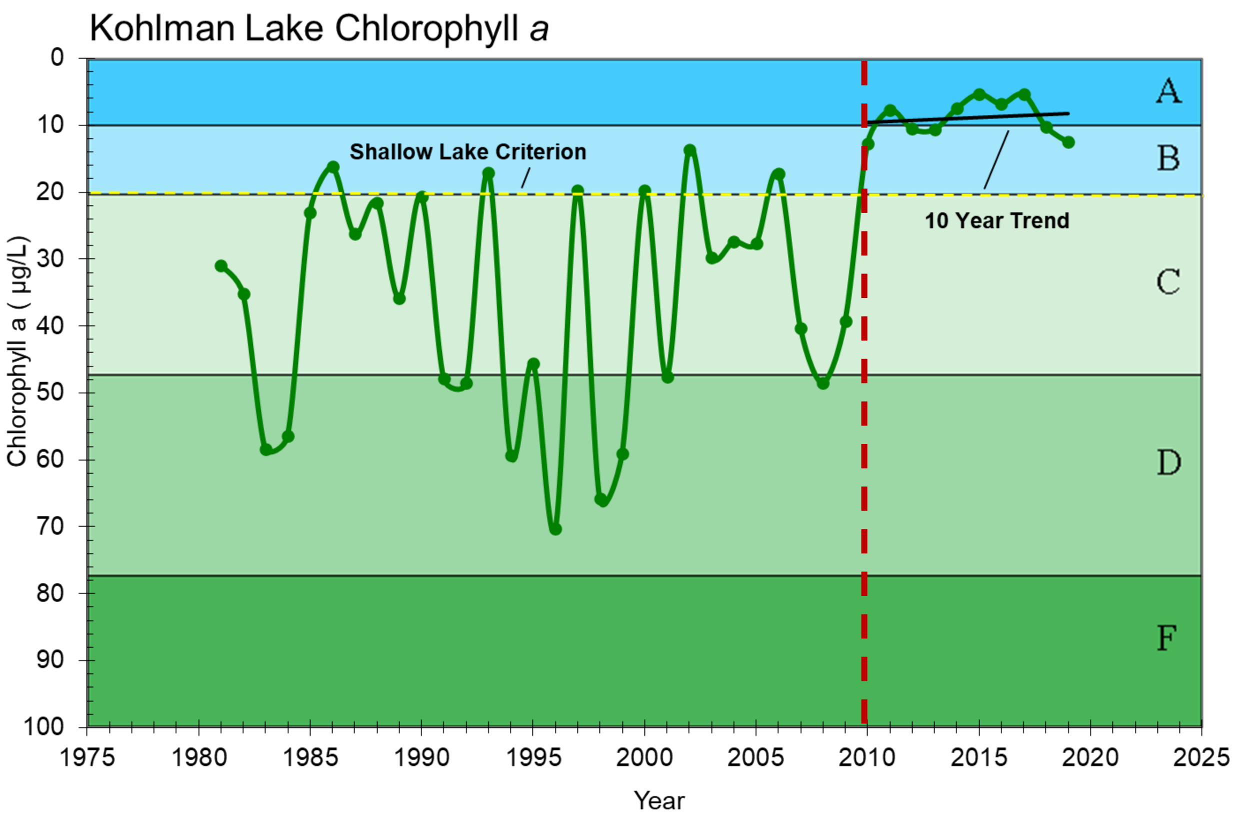
Kohlman Lake





Factors Influencing Alum Longevity

Will it last?

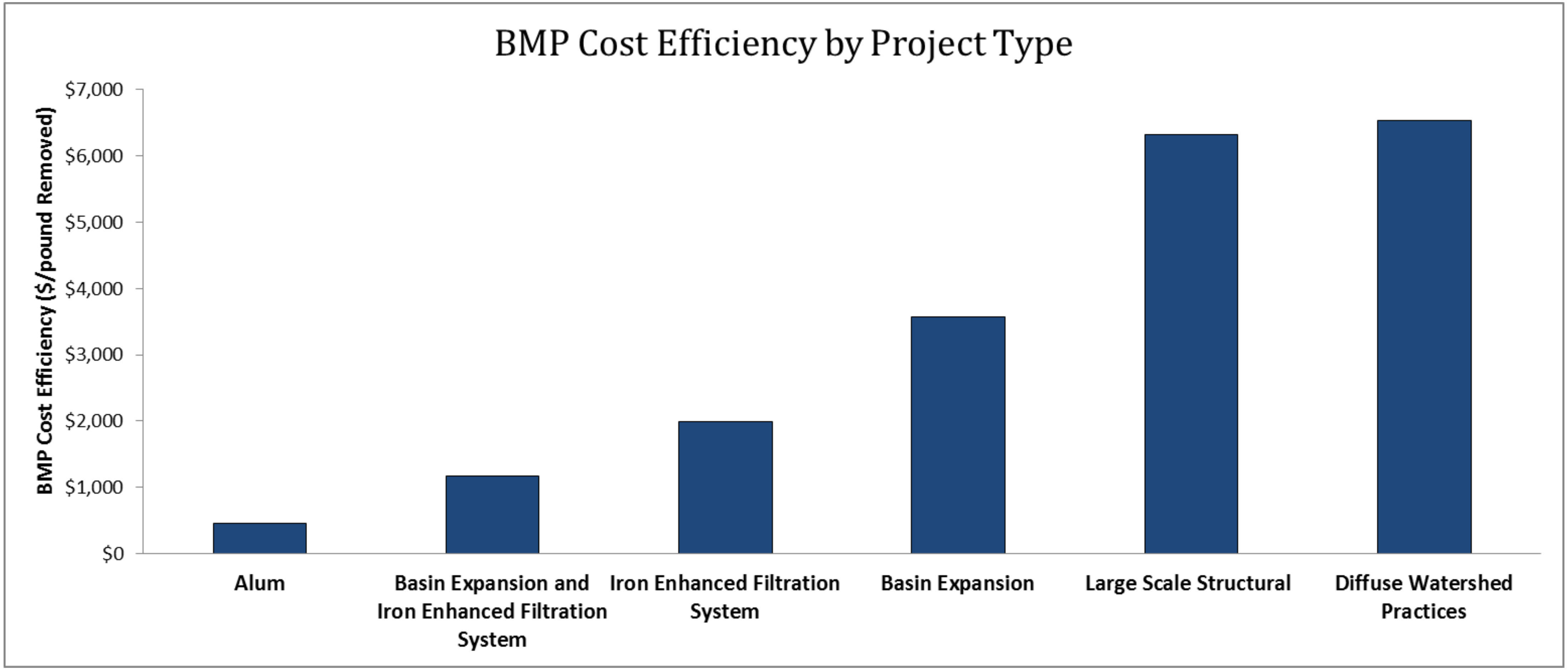
Alum Dose (47%)

Watershed to Lake Area Ratio (32%)

Proxy for watershed nutrient loading and alum burial

Costs for Alum Treatments

Is it cost effective?



Blackhawk and Thomas Lake Management Plan Wenck 2013
Neighborhood Lakes Management Plan Wenck 2014
Bald Eagle Lake TMDL Implementation Plan, Wenck 2010

Aluminum Toxicity – Humans and the Environment

- Aluminum is the third most abundant element and most abundant metal in the earths crust.
  - Occurs naturally in lake sediments
  - Occurs in all food, water, air, and soil
- WHO: ***safe daily intake*** of 40mg per kilogram of body weight per day
  - Inhaled/ingested Al does not report to bloodstream
- Dissolved aluminum (Al^{3+}) can cause toxicity if pH is below 6
  - pH is easily controlled with buffers
  - Aluminum does not bioaccumulate
- Long term habitat benefits
  - Some macroinvertebrate reduction but lake rebounds quickly to better conditions

Source: CDC Public Health Statement for Aluminum;
World Health Organization Safety Evaluation of certain Food Additives

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Conclusions

- Alum is effective for restoration in shallow lakes
  - Typically, the most cost-effective nutrient reduction practice
  - Lasting effects if dosed correctly
  - Plant establishment prevents resuspension
- Alum use is safe for both humans and lake organisms
  - Minimal human exposure
  - improved habitat
  - pH control to protect fish and macroinvertbrates

Next Topic: Post Alum Treatment Expectations in Shallow Lakes – Aquatic Vegetation Management

- Water quality following alum treatment
- Aquatic vegetation assessment and management
- Balancing recreational use and aquatic vegetation
- You are not alone! Examples in other lakes



Questions?

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