An Innovative In-Lake Alum Addition System to Improve Lake Water Quality and Enhance Effectiveness of Wet Detention Ponds

Florida Stormwater Association

June 21, 2019

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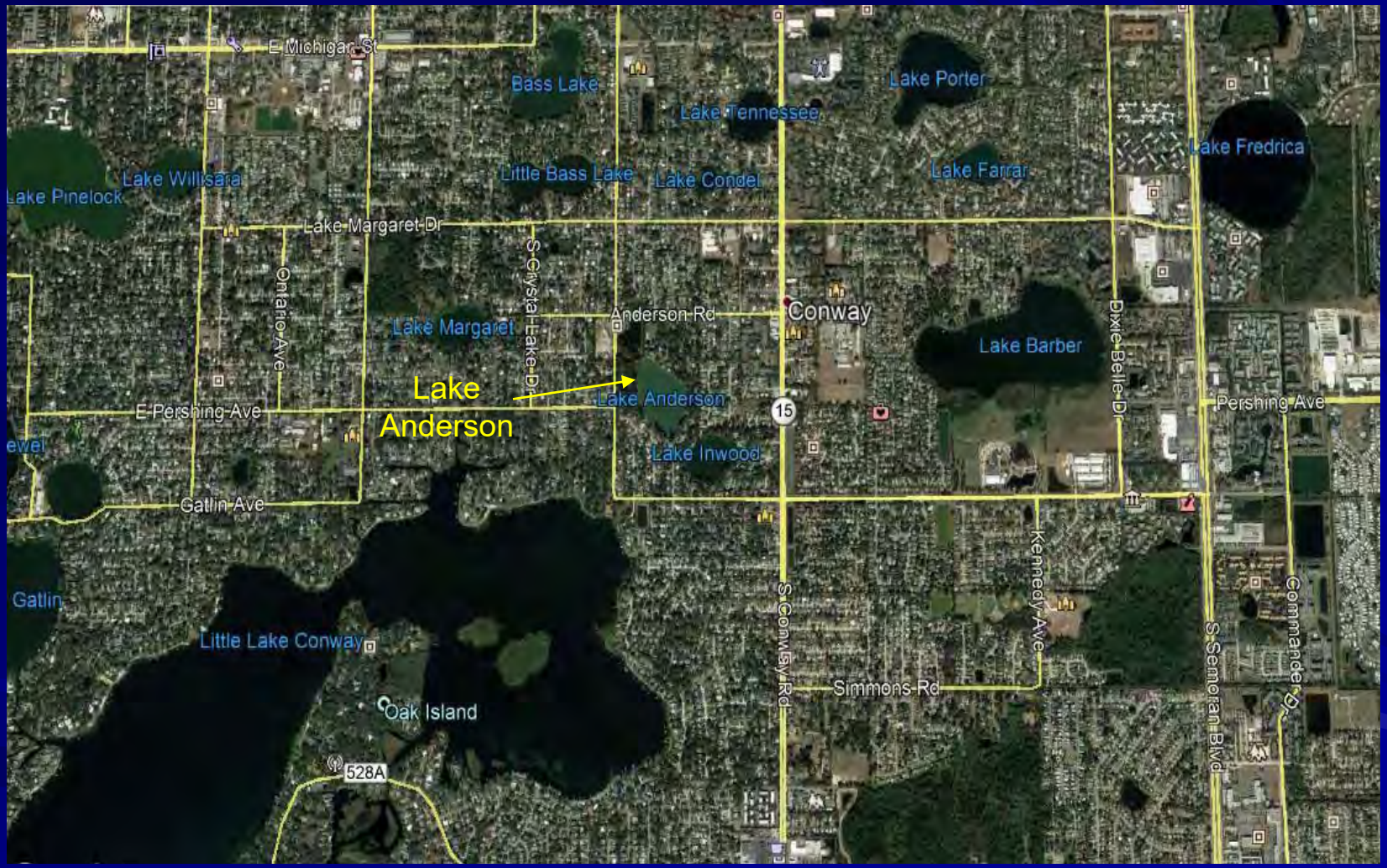
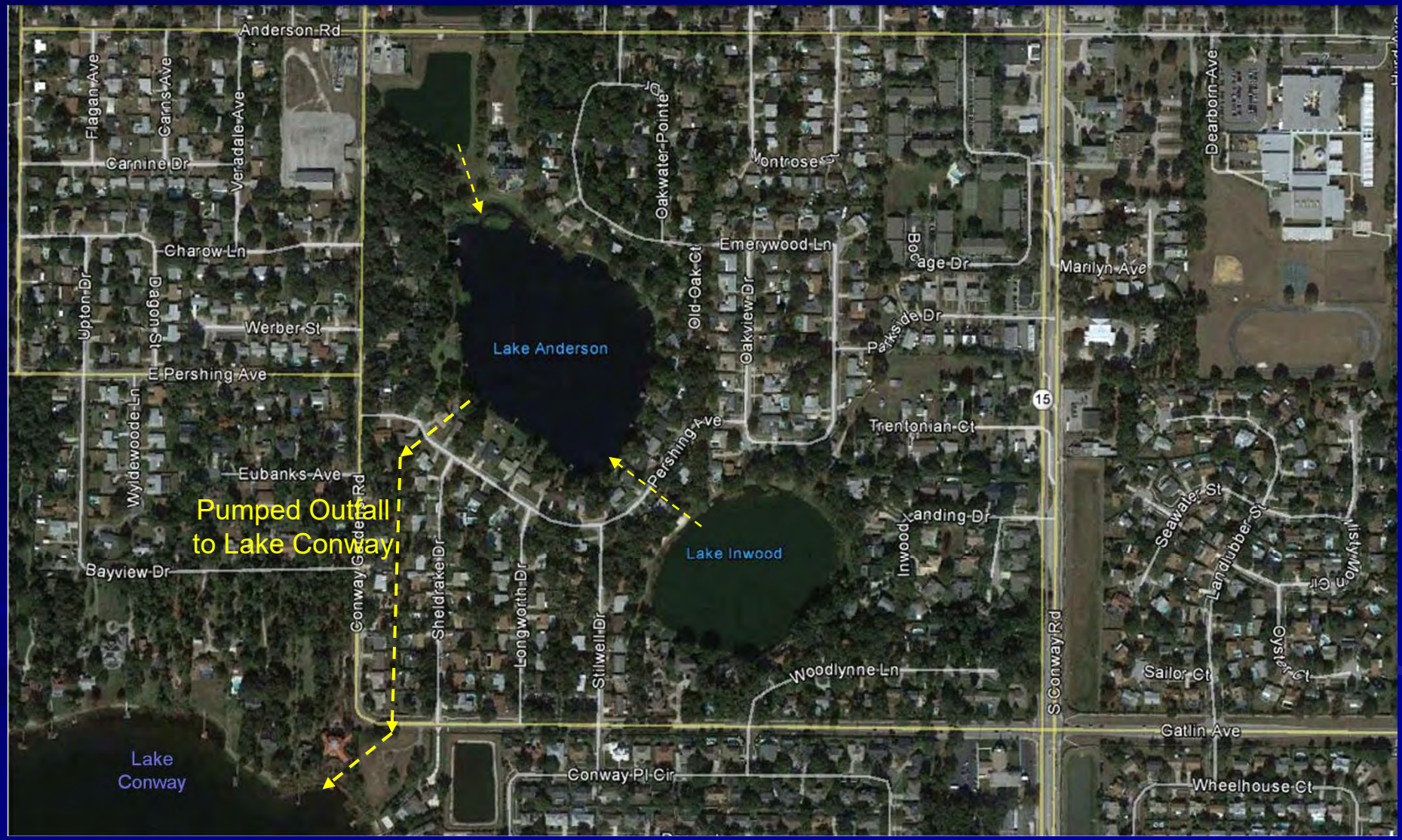
Lake Anderson

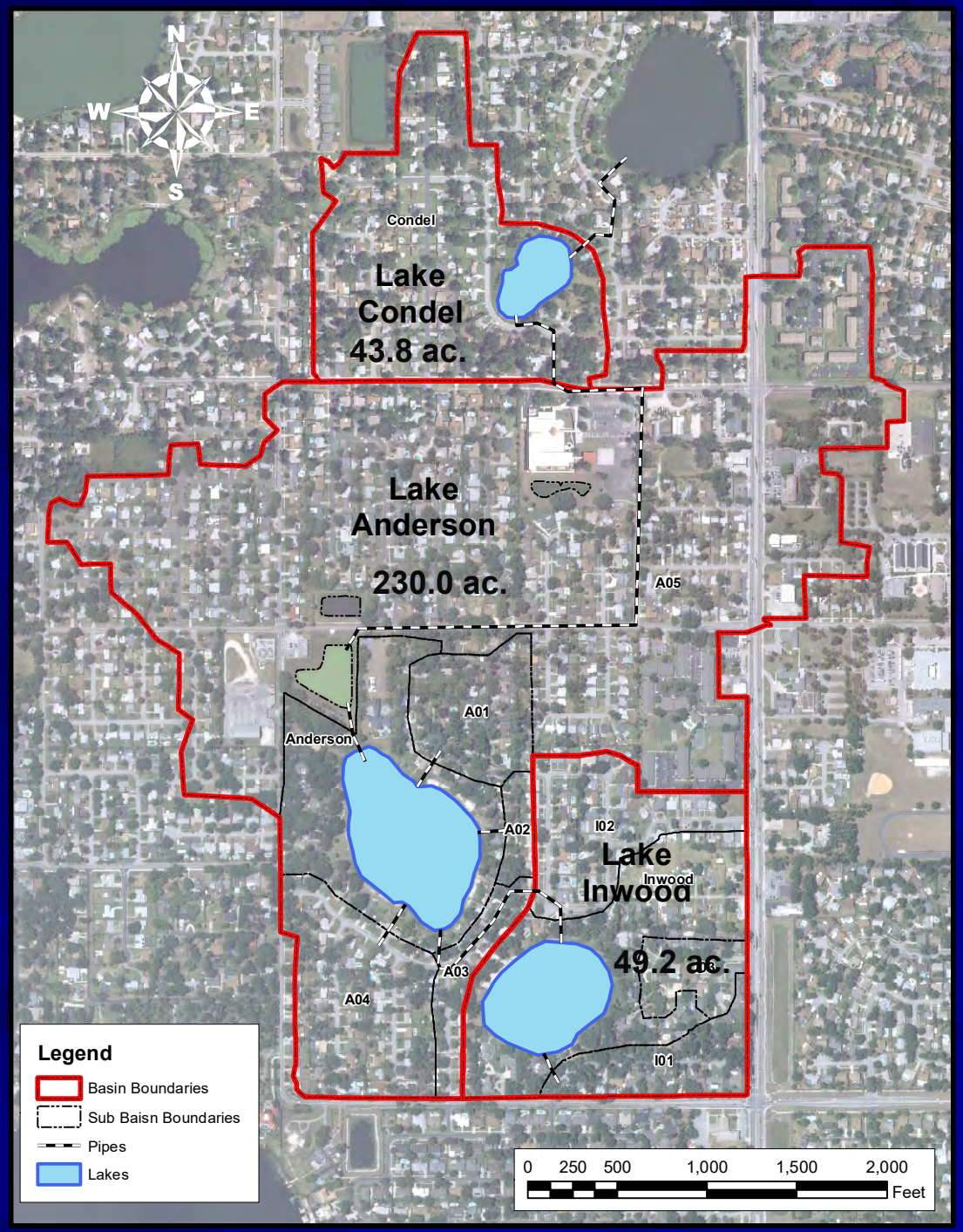


Overview of Lake Anderson



Water Depth Contours (ft) for Lake Anderson on October 14, 2011

Bathymetric Parameter	Value
Surface Area	12.7 acres
Total Volume	169 ac-ft
Mean Depth	13.3 ft
Maximum Depth	> 30 ft



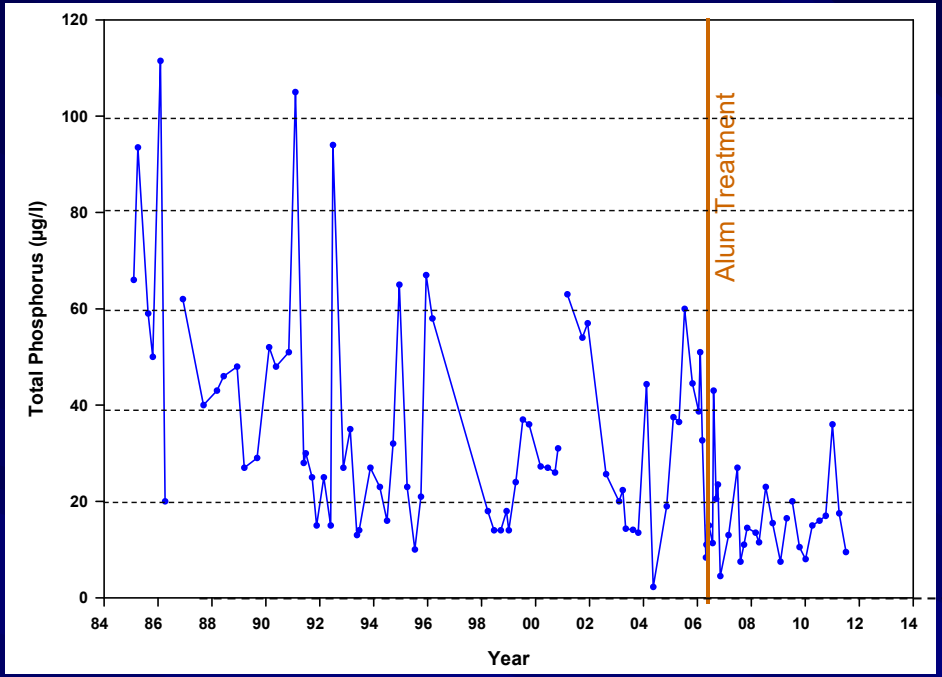
Watershed Areas Discharging to Lake Anderson

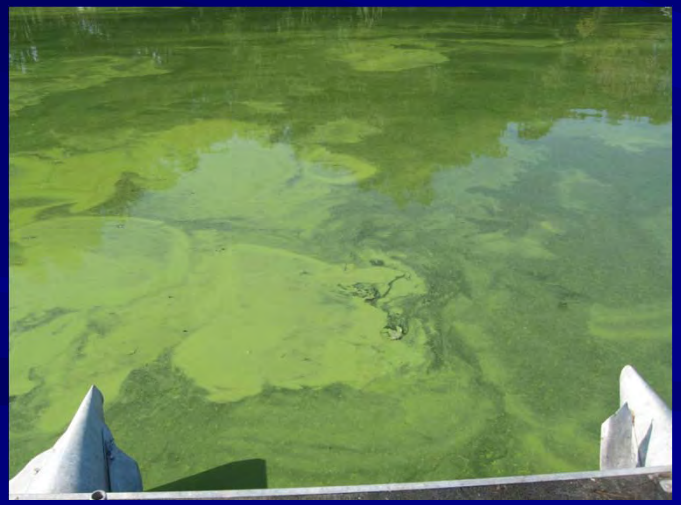
Sub-Basin I.D.	Total (acres)	Percent Of Total
A01	10.61	4.6
A02	2.38	1.0
A03	5.55	2.4
A04	18.87	8.3
A05	173.05	75.2
Overland Flow	19.54	8.5
Totals:	230.0	100

- Most of the basin uses septic tanks for sanitary waste disposal

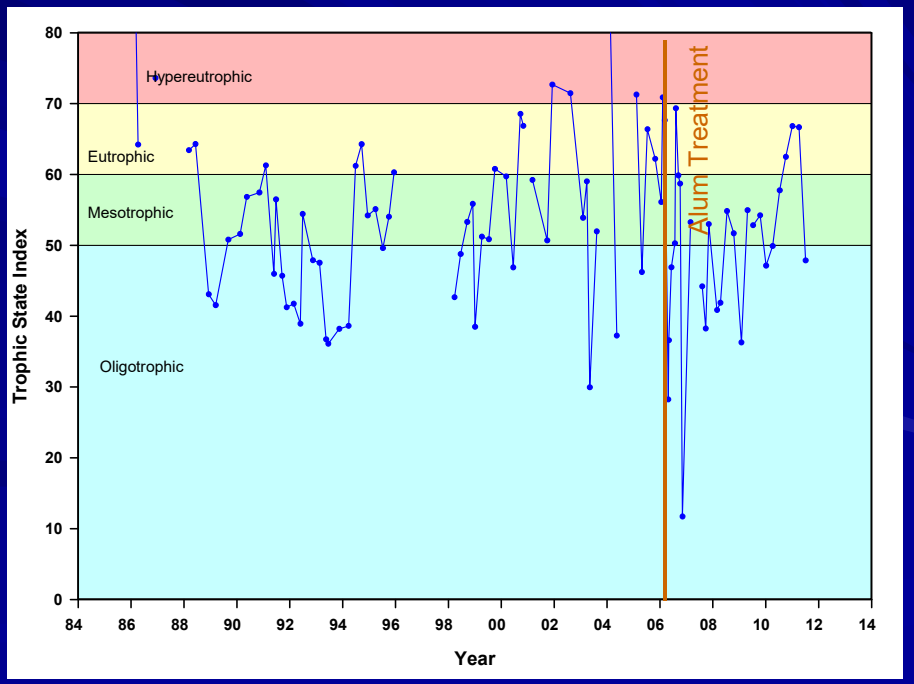
- Soils are well drained

Trends in Total P and TSI Values in Lake Anderson from 1985 - 2012

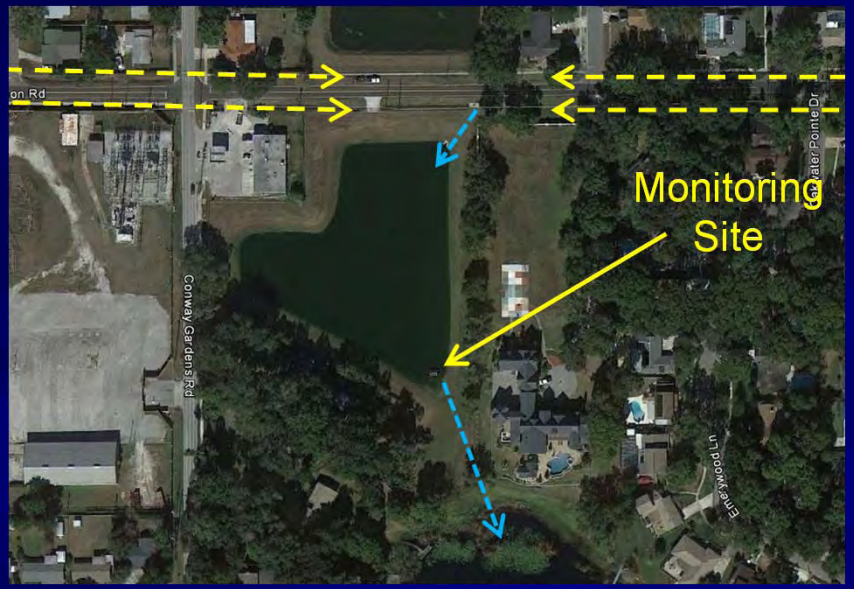


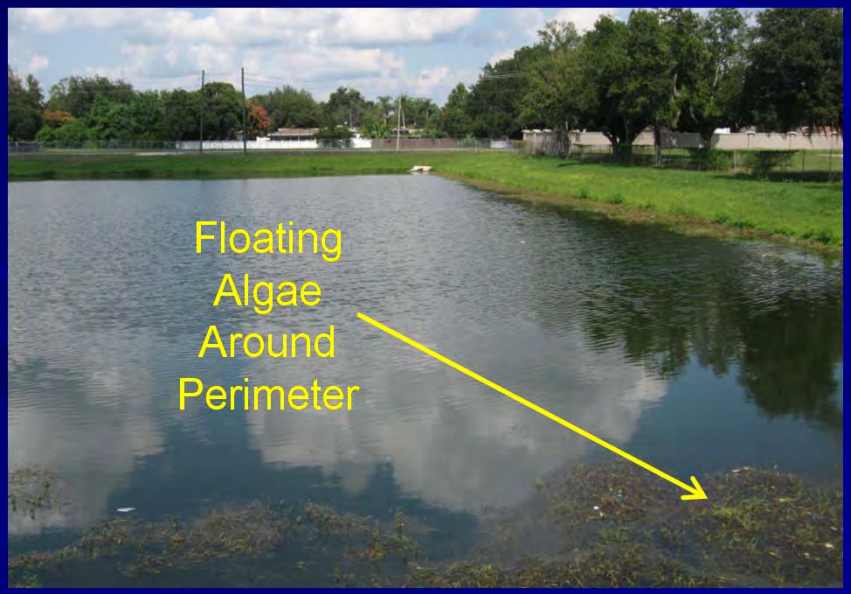


Microcystis Bloom Observed on January 20, 2011



Photographs of the Treatment Pond Monitoring Site





Lake Anderson Study

- During 2011-2012 ERD conducted a Hydrologic/Nutrient Budget Study and Water Quality Management Plan for Lake Anderson which included:
  - Bathymetry
  - Sediment characterization
  - Runoff and pond water quality characterization
  - Groundwater seepage
  - Developed hydrologic budget
  - Developed nutrient budget
  - Water quality management plan
    - Recommended alum sediment inactivation
    - Alum enhancement system for existing treatment pond

Lake Anderson Pond Overview

Typical wet detention pond removal efficiencies:

65% for TP
35 % for TN
80% for TSS

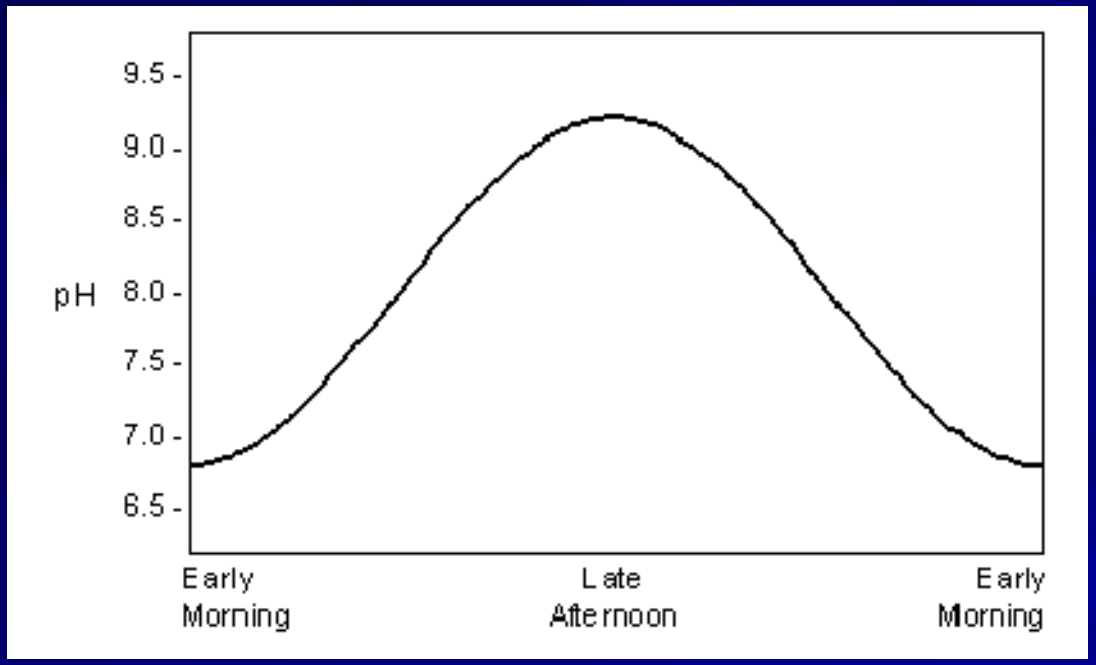
Alum addition system recommended to reduce nutrient loadings

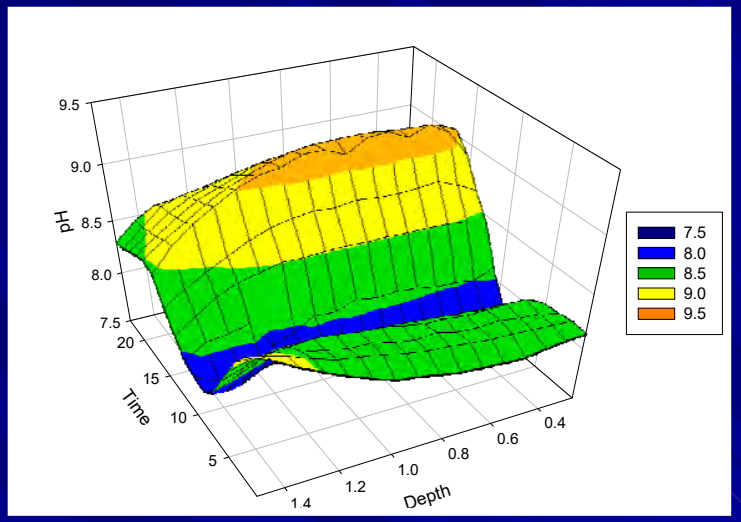
Lake Anderson Pond Alum Enhancement System

- Traditional alum treatment systems are designed to treat stormwater inflows
  - Inflow discharge is measured
  - Alum is added in proportion to the inflow rate
  - Generated floc is captured in a settling pond or allowed to discharge into the receiving water
- Lake Anderson system is a simplified process that is designed to treat the pond water rather than the runoff inflow
  - Alum addition is based on the water column pH
    - Uses the established relationship between water pH and algal productivity
    - Increases in nutrients result in increases in algal growth which results in a proportional increase in pH
    - pH is used as a surrogate for nutrient concentrations
  - Alum is added to achieve a pre-set pH value of 7 or less
  - System is designed to distribute floc throughout the water column and maximize the contact time between the floc and water
  - Floc containing nutrients settles on the pond bottom
- System provides a low cost enhancement in pond performance

Effects of Algal Productivity on pH

Diurnal pH Fluctuation in Eutrophic Ponds and Lakes





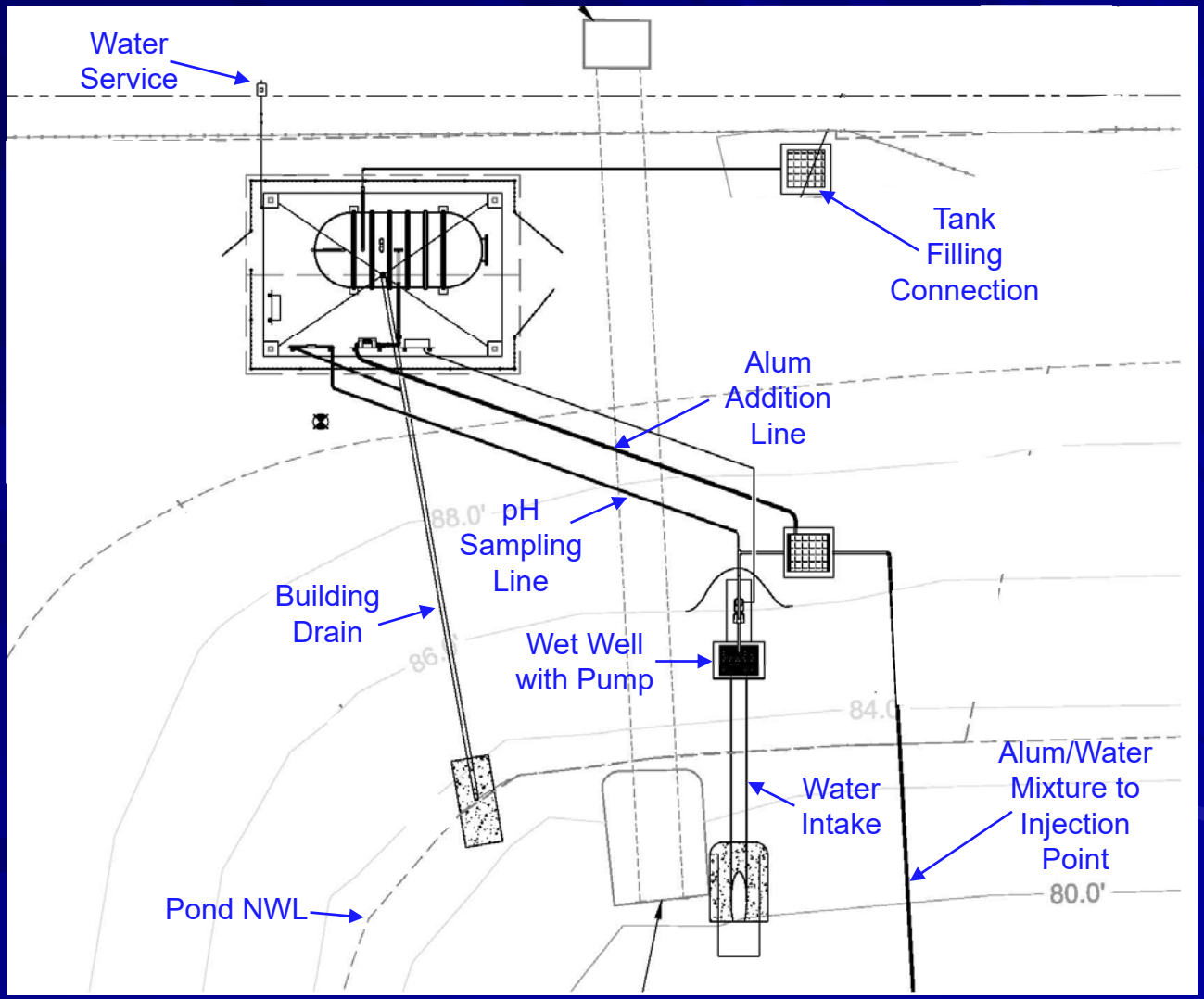
Lake Hancock
October 25, 2005

- Algal production causes pH to increase
- Respiration causes pH to decrease
- Magnitude of diurnal pH shift is a function of the rate of production and respiration
- Algal production is fueled by nutrients
- pH can be used as a surrogate for nutrient concentrations

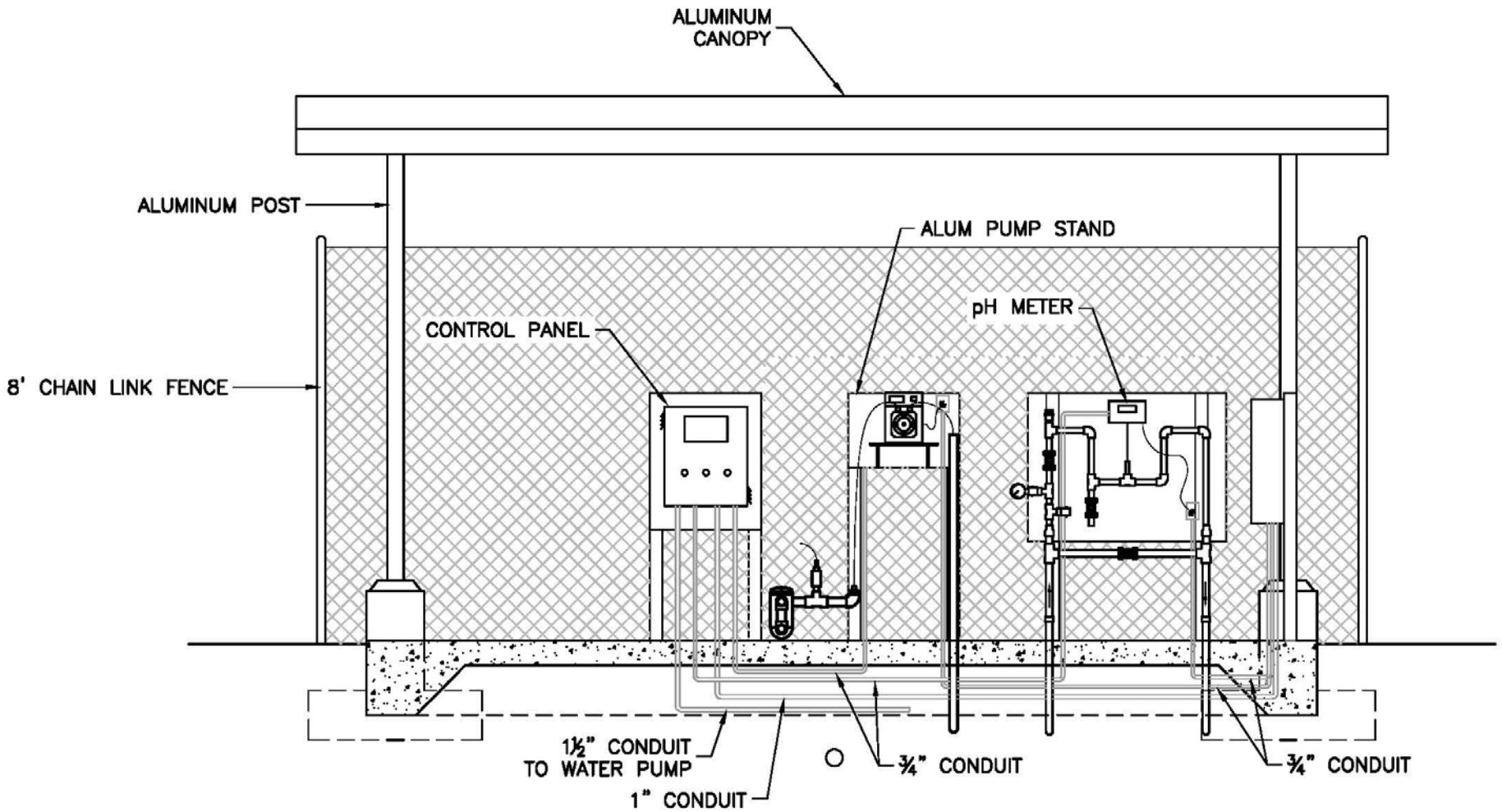
Pond Enhancement System Overview

System Overview

- Required modification to the stormwater permit for the pond
- Construction cost ~ $220,000
- Alum use estimated to be ~ 5,200 gal/yr



Alum Dosing and pH Monitoring Systems



Lake Anderson Alum Addition System

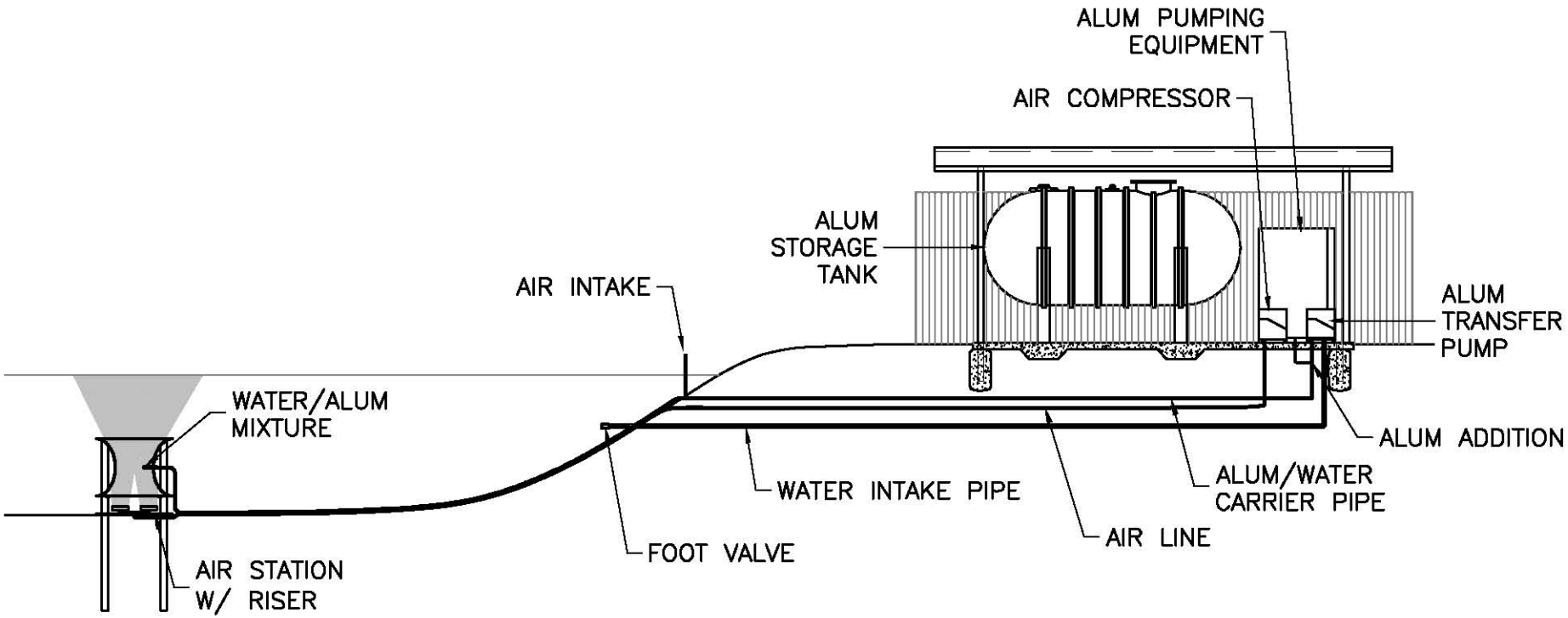
Circulation Pump

1,500 gallon Alum Storage Tank

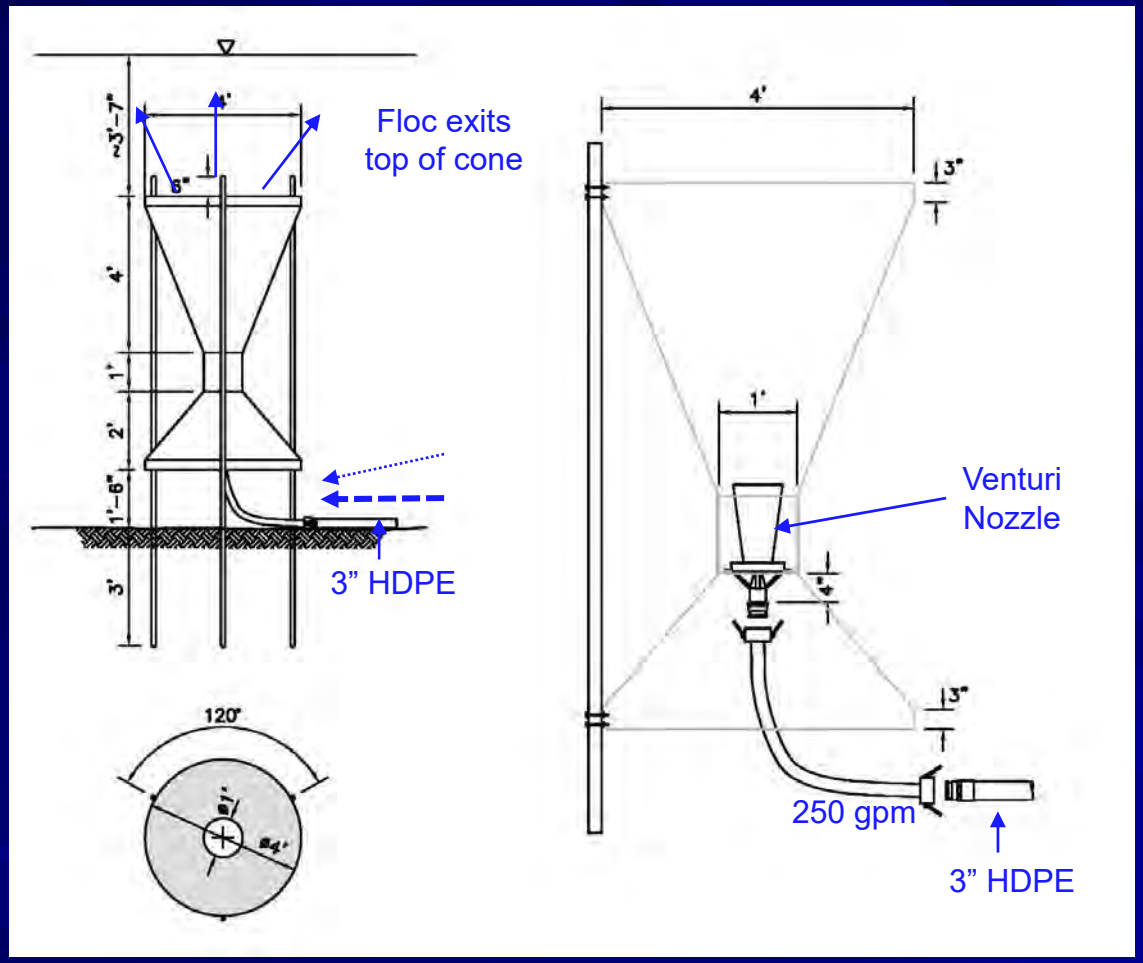
Control System

Venturi for Alum Addition

Schematic of System Components



Distribution Cone



- Venturi nozzle pulls in 3 times as much water as pumped
- Alum floc exits at the surface
- Entrained air keeps floc floating in the water column

Lake Anderson Pond System

PLC Control System

Water recirculation pump

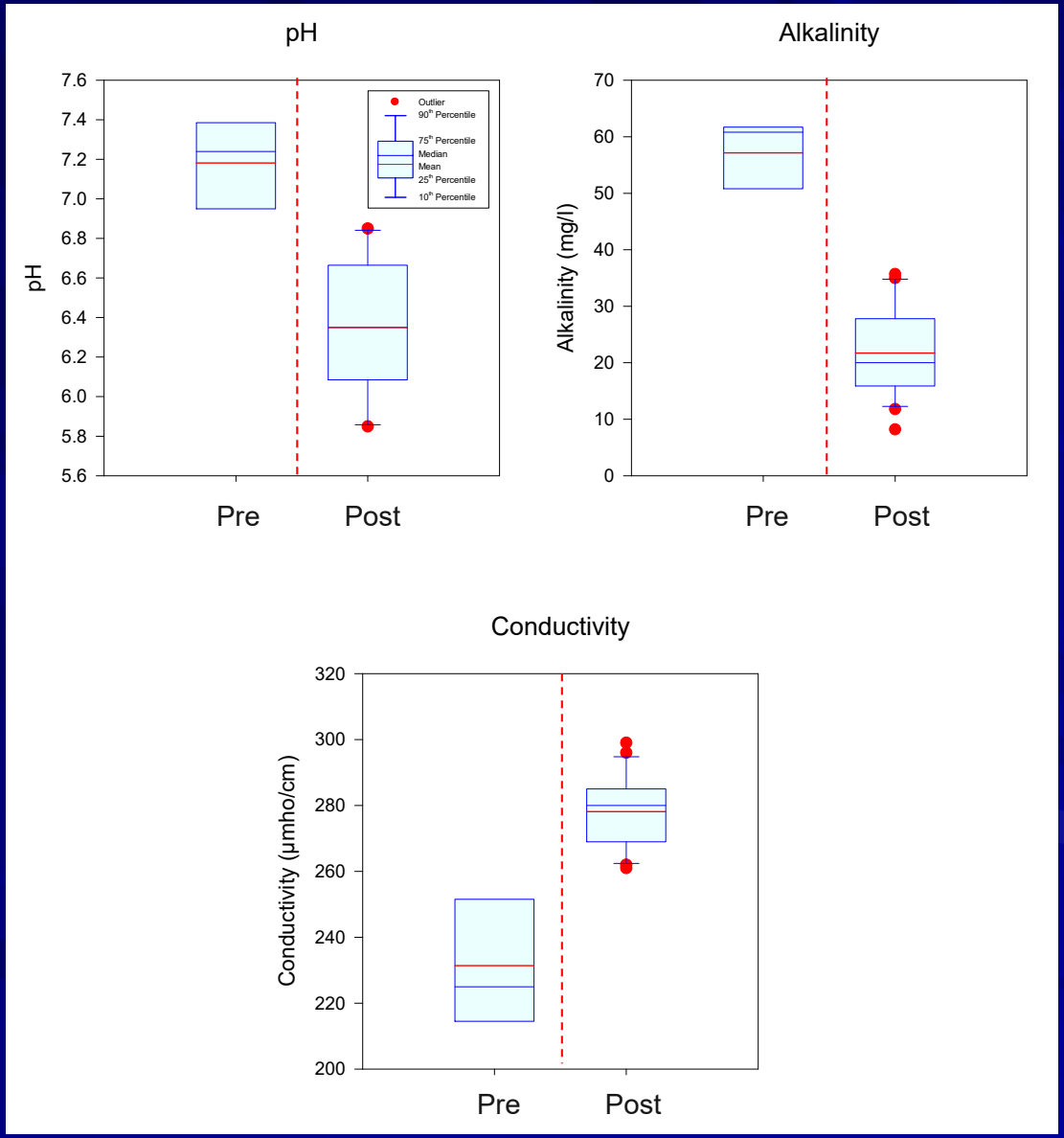
Distribution cone

Fish bedding along pond bank

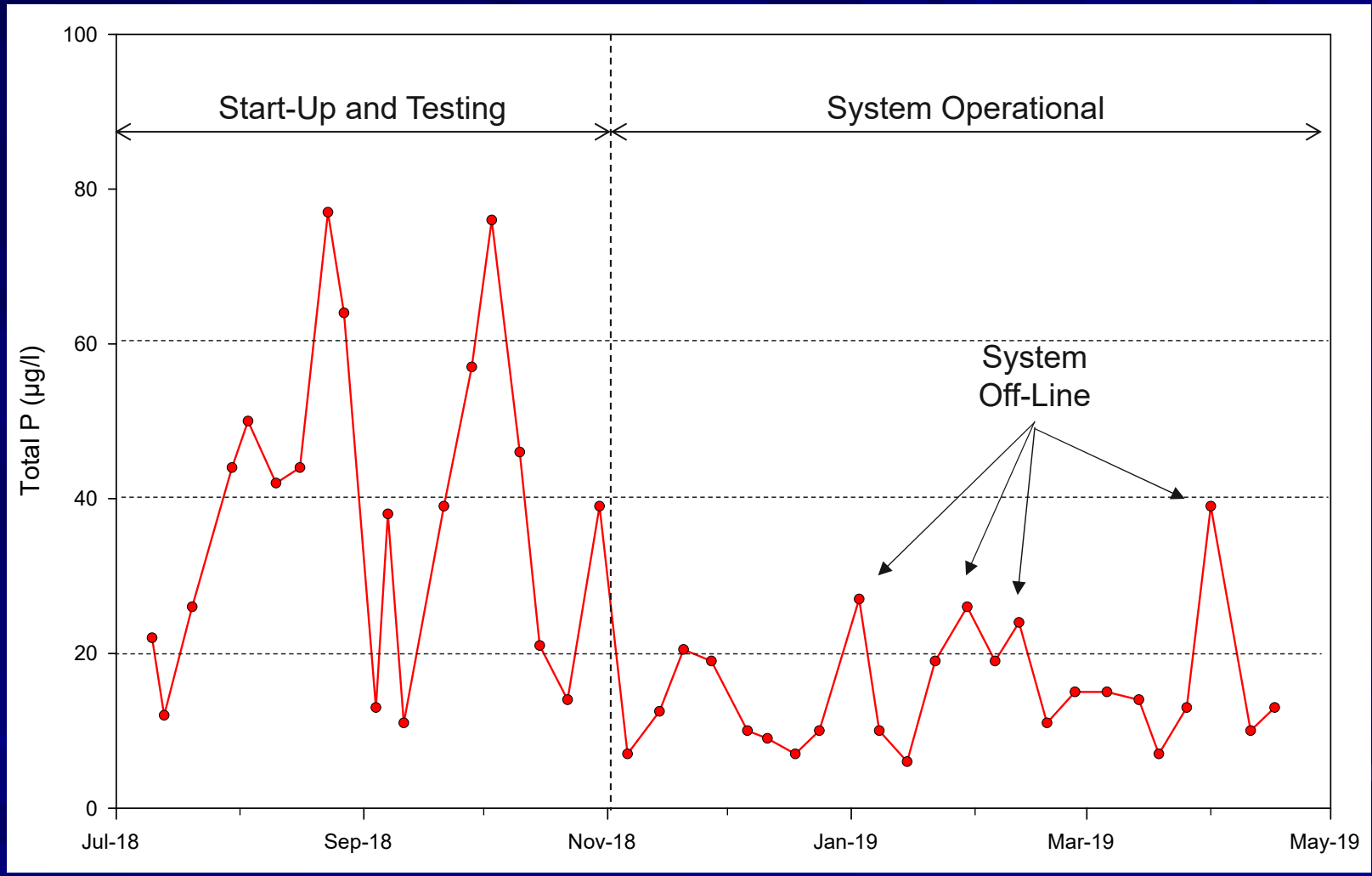
Chemical Use and Load Reductions

Parameter	Units	Value
Pond Drainage Basin	acres	175.1
Runoff to Pond	ac-ft/yr	156
Assumed alum dose	mg Al/L	6
Alum Usage	gal/yr	5,203
Alum Cost @ $0.55/gal	$	2,862
Current TP Load	kg/yr	22.6
TP Removal	%	85
	kg/yr	19.2
Construction Cost	$	220,000
Annual O & M	$	7,862
20-year Present Worth	$	326,842
TP Mass Removal Cost	$/kg	851
	$/lb	386

Pre and Post pH, Alkalinity, and Conductivity

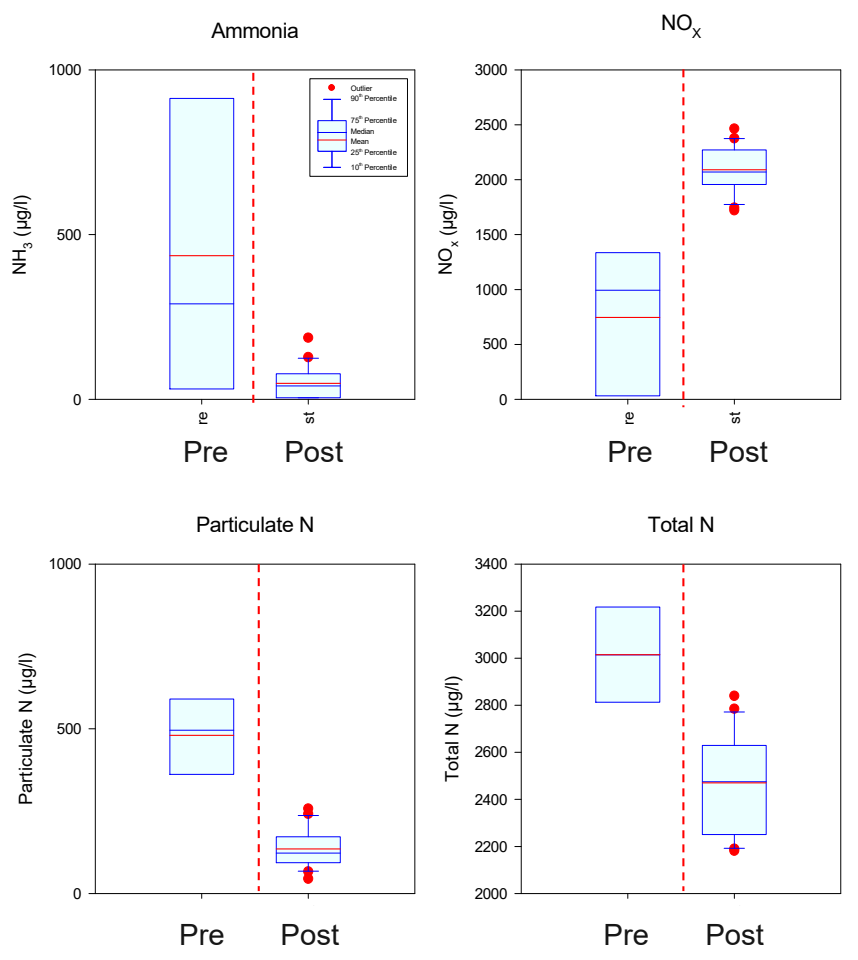


Phosphorus Concentrations

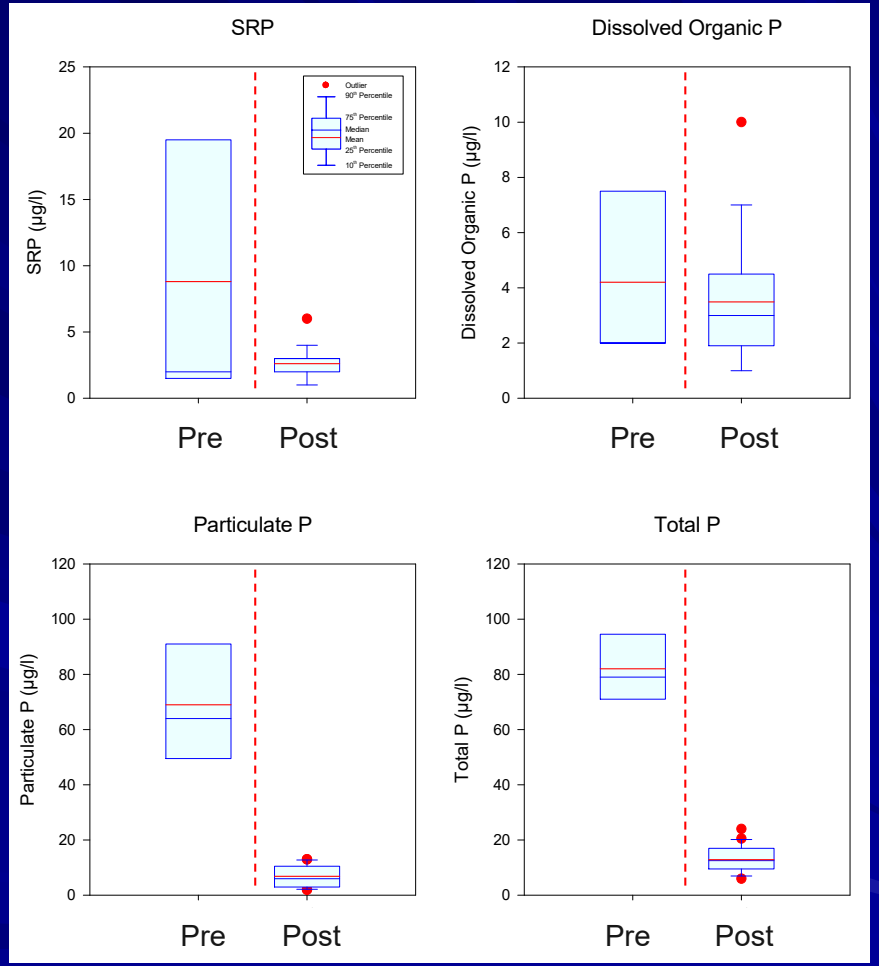


Pre and Post Nutrient Concentrations

Nitrogen

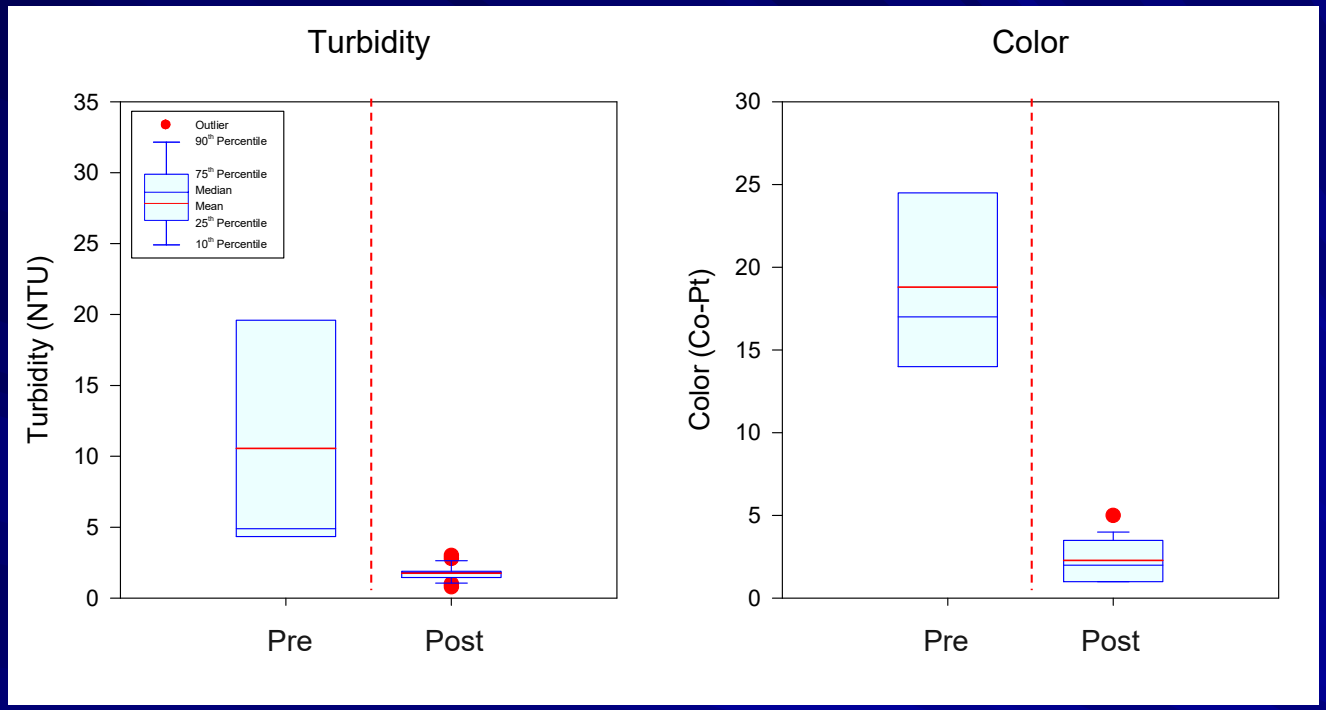


Phosphorus



- System increased pond efficiency to 80% for TN and 85% for TP

Pre and Post Turbidity and Color



Pre vs. Post Removal Efficiencies

Parameter	Units	Pre	Post	Percent Change (%)
Ammonia	µg/L	177	51	-71
NO_x	µg/L	264	2,061	681
Particulate N	µg/L	466	131	-72
Total N	µg/L	3,008	2,446	-19
SRP	µg/L	4	2	-46
Particulate P	µg/L	66	6	-91
Total P	µg/L	81	12	-85
Turbidity	NTU	7.5	1.7	-77
Color	Pt-Co	18	2	-89

Enhanced Pond Removal Efficiencies

Pond TP Removal = 65% + (35% x 0.85) = 95%

Pond TN Removal = 30% + (70% x 0.19) = 43% - with current NOx increase
Pond TN Removal = 30% + (70% x 0.78) = 85% - w/o NOx increase

Aluminator !

Questions?