



# **Bear Lake Hydrologic Reconnection and Wetland Restoration**

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# Acknowledgements



# The Muskegon Lake Area of Concern (AOC)





# What is an Area of Concern (AOC)?

- EPA designation for environmentally degraded areas in the Great Lakes
- 27 remaining in the Great Lakes basin
- Designated “Beneficial Use Impairments”, or BUIs
- Goal is to delist BUIs and eventually AOCs



# The Muskegon Lake AOC

- 4,149 coastal drowned river mouth lake, or *lacustrine estuary*
- Lake is approximately 75% of its original size due to historic industrial fill
- Designated an AOC because of water quality, habitat loss, high levels of nutrients and toxics
- Historical degradation and contamination without PRPs
- On target for 2019 delisting



# Loss of Fish and Wildlife Habitat

## BUI

- Stakeholder-driven goals
- Funding from local, state, federal agencies
- Projects completed with voluntary landowners
- 25+ projects completed to date

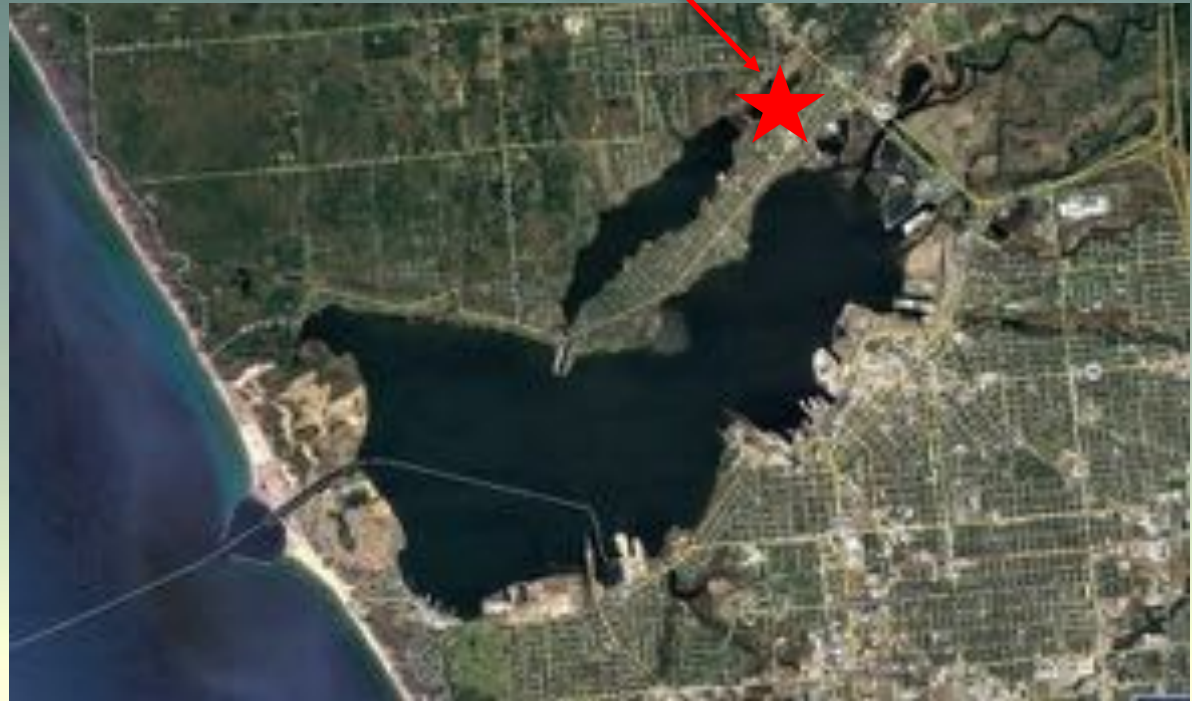
Metric	Target	Achieved
Shoreline softening	24,000 feet	23,667 feet
Wetland creation	73 acres	81 acres
Open water restoration	19 acres	62.1 acres
Marine debris/fill removal	123 acres	93.1 acres



# BEAR LAKE HYDROLOGIC RECONNECTION

## Project Location

- Wetland restoration through reconnection of 36 acres of former celery farm to Bear Creek, Bear Lake, and Lake Michigan
- Property owned by Muskegon County







Muskegon Lake

Lake Michigan

Bear Lake

West Pond

Bear Creek

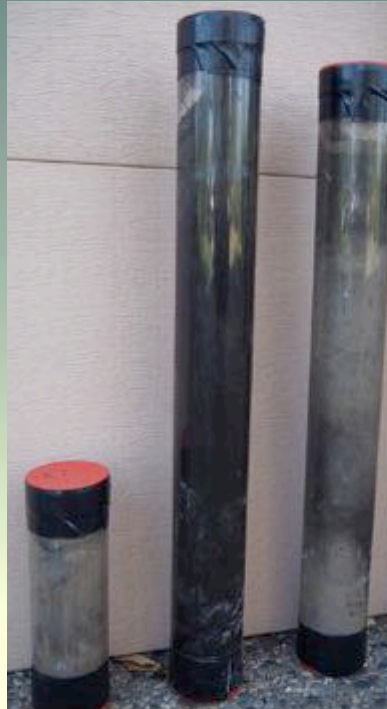
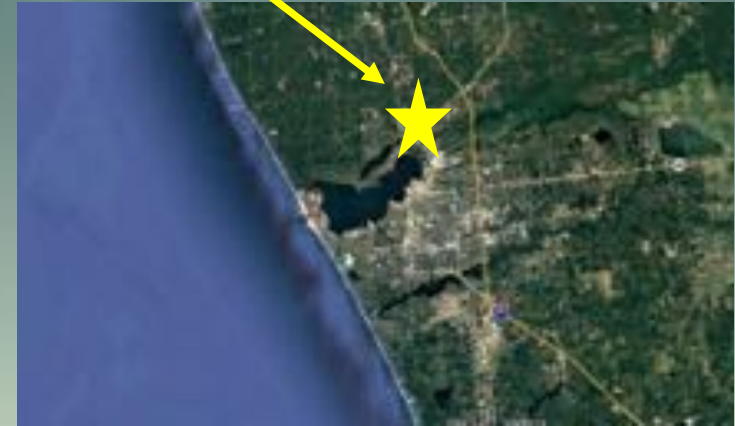
East Pond



# OBJECTIVES AND CHALLENGES

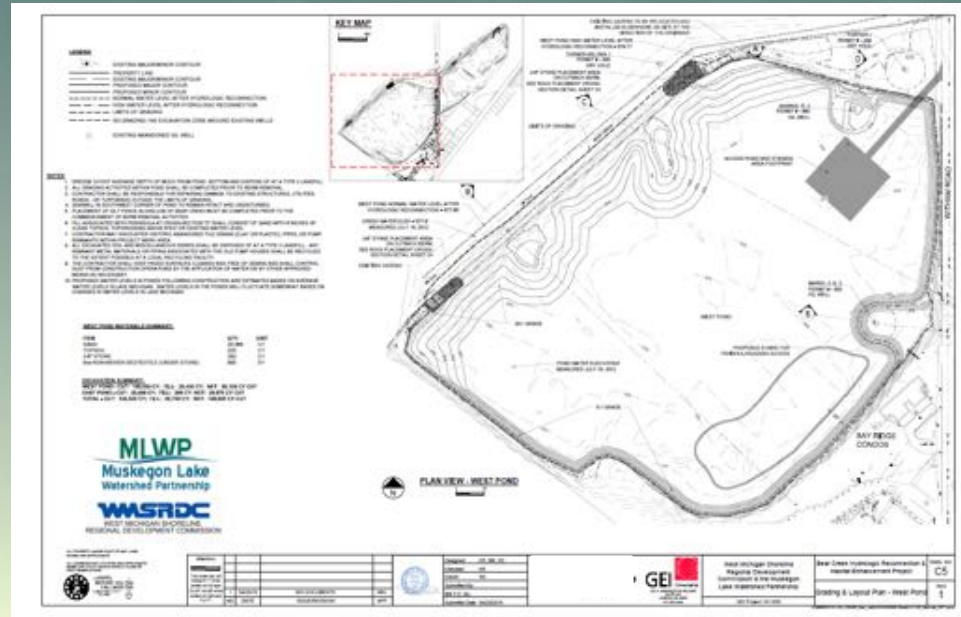
- Hydrologic reconnection of 36 acre celery ponds to Bear Lake/Lake Michigan
- Very high phosphorus in soils (2000-4000 mg/kg) and water (500-800 ug/L), Bear Lake has a TMDL
- Elevated arsenic levels in soil
- Former oil wells
- Adjacent landowners

## Project Location



# PROJECT DESIGN AND OBJECTIVES

- Dewater 60 million gallons of water and treat at county wastewater plant
- Excavate approximately 150,000 cubic yards and dispose at landfill
  - Excavate to reach soil below TP threshold of 600 ppm, while considering habitat
- Install habitat structures and native seed/plants







# Wildlife rescue and relocation



# Fish and wildlife relocation

- Fyke nets
- Seines
- Minnow traps
- Captured and relocated over 45,000 fish
- Nearly 20 species of fish were relocated with sunfishes (*Lepomis* spp.), golden shiners (*Notemigonus crysoleucas*), and killifish (*Fundulus diaphanus*) being the most common.
- Several painted (*Chrysemys picta*) and snapping turtles (*Chelydra serpentina*) were also relocated.



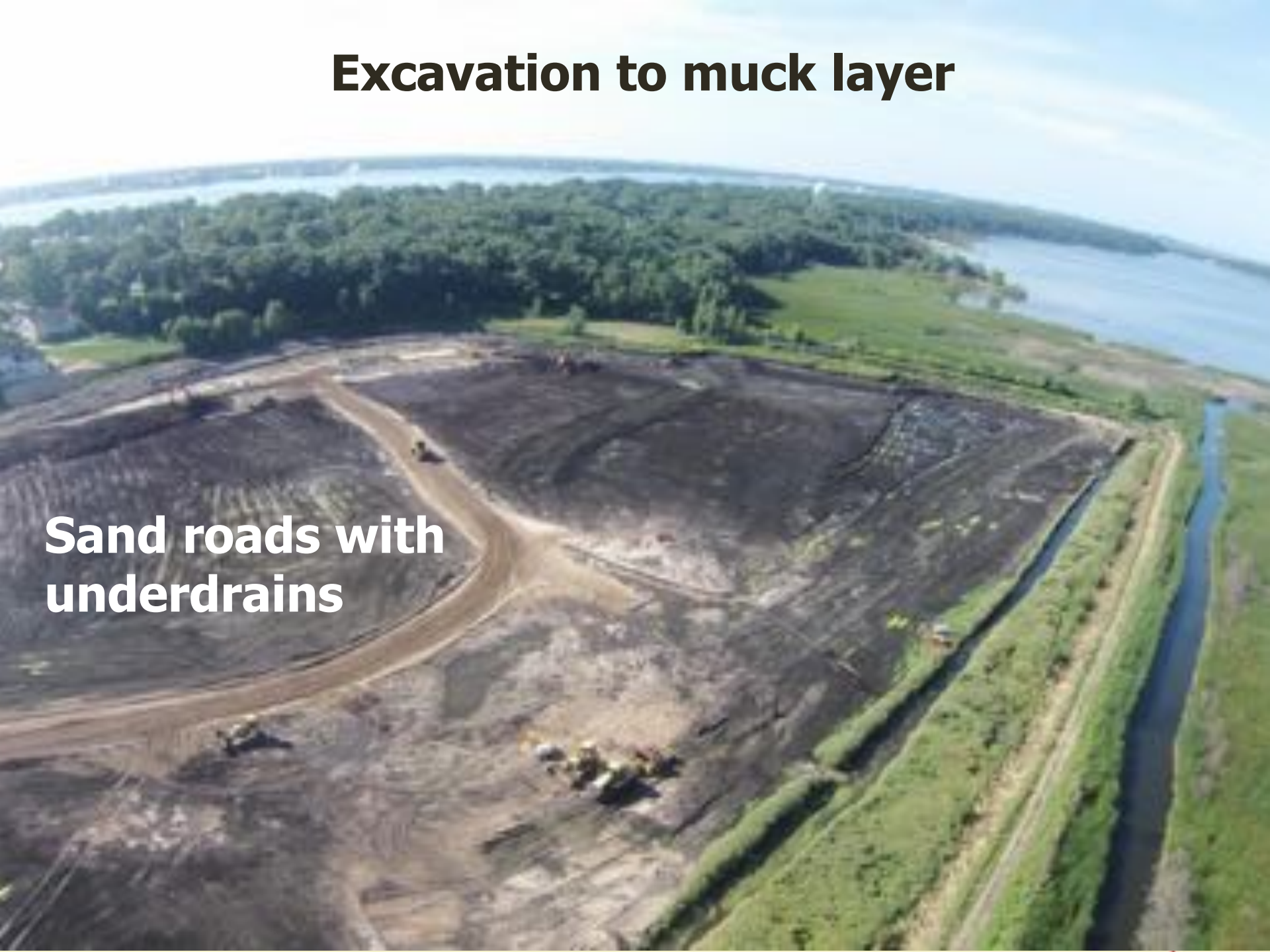






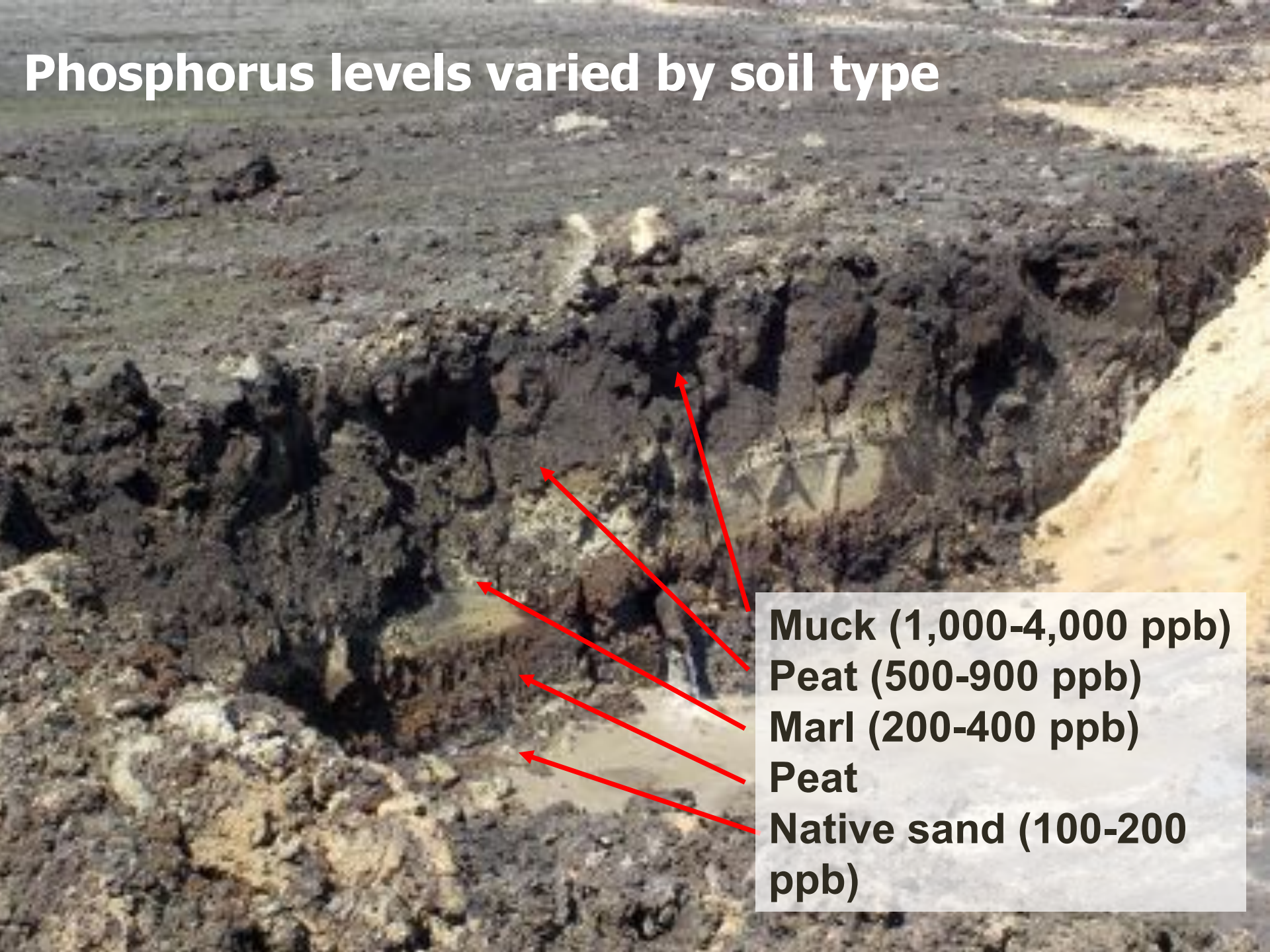
# Excavation to muck layer

**Sand roads with  
underdrains**





# Phosphorus levels varied by soil type



**Muck (1,000-4,000 ppb)**

**Peat (500-900 ppb)**

**Marl (200-400 ppb)**

**Peat**

**Native sand (100-200 ppb)**



# Excavation to native sand

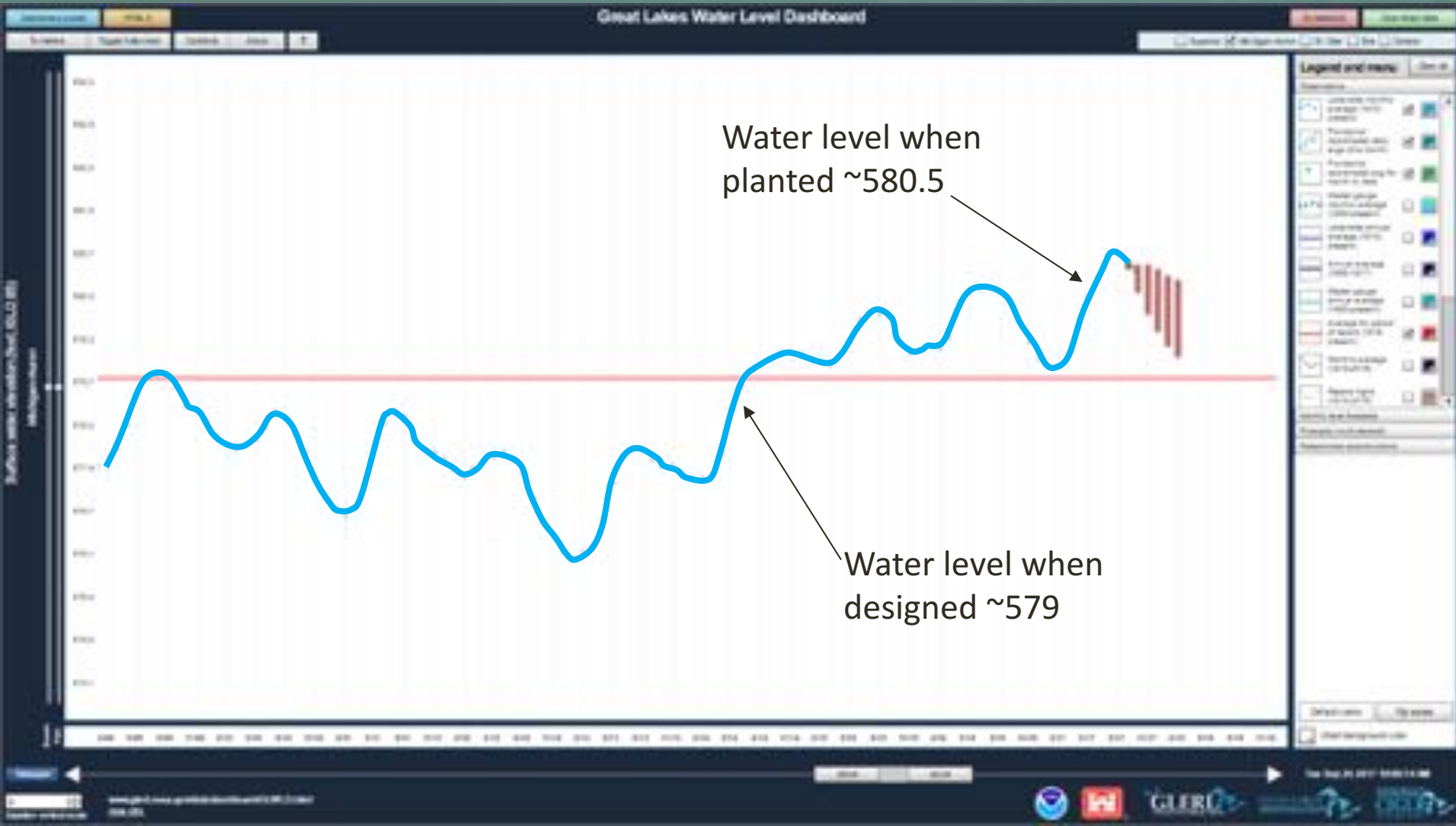




# Habitat structures



# ADAPTAVE DESIGN MODIFICATIONS







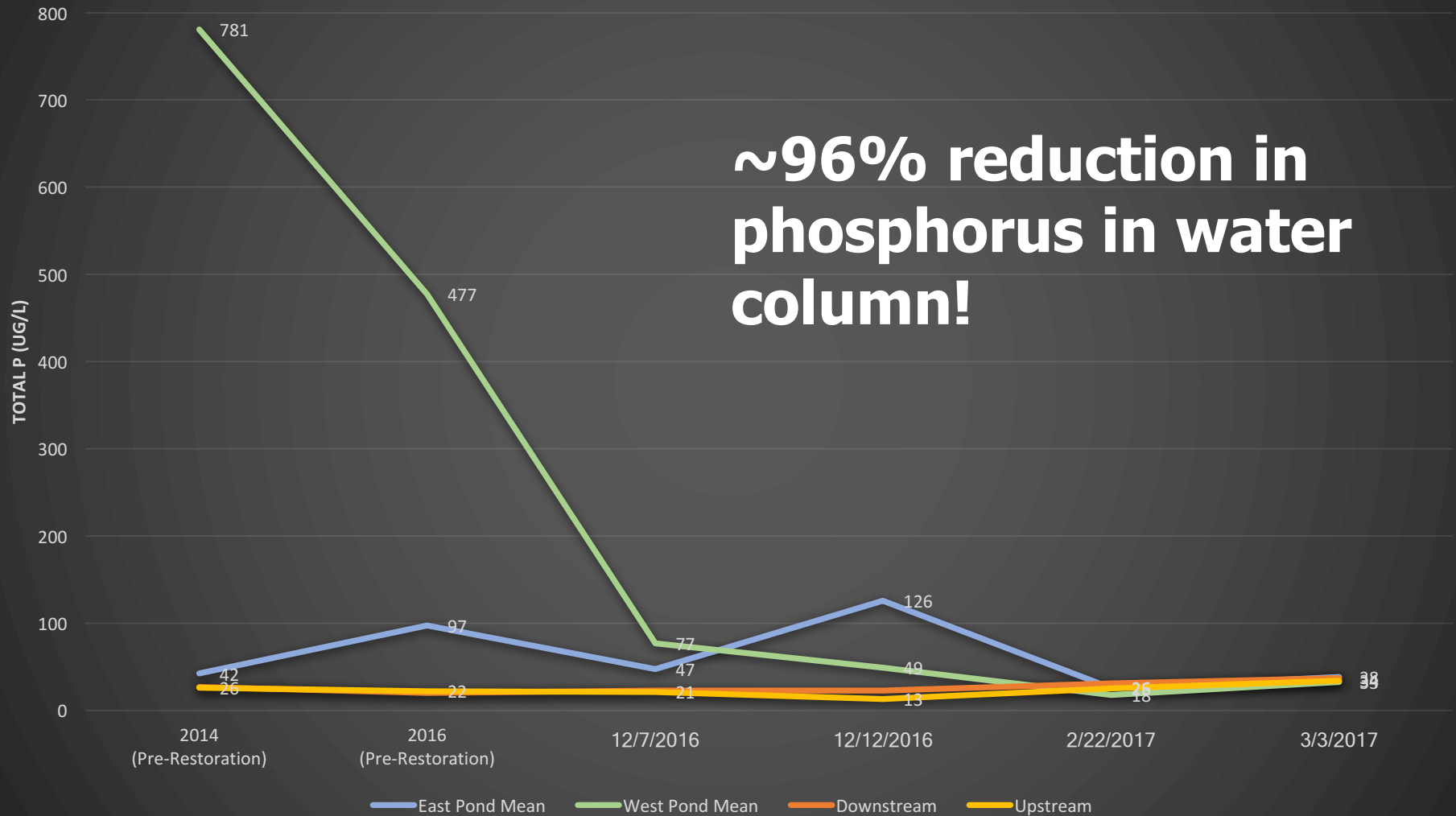




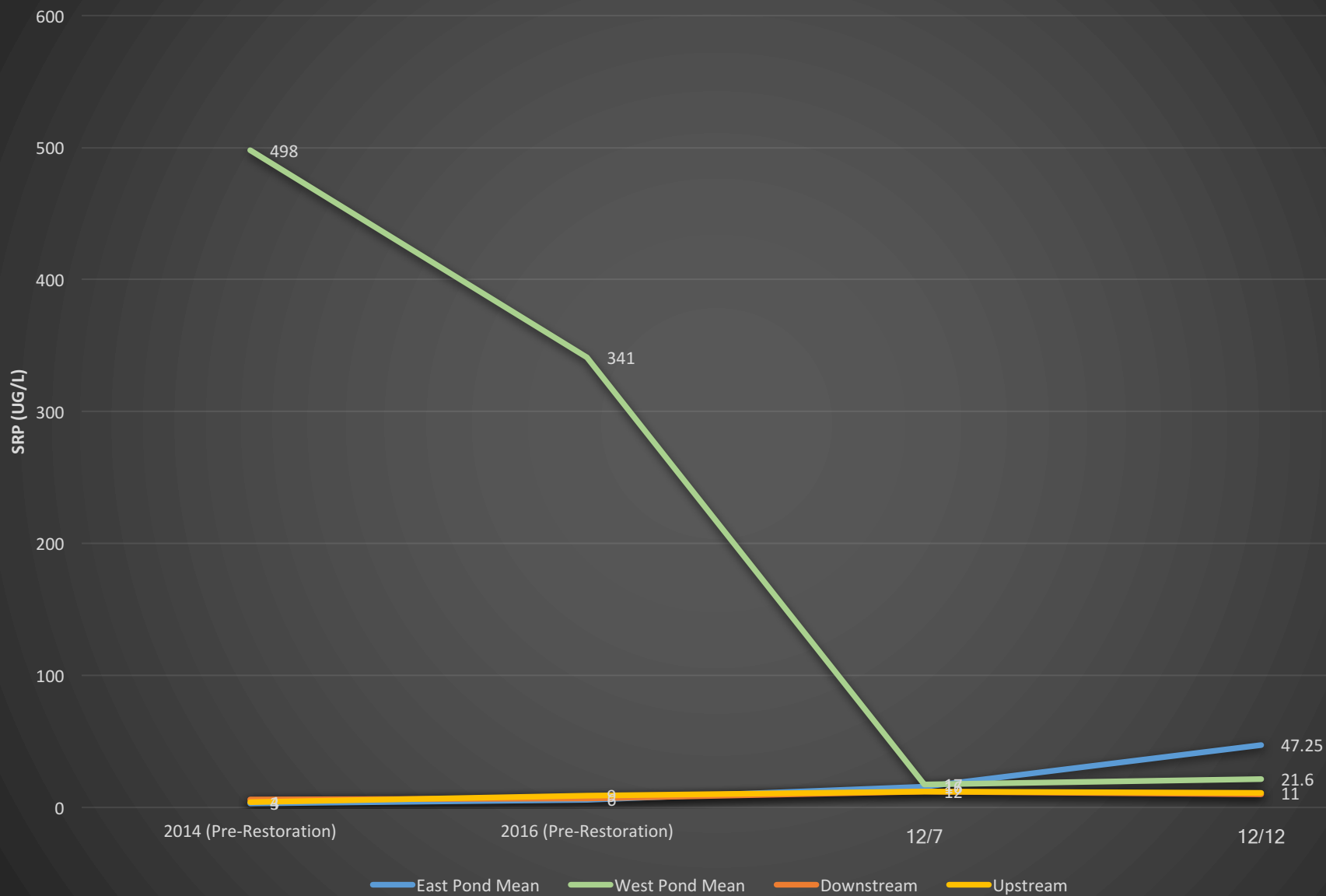
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## Total Phosphorus



## Soluble Reactive Phosphorus











# PLANTING

		Emergent Zone A 269,461 sq ft 6.2 acres	Emergent Zone B 9,140 sq ft 0.2 acre	Submergent Zone 64,827 sq ft 1.5 acre
Scientific Name	Common Name			
<i>Asclepia incarnata</i>	Swamp milkweed	200		
<i>Decodon verticillatus</i>	Swamp loosestrife	200		
<i>Iris virginica shrevei</i>	Blue flag iris	400		
<i>Liatris spicata</i>	Marsh blazing star	200		
<i>Lobelia cardinalis</i>	Cardinal flower	200		
<i>Nuphar advena</i>	Spatterdock	500		400
<i>Nymphaea tuberosa</i>	White water lily	500		400
<i>Peltandra virginica</i>	Arrow arum	1,500		700
<i>Pontederia cordata</i>	Pickernelweed	1,800		600
<i>Sagittaria latifolia</i>	Arrowhead	1,200		
<i>Vallisneria americana</i>	Wild celery	500		1,000
<i>Carex comosa</i>	Bristly sedge	200	100	
<i>Carex muskingumensis</i>	Sand bracted sedge	200	100	
<i>Carex vulpinoidea</i>	Brown fox sedge		100	
<i>Juncus effusus</i>	Soft rush	400	100	
<i>Schoenoplectus acutus</i>	Hardstem bulrush	700		
<i>Schoenoplectus pungens</i>	Common threesquare	1,200		
<i>Schoenoplectus tabernaemontani</i>	Softstem bulrush	1,200		
<i>Sparganium eurycarpum</i>	Common burreed	800		
	<b>TOTALS:</b>	<b>11,900</b>	<b>400</b>	<b>3,100</b>















# ADAPTIVE MANAGEMENT

- Nutrient poor soil + high water levels=Slow plant growth
- Muskrat damage
- Hydrologic reconnection + high water levels=Jet skis, pontoons, and fishermen
- Invasive species treatments

















# THANK YOU!

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