Lake Lawrence Cyanobacteria Management Plan
Draft Plan

April 16, 2026

THURSTON COUNTY
WASHINGTON
SINCE 1852

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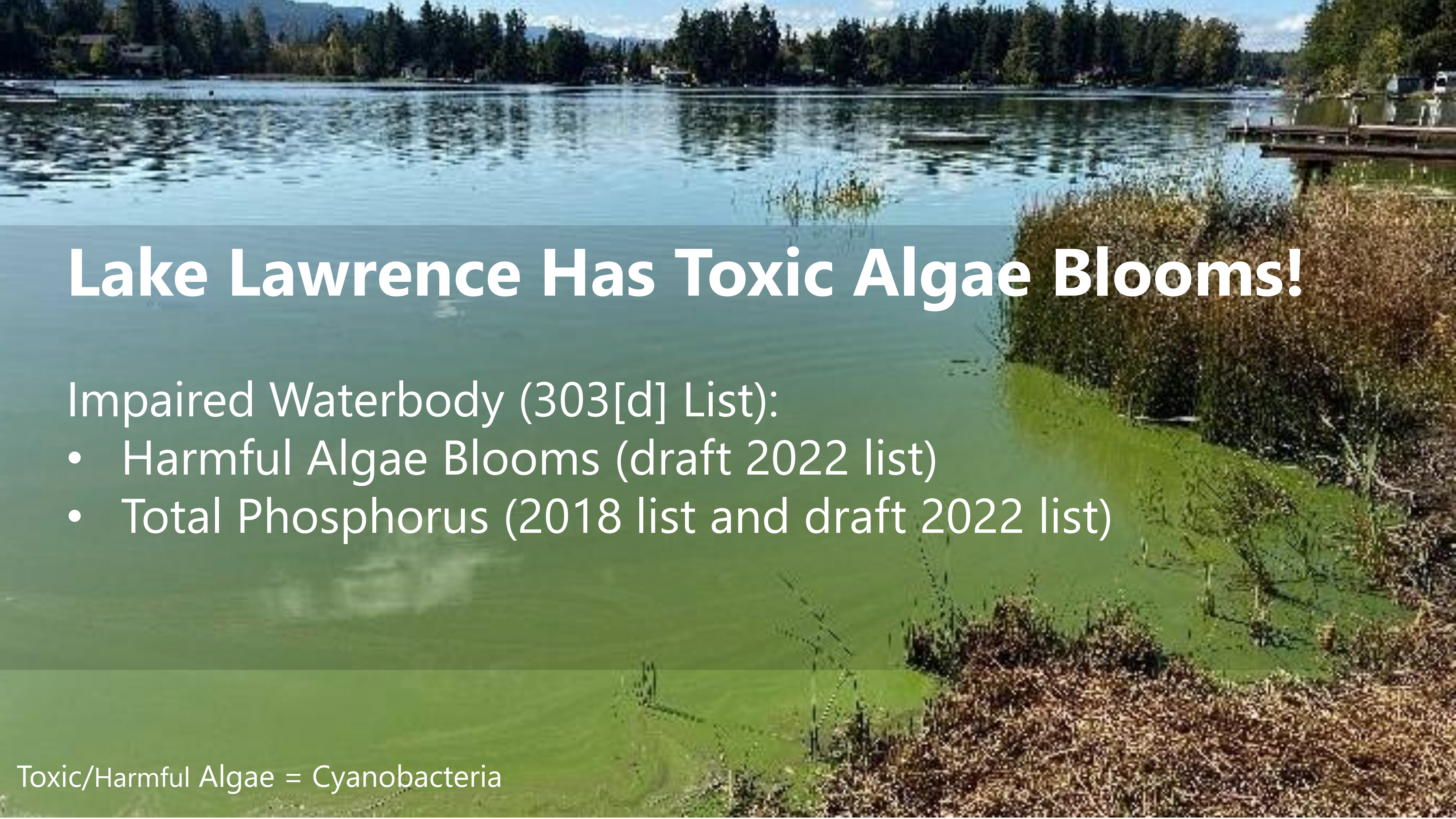
Agenda

1. Why are there blooms?
2. Phosphorus Load
3. Management Recommendations
4. Timeline & Costs
5. Questions and Discussion



Lake Lawrence Has Toxic Algae Blooms!

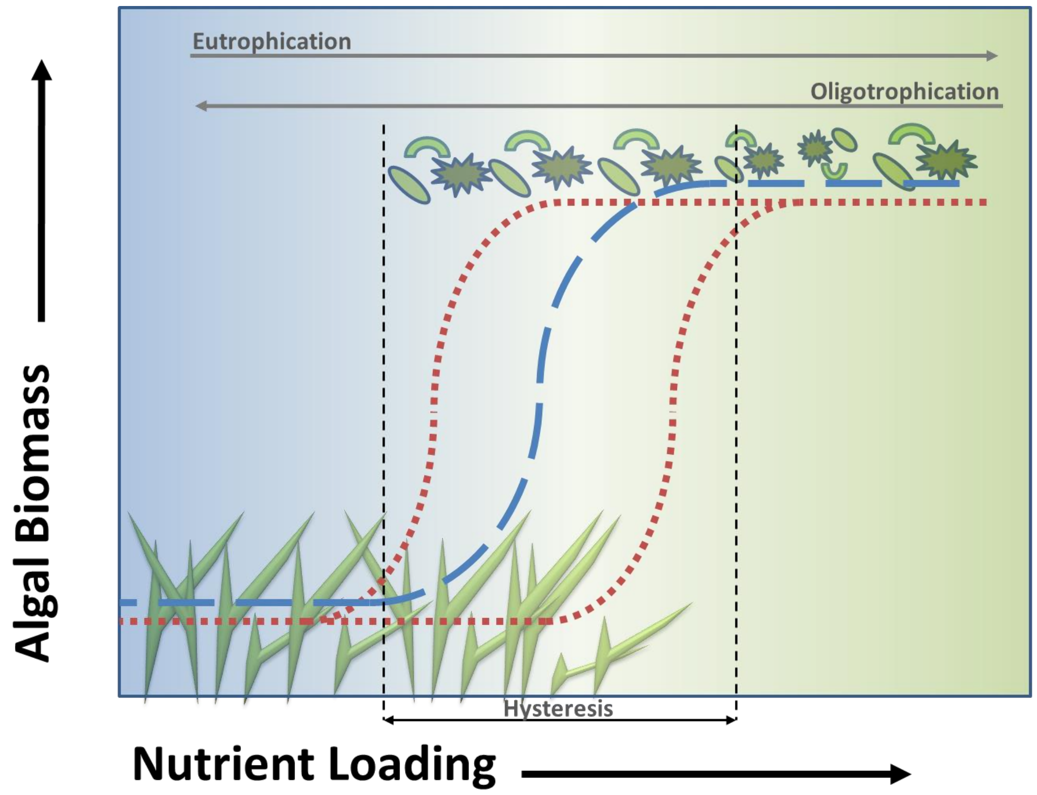
Impaired Waterbody (303[d] List):

- Harmful Algae Blooms (draft 2022 list)
- Total Phosphorus (2018 list and draft 2022 list)

Toxic/Harmful Algae = Cyanobacteria

Lake Eutrophication

- Increasing nutrients in a lake, frequently from land runoff, which increases algae growth and decay
- Natural and cultural nutrient sources



- Moderate amounts support ecological diversity and fish productivity
- Excessive amounts impact ecology and human activities

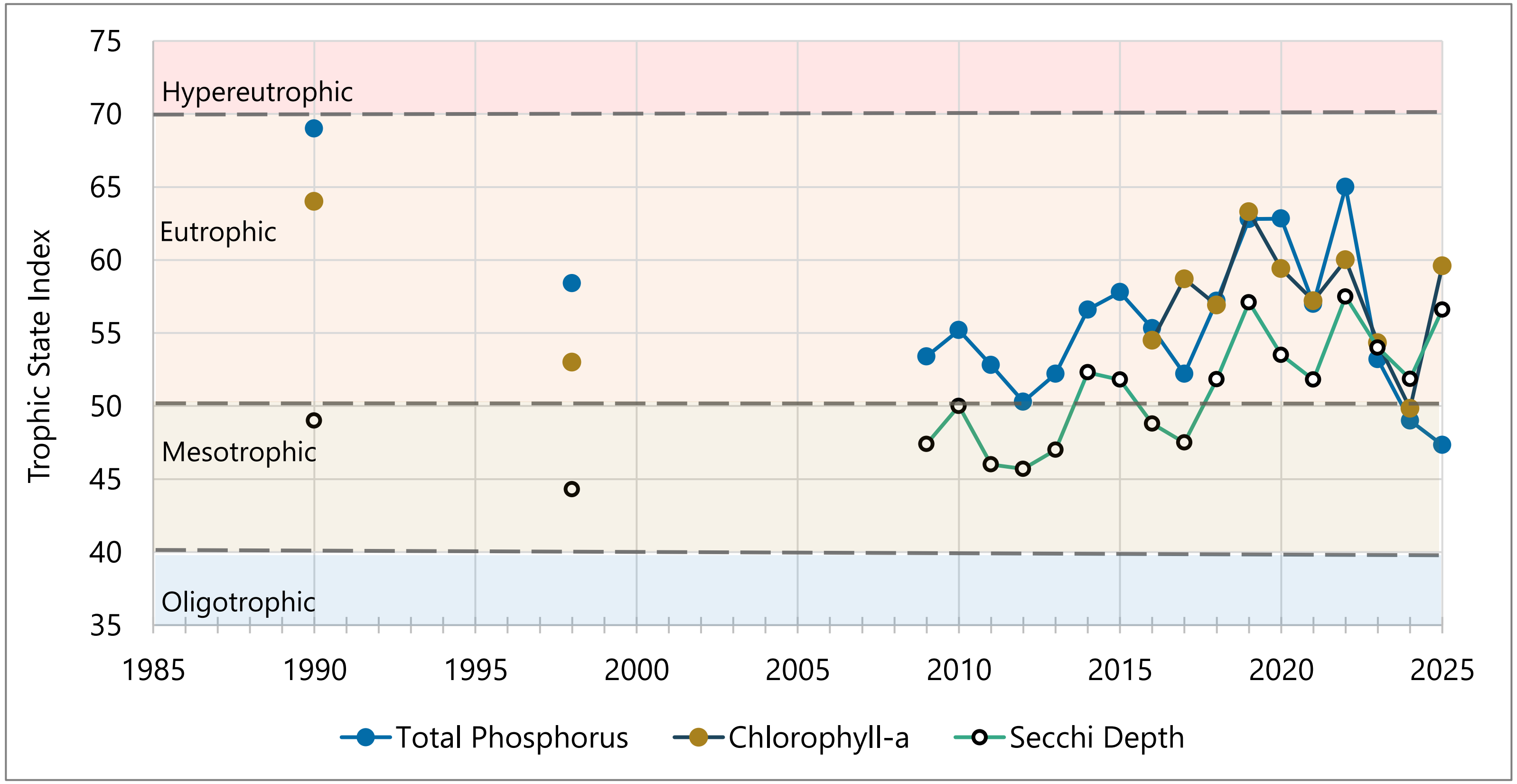
Lake Trophic State

Classes
- Hypereutrophic
- Eutrophic
- Mesotrophic
- Oligotrophic

Trophic Class	Trophic State Index	Total Phosphorus (µg/L)	Chlorophyll-a (µg/L)	Secchi Depth (meters)
Hypereutrophic	> 70	> 96	> 56	< 0.5
Eutrophic	50 to 60	24 to 48	7.2 to 20.1	1 to 2
Mesotrophic	40 to 50	12 to 24	2.6 to 7.2	2 to 4
Oligotrophic	< 40	< 12	< 2.6	> 4

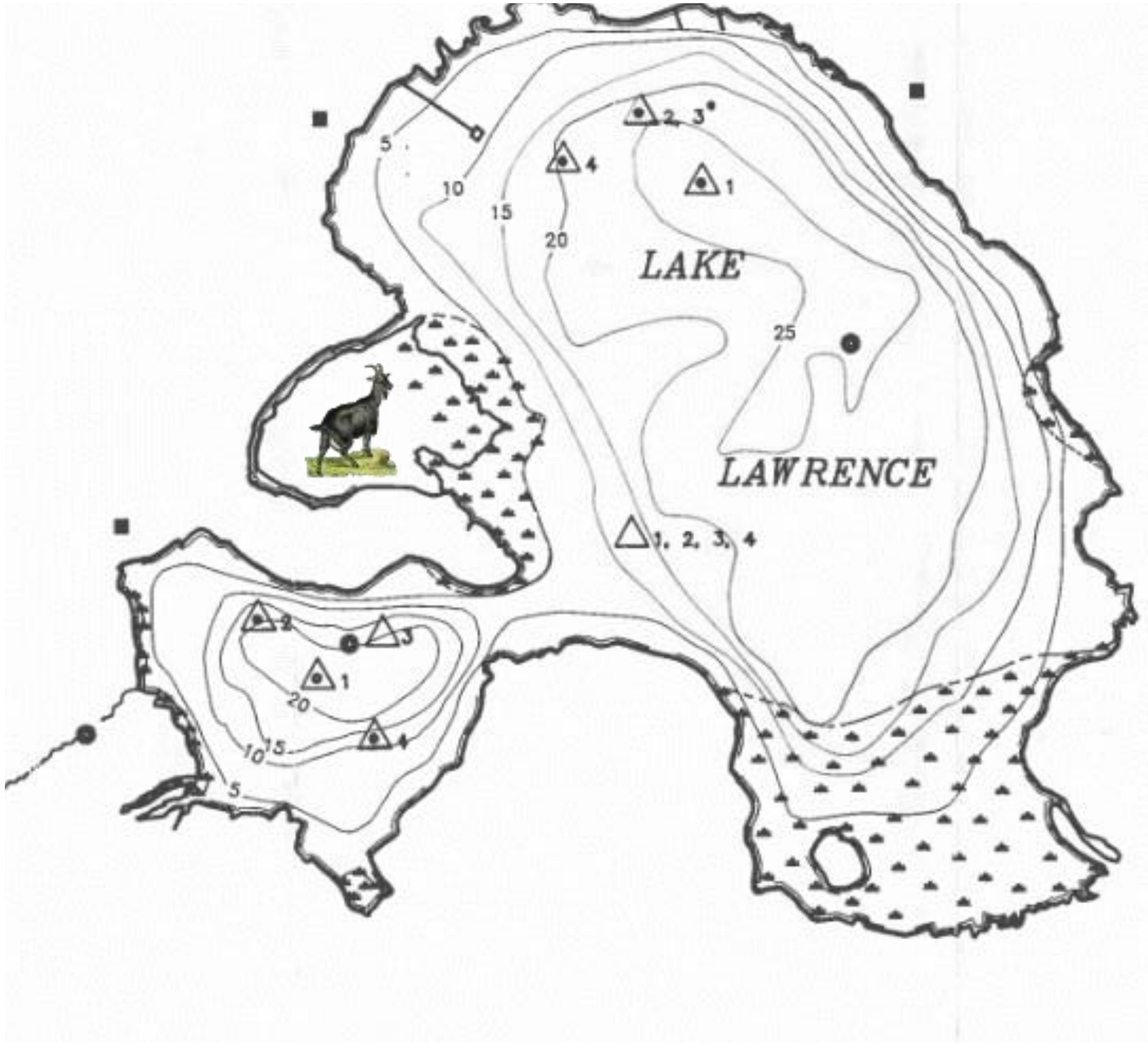
Indices (Summer Mean)
- Total Phosphorus
- Chlorophyll-a
- Secchi Depth

Big (East) Basin Trophic State Indices



Lake Lawrence TSI:
- **Eutrophic** (sometime mesotrophic)
- No apparent trend.

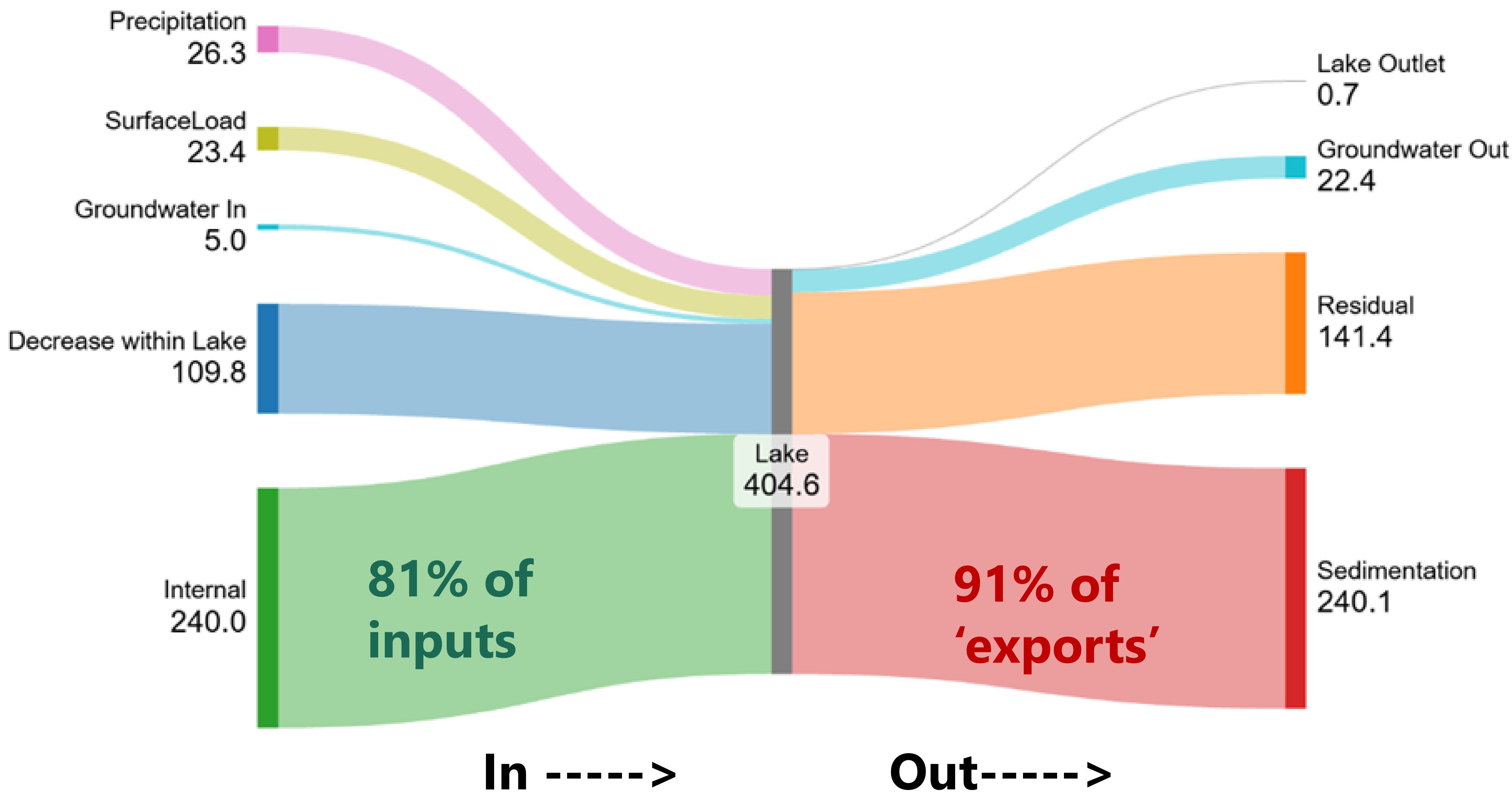
Where Does the Phosphorus Come From?



Deschutes River diversion in early 1900s dumped excess river sediment, containing erosion from newly logged forests, which settled to the lake bottom.

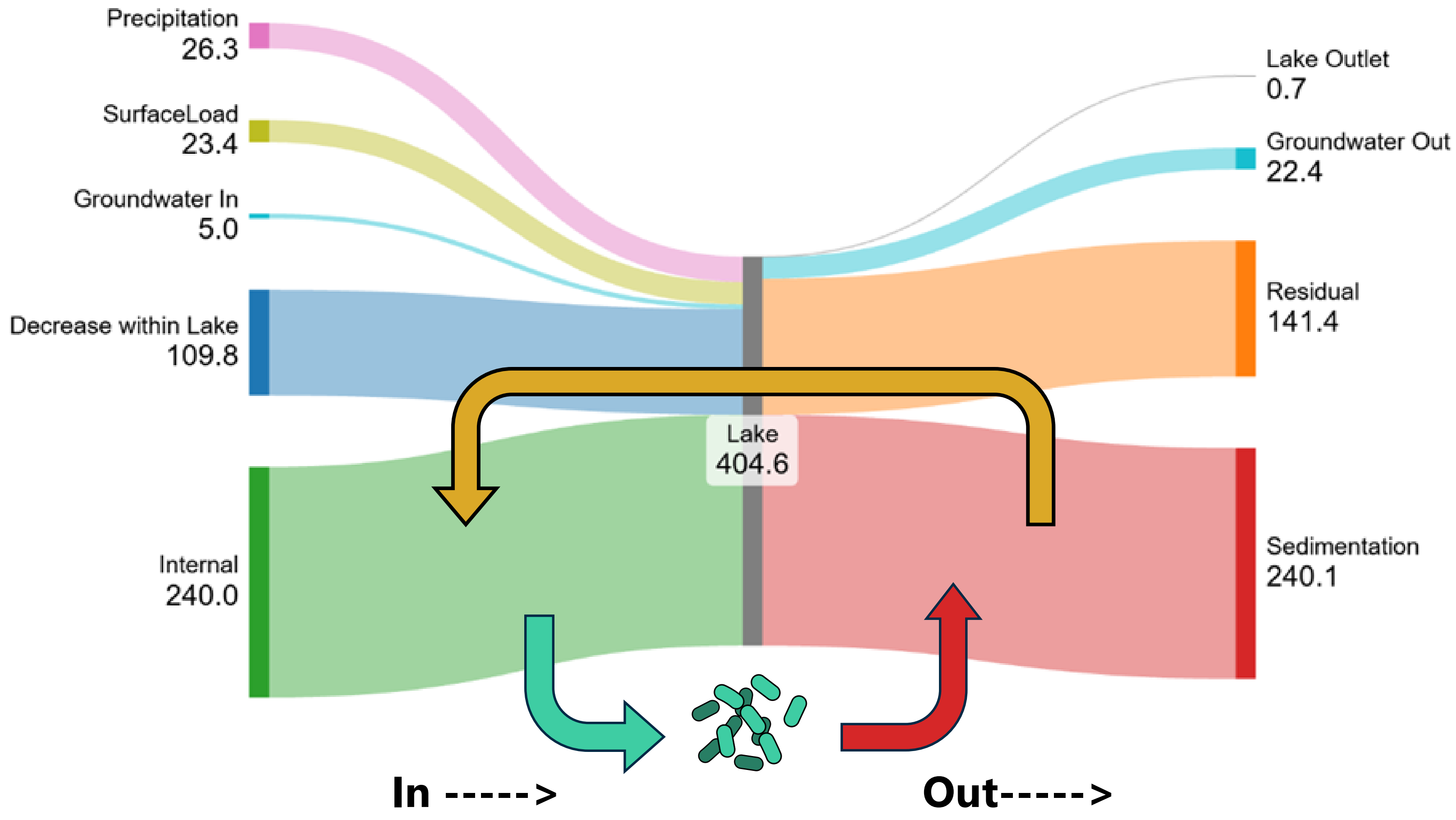
Today, nutrients enter the lake via surface water and groundwater inflows and very little is exported…

Phosphorus Budget (kg/year)



Where Does the Phosphorus Come From?

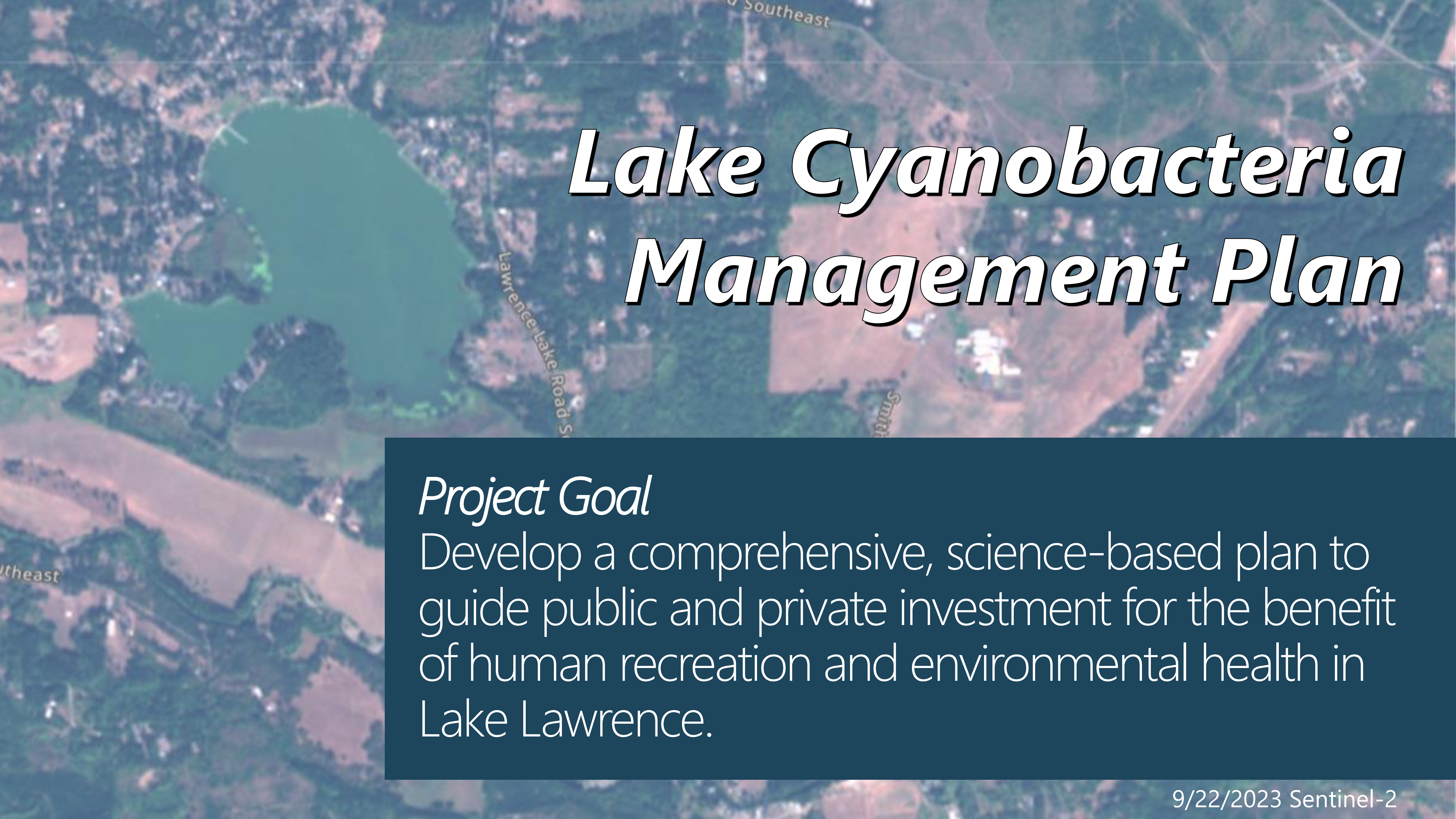
Phosphorus Budget (kg/year)



Nutrients and organic matter settle and accumulate in the lake sediments.

Phosphorus is released during decay; some may bond to metals in sediment.

Low oxygen dissolves the Fe-P complexes, allowing P to be released from the sediments.



Lake Cyanobacteria Management Plan

Project Goal

Develop a comprehensive, science-based plan to guide public and private investment for the benefit of human recreation and environmental health in Lake Lawrence.

9/22/2023 Sentinel-2

Lake Cyanobacteria Management Plan

The Plan focuses on Surface Water Quality
The Plan does not focus on…

- Fisheries
- Aquatic Plants
- Drinking/Ground Water Quality
- Flooding

We will consider co-benefits/consequences of surface water quality management strategies for those endpoints.

1. **Background**
   - Lake & Watershed History, Uses
   - Previous & Current Management Actions
2. **Goals, Objectives, and Success Measures**
3. **Monitoring Study Findings, Water & Phosphorus Models**
4. **Recommended Management Actions** (including timeline & costs)
5. **Adaptive Management Framework**
6. **Appendices**
   - A: Water Quality Report & Budgets
   - B: Laboratory Reports
   - C: Cyanobacteria Management Methods
   - D: Additional Funding Options
   - E: Glossary

Management Elements for Lake Lawrence

ESTABLISH ALGAE MANAGEMENT OBJECTIVES

CHOOSE & IMPLEMENT IN-LAKE STRATEGIES

CONTINUE WATER QUALITY MONITORING & ALGAE SURVEILLANCE

IMPLEMENT WATERSHED SOURCE CONTROL ACTIVITIES, EDUCATION & OUTREACH

ADAPTIVE MANAGEMENT FRAMEWORK

FUNDING & ADMINISTRATION

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Lake Management Objectives

1. *Within a 5-year period, no more than 1 year with 2+ bloom events or events that last longer than 3 weeks.**
2. *Lake Lawrence is maintained at or below a 'mesotrophic' status (summer avg)*
   - *Surface Chl-a < 7.2 µg/L*
   - *Surface TP < 24 µg/L*
   - *Secchi depth > 2.0 meters*

Trophic Class	TSI	TP (µg/L)	Chl-a (µg/L)	Secchi (m)
Hypereutrophic	> 70	> 96	> 56	< 0.5
Eutrophic	50 to 60	24 to 48	7.2 to 20.1	1 to 2
Mesotrophic	40 to 50	12 to 24	2.6 to 7.2	2 to 4
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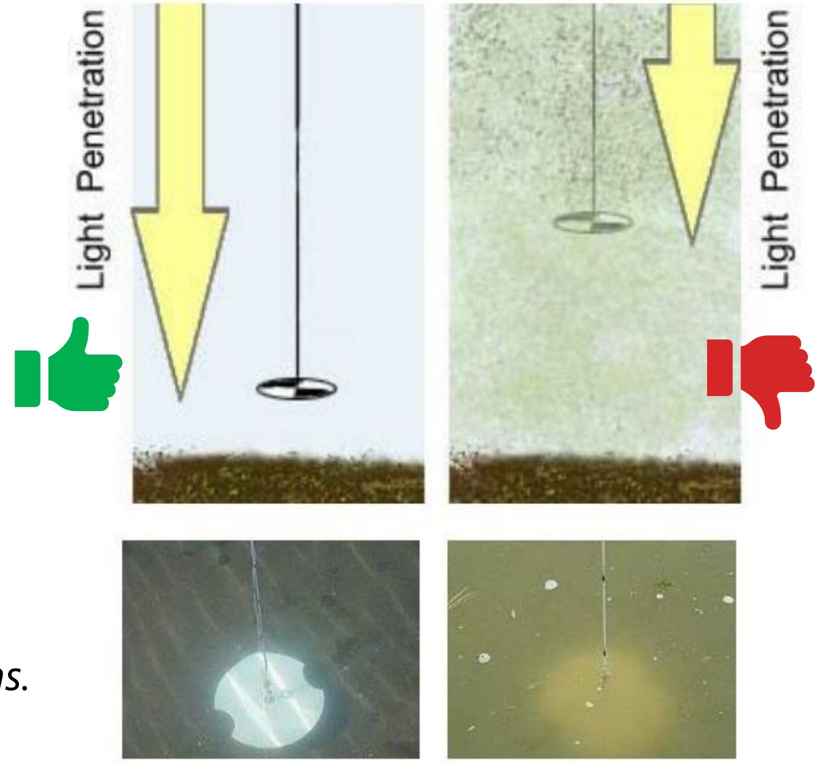

**Adapted from Ecology's criteria for determining lake impairment due to harmful algae blooms. Achieving these goals should allow the lake to be delisted from the 303(d) list if maintained.*

Managing Algae Requires Phosphorus Control…

“Phosphorus Inactivation”

Lake Management Alternatives

In-Lake Controls - Feasible

- Hypolimnetic Oxygenation
- Phosphorus Inactivation
  - Alum
  - Lanthanum
  - Iron, Calcium
  - Proprietary Chemicals

Lock-in Sediment P

In-Lake Controls - Infeasible (high cost and/or low effectiveness/confidence)

- *Algaecides*
- *Dredging*
- *Microbes/Enzymes*
- *Dye*
- *Barley Straw*
- *Dilution/Flushing*
- *Drawdown*
- *Hypolimnetic Withdrawal*
- *Nanobubbler*
- *Ultrasound (LG Sonic)*
- *Biomanipulation*
- *Lake Circulation*
  - *Surface or whole*
  - *Aeration*
  - *Solar Bee*

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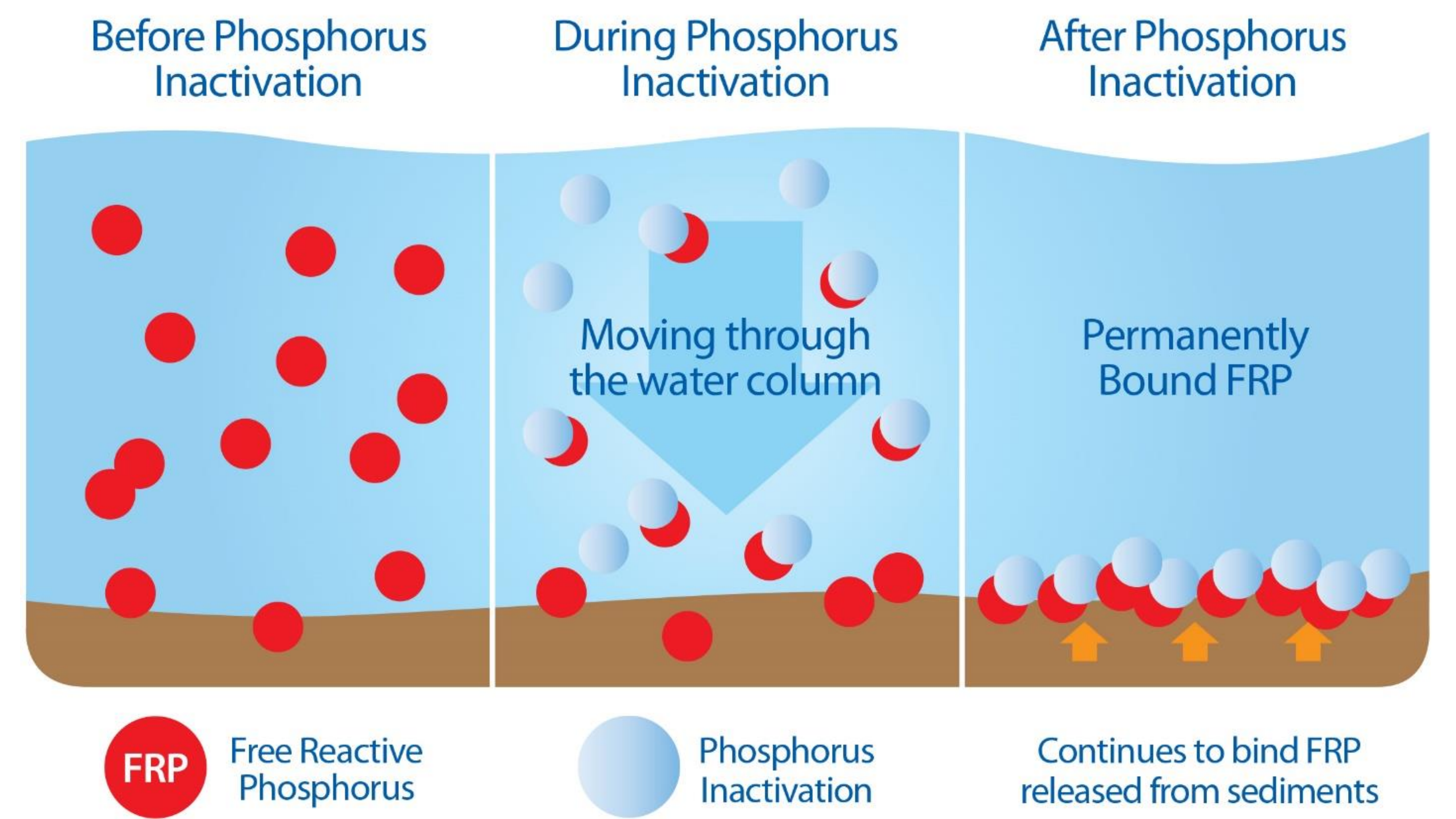
Lake Management Alternatives

Option A: High Dose, Lake Reset Treatment
Designed to Last 10+ Years

Option B: Annual, Low Dose Treatment
Annual Maintenance Doses (sub-option to pilot Iron Treatment)

Option C: Hypolimnetic Oxygenation
Built infrastructure to provide long-lasting benefits


Before Phosphorus Inactivation
During Phosphorus Inactivation
After Phosphorus Inactivation
Moving through the water column
Permanently Bound FRP
FRP
Free Reactive Phosphorus
Phosphorus Inactivation
Continues to bind FRP released from sediments

Chemical Phosphorus Inactivation Comparison

	Alum	Lanthanum	Iron
Commercial Products	Available from general chemical suppliers		
Mode of Inactivation	Forms stable complexes with dissolved phosphorus. Forms floccules that pull particulat phosphorus from the water column. Stable at pH range 6 to 9		
Application Approach	Applied at water surface, sink and incorporate into the lake sediments.		
Relative Cost	**$-$$ (unbuffered)** **$$-$$$ (buffered)**		
Potential Negative Consequences	Possible aquatic life toxicity with improper application		
Permitting	Approved in Ecology Permit, with pre- and post-treatment monitoring requirements.		
Longevity	**1 year (unbuffered)** **5 to 10+ years (buffered)**		
Confidence in Effectiveness	**High, established studies.**		
Recent Examples in Washington	Lacamas Lake, Camas, Washington (2024, 2025 treatment with lanthanum) Lake Ketchum, Snohomish County, Washington (2025, annually [unbuffered]) Blackmans Lake, Snohomish, Washington (2025		

Option A: Lake 'Reset' Treatment

Blackmans Lake 2025 Alum Treatment

- Whole-lake treatment
- Higher dose of Buffered Alum or Lanthanum (EutroSORB G/SI or Phoslock)
- One-time treatment may last 10+ years, particularly in lakes with low external loading
- High upfront cost
- APAM permit-required monitoring and reporting

Implementation Timing:

- Year 1 – Obtain Funding & Sediment Study
- Year 2 Spring – Treatment

Costs:

$0.76 million (buffered alum)
$1.1 to $1.4 million (lanthanum)
($76K to $141K / year, annualized over 10 years)

For Example…

Lanthanum treatments in Long Lake in 2023 (Thurston County)

Alum ‘reset’ treatments in Green Lake, Seattle, in 1991, 2004, and 2016

Lake Management Alternatives

Option A: High Dose, Lake Reset Treatment
Designed to Last 10+ Years

Option B: Annual, Low Dose Treatment
Annual Maintenance Doses (sub-option to pilot Iron Treatment)

Option C: Hypolimnetic Oxygenation
Built infrastructure to provide long-lasting benefits

Option B1: Annual, Lower Dose Treatments

- Annual (or regular) treatments
- Lower doses of Alum or Lanthanum (EutroSORB G/SI or Phoslock)
  - If Alum- provides ongoing water quality clarification and flexibility
  - If Lanthanum – spreads out costs, but only targets sediment
- No high upfront cost, but higher costs/treatment due to mobilization and…
- APAM permit-required monitoring and reporting
- Likely long-term commitment to treatment

Implementation Timing:

- Year 1 –Sediment Study & 1st Treatment
- … Annual Treatments

Annual Treatment Cost:
$86,500 (alum) or $134,000 to $165,300 (lanthanum)
10 Year Total Cost:
$1 million (alum) or $1.6 to $2 million (lanthanum)

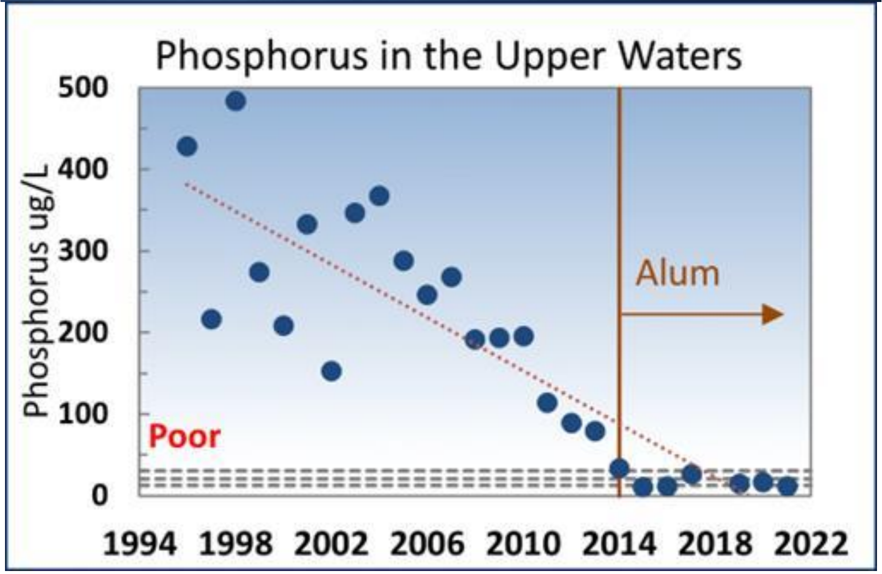
For Example…

August 2019 Pre Treatment

August 2021

Kitsap Lake does annual EutroSORB G treatments (lanthanum)

Lake Stevens does annual alum treatments



Option B2: Pilot Zero Valent Iron (ZVI) Treatment

- Performance in [anoxic] lakes is understudied and unknown = PILOT in Lake Lawrence
- Low materials cost.
- Low confidence in success based on case studies.
- If effective, monitor to determine if and when additional treatments are needed
- If not effective, pursue B1 Annual Alum/Lanthanum treatments

Implementation Timing:
- Year 1 –Pilot Treatment
- ongoing– continue, or switch to alum/lanthanum treatments

Costs:
$57,000 / treatment (year)

If Effective	$57,000 over 10 years
If Not Effective	$1-2M over 10 years

Lake Management Alternatives

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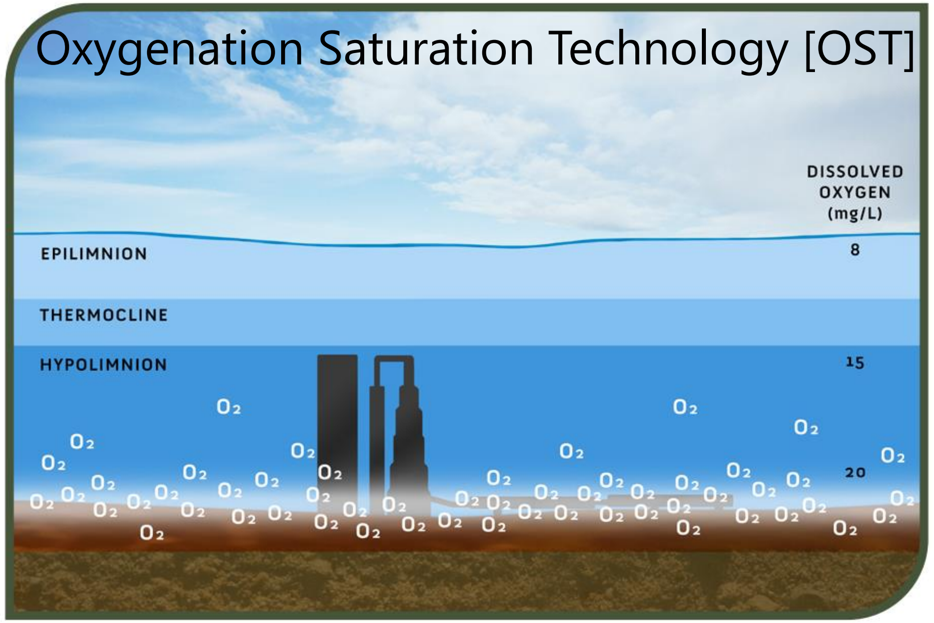
Built infrastructure to provide long-lasting benefits

Option C: Hypolimnetic Oxygenation

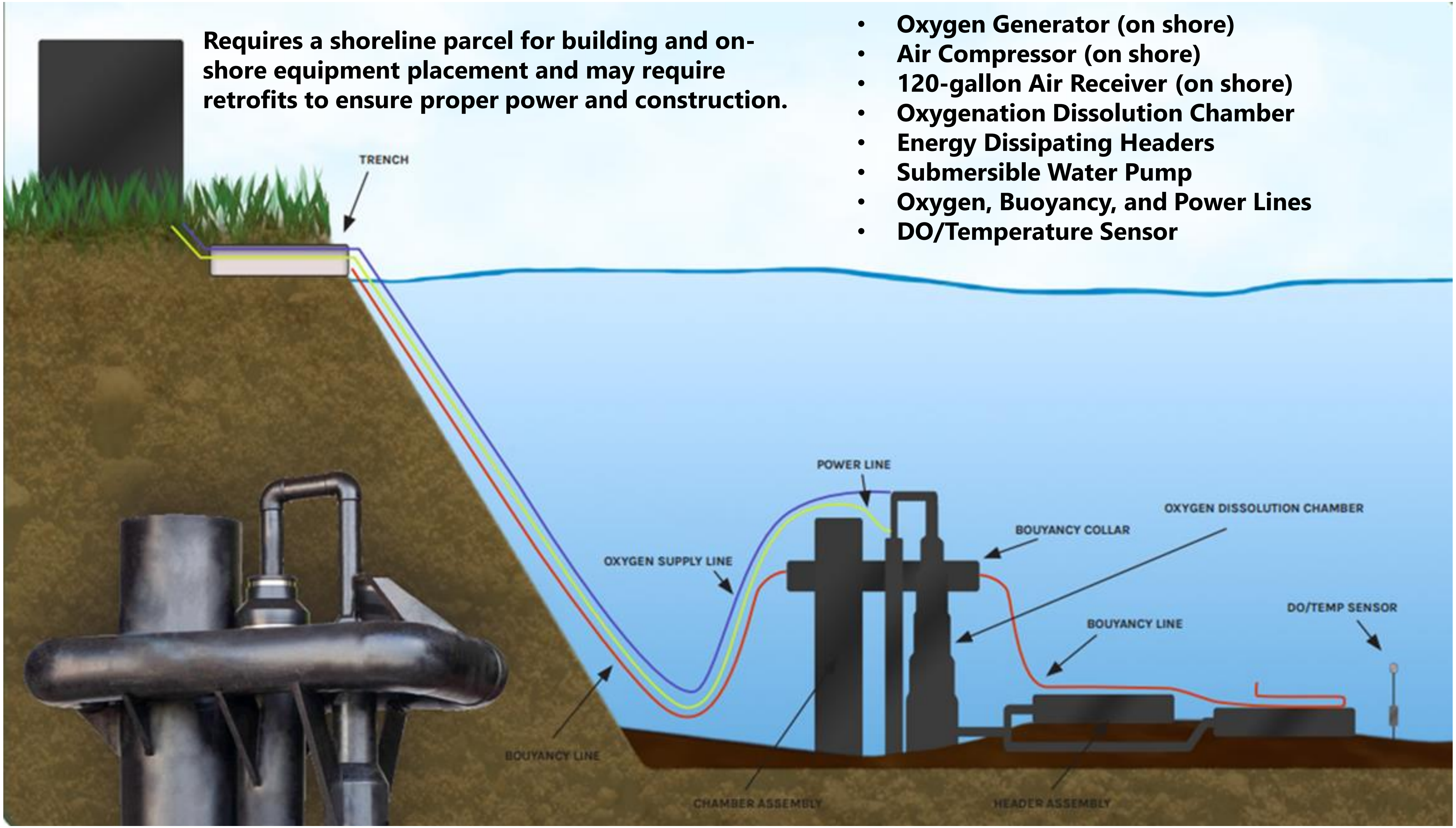
- Oxygen delivered to deepest part of the lake all summer
- Oxygen locks the P in sediments to prevent release from iron bonds.
- Currently being implemented for Spanaway Lake in Pierce County.
- Requires continuous power supply/operation, regular maintenance, land for on-shore facility.
- *Added benefit:* Provides cool habitat for cold-water fish, like trout



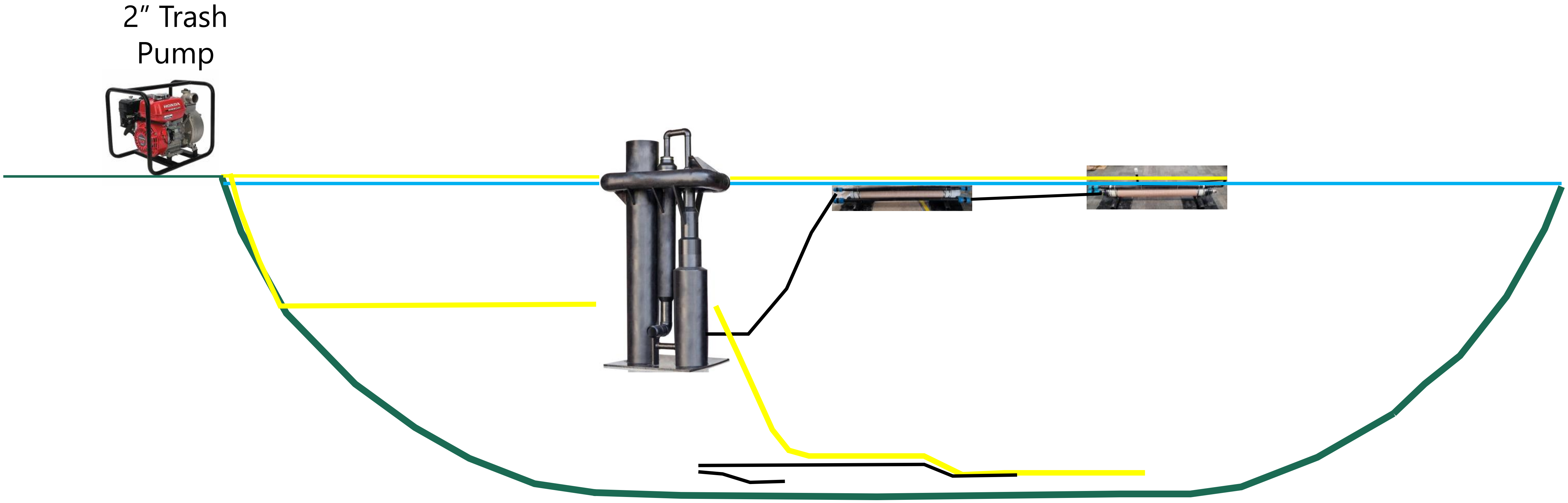
OST System Components

Requires a shoreline parcel for building and on-shore equipment placement and may require retrofits to ensure proper power and construction.

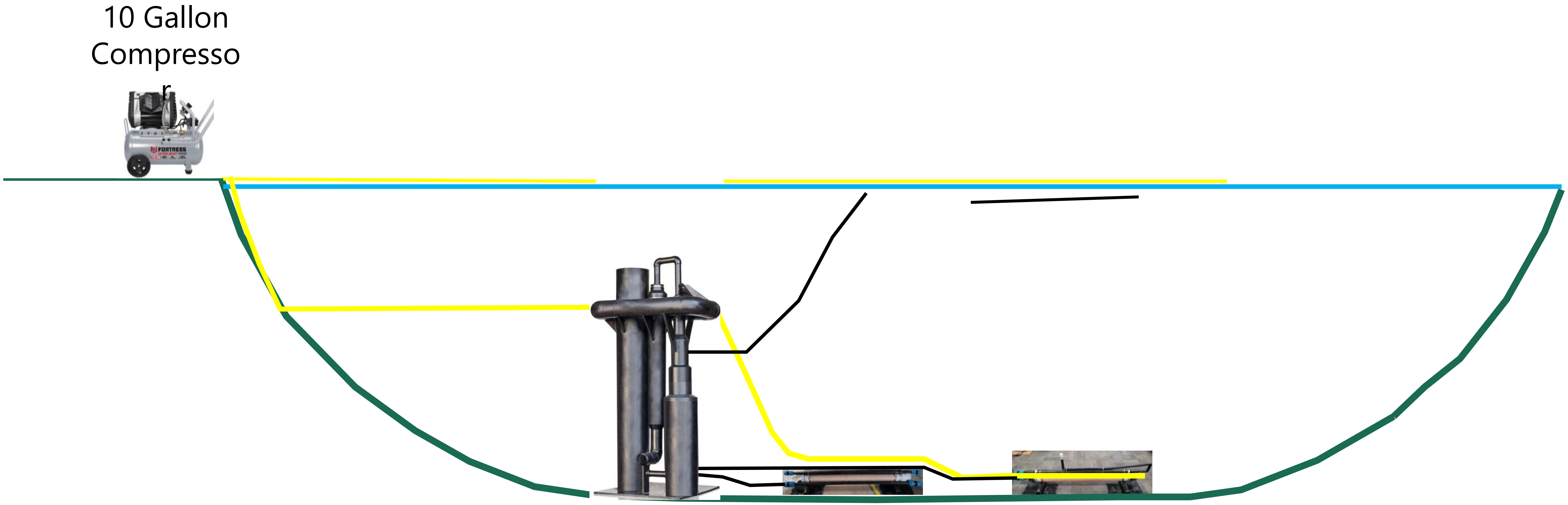
- **Oxygen Generator (on shore)**
- **Air Compressor (on shore)**
- **120-gallon Air Receiver (on shore)**
- **Oxygenation Dissolution Chamber**
- **Energy Dissipating Headers**
- **Submersible Water Pump**
- **Oxygen, Buoyancy, and Power Lines**
- **DO/Temperature Sensor**



OST® Deployment



OST® Recovery



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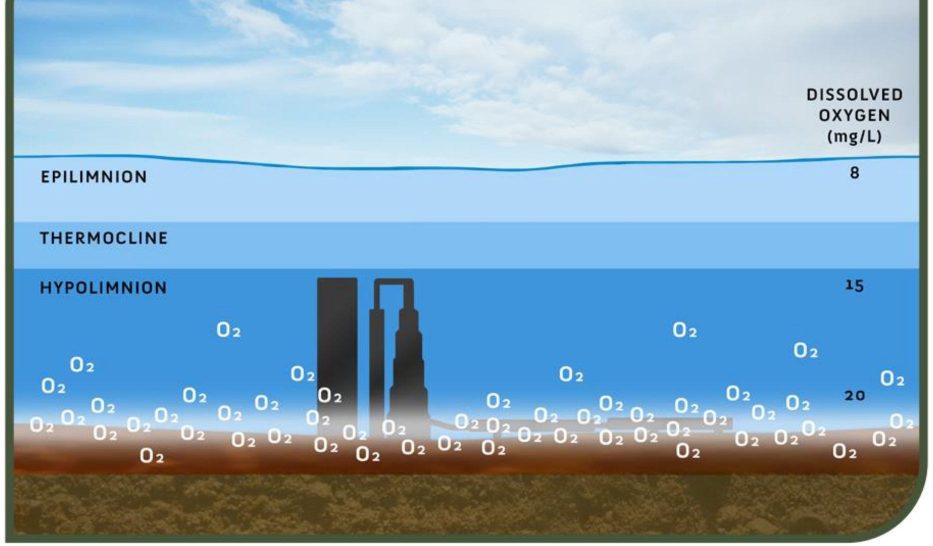
Oxygenation Saturation Technology [OST]



Implementation Timing:
- Year 1 – Secure Funding, Begin Design & Permitting
- Year 2 – Design & Permitting
- Year 3 – Installation

Costs:
$2.4 million to design, permit, & construct
$22,000 O&M
= $260,000 / year, annualized over 10 years

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Watershed Management Strategies

Watershed source is primarily **Groundwater**

1. OSS Inspections, repair, replacement
2. Pollution reduction (e.g., pet waste, fertilizers, waterfowl habitat)
3. Agricultural BMPs
4. Native plantings

Your SEPTIC SYSTEM affects your lake

Don't let your septic system spoil your lake.

Schedule routine inspections.

Make Clear Choices for Your Lake

Your PET'S WASTE affects your lake

If it's in your yard, it's in your lake.

Scoop pet waste, bag it and place it in the trash.

Healthy shorelines attract beneficial wildlife

Watch your shoreline come alive

Your LAWN CARE affects your lake

Have a beautiful lawn the natural way . . .

LakeWise ©Snohomish County

When Could We Implement These P Inactivation Options and What Do They Cost?

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Timing	Option A – "Lake Reset" Treatment		Option B1 – Annual Lower Dose Treatment		Option B2 – ZVI Pilot		Option C: Hypolimnetic Oxygenation System	
	Activity	Cost (2026$)	Activity	Cost (2026$)	Activity	Cost (2026$)	Activity	Cost (2026$)
Year 1	Secure Funding	–	Plan and Conduct Alum or Lanthanum, +Monitoring	$86.5K to $165K	Plan and Conduct ZVI Treatment	$57K	Secure Funding	–
Year 2								
Year 3								
Year 4-10								
Year 10								
Total 10-Year Cost								
Annualized 10-Year Cost								

Timing	Option A – "Lake Reset" Treatment		Option B1 – Annual Lower Dose Treatment		Option B2 – ZVI Pilot		Option C: Hypolimnetic Oxygenation System	
	Activity	Cost (2026$)	Activity	Cost (2026$)	Activity	Cost (2026$)	Activity	Cost (2026$)
Year 1	Secure Funding	–	Plan and Conduct Alum or Lanthanum, +Monitoring	$86.5K to $165K	Plan and Conduct ZVI Treatment	$57K	Secure Funding	–
Year 2	Design and Implement	$760K to $1.41M	Conduct Alum or Lanthanum, +Monitoring	$86.5K to $165K	Review Pilot Effectiveness & Plan Future Treatment(s)	If effective, $0. If not effective, $86.5K to 165K.	Design, Permitting, & Procurement	$220K + permitting
Year 3	Routine Monitoring	–	Conduct Alum or Lanthanum, +Monitoring	$86.5K to $165K	TBD, depending on ZVI effectiveness + Monitoring	$0 to $165K	Installation	$2.2M
Year 4-10	Routine Monitoring	–	Conduct Alum or Lanthanum, +Monitoring	$86.5K to $165K per year		$0 to $165K per year	System Operations & Maintenance +Monitoring	$22K per year
Year 10	Re-evaluate P Budget							
Total 10-Year Cost	$760K to $1.41M		$1M to $2M		If ZVI Effective: $57K Else: $1M to $2M		$2.6M	
Annualized 10-Year Cost	$76K to $141K		$100K to $200K		If ZVI Effective: $5.7K Else: $100K to $200K		$260K	

How can this be funded?

- Lake Management District Rates
- Thurston County Budget Allocations
- State Legislative Budget Allocations
- Freshwater Algae Control Grants
- Clean Water State Revolving Fund Loans
- Centennial Clean Water Grants (not in-lake treatment)
- Section 319(h) Clean Water Grants (not in-lake treatment)
- Onsite Sewage Financial Assistance Loans (Craft3) (for individual property owners with septic, only)

Sediment P Inactivation Options Summary

	Option A: 'Lake Reset' Treatment	Option B1: Annual, Lower Dose Treatments	Option B2: Pilot ZVI Treatments		Option C: Hypolimnetic Oxygenation
Expected Effectiveness	High	High	Low confidence		High
Timeframe for Implementation	Once, in Year 2	Treat Annually	Pilot in Year 1, if ineffective adapt to B1		Install in Year 3, Ongoing O&M (~$22K)
Extra Benefits	Long-term management	Added flexibility	Contribute to lake management science		Long-term management Improve fish habitat
Drawbacks/ Considerations	Potential toxicity if not properly applied Higher upfront cost	Potential toxicity if not properly applied Long-term commitment, additional monitoring	ZVI not well studied in lakes Long-term commitment, additional monitoring		Requires on-shore parcel & power
Annualized Cost -- Total Cost (10 yr)	$76,000-$141,000 -- $0.76-1.41 million	$100,000-$200,000 -- $1-2 million	*If effective*: $5,700 $57,000	*If else:* See option B1	$260,000 -- $2.6 million

Option A:
One-time
Lake Reset

Option B1:
Annual Alum/La
Treatments

Option B2:
Pilot ZVI

Option C:
Oxygenation

Discussion:

Which of these
P- Inactivation methods
do you prefer?

Project Schedule

Project Step	Action	Period
Lake and Watershed Monitoring	*Published Monitoring Plan (QAPP)*	*October 2024*
	***Public Meeting 1**: Project Overview and Plan*	*July 2024*
	Lake and Watershed Monitoring	*Oct 2024 to Oct 2025*
	***LMDSC/TC Meeting**: Monitoring Update*	*May 2025*
Lake Cyanobacteria Management Plan	***LMDSC/TC Meeting**: P Budget Results, Potential Management Actions*	*December 2025*
	Pre-Draft Plan for County & LMDSC review	Ready!
	Public Meeting: Present Draft Plan	**TODAY!**
	Draft Plan for Ecology & Public review	April/May 2026
	Final Meeting: Present Final Plan	June 2026
	Deliver Final Plan	June 2026

Thank you!

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