Spanaway Lake 2021 Phosphorus Monitoring Project

Rob Zisette
Herrera Environmental Consultants

FOSL Annual Meeting
February 24, 2022

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QUALITY ASSURANCE PROJECT PLAN

SPANAWAY LAKE 2021 PHOSPHORUS MONITORING

Prepared for
Friends of Spanaway Lake

Prepared by
Herrera Environmental Consultants, Inc.

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Presentation Outline

Thermal Stratification

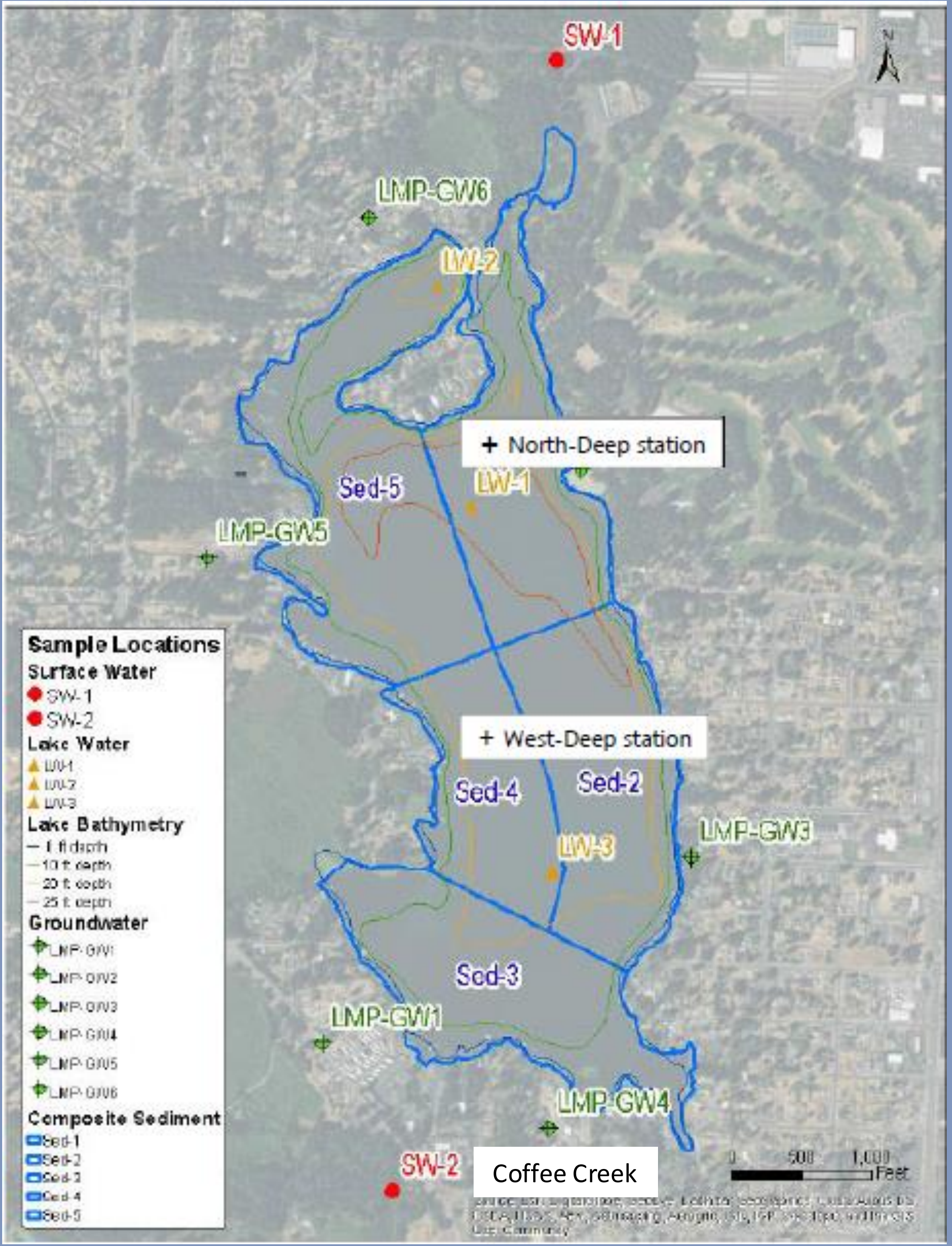
Dissolved Oxygen Profile

Total and Dissolved Phosphorus Profiles

Total Phosphorus Loadings

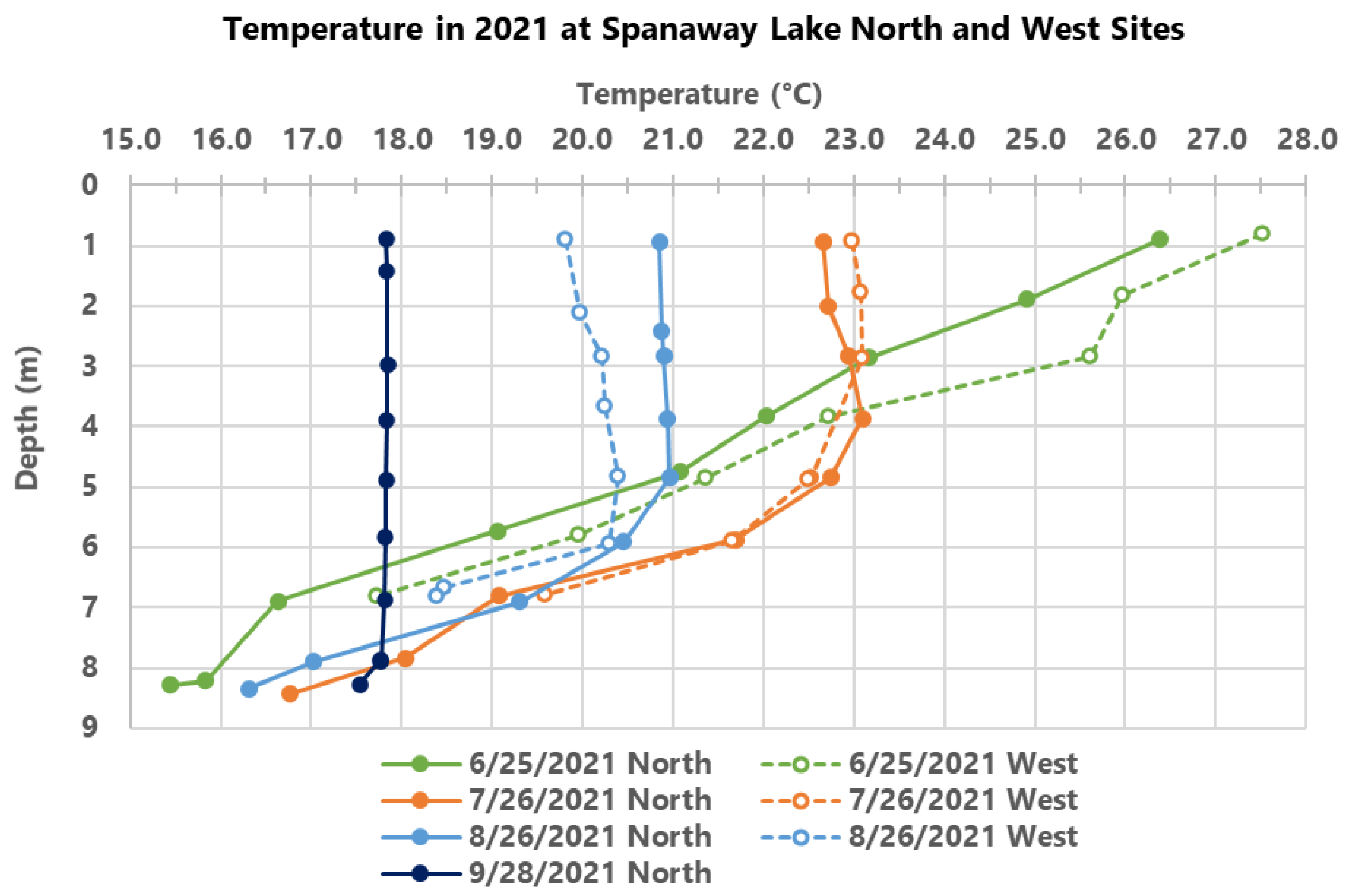
Historical Data Sources:

- 2018: Lindauer 2019
- 2015/2012: Pierce County 2016



Thermal Stratification
2021

- Thermocline = maximum temperature change >1 ºC/m, separates epilimnion, metalimnion, hypolimnion
- Stable thermocline July?–August (6?→7 m)
- Stratification before July unknown



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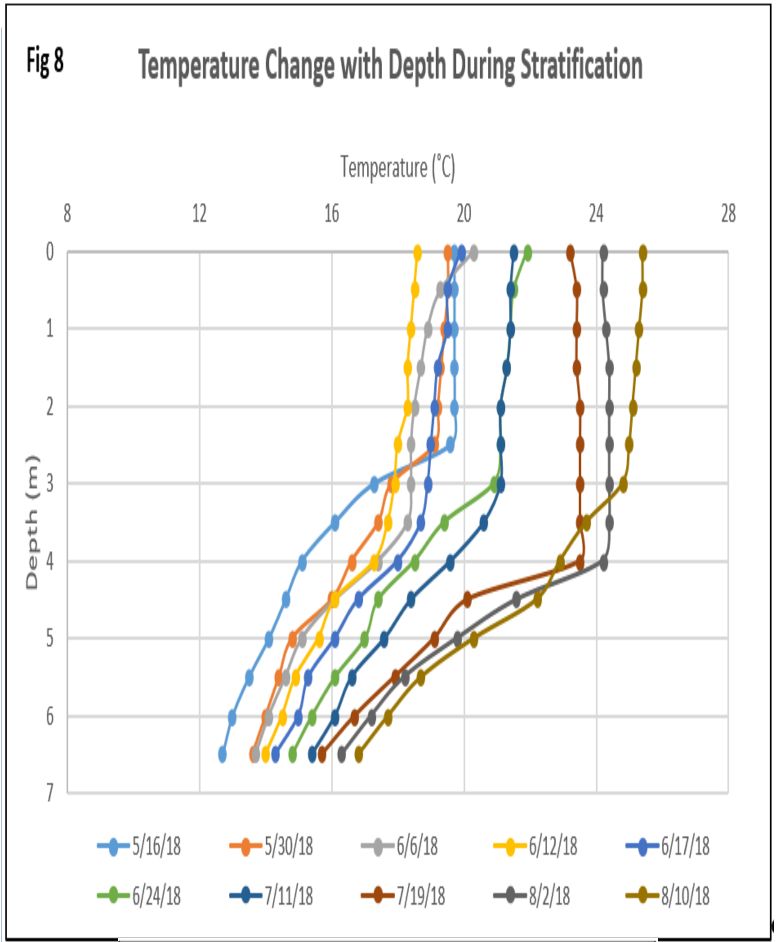
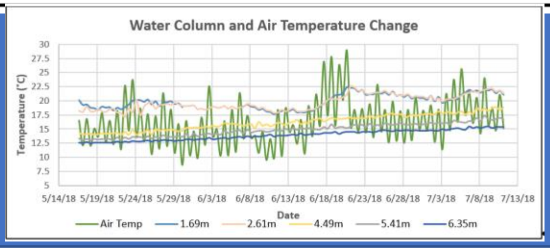
Thermal Stratification

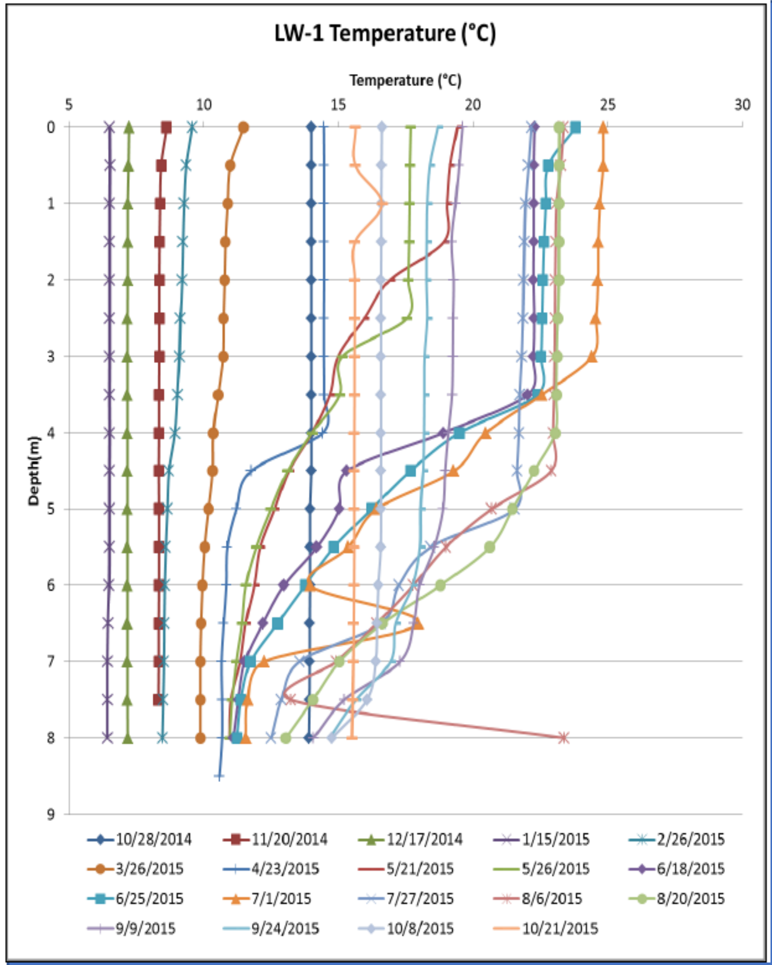
2018 and 2015





2018:

- Stable thermocline May–Sept (2.8→5.5 m)



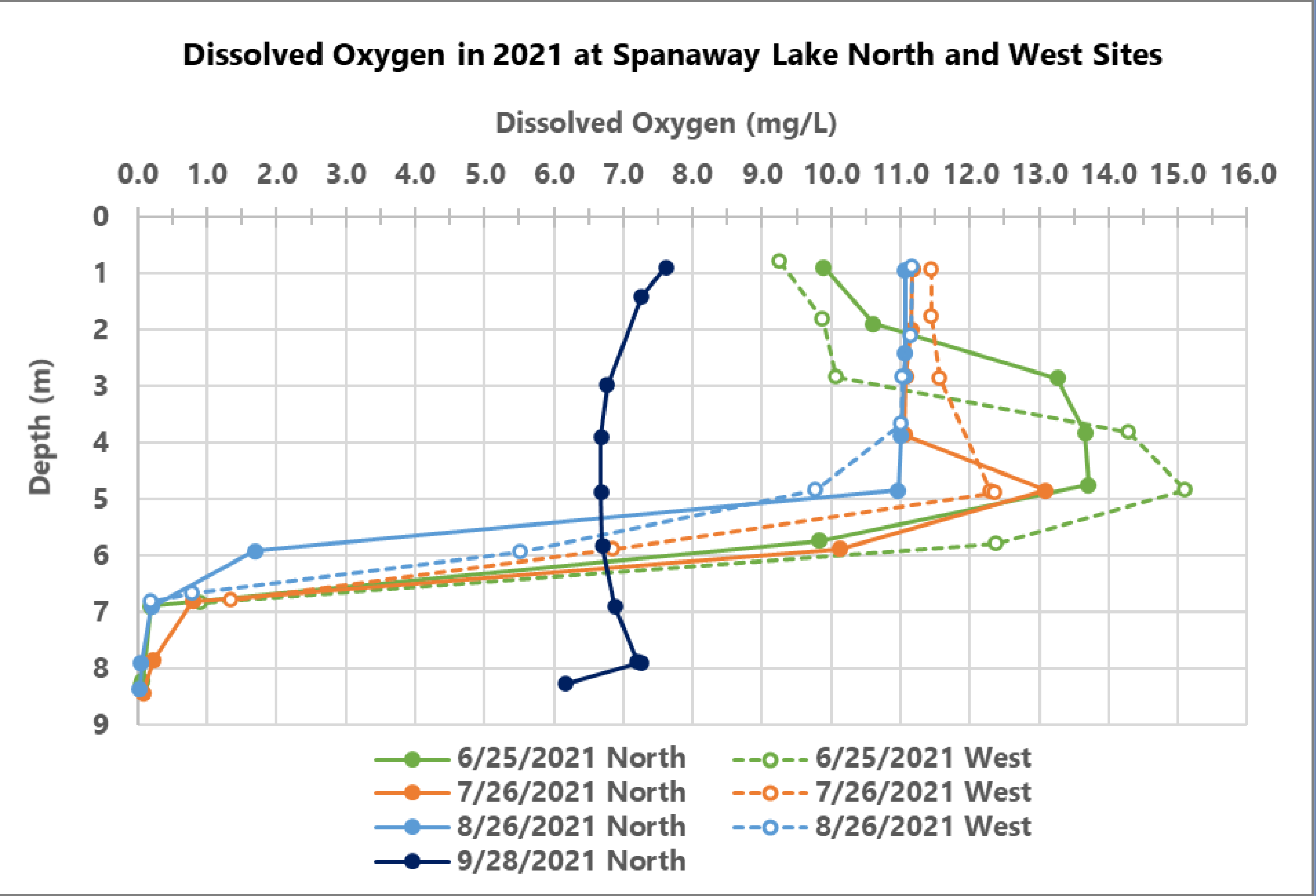
2015:

- Stable thermocline April–Aug (1.8→5.5 m)

Dissolved Oxygen
2021

- Metalimnetic peak at 5 m
- June-July

- Bottom Anoxia (< 2 mg/L) June–August (>6 m)



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Dissolved Oxygen

2018 and 2015

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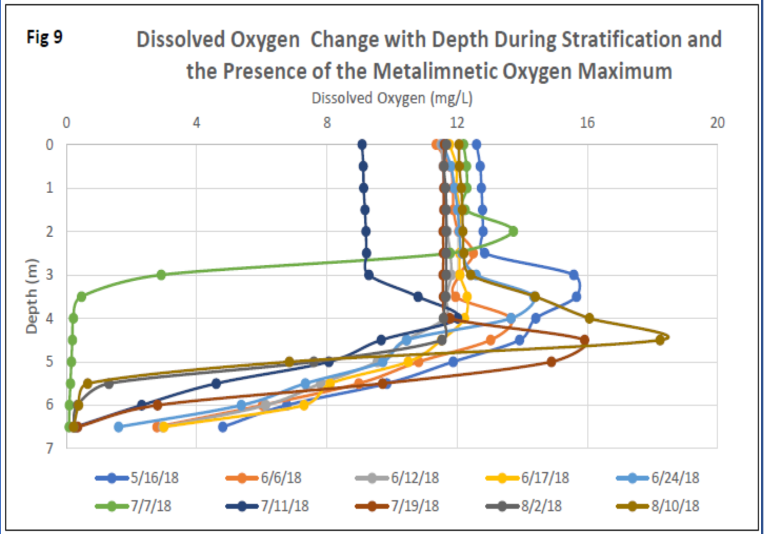
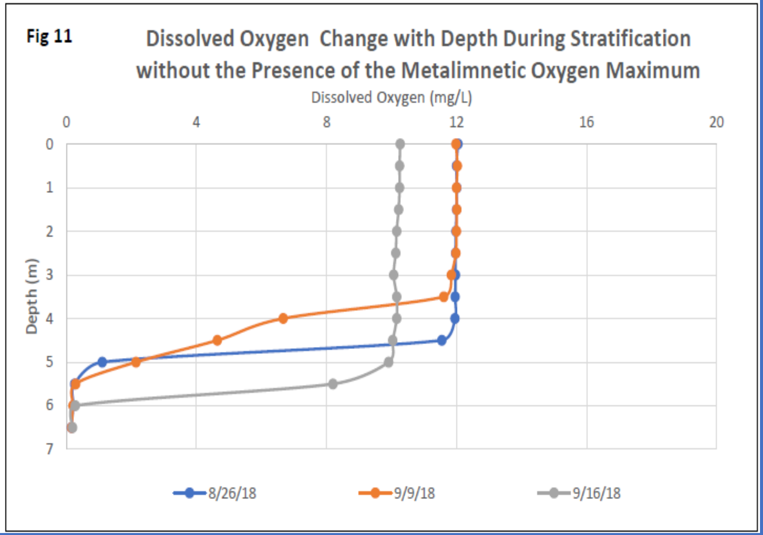
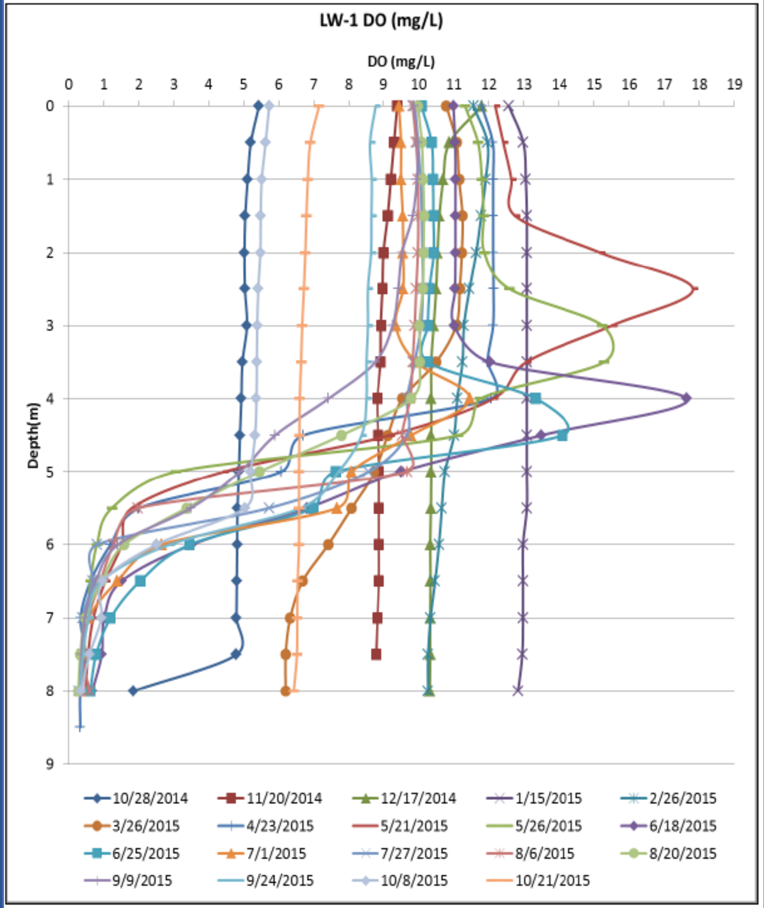




2018:

- Metalimnetic peak at 2-4 m
- Bottom Anoxia June–Sept (>5-6 m)



2015:

- Metalimnetic peak at 2-4 m
- Bottom Anoxia April–Oct (>5.5-6.5 m)

Lake Total and Dissolved Phosphorus

2021

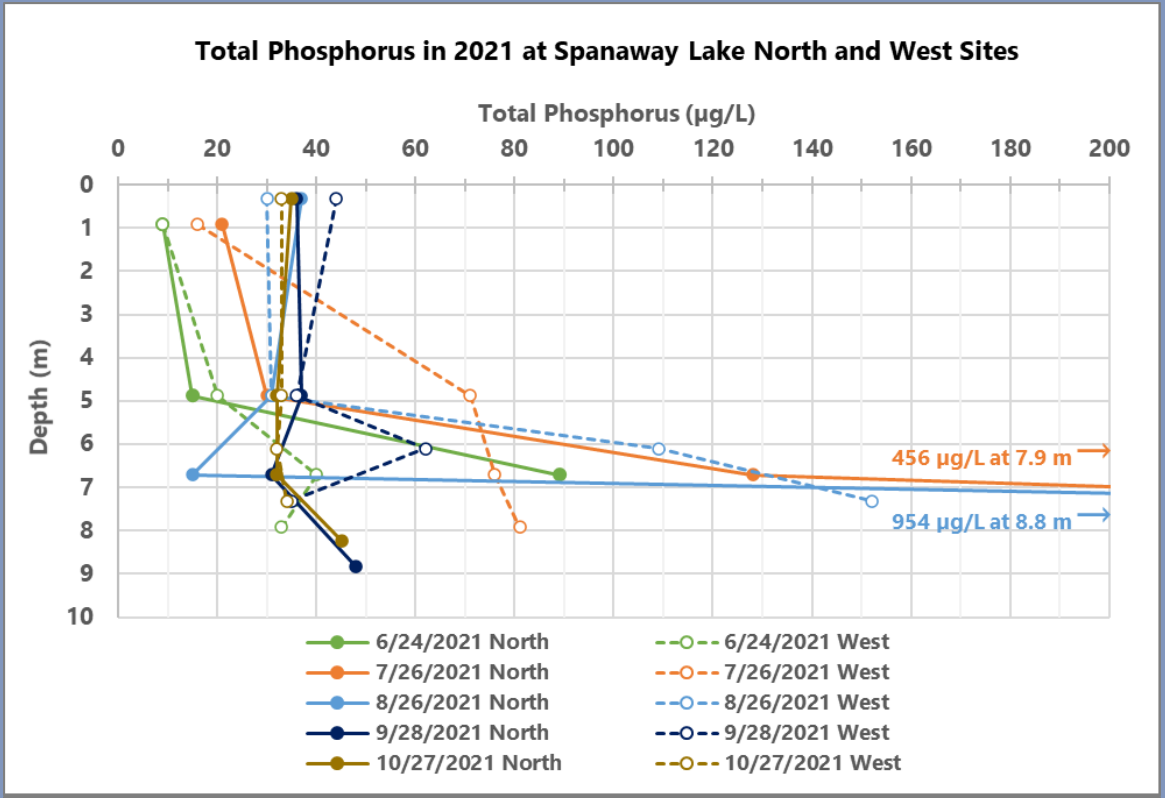
TP = 10-40 ug/L surface

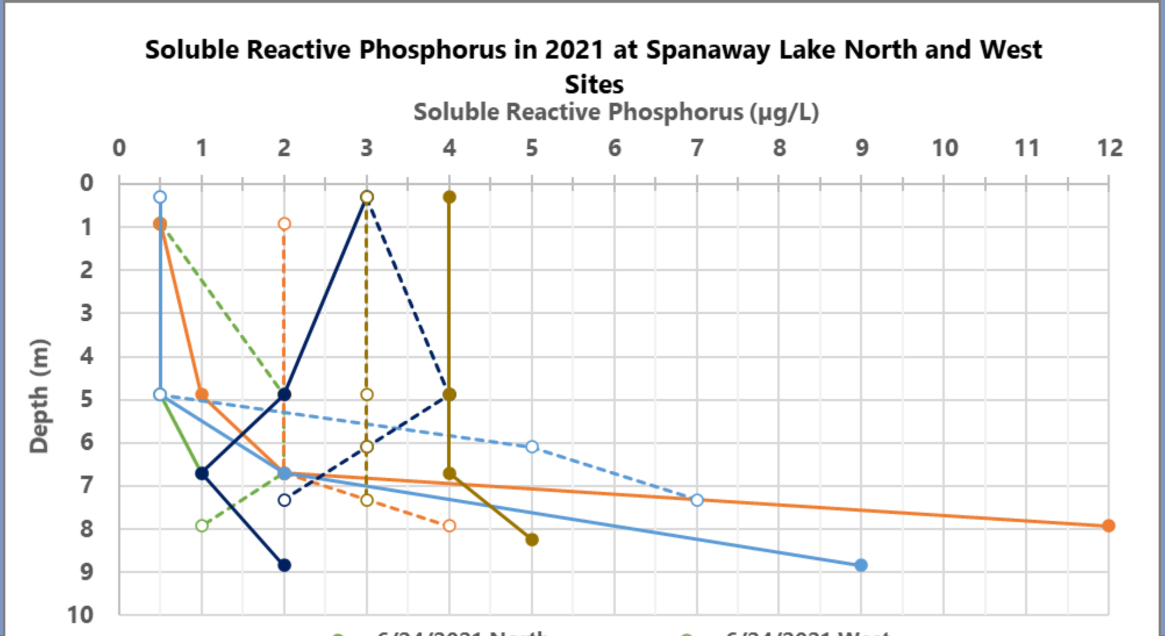
TP = 15-954 ug/L near bottom

SRP = <5 ug/L surface

SRP = 2-12 ug/L bottom

Low bottom SRP with low DO and high TP is unusual; may be due to high uptake/adsorption/ precipitation





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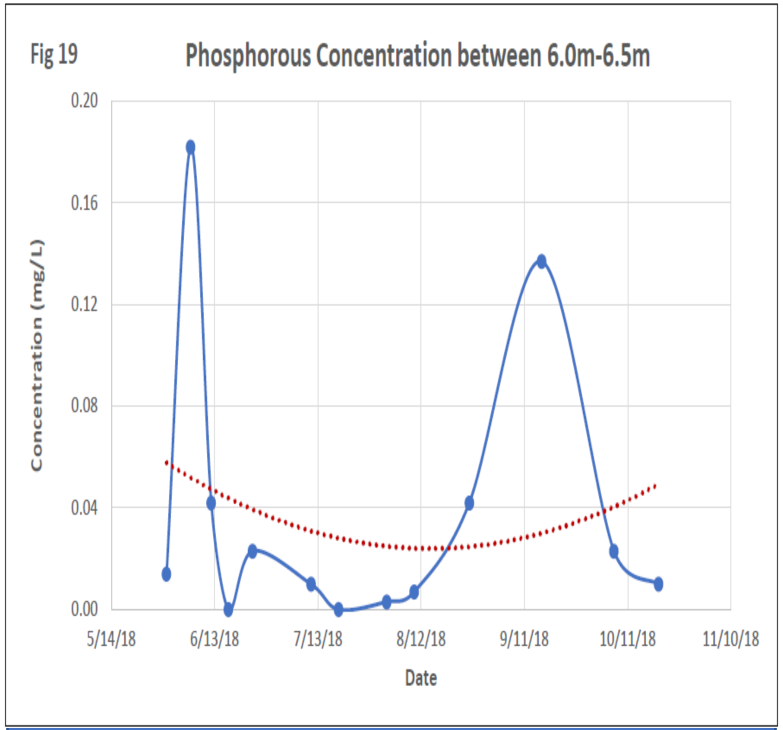
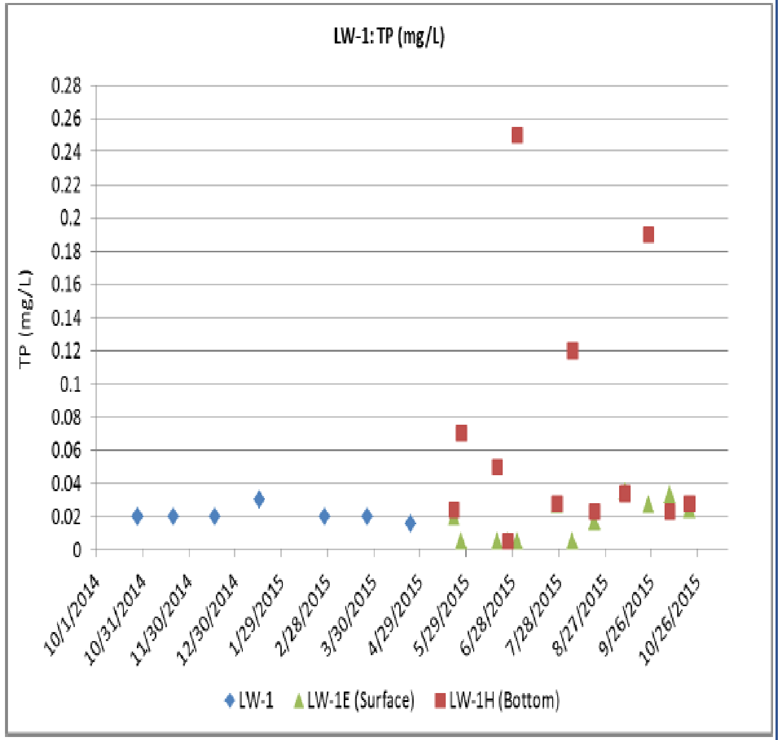
Lake Total and Dissolved Phosphorus

2018 and 2015 (and 2012)



2018:

- DP <5 ug/L by ICP-MS in surface and bottom (DP~SRP)
- RP = 0-180 ug/L by spec (undigested RP<TP)



2015:

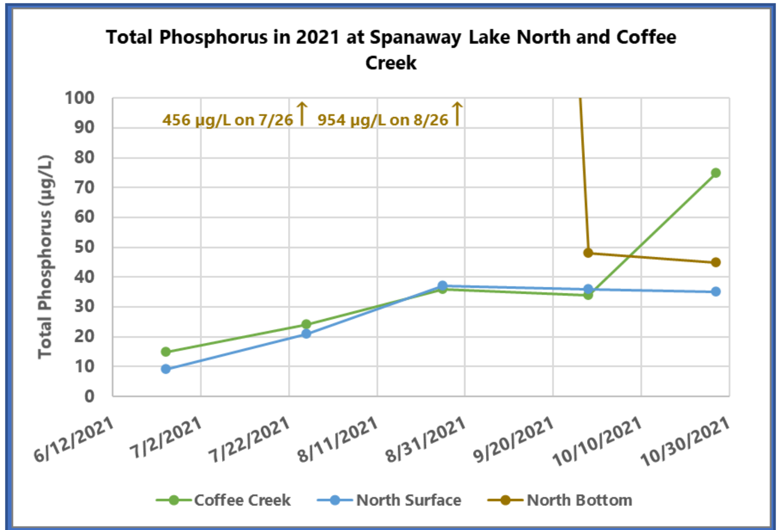
- TP <30 ug/L surface
- TP <10-250 ug/L near bottom

2012:

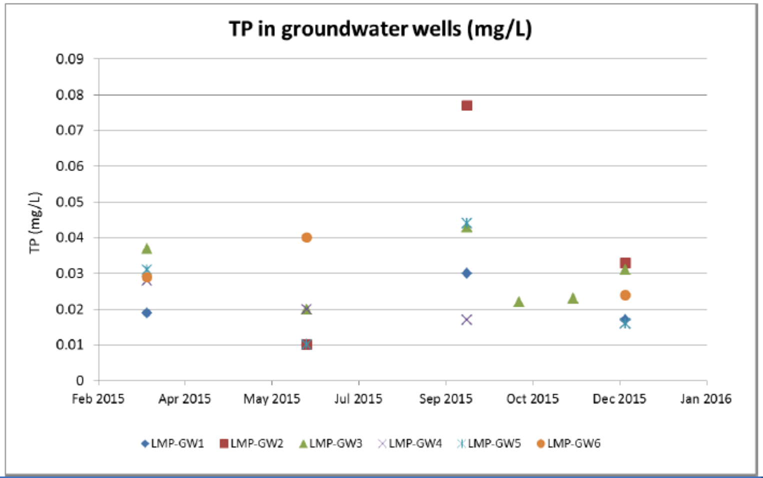
- TP = 8-37 ug/L surface
- TP = 34-1,170 ug/L at bottom

Total Phosphorus Inputs

2021 Coffee Creek and 2015 Coffee Creek and Groundwater



Image



2021

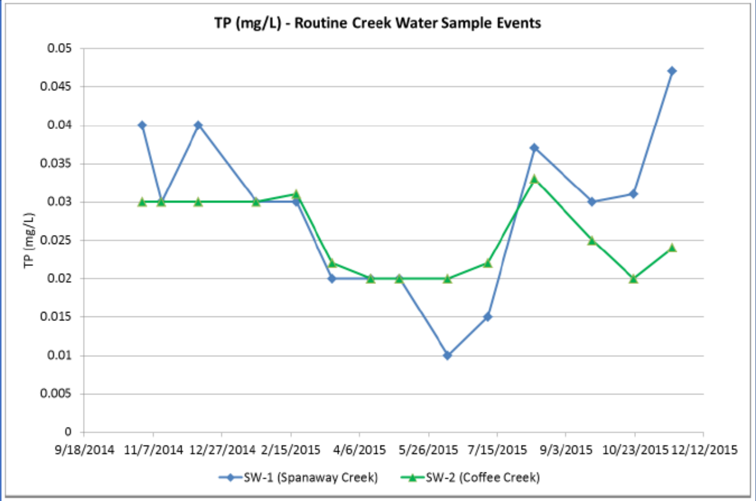
Coffee Creek:

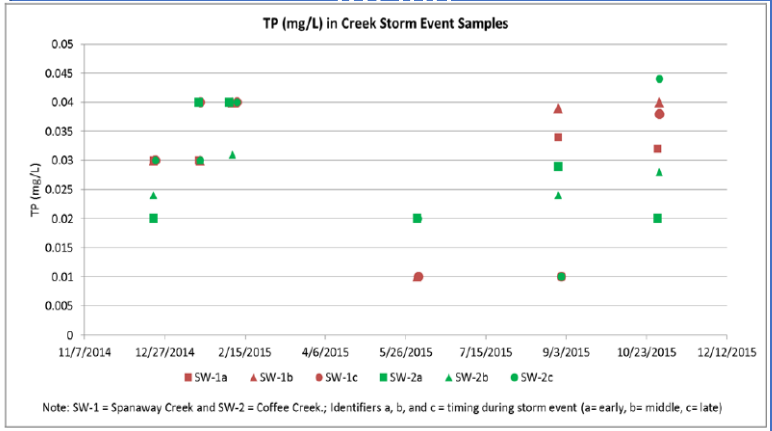
- 15-36 ug/L base
- 34-75 ug/L storm

2015

Upgradient Groundwater:

- 18-42 ug/L





2015

Coffee Creek:

- 20-33 ug/L routine
- 10-44 ug/L storm

Water Budget

Water volume balance method estimates net groundwater from surface input/output difference as positive each month

Groundwater and Coffee Creek total ~95% of water input in winter and summer

Lake Management Plan (Pierce County 2016)				
Input	Acre-feet		Percent of Total	
	Annual	Summer	Annual	Summer
Groundwater	9,124	1,078	65%	62%
Coffee Creek	4,102	613	29%	35%
Precipitation	662	55	5%	3%
Stormwater	48	4	0.3%	0.2%
Total Input	13,936	1,750	100%	100%

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Phosphorus Budget

External Volume x mean TP concentration:

- Groundwater largest source (includes 37% septage)
- Coffee Creek ~50% of groundwater
- Stormwater/precipitation insignificant
- Annual only but summer estimated here

Internal Load:

- Sediment TP method unreliable and added without balance
- Sedimentation by traps unreliable to balance in 2019
- Other unaccounted inputs include cyanobacteria migration, deep/shallow sediment release, bird poop, plant decay

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Lake Management Plan (Pierce County 2016)				
Input	Kilograms		Percent of Total	
	Annual	Summer	Annual	Summer
Groundwater	304	36	29%	6%
Coffee Creek	129	19	12%	3%
Precipitation	26	2	2%	0.3%
Stormwater	13	1	1%	0.2%
Internal Load	577	577	55%	91%
Total Input	1,049	635	100%	100%

Updated Annual TP Budget (Pierce County 2019)		
Input	**Kilograms**	**% Total**
Groundwater	309	35%
Coffee Creek	110	12%
Other Inputs	469	53%
Total Input	888	100%
Output		
Outlet	428	48%
Sedimentation	460	52%
Total Output	888	100%

Conclusions

- Lake strongly is stratified each summer with thermocline progressing to 6 m depth
- Lake bottom goes anoxic, earlier in 2015 than 2018 or 2021
- TP peaks in bottom portion of hypolimnion primarily from sediment release
- Low SRP in anoxic bottom water is unusual and not fully understood
- Similarly low TP in Coffee Creek and groundwater because stream is fed primarily by groundwater
- Groundwater is the major external TP source, but relatively low in summer
- High sediment release of P during summer fuels cyanobacteria blooms

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Next Steps/Recommendations

Herrera will:

- Review data quality as per QAPP
- Prepare technical memorandum to present and discuss 2021 monitoring data

We recommend:

- Calculate monthly P budget based on mass balance In = Out
  - Estimate groundwater in/out using MODFLOW model as planned
  - Account for sedimentation loss (inverse of retention time)
  - Evaluate the net residual gain from internal load (deep/shallow sediment release, waterfowl, and plant decay).

- Also predict internal loading from 1) net hypolimnion TP increase and 2) consider lab incubation of sediment cores (see Burnet and Wilhelm 2021) and test effects of inactivation options (Fe, Al, La).

- Analyze sediment cores for available and permanently bound P fractions.

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