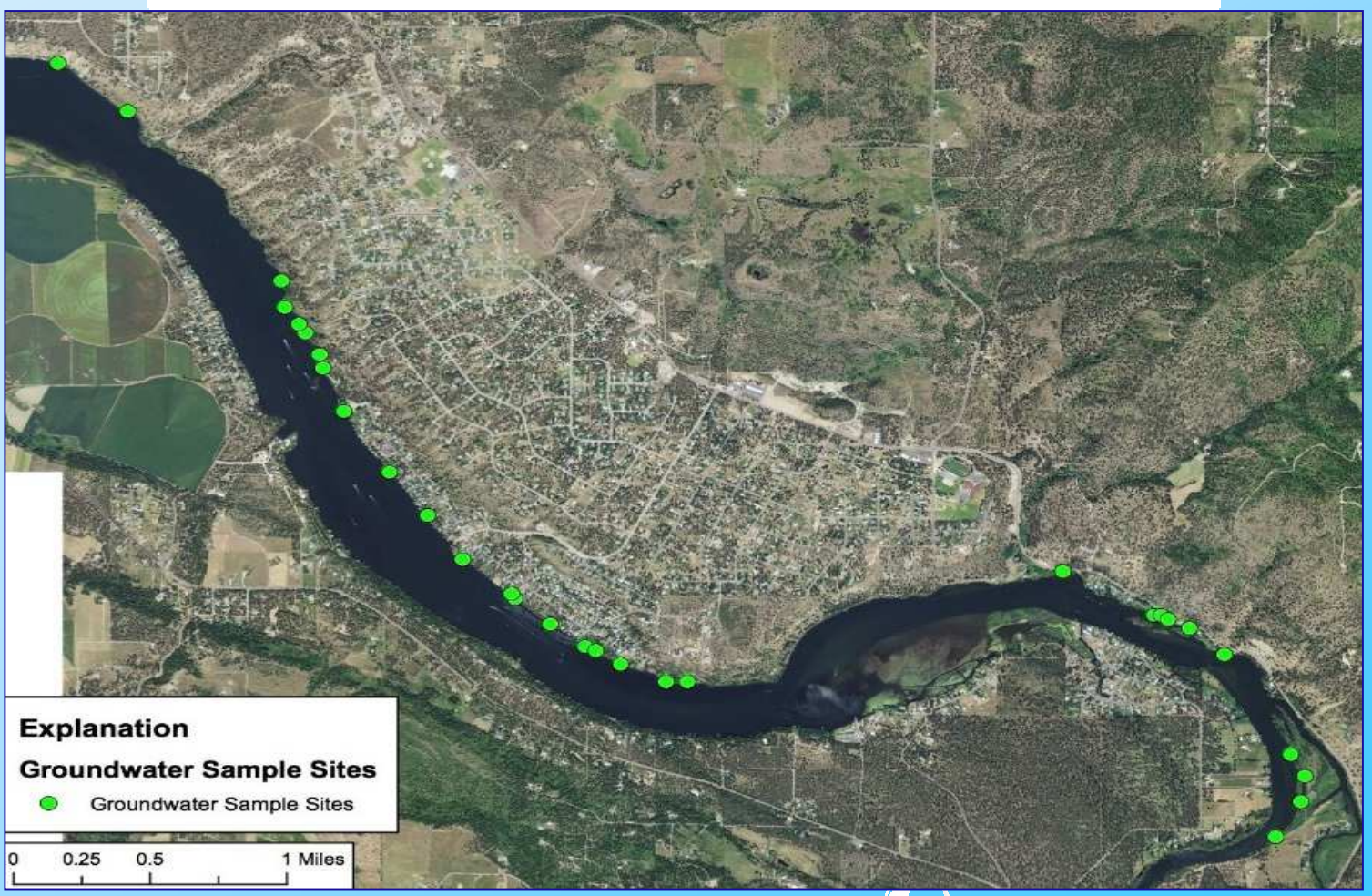
Lake Spokane Groundwater Nutrient Study - Phase 1 & 2

The Players

- WA Department of Ecology: Karin Baldwin
- The United States Geological Survey (USGS): Andy Gendaszek
- Stevens County Conservation District: Charlie Kessler

2014-2015
LAKE SPOKANE GROUNDWATER NUTRIENT STUDY



IMPORTANT POINTS

Ecology can not require communities to install wastewater treatment facilities.

A community needs to be in favor of a treatment facility before an effort to build one begins.

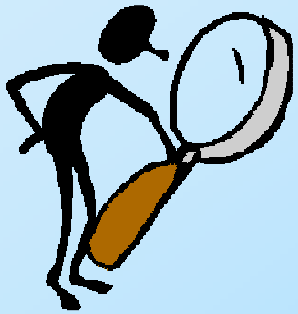
WHY STUDY GROUNDWATER?

- Better understand how nutrients get into Lake Spokane.
- Called for in the Lake's water quality improvement plan
- Limit Algae blooms & fish kills that restrict our enjoyment of the lake
    - This will take a watershed-wide effort

WHAT'S GOING ON UPSTREAM…

- 3 WA Cities & 2 WA Businesses upgrading treatment facilities by 2021
- 3 ID Cities upgrading treatment facilities by 2024
- Since 2001approx. 20,500 homes & businesses over aquifer hooked up to sewer
- Between 2010 & 2014: 81 riparian planting & numerous stormwater reduction projects completed
- As of 2010 over $534 million and rising spent to improve lake water quality

BACK TO THE LAKE…

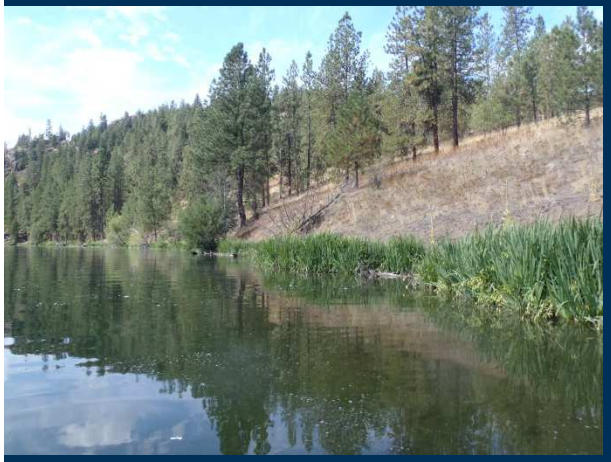


We don't know how many nutrients come from the land and groundwater around the lake

Ecology partnered with the USGS to study if nutrients were coming from septic systems

USGS
science for a changing world

Characterization of Nitrogen and Phosphorus in Groundwater Discharging to Lake Spokane



Andy Gendaszek agendasz@usgs.gov

May 2016

Nine Mile Falls, Washington

U.S. Department of the Interior
U.S. Geological Survey

U.S. Geological Survey
Washington Water Science Center
Tacoma, Washington
http://wa.water.usgs.gov

USGS - Earth Science Agency

- The USGS is a fact-finding research agency of the federal government with no regulatory responsibility
- Operates under Fundamental Science Practices
- USGS Water data are publicly available from their National Water Information System database

- **Washington Water Science Center**
  - **USGS water program within Washington State, stream gaging network since 1892**

Introduction

- Question: Are significant levels of nutrients from groundwater and on-site septic systems (OSS) reaching Lake Spokane?
- Approach to this question is taking place in two phases.
  - Phase 1 – General survey of aquatic plants for analysis of ^{15}N, an indicator of wastewater influence; preliminary sampling of shallow groundwater chemistry in Spring 2015
  - Phase 2 – Expanded shallow groundwater chemistry sampling; measure groundwater seepage in order to estimate nutrient inputs to Lake Spokane.
- Timeline – Phase 1 is completed and report published; Phase 2 just beginning, expected completion in late 2018

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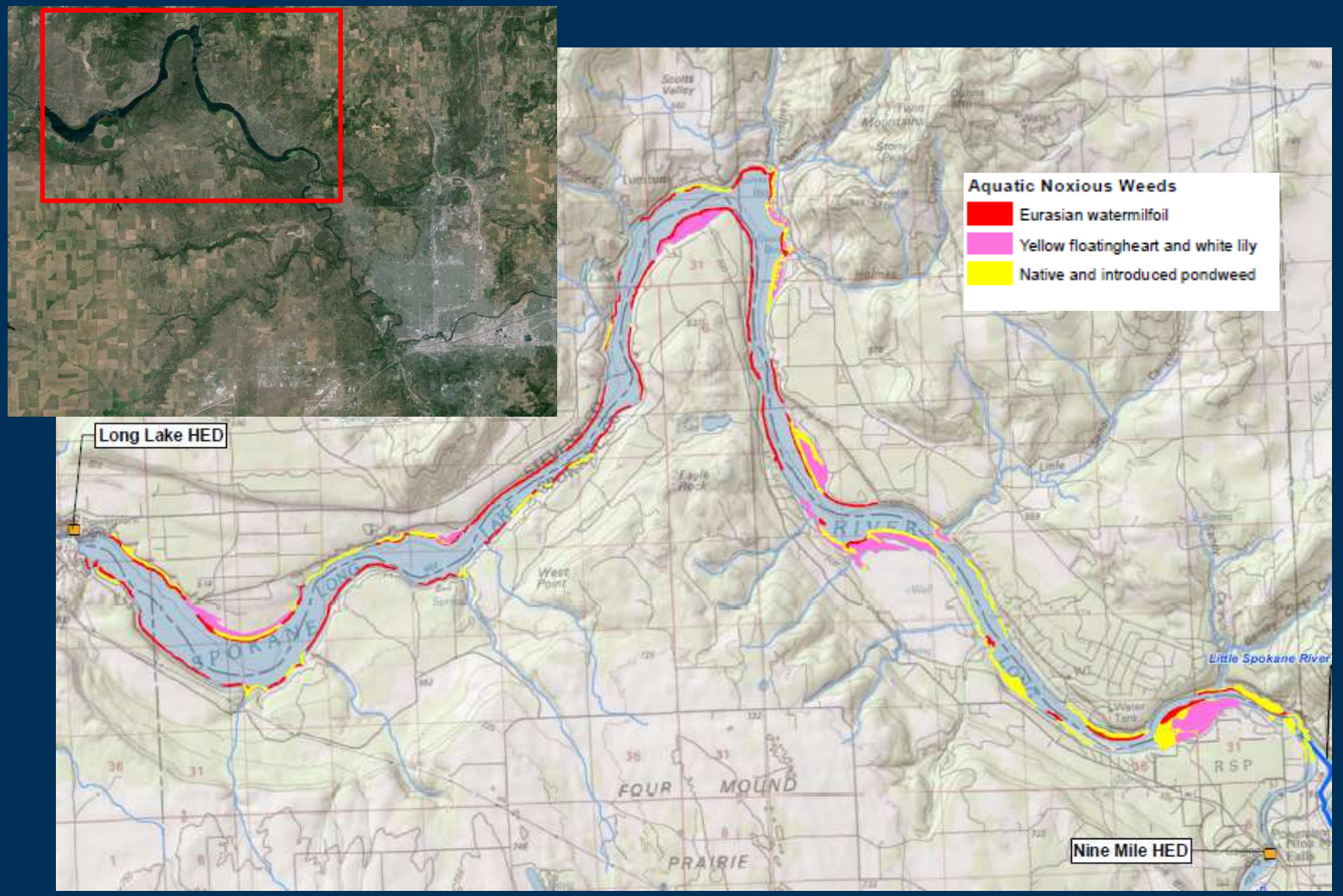
Study area: Lake Spokane



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From: Avista, 2012 FERC

Onsite Septic Systems (OSS) along Lake Spokane

- ~ 1,600- 1,700 OSS along Lake Spokane shoreline
- Nutrients including nitrogen and phosphorus are released through OSS drain fields and infiltrate to GW
- Some nitrate is removed in drain fields, but it is highly mobile in the subsurface
- Phosphorus; some absorbs to sediment and some can move with groundwater into the lake

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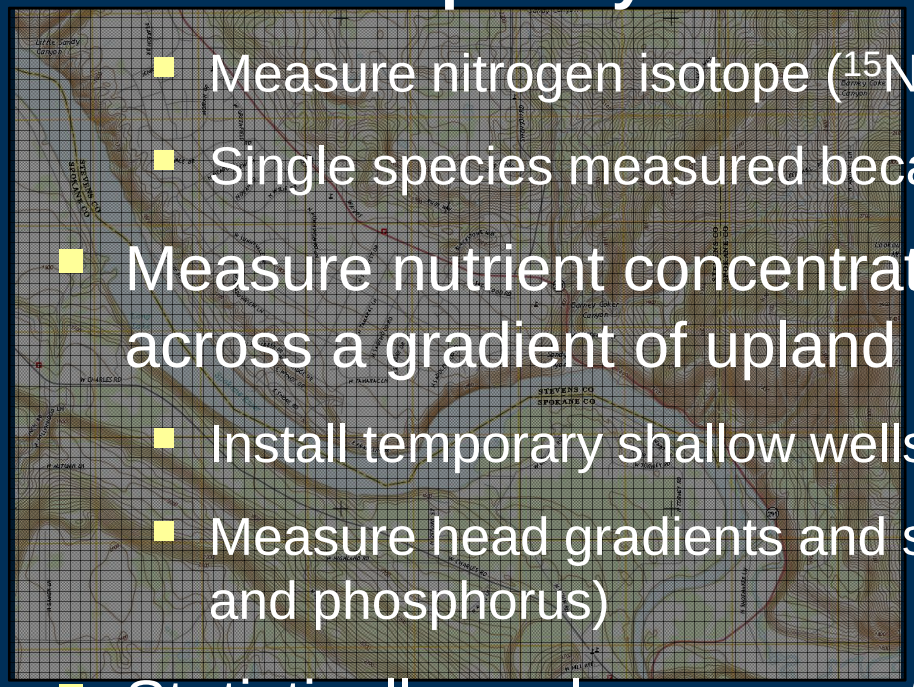
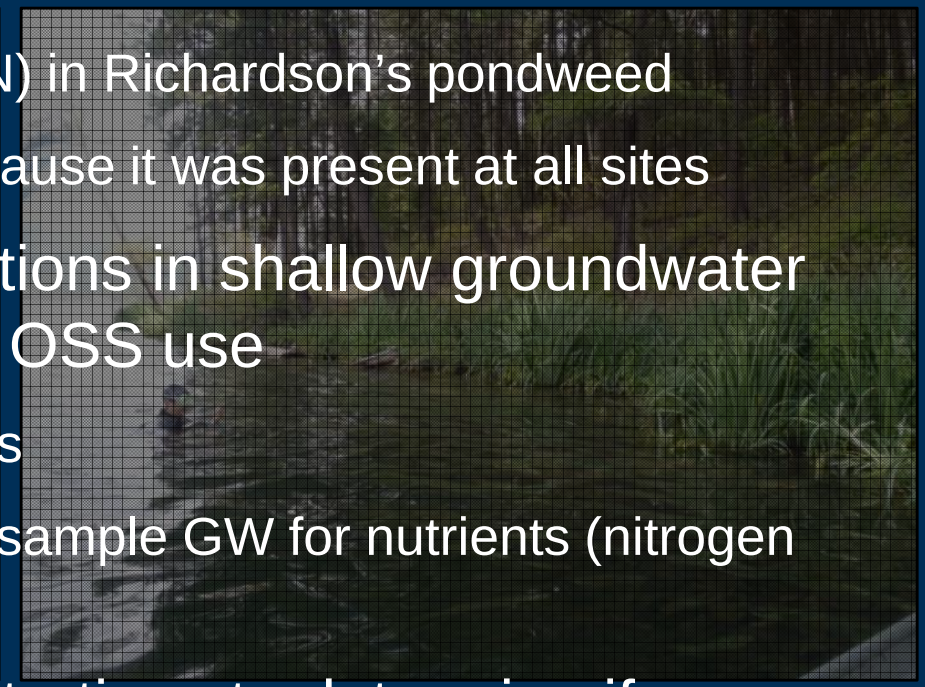
Approach

- **Try to identify areas where groundwater inflow may contain septic-system effluent**
  - Measure nitrogen isotope (^{15}N) in Richardson's pondweed
  - Single species measured because it was present at all sites
- Measure nutrient concentrations in shallow groundwater across a gradient of upland OSS use
  - Install temporary shallow wells
  - Measure head gradients and sample GW for nutrients (nitrogen and phosphorus)
- Statistically analyze concentrations to determine if a difference exists between nutrient concentrations downgradient of developed and undeveloped land.





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Why sample plants for ^{15}N?

- Rooted aquatic plants acquire nitrogen from bed-sediment pore water
- Elevated stable isotope ratio of ^{15}N indicative of increased level of septic influence
- ^{15}N ratio of plant material is acquired continuously over plant growing season thus integrating the sampling period and capturing pulsed event that might otherwise be missed
  - High ^{15}N ratios in plant tissue indicates possible uptake of OSS nitrogen

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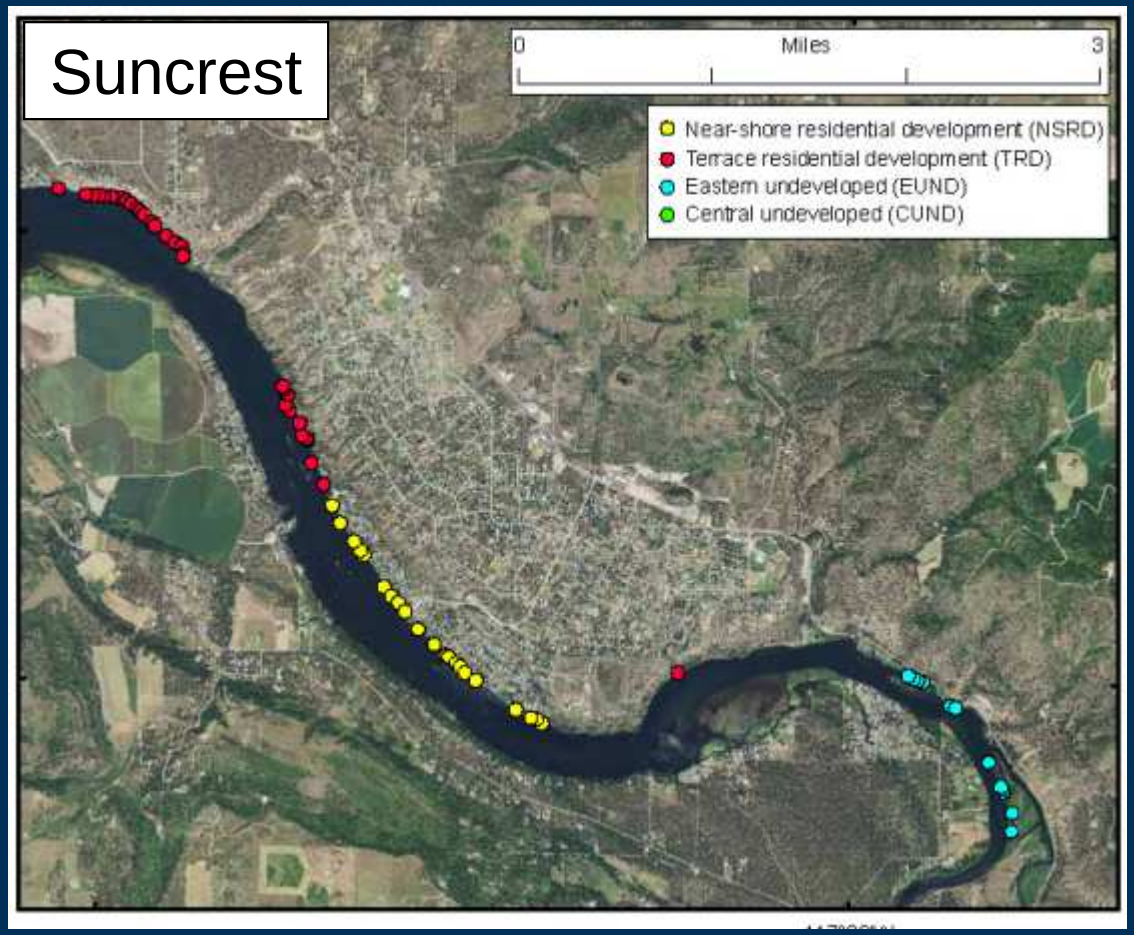
Locations of aquatic vegetation samples analyzed for $\delta^{15}N$



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Sampling of aquatic vegetation & analysis

- Sample rooted aquatic vegetation (Richardson's pond weed) in Lake Spokane (Aug/Sept 2014)
- Dried, processed, and weighed at USGS office in Tacoma
- Analyzed for ^{15}N at UC Davis stable isotope lab

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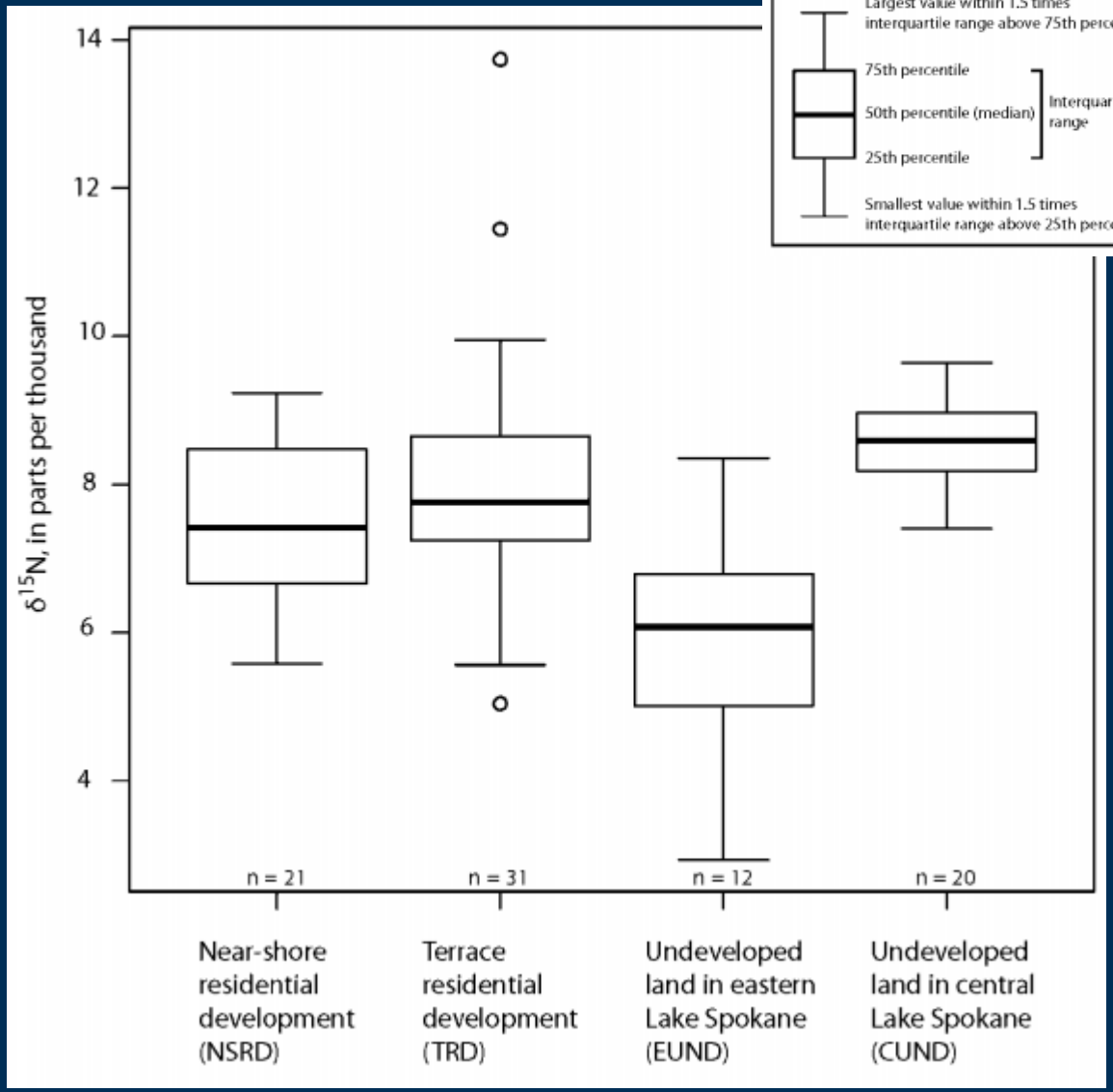
Results: $\delta^{15}N$ in aquatic vegetation

- $\delta^{15}N$ in undeveloped area near Nine Mile Falls (EUND) was significantly less than other land use groups



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Sampling of Shallow Groundwater

- Sampled filtered GW in March and April, 2015 for dissolved nutrients (nitrate+nitrite, ammonia and orthophosphate)
- Samples collected from 30 locations across same land use areas (except undeveloped area near Tum Tum)
- Samples chilled and shipped to USGS water quality lab for analysis
- At 21 of 30 sites, also measured vertical hydraulic gradients to identify groundwater discharge

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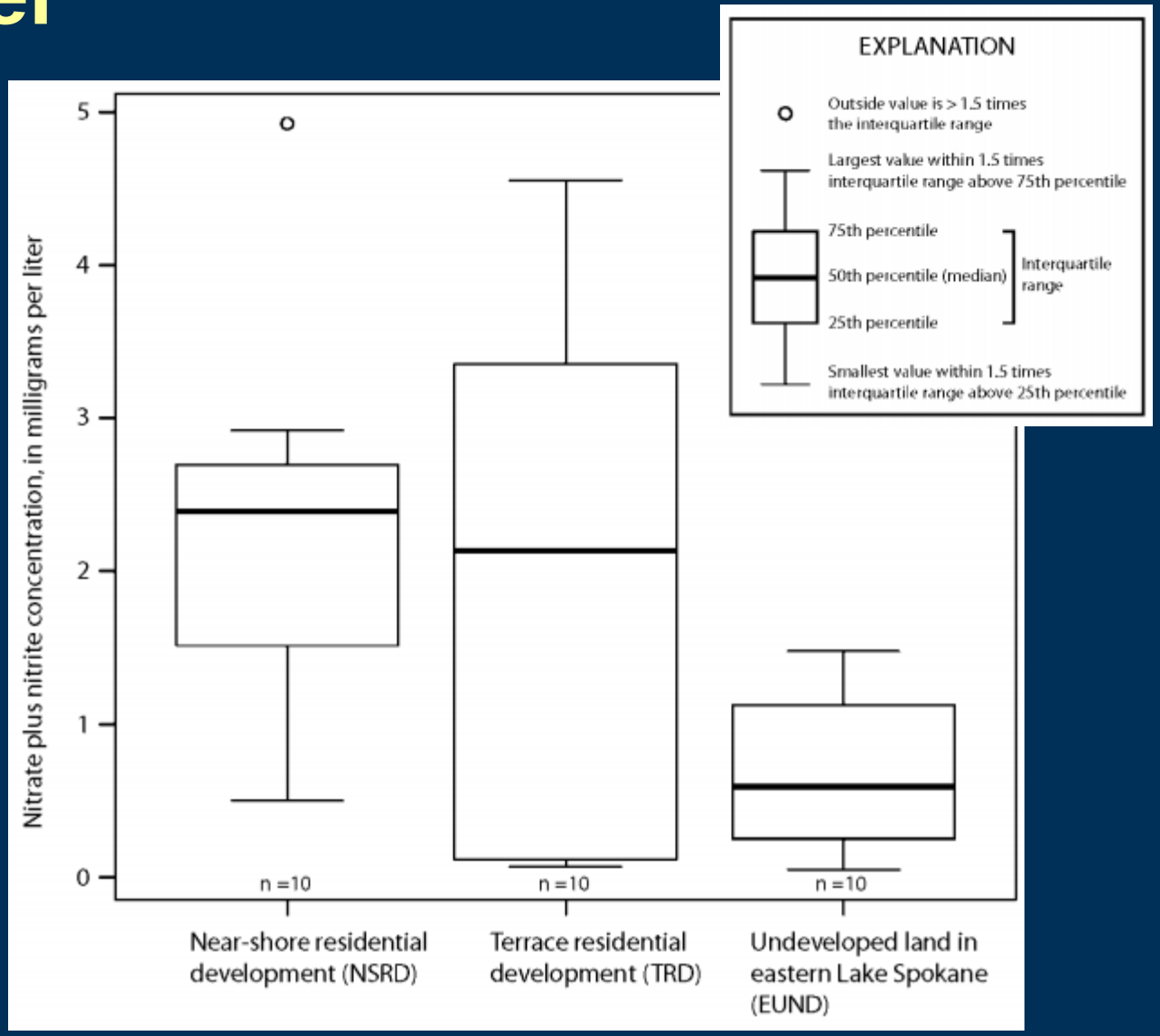
Results: Nitrate plus nitrite in groundwater

- Undeveloped (EUND) < Nearshore (NSRD) p-value <0.001)
- Other populations were not statistically different from each other



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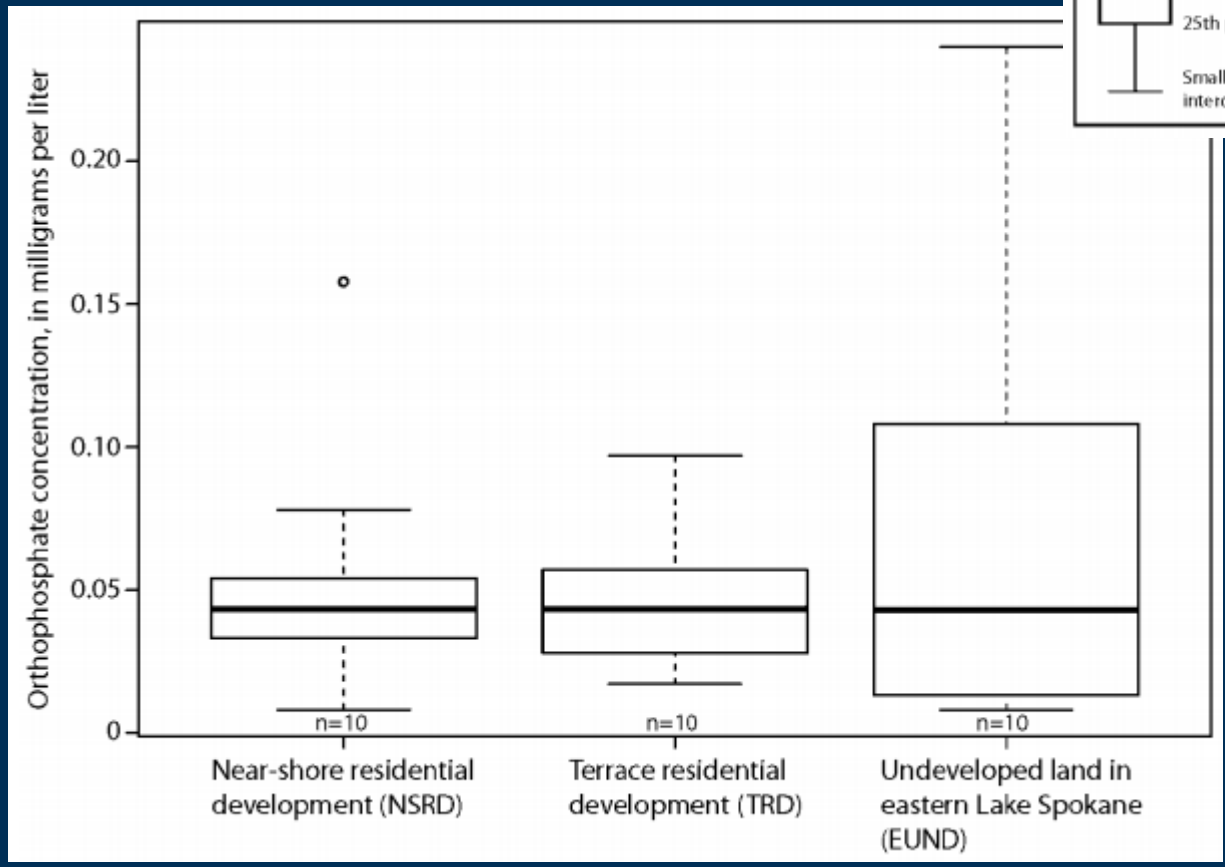
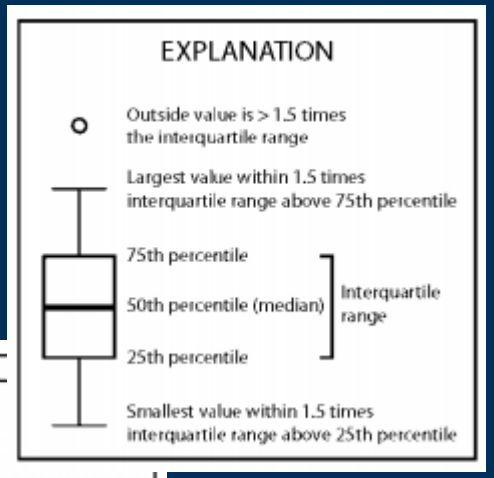
Results: Orthophosphate in groundwater

- No statistical difference between landcovers





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Summary – Phase 1

- Lower $\delta^{15}N$ at undeveloped area near Nine Mile Falls supported selection of that area as undeveloped landcover for subsequent GW sampling
- Nitrogen: GW samples downgradient from near-shore residential development were elevated relative to undeveloped landcover
- Phosphorus: GW samples at undeveloped landcover were not statistically different compared to samples downgradient from the two developed landcovers
- Nitrogen is more mobile in GW compared to phosphorus, which sorbs to sediments
- Seasonal variation in nutrient concentrations and fluxes of nutrients from GW remain unquantified

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LAKE SPOKANE PHOSPHORUS

Stevens County Conservation District

History

- May 2010 Spokane River and Lake Spokane Dissolved Oxygen TMDL approved by EPA
- Regulated dischargers ask "What is happening downstream in Lake Spokane?"
- Fall 2010, SCCD submits grant application to Ecology for project "*Lake Spokane – Clean not Green*"

History

- Fall 2011, SCCD applies for another Ecology grant to work with USGS to study groundwater inputs to Lake Spokane – not successful
- Winter 2012 SCCD starts working with Lakeside High School science teacher Teri Sardinia to introduce students to natural resources with emphasis on the Spokane River Watershed

History

- 2012-13 SCCD and Lake Spokane Association conduct optical brightener monitoring in an attempt to determine if there are septic system influences on the lake – nothing definitive

- August 2013, SCCD hosts a meeting seeking regional support for a study of groundwater inputs to Lake Spokane – some it is a waste of funds since we know septics have to be contributing nutrients to the lake

History

- Ecology ERO has limited funding available to work with USGS on what has become Phase 1 of a larger groundwater study
- Fall 2015, SCCD tries again for an Ecology grant to expand the groundwater study in conjunction with USGS and is successful
- *Energy and persistence conquer all things* – Benjamin Franklin

Lake Spokane Phosphorus Input II

- One of SCCD's guiding principles is to seek local solutions to local problems
- A Citizens' Advisory Committee (CAC) will be formed and will met quarterly during the life of the project
- CAC will be provided information on project status and will help keep the community informed about project activities

Lake Spokane Phosphorus Input II

- SCCD will continue working with Lakeside High School and the Nine Mile School District on education efforts
- SCCD has developed a water quality questionnaire to better understand the level of knowledge and education needs for the Lake Spokane area

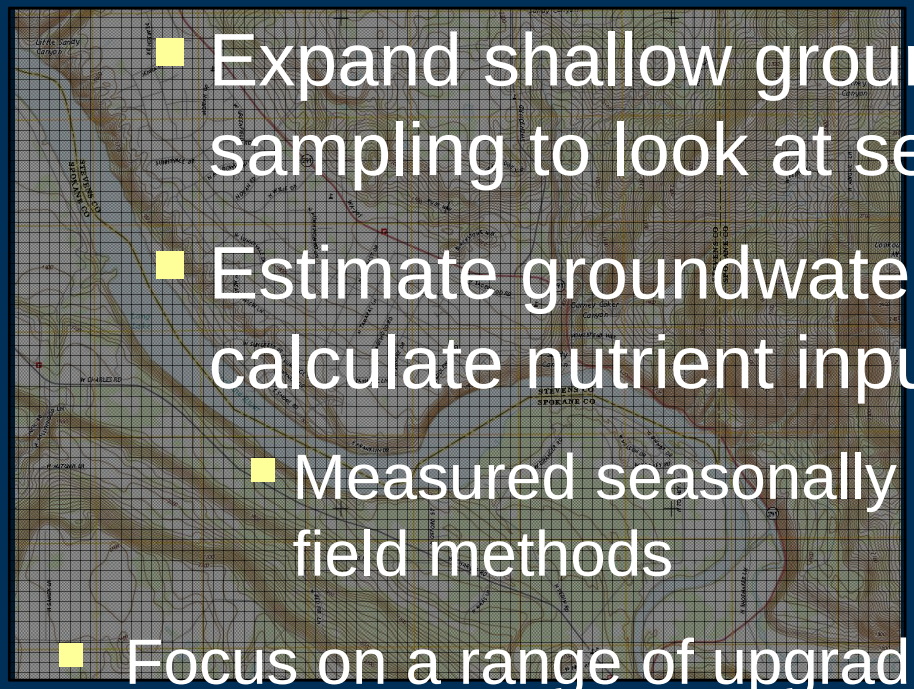
Lake Spokane Phosphorus Input II

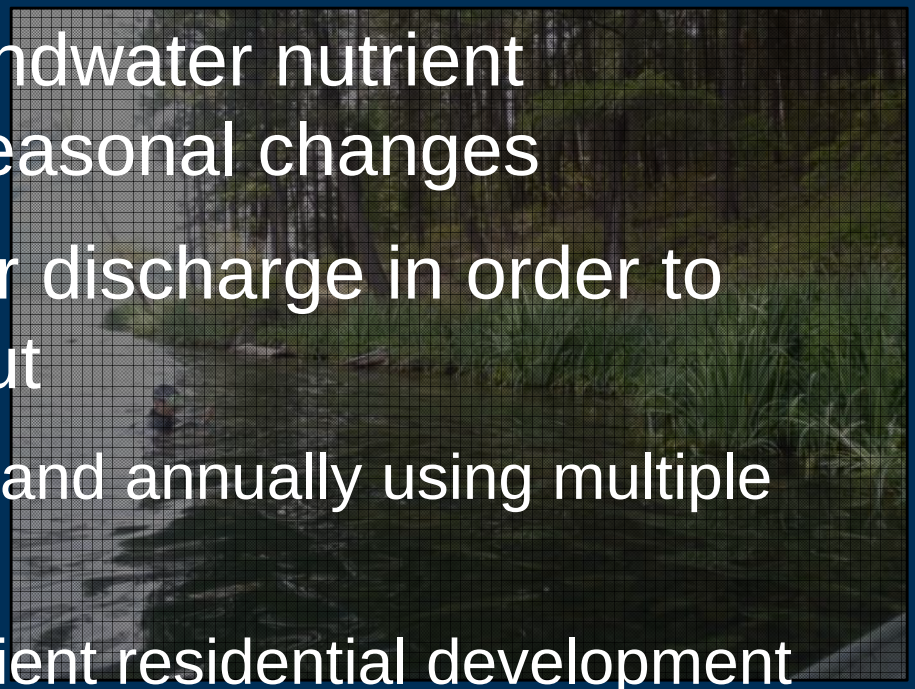
- SCCD will provide monitoring assistance to USGS as needed
- SCCD will coordinate with Stevens PUD to collect groundwater samples from wells that currently provide dinking water to the Suncrest area
- SCCD will provide a final report in conjunction with USGS

Looking at 1 small piece of the puzzle

Phase 2 Approach

- Build on Phase 1 in two ways
  - Expand shallow groundwater nutrient sampling to look at seasonal changes
  - Estimate groundwater discharge in order to calculate nutrient input
    - Measured seasonally and annually using multiple field methods
- Focus on a range of upgradient residential development similar to Phase 1





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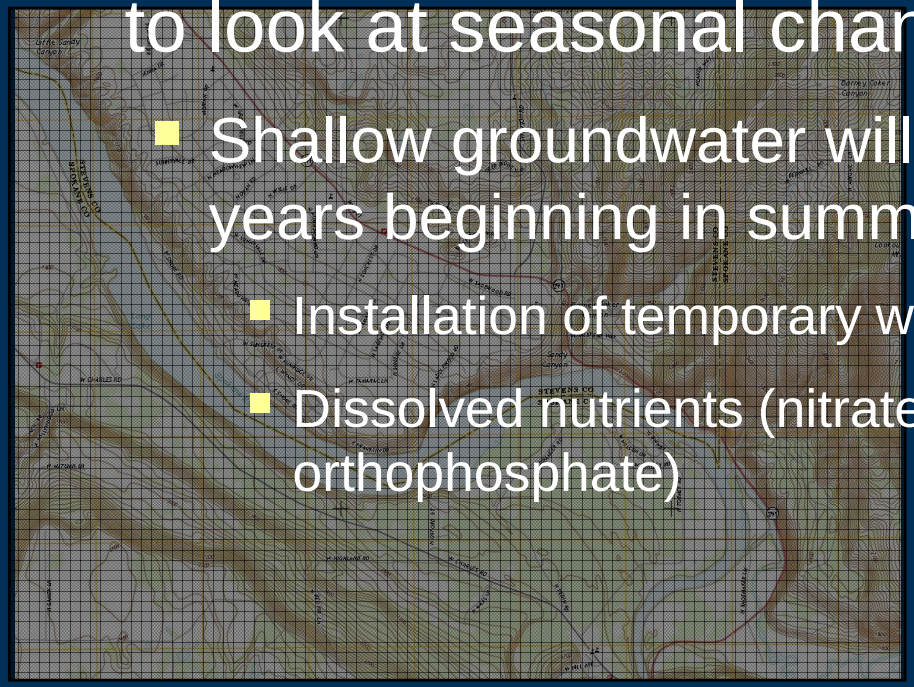
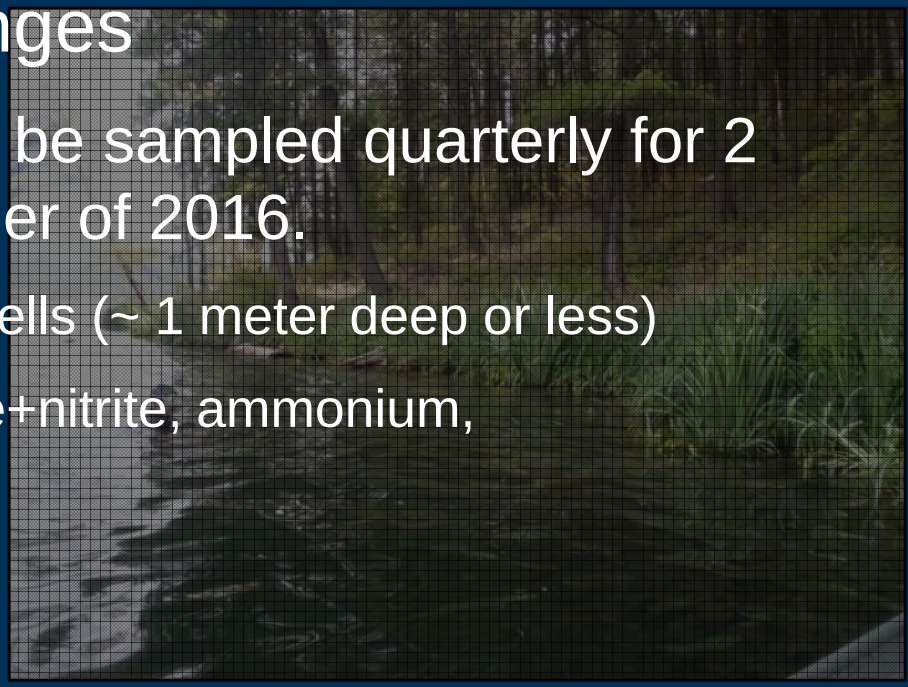
Phase 2 Approach

- Expand shallow groundwater nutrient sampling to look at seasonal changes
  - Shallow groundwater will be sampled quarterly for 2 years beginning in summer of 2016.
    - Installation of temporary wells (~ 1 meter deep or less)
    - Dissolved nutrients (nitrate+nitrite, ammonium, orthophosphate)





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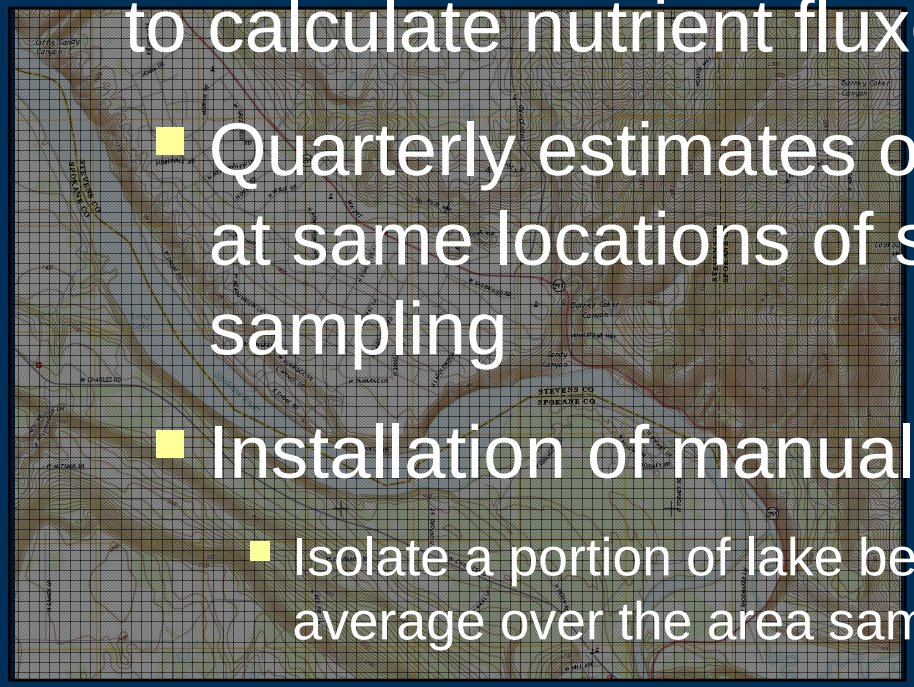
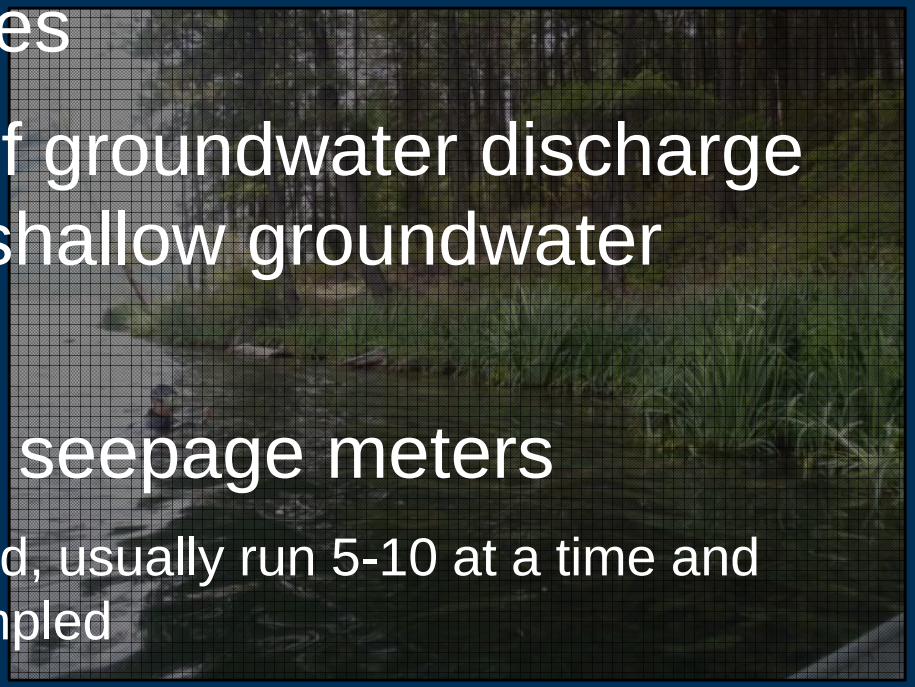
Phase 2 Approach

- Estimate flux of groundwater discharge in order to calculate nutrient fluxes
  - Quarterly estimates of groundwater discharge at same locations of shallow groundwater sampling
  - Installation of manual seepage meters
    - Isolate a portion of lake bed, usually run 5-10 at a time and average over the area sampled
    - Determine change in volume of water in a flexible capture bag
    - Estimate of discharge at one point in space and time





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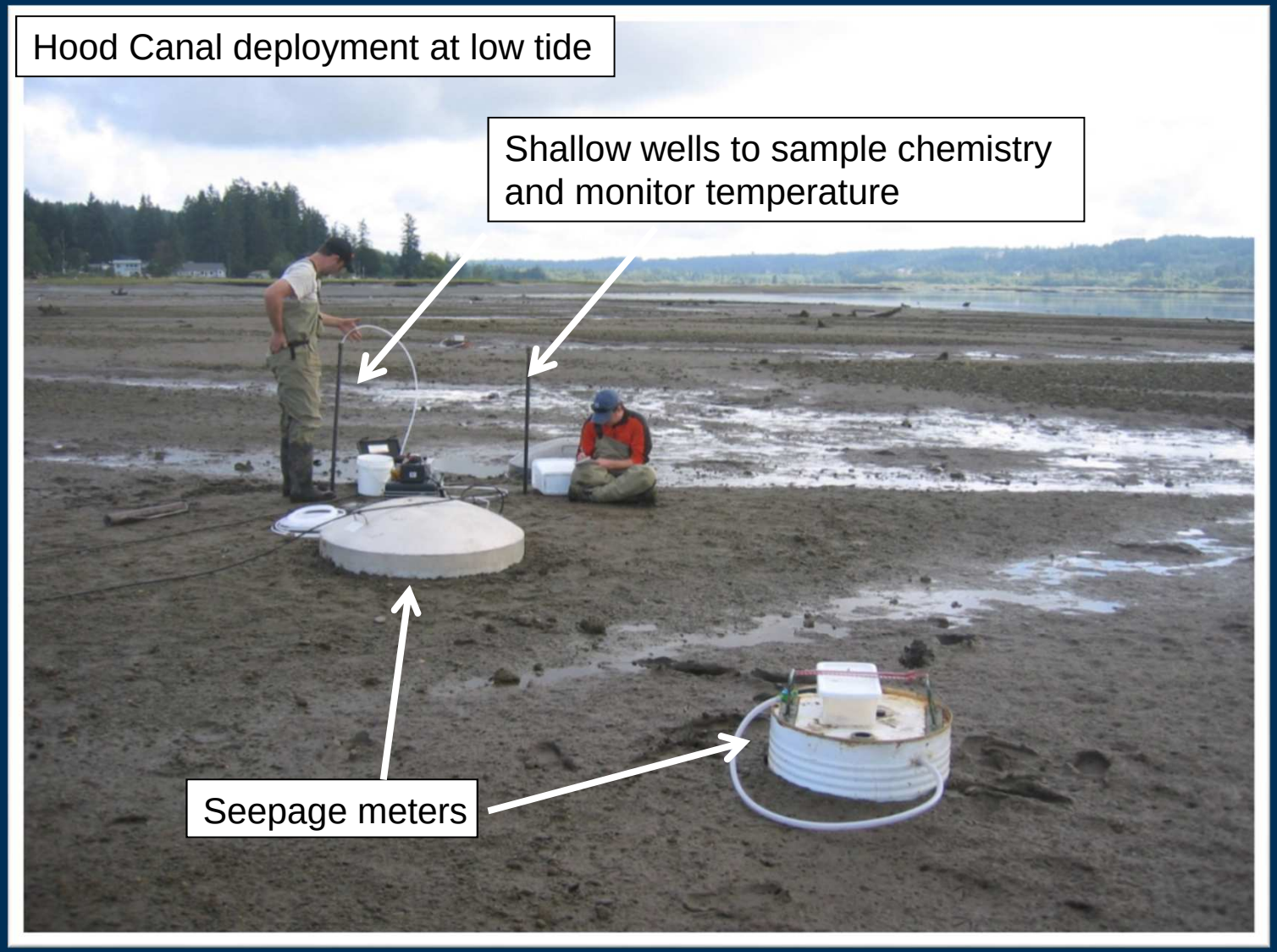
Seepage meter measurements



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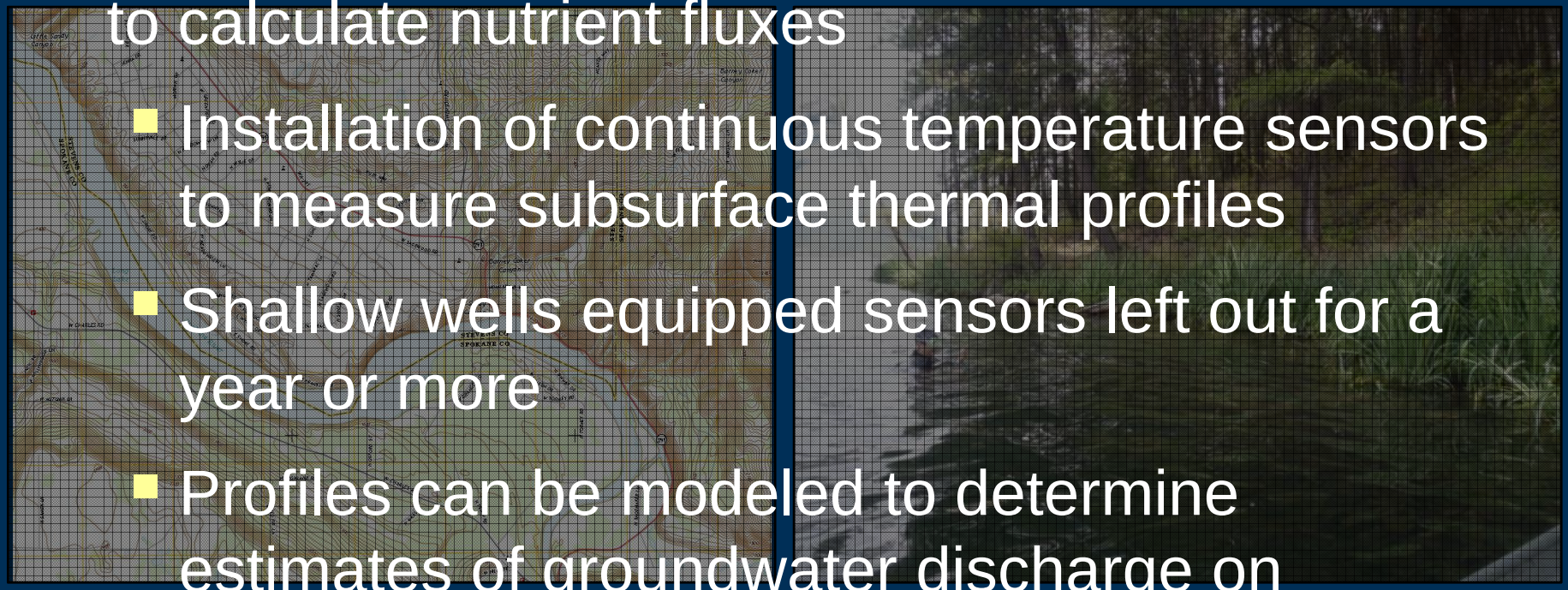
Phase 2 Approach

- Estimate flux of groundwater discharge in order to calculate nutrient fluxes
  - Installation of continuous temperature sensors to measure subsurface thermal profiles
  - Shallow wells equipped sensors left out for a year or more
  - Profiles can be modeled to determine estimates of groundwater discharge on varying time scales.



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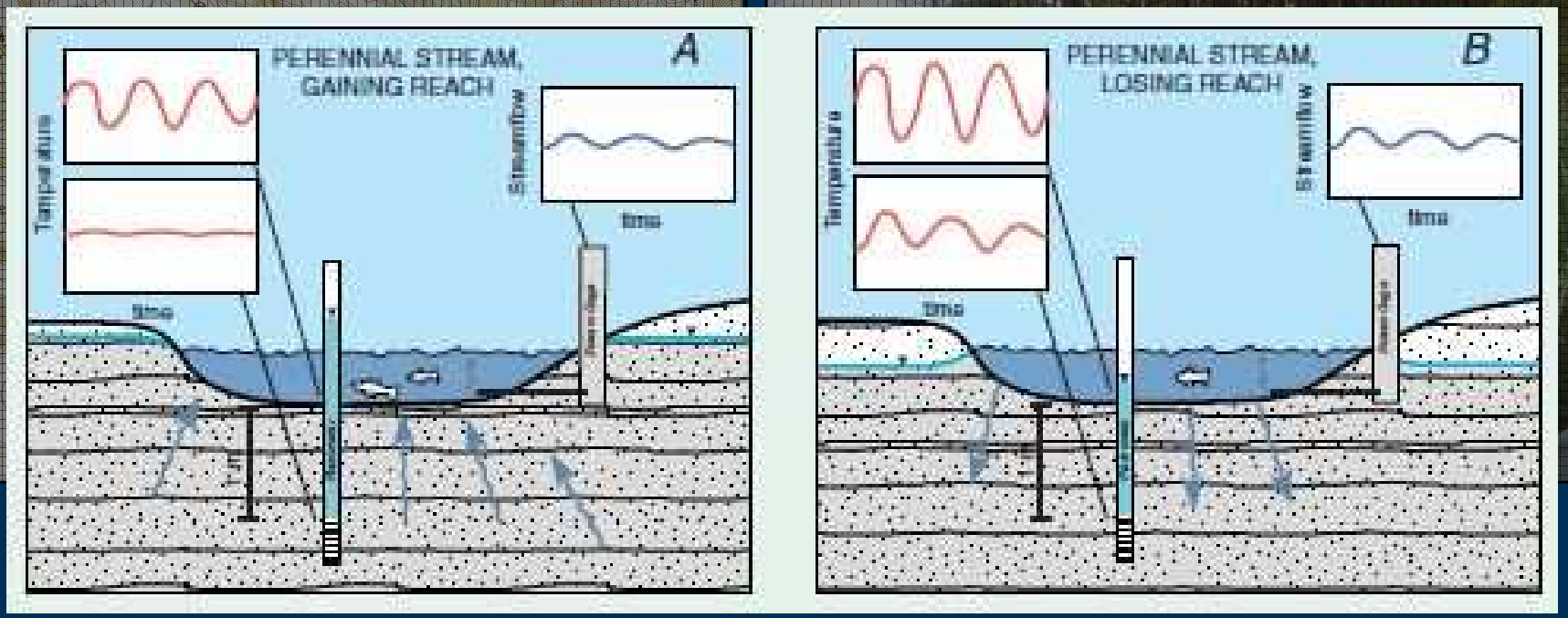
Phase 2 Approach

- Temperature modeling to estimate groundwater flux from heat balance equations



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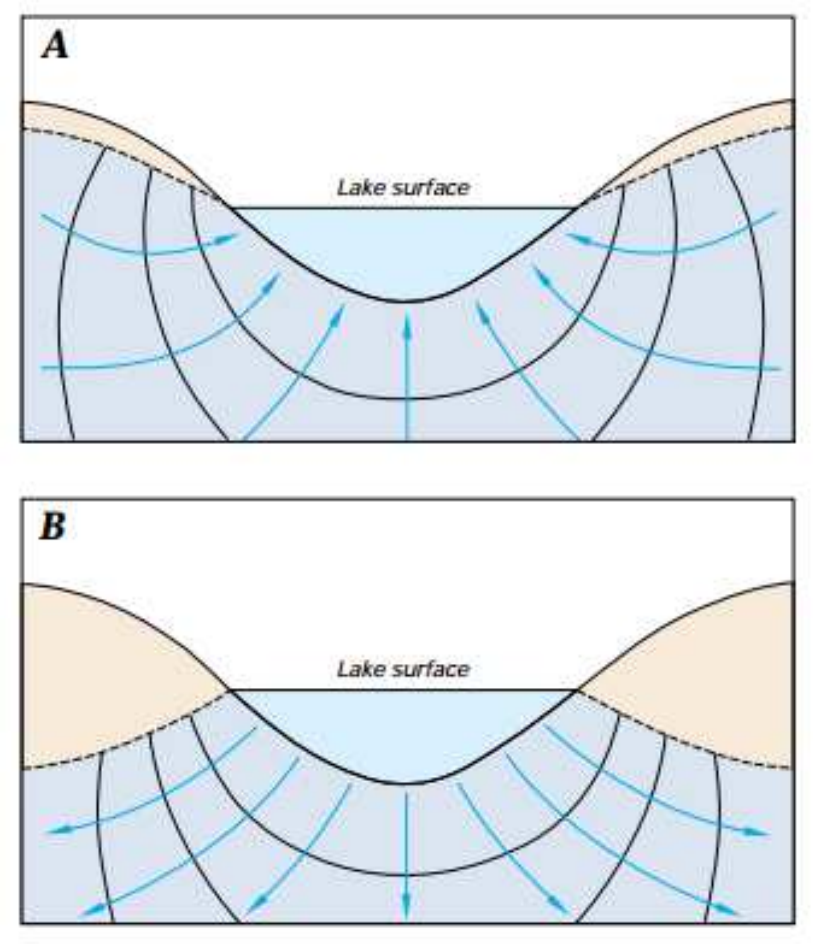
Groundwater Flow Pathways and GW/SW Interactions

- GW may discharge to or from a lake depending on its hydraulic relation to the lake
- GW/SW interactions may vary seasonally with changes in lake stage



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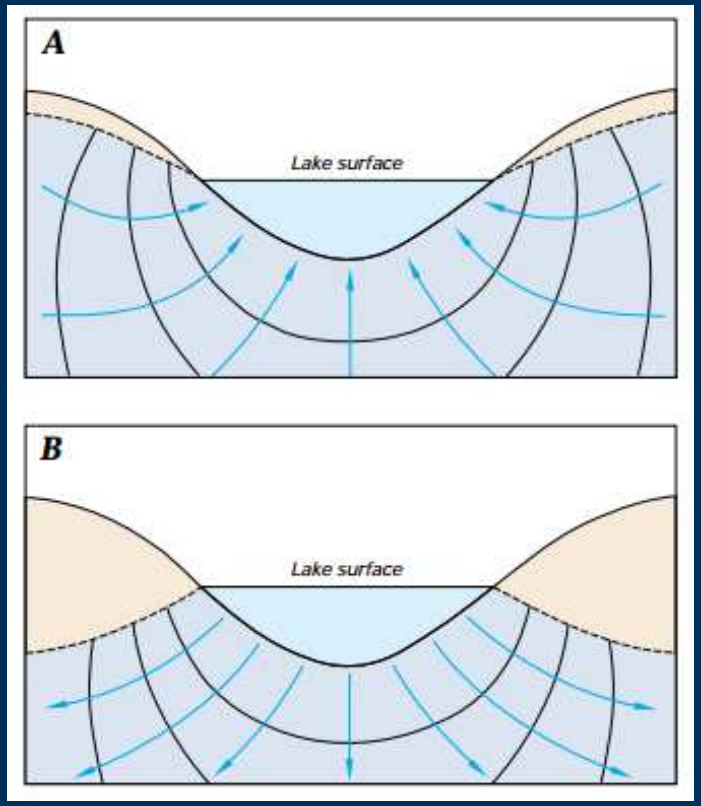
Summary – Phase 2

- Expand spatial and temporal extent of shallow groundwater nutrient sampling to look at seasonal changes across a larger area of Lake Spokane
- Estimate groundwater discharge to Lake Spokane in order to calculate nutrient input
- Field work 2016 – 2018; Phase 2 report finalized in 2018



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Publication and Project Website

- Gendaszek, A.S., Cox, S.E., and Spanjer, A.R., 2016, Preliminary characterization of nitrogen and phosphorus in groundwater discharging to Lake Spokane, northeastern Washington, using stable nitrogen isotopes: U.S. Geological Survey Open-File Report 2016-1029, 22 p., http://dx.doi.org/10.3133/ofr20161029

- http://wa.water.usgs.gov/projects/lakespokane/

Questions?

Karin Baldwin
Department of Ecology
karin.baldwin@ecy.wa.gov
(509) 329-3601

Charlie Kessler
Stevens Co. Conservation District
ckessler@co.stevens.wa.us
(509) 685-0937 x111

Andy Gendaszek
United States Geological Survey
agendasz@usgs.gov