



Characterization of Nitrogen and Phosphorus in Groundwater Discharging to Lake Spokane



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TMDL advisory group – May 2017

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Introduction

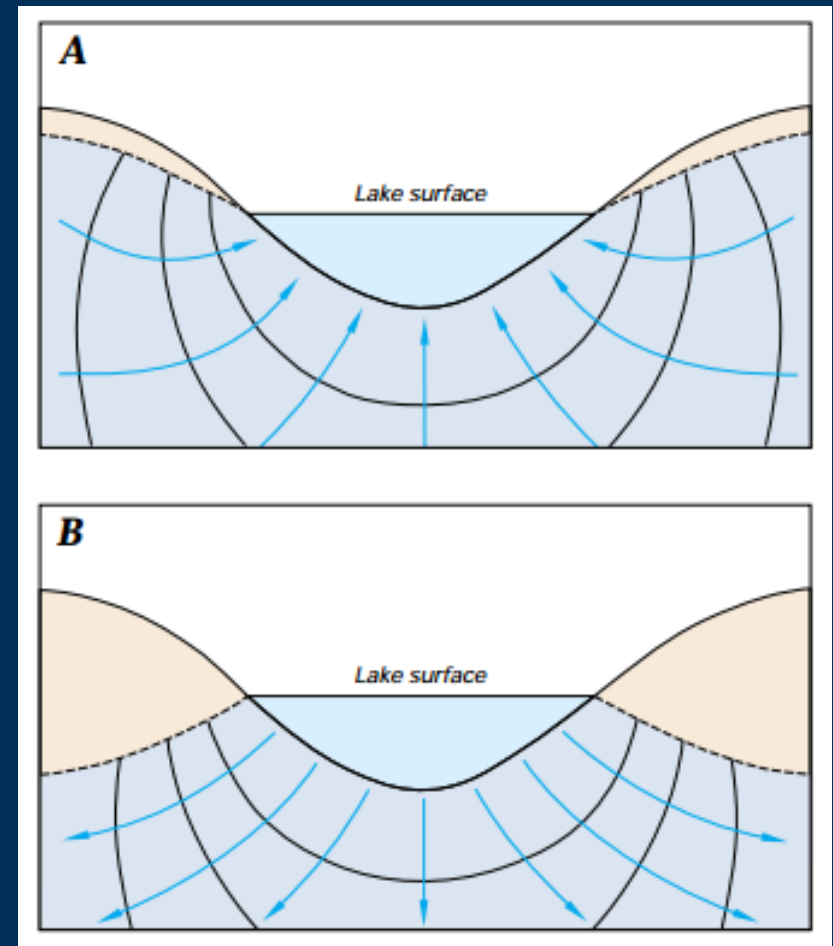
- Question: Are significant levels of nutrients from groundwater reaching Lake Spokane?
- Approach to this question is taking place in two phases.
 - Phase 1 – general survey of aquatic plants for analysis of ^{15}N , a stable isotope of nitrogen, indicative of wastewater influence; preliminary sampling of shallow groundwater chemistry
 - Phase 2 – Expand the shallow groundwater chemistry sampling and add-on measurements of groundwater seepage in order to estimate fluxes entering the lake.
- Timeline – phase 1 is completed and report published; phase 2 started Oct. 2016, expected completion in late 2018.

Phase 2 Approach

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

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



Phase 2 Approach

- **Expand shallow groundwater nutrient sampling to look at seasonal changes**
 - Shallow groundwater will be sampled quarterly for 2 years beginning in fall of 2016.
 - Installation of temporary piezometers (~ 1 meter deep or less)
 - 20-30 locations across low, medium and high residential areas
 - Dissolved nutrients (nitrate+nitrite, ammonium, orthophosphate)
 - Nitrate isotopes (^{15}N and ^{18}O in water)
 - Dissolved Boron (indicator of residential wastewater)

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
 - Seepage meters
 - Lakebed Temperature profiles

Phase 2 Approach

- Seepage meters
 - Isolate a portion of lake bed, usually run 5 meters 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

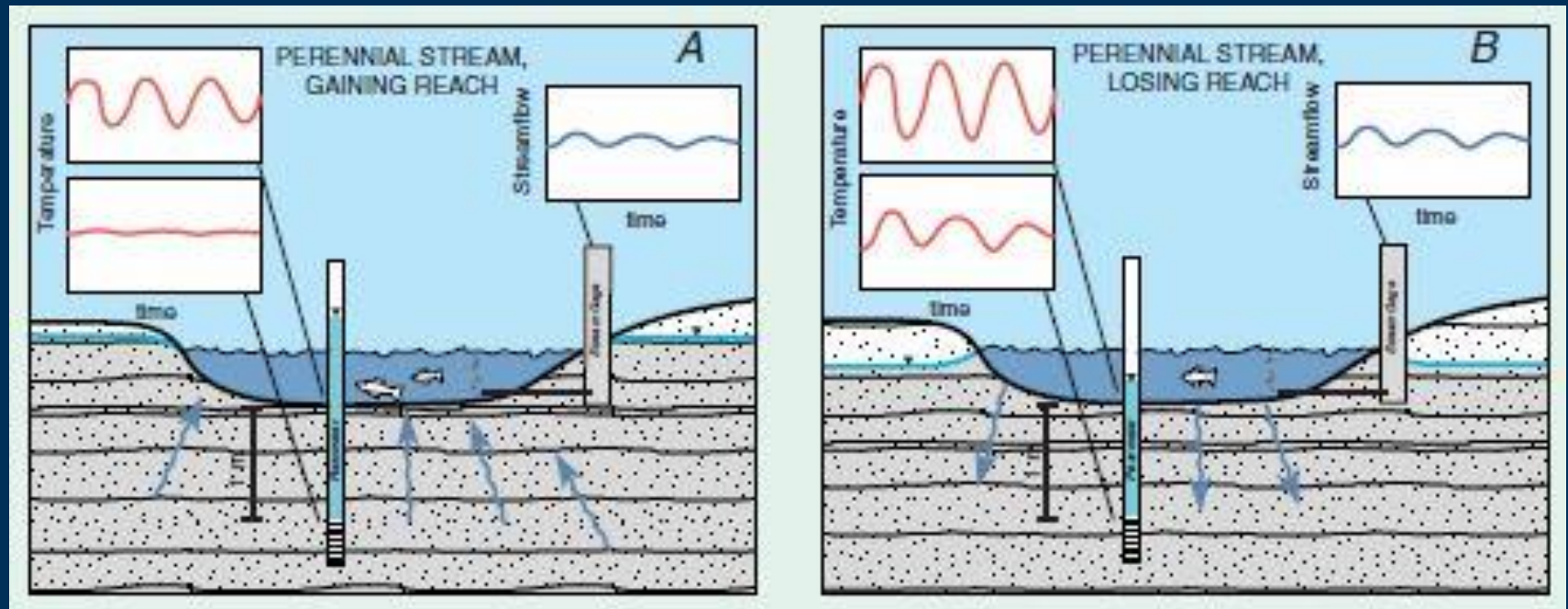


Phase 2 Approach

- **Measuring lakebed temperature profiles**
 - Installation of continuous temperature sensors to measure subsurface thermal profiles
 - Custom designed temperature rods
 - Profiles can be modeled to determine estimates of groundwater discharge on varying time scales.

Phase 2 Approach

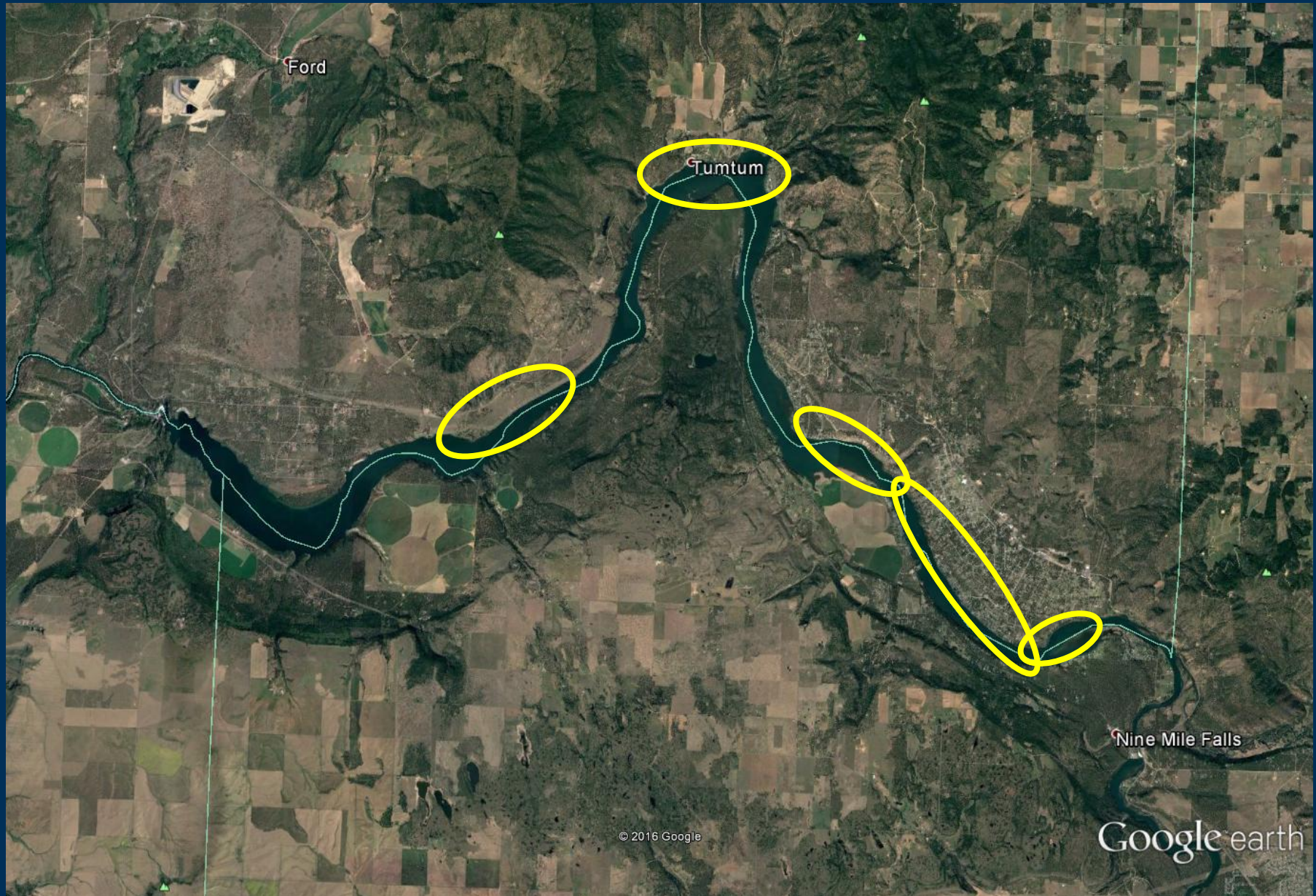
- Temperature modeling to estimate groundwater flux from heat balance equations



Seepage meter locations



Additional GW locations



Preliminary data

- About 60 samples collected so far since October 2016
- Nutrient concentration ranges:
 - Ammonia: <0.01 to 0.96 mg-N/L
 - Nitrate+Nitrite: <0.001 to 7.60 mg-N/L
 - Orthophosphate: 0.010 to 0.306 mg-P/L
- Still early to tell for sure BUT:
 - Seasonal differences are minor
 - Landuse effect is present for nutrients, undeveloped has less, but more analysis needed.
- Seepage flux is generally low, and seems to vary with season.
 - Highest values this past May, after wet winter. Further analysis needed

Summary

- Completed 3 trips so far, next one in August 2017
- Still looking for places to sample along Suncrest and Tum Tum
- Seasonality seems to be more important for seepage compared to GW chemistry at the moment, but still too early to tell.
- We will present data so far at the Spokane River Forum in November 2017, and final report due by December 2018.
- <http://wa.water.usgs.gov/projects/lakespokane/>
- 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>

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>
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Questions ?

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