Spatially telescoping measurements for efficient characterization of GW-SW interactions: Lucile Creek, Alaska

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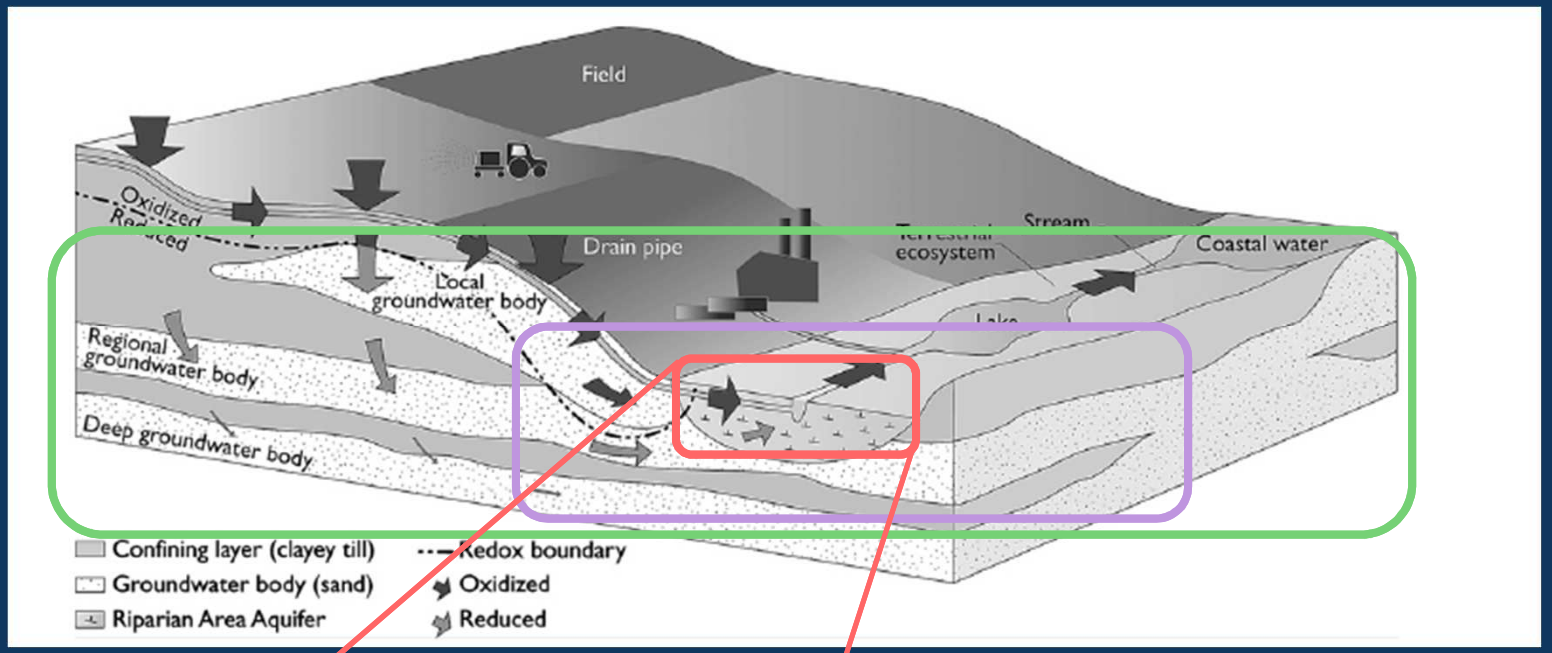
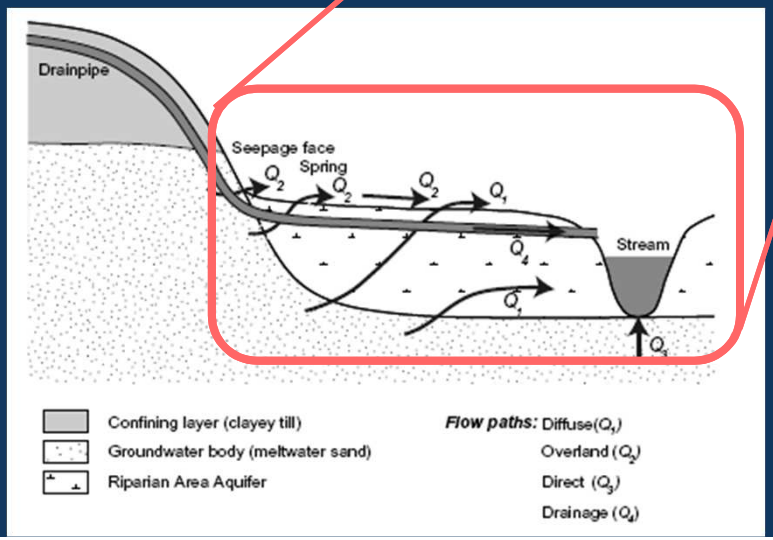
Groundwater – surface water interaction, conceptual

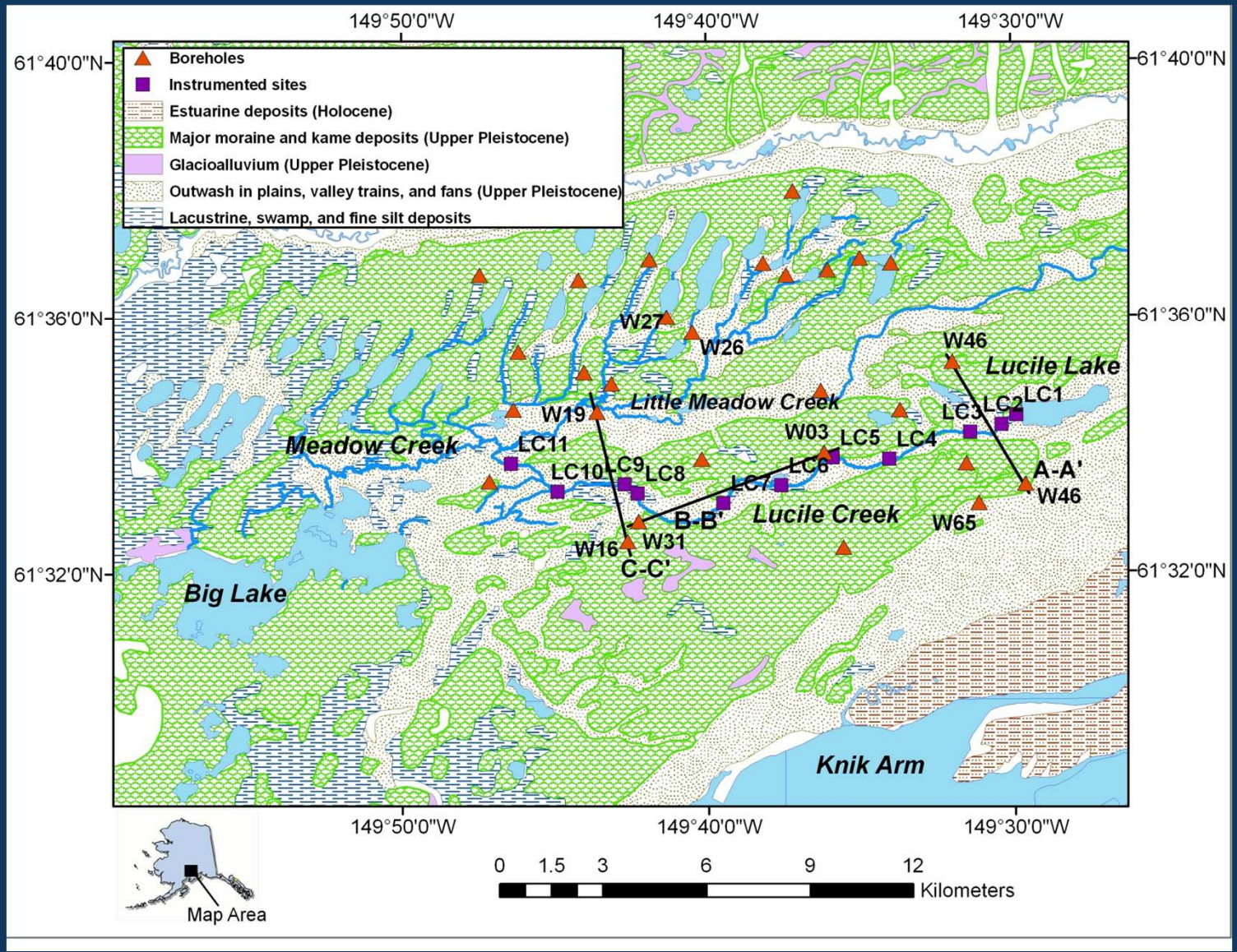




- Regional hydrogeologic setting
- Riparian hydrogeological type
- Riparian flow path type

Figures from Dahl et. al., 2007

Lucile Creek area



Study Objectives

- **Conceptual** multi-scale typology of GW-SW interactions
  - ✓ Regional hydrogeologic setting
  - ✓ Riparian hydrogeological type
  - ✓ Riparian flow path type

- **Quantify** fluxes from ground water at different measurement scales
  - ✓ Measured water fluxes: calibration targets for regional groundwater flow model
  - ✓ Spatial distribution of water fluxes

???

Hydrologic process ⟷ Measurement scale

Solution: *Adapt measurement campaign in spatially telescoping sequence*

The spatially telescoping approach

Catchment scale

- Hydrogeologic cross-sections
- Geomorphic indices

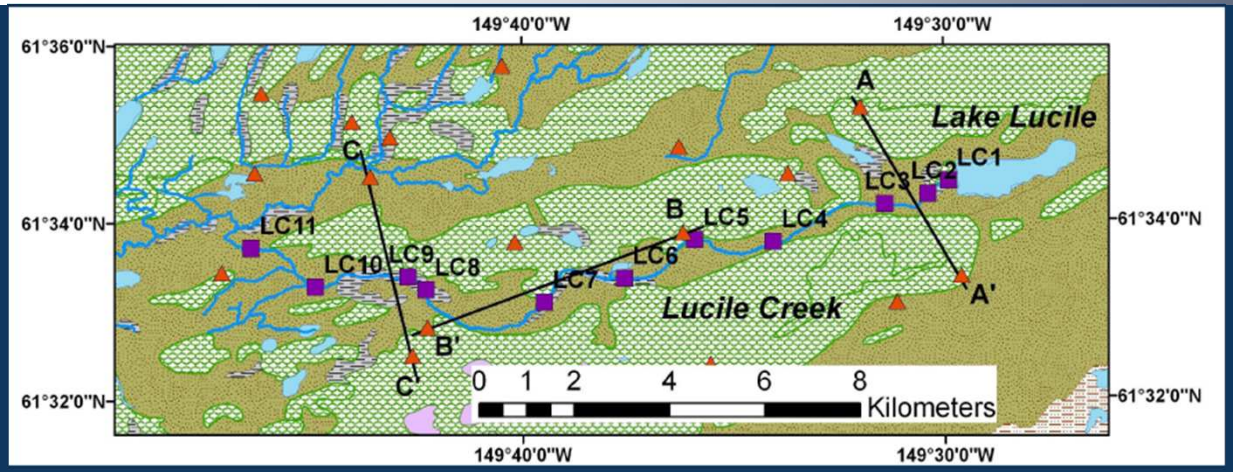
Reach scale

- Differential discharge measurements
- Chemical/isotopic composition of groundwater, stream water

Point scale

- Hydraulic gradients
- Vertical water fluxes
  - Seepage meters
  - Temperature methods

Results: Geomorphic indices

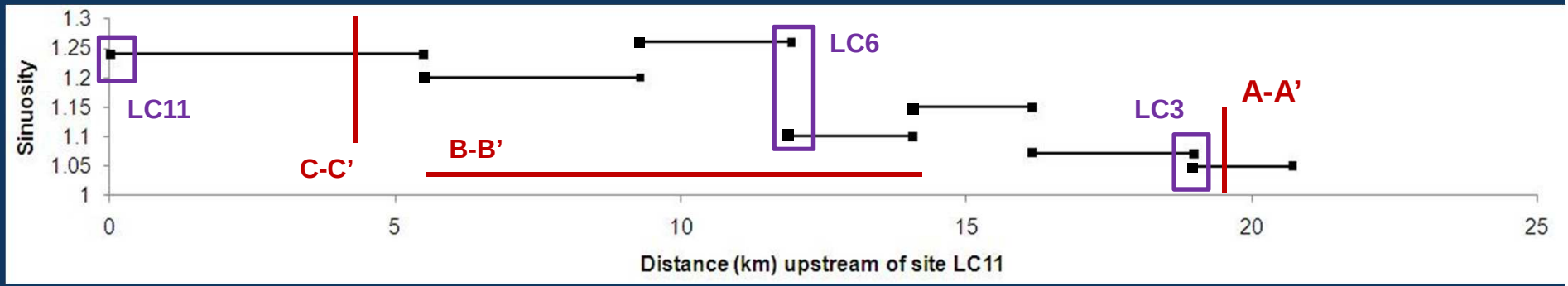


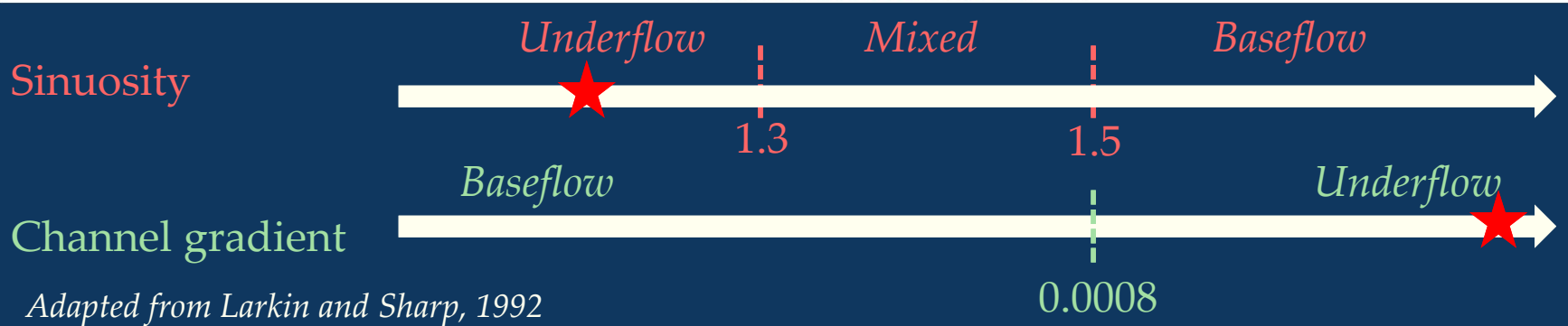
Lucile Creek

Mean channel gradient: 0.002

Mean sinuosity: 1.16

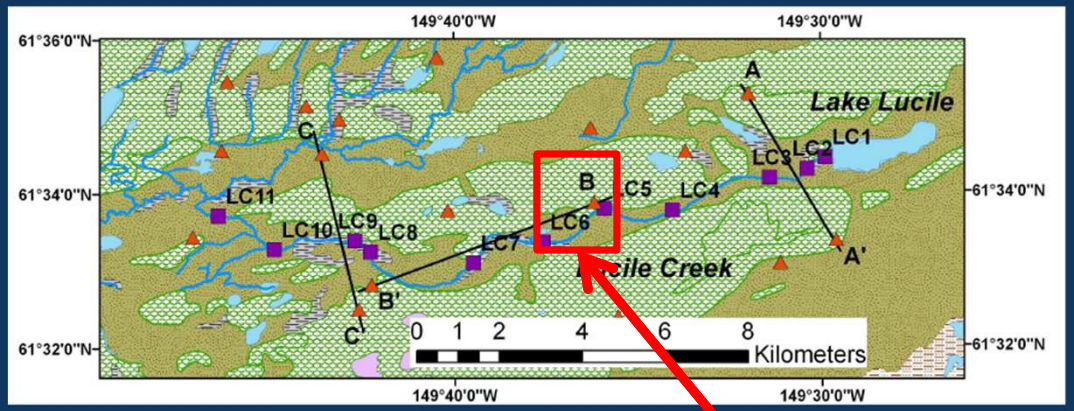
Underflow-dominated

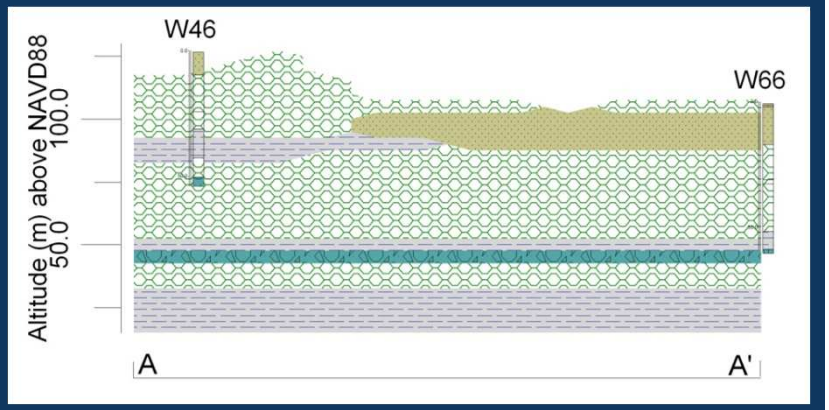


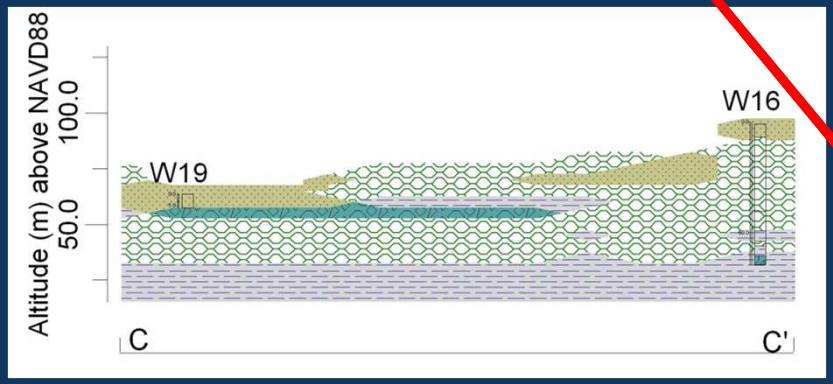


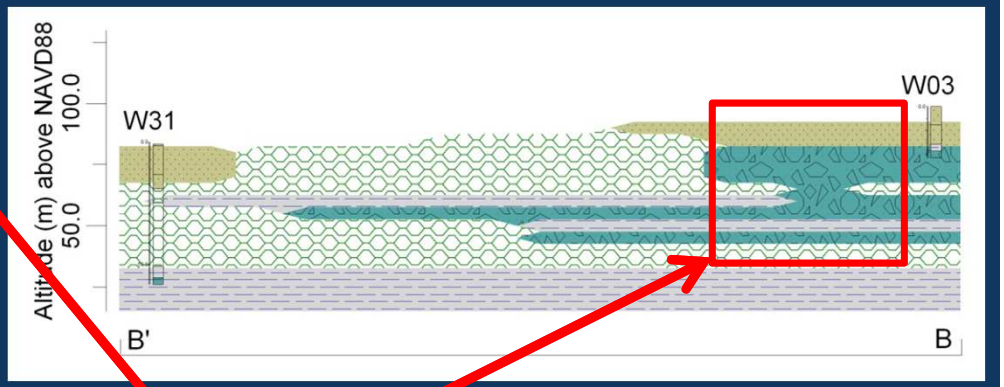
Adapted from Larkin and Sharp, 1992

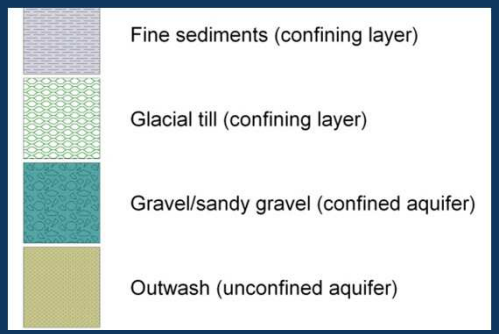
Results: Hydrogeologic cross-sections





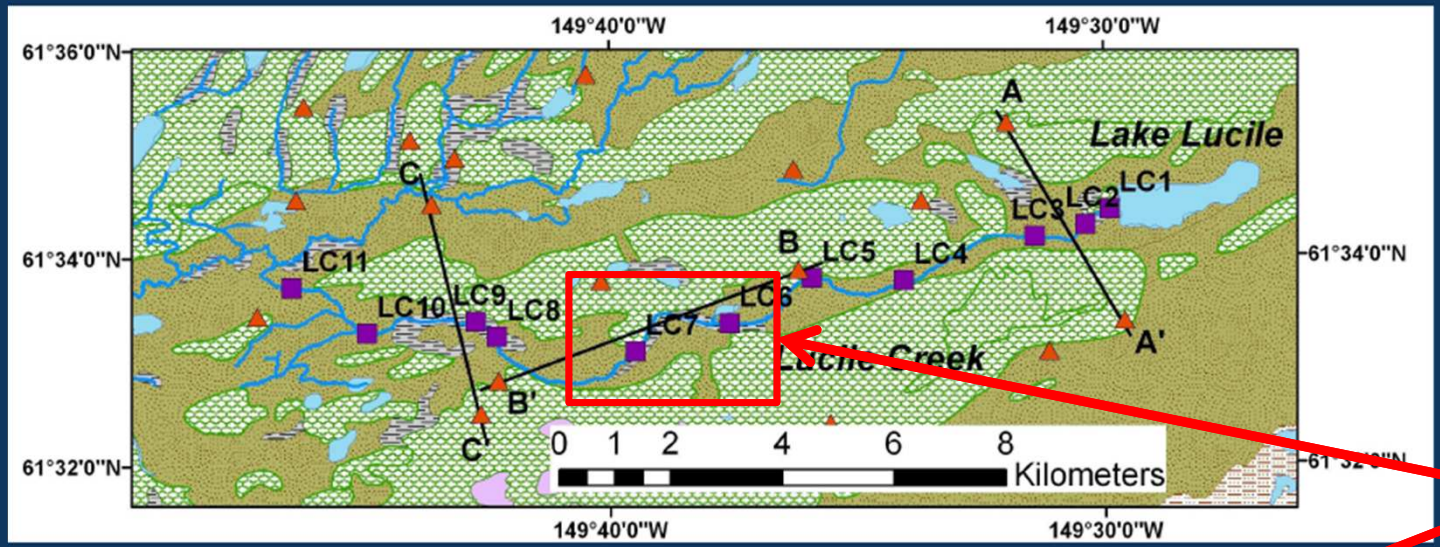


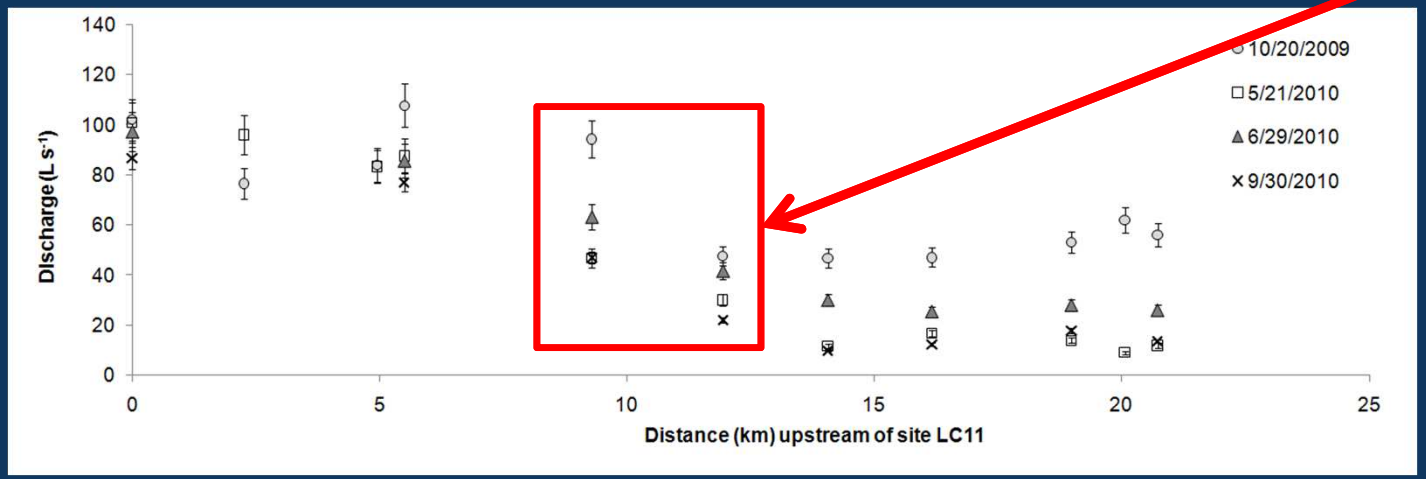




Regional, riparian aquifers hydraulically connected

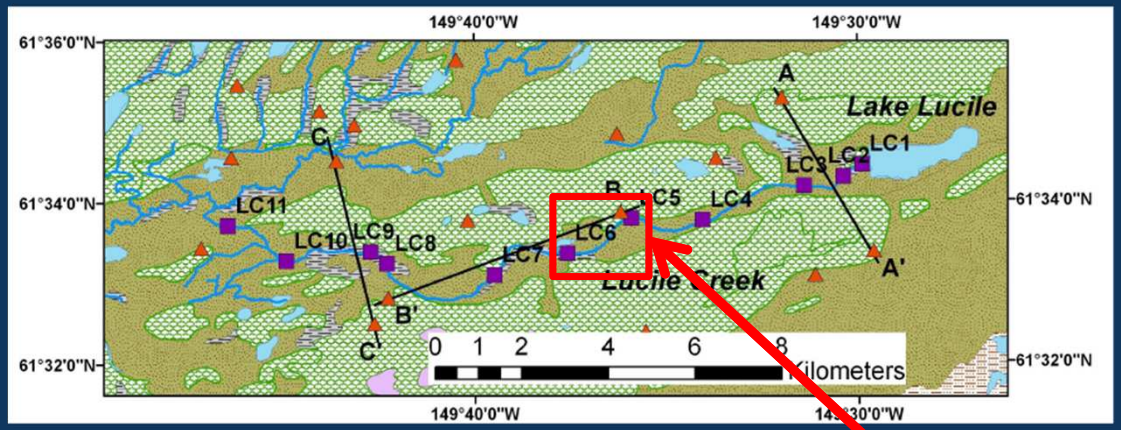
Results: Differential discharge

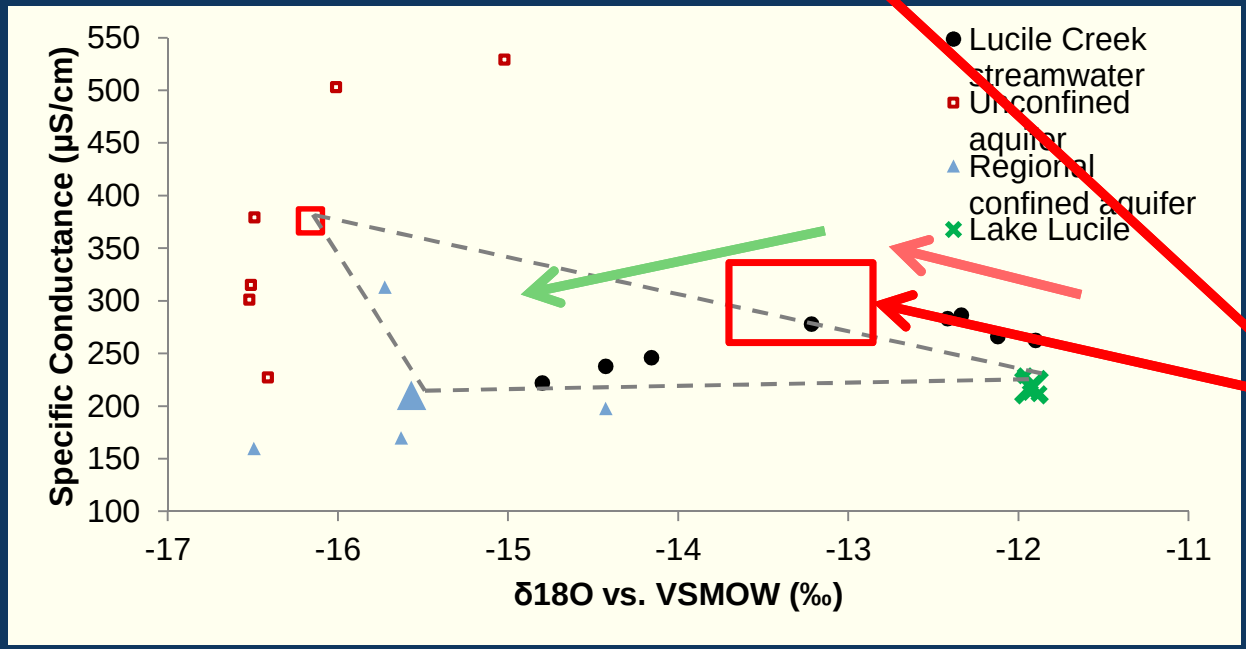




Large gain in baseflow

Results: Chemical/isotopic tracers

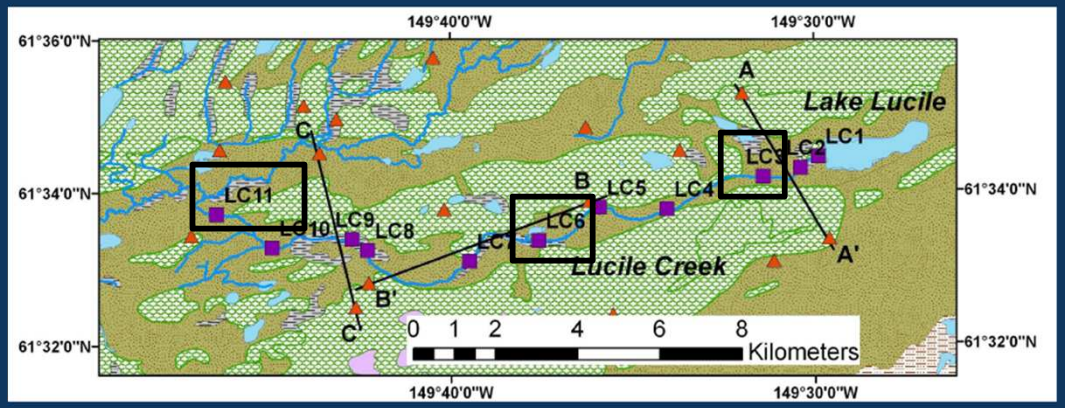




1. Stream water moves toward 'unconfined aquifer ' end member
2. Stream water moves toward 'regional aquifer' end member

Increasing contribution of regional ground water

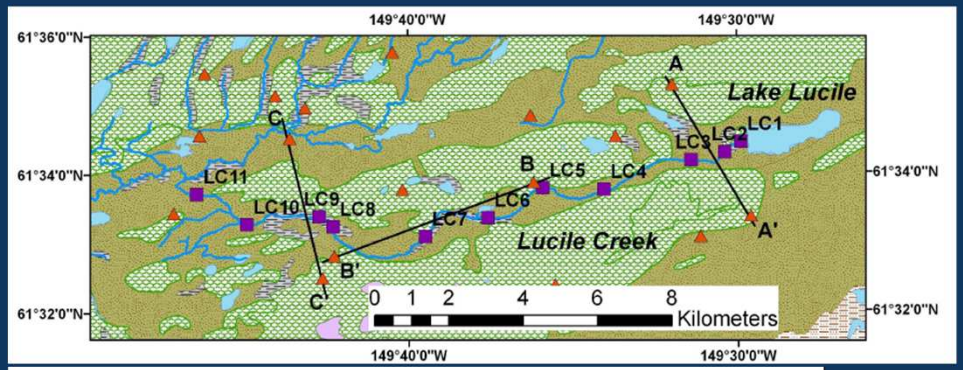
Results: Point vertical fluxes, physical methods

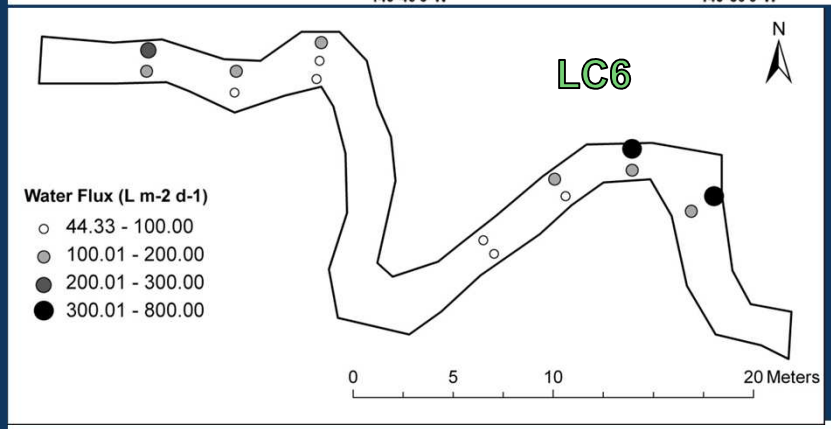


	LC11	LC6	LC3
Hydraulic gradient [--]	0.0048	0.094	0.008
Vertical flux [L m^{-2} d^{-1}]	0.27	77.8	0.15

Point-scale verification of reach-scale flux estimates

Results: Point vertical fluxes, temperature methods



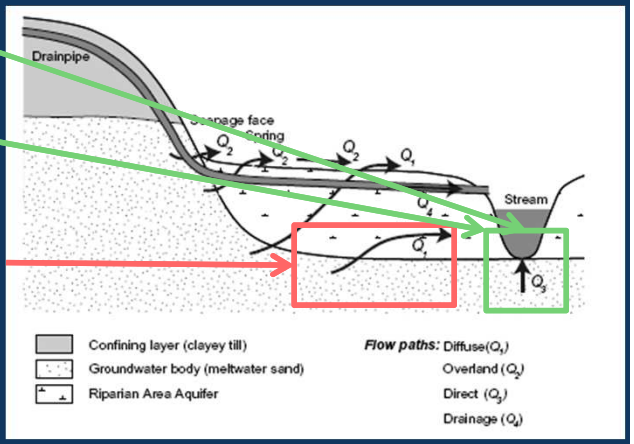


Riparian flow path type:

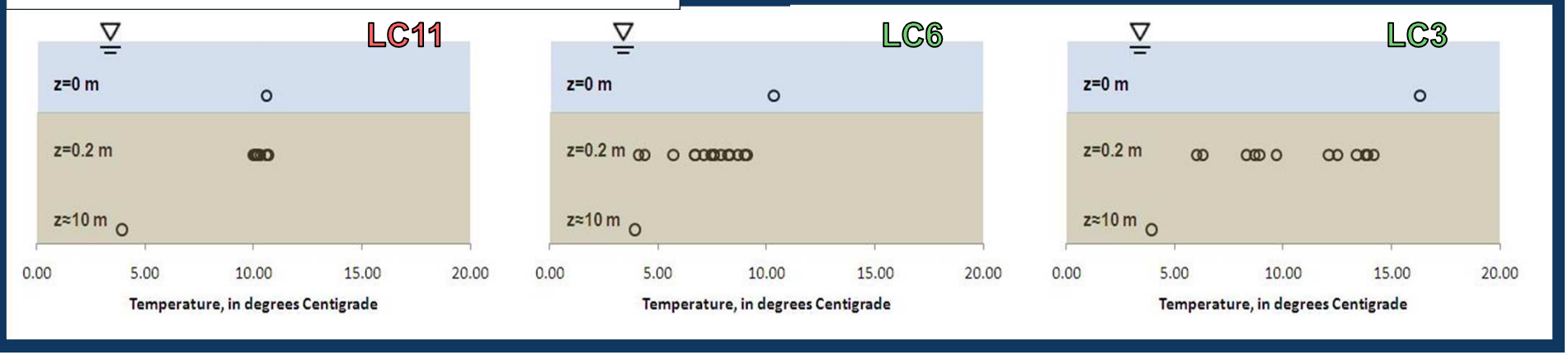
LC3: Direct

LC6: Direct

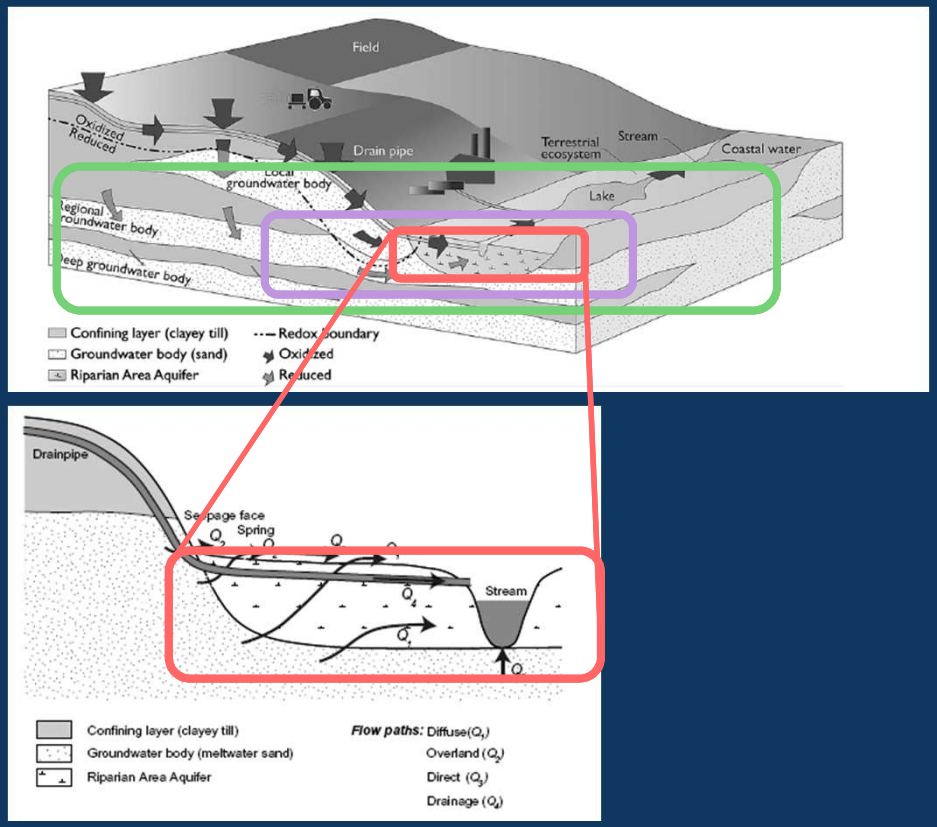
LC11: Diffuse



Transition from direct → diffuse riparian flow path type



Conclusions: Typology of GW-SW Interaction



Figures from Dahl et. al., 2007

- Regional hydrogeologic setting:
  - *A three-unit system (unconfined aquifer, confining layer, confined aquifer)*
- Riparian hydrogeological type:
  - *Confined, evolving towards unconfined regional, unconfined local*
- Riparian flow path type:
  - *Direct, evolving towards diffuse*

Conclusions: Water fluxes, quantified

- Ground water contributes
  - 45-75% of total discharge measured at site LC11, near confluence with Meadow Creek (*based on differential discharge measurements*)
  - 77% of total discharge (*based on 3-component mixing model from chemical isotopic tracers*), with

    6% from unconfined aquifer

    71% from confined aquifer

- Point measurements agree with reach-scale measurements – and add additional information
  - LC3: 151.12 L m^{-2} d^{-1} mean, 0.76 coefficient of variation
  - LC6: 188.12 L m^{-2} d^{-1} mean, 1.06 coefficient of variation
  - LC11: 12.35 L m^{-2} d^{-1} mean, 0.57 coefficient of variation

Acknowledgements

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