

Effect of Changing River Stage on Uranium Flux through the Hyporheic Zone

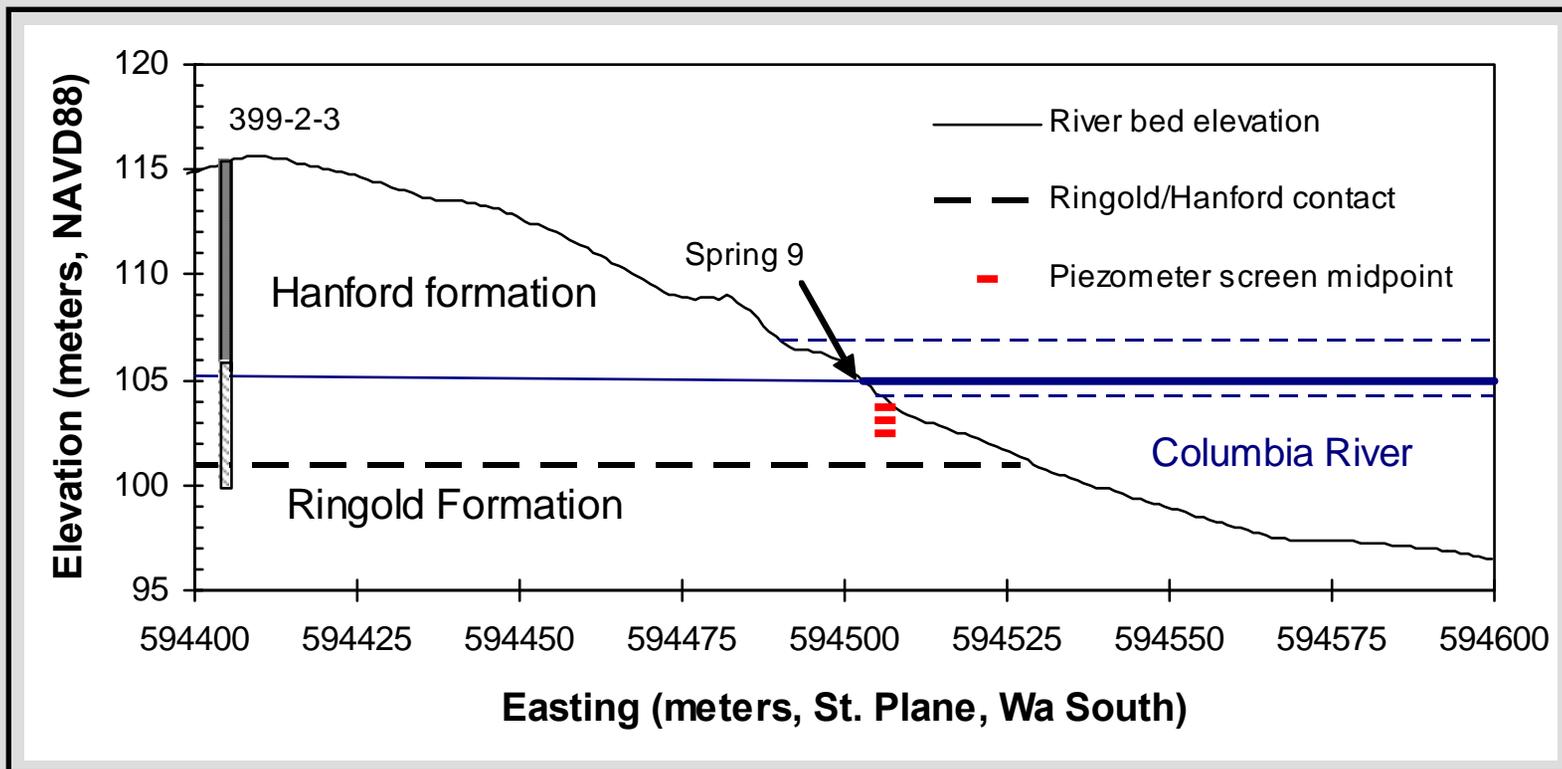
At the Shoreline of the Hanford Site's 300 Area

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Overview

- ▶ Site Description
- ▶ Purpose & Methods
- ▶ Water Flux
 - Influence of river stage
 - Temporal Variation
 - Relationship with river and near shore aquifer
- ▶ Uranium Flux
 - Influence of river stage
 - Temporal Variation
 - Relationship with river and near shore aquifer
 - Impact of dilution by river water
- ▶ Total Monthly discharge

Site Description



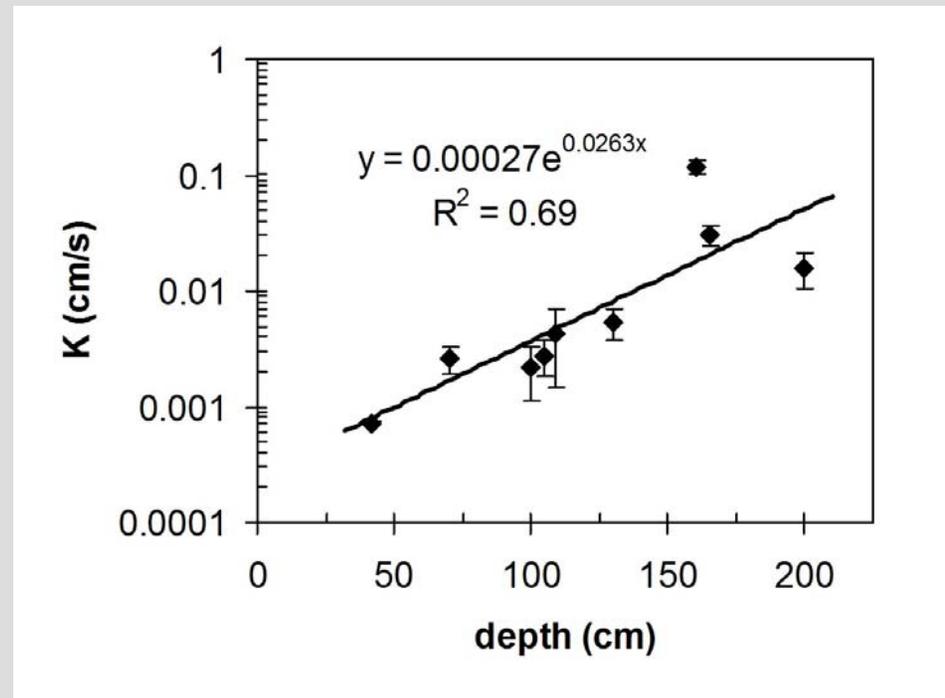
- ▶ Geology
 - Hanford- Missoula flood deposits
 - Ringold- older, more consolidated
 - Uranium confined in Hanford formation
- ▶ Piezometers
 - Installed at 3 depths
 - Always inundated

Purpose & Methods

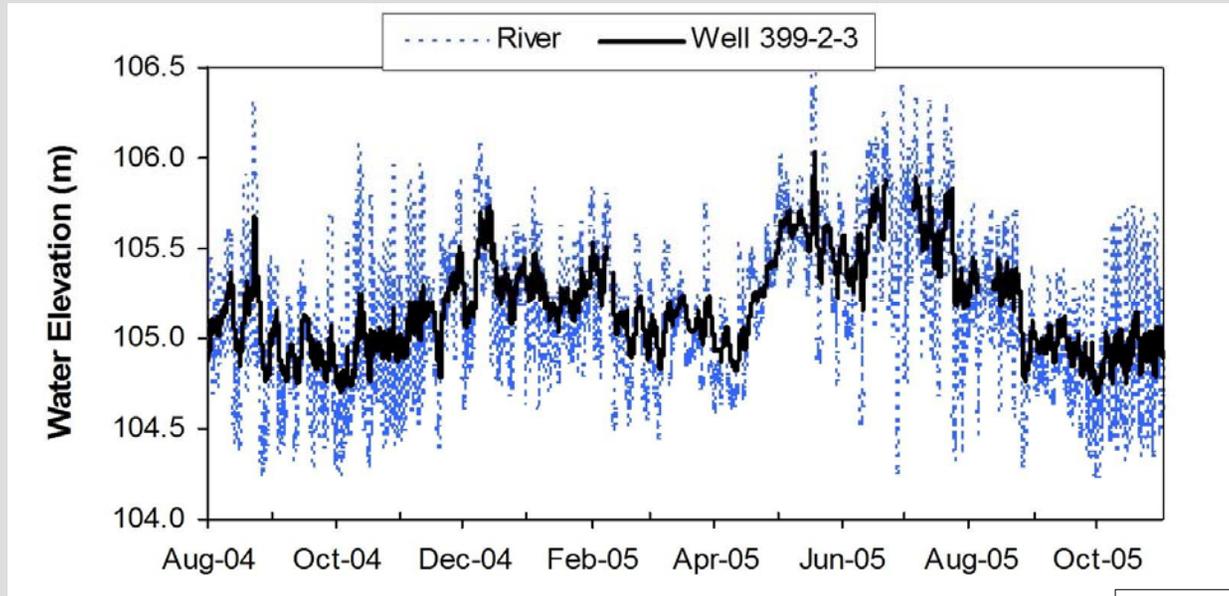
- ▶ Characterize uranium flux at the sediment-water interface
 - Installed piezometers in Hyporheic Zone
 - Did pneumatic slug testing in piezometers
 - Installed continuous pressure, temperature, specific conductance probes in piezometers (Solinst, Canada)
 - Installed continuous water level probes in adjacent wells
 - Collected discrete water samples from piezometers
 - Used Darcy's law to calculate water flux every 30 minutes over a 15 month study period
 - Used specific conductance-uranium correlation to calculate uranium flux at each time step

Hydraulic Conductivity

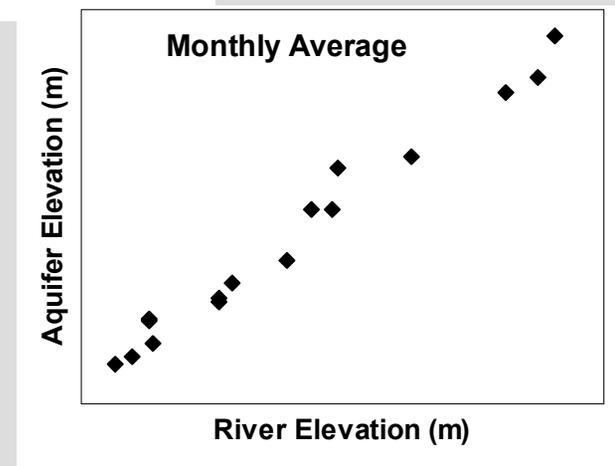
- ▶ Slug tests in 9 piezometers
 - Multiple slug tests in each piezometer
- ▶ Effective K
 - Harmonic mean used to calculate effective K between each screen mid-point and riverbed

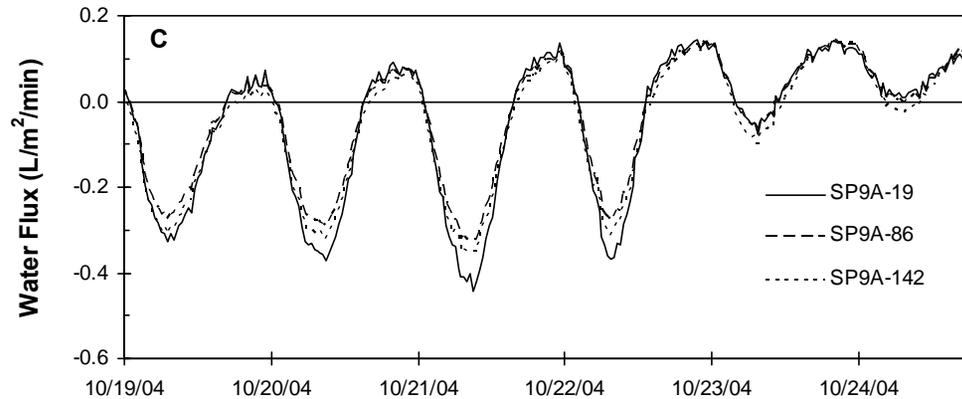
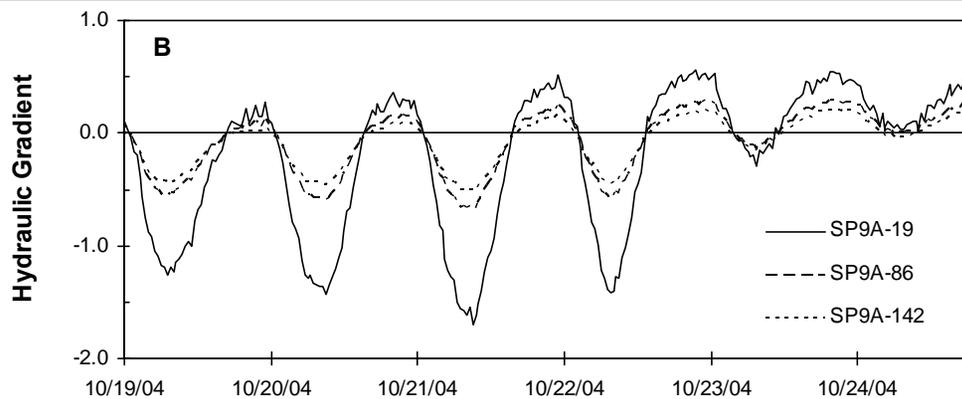
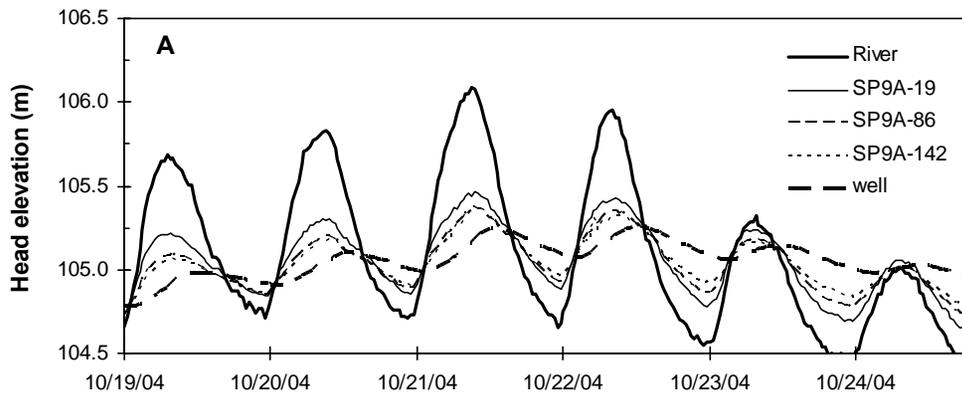


Water levels



- ▶ Aquifer elevation controlled by river elevation
- ▶ Average water elevations over study period
 - River- 105.12 m
 - Near-shore Aquifer- 105.18 m





Example Data

Head data

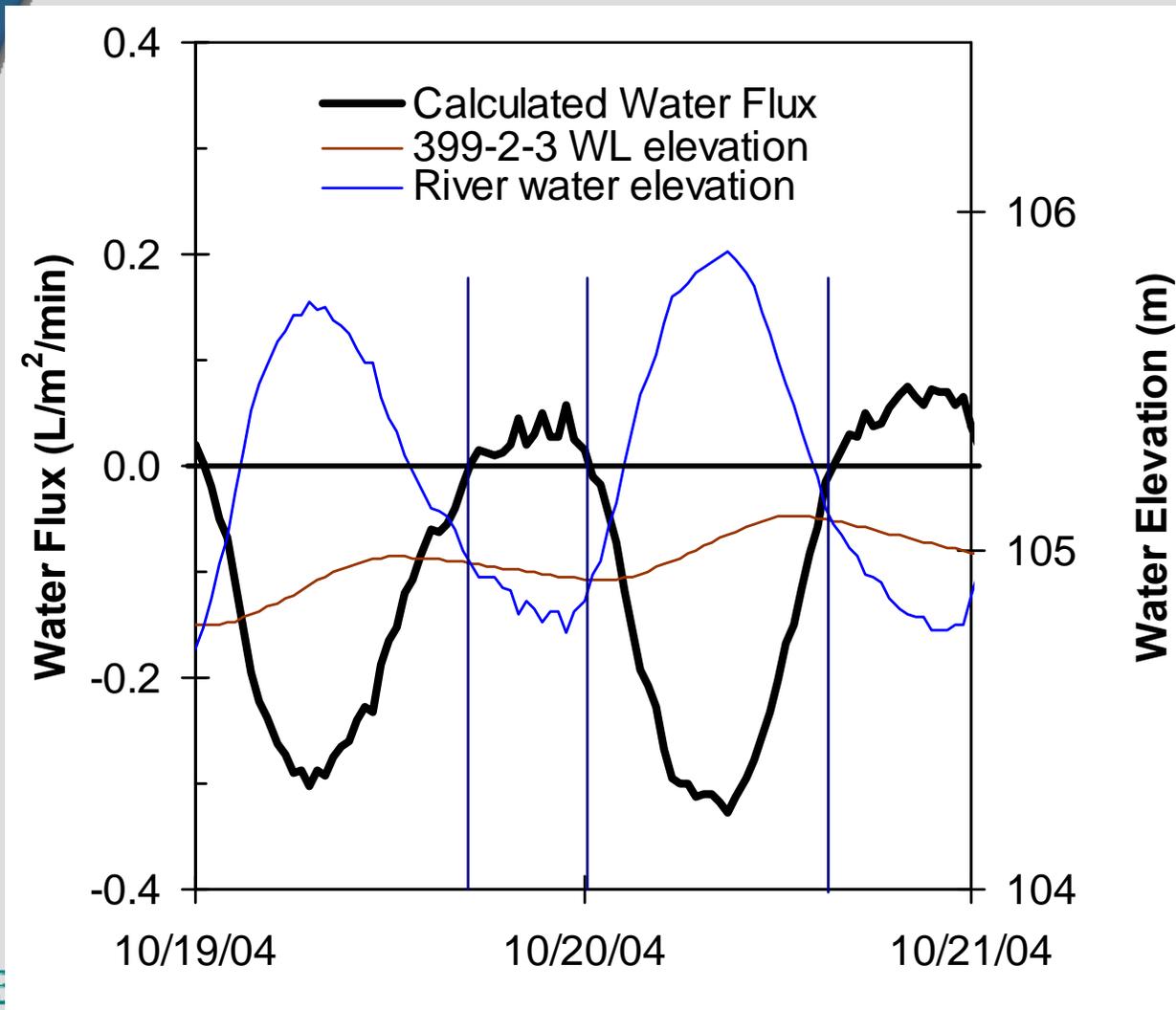


Hydraulic Gradient



Water flux

Water Flux Data

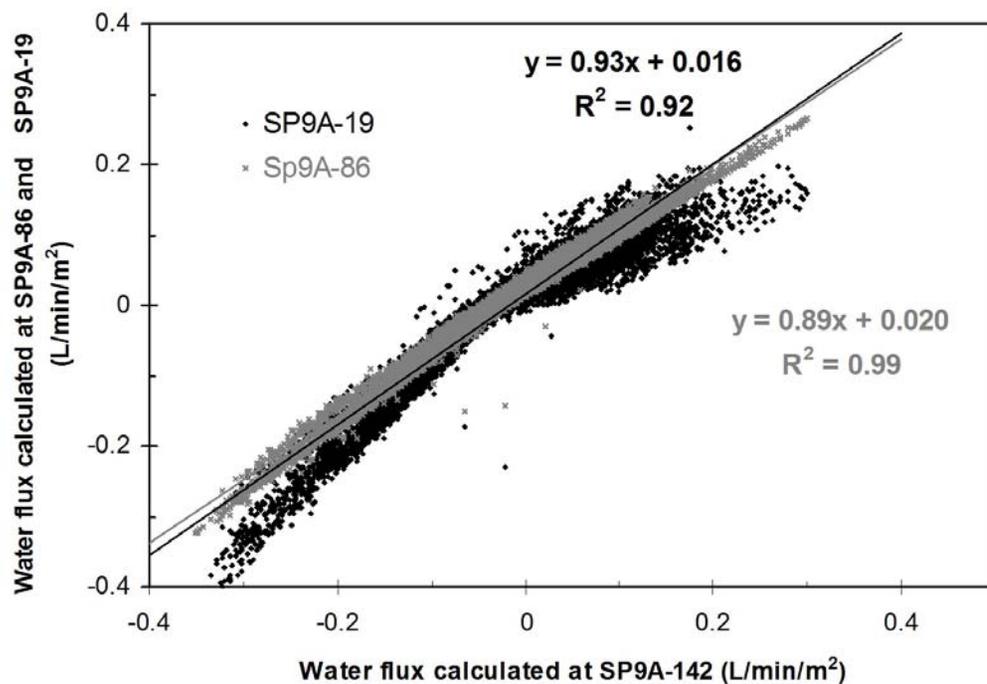


▶ Water flux averaged

▶ Snicker Test

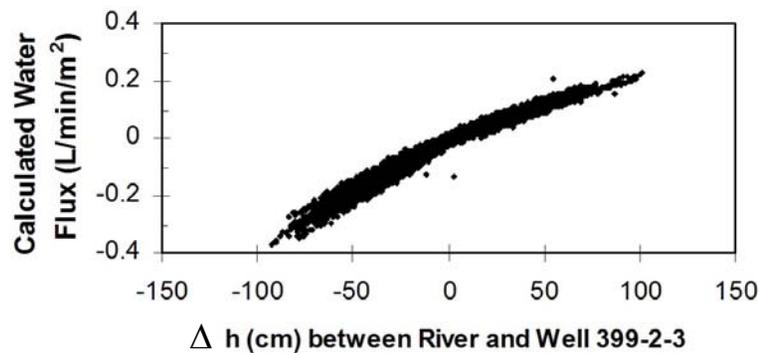
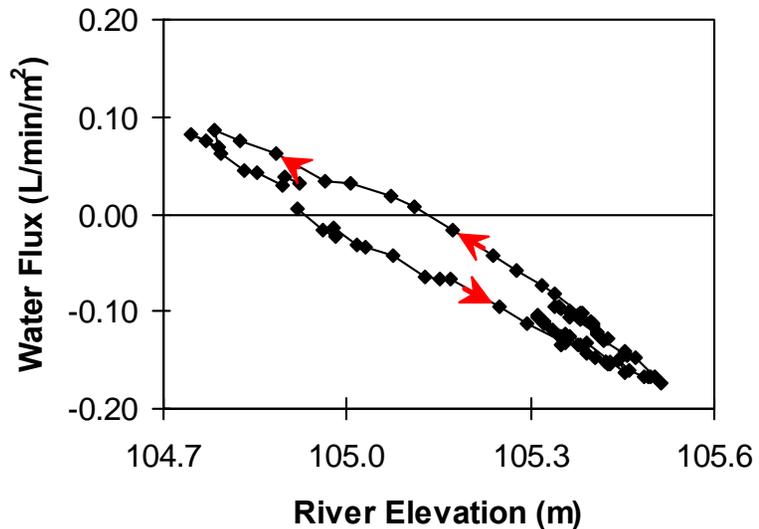
- River > Aquifer, flux negative
- River < Aquifer, flux positive

Intercomparison of Water Flux



- ▶ Excellent agreement between water flux calculated at different piezometers
- ▶ Water Flux data averaged at each time step for remainder of analyses

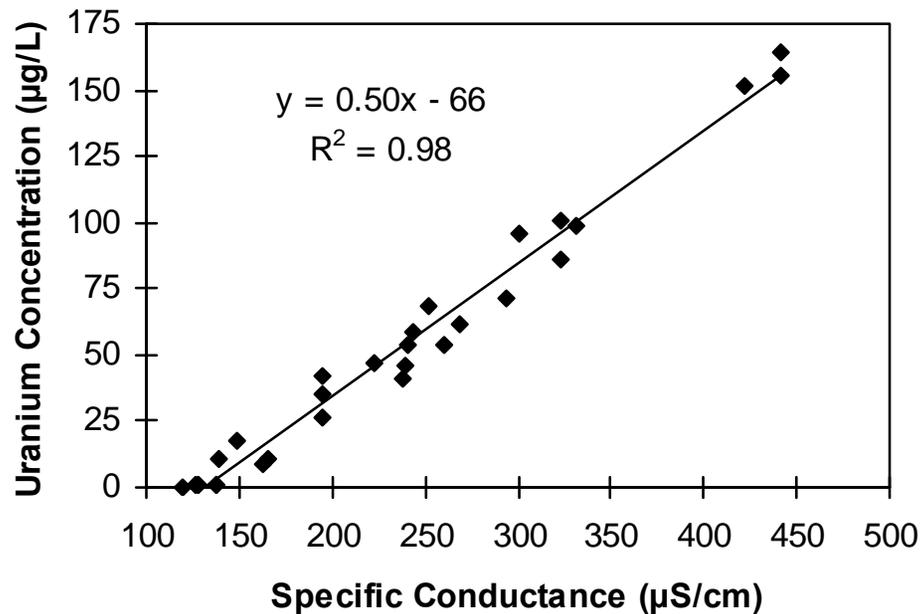
Water Flux Hysteresis



▶ Water flux is not proportional to river stage

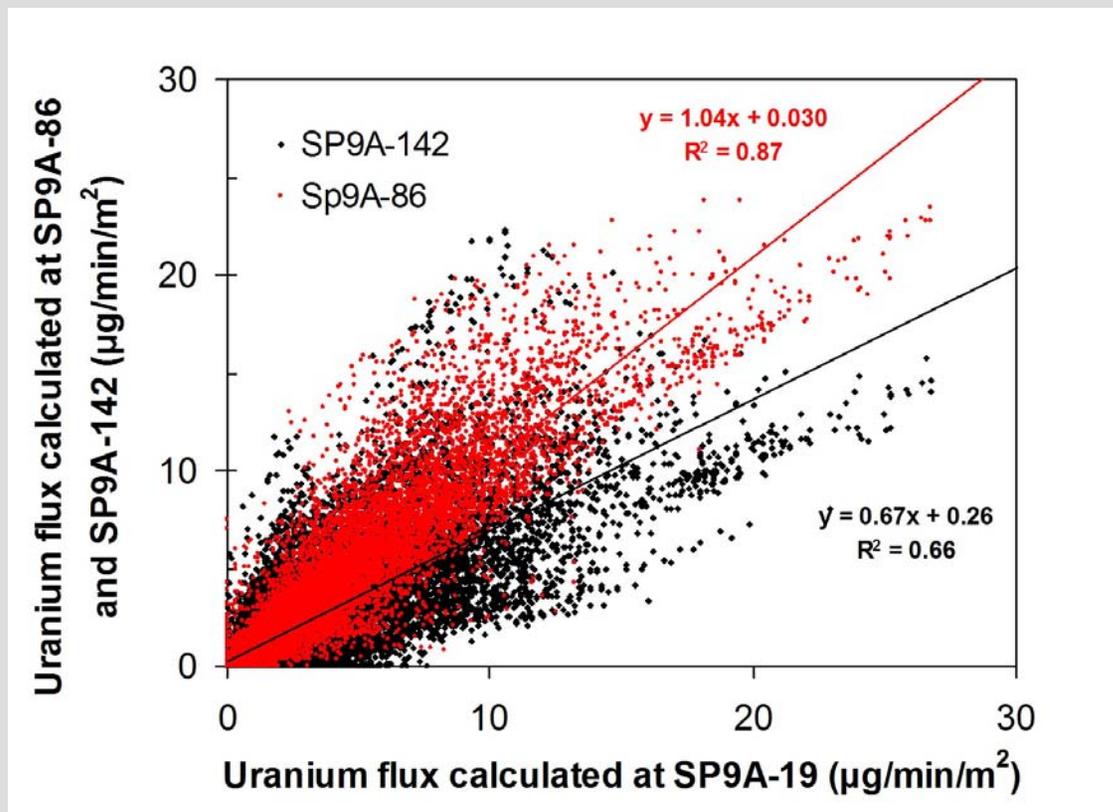
▶ Water flux is a function of river stage and aquifer elevation

Specific Conductance Uranium Relationship



► This relationship observed for many years at springs on the Hanford Reach.

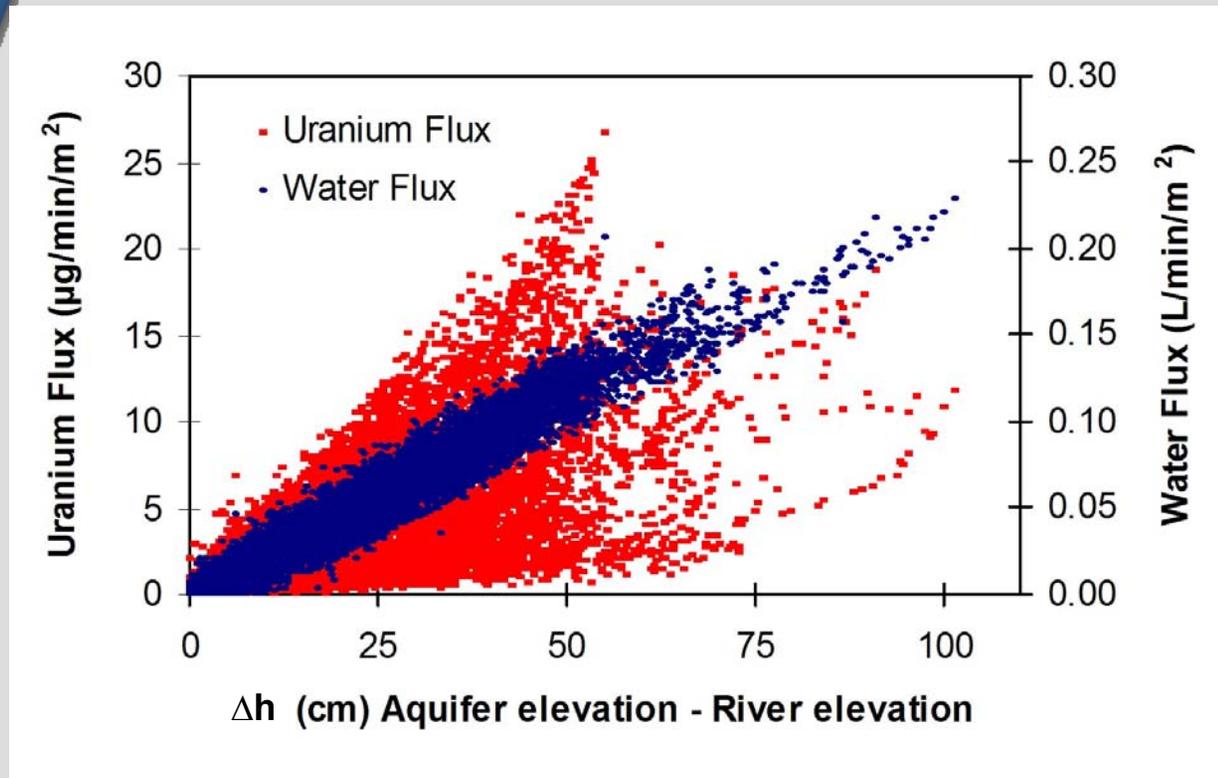
Uranium Flux Intercomparison



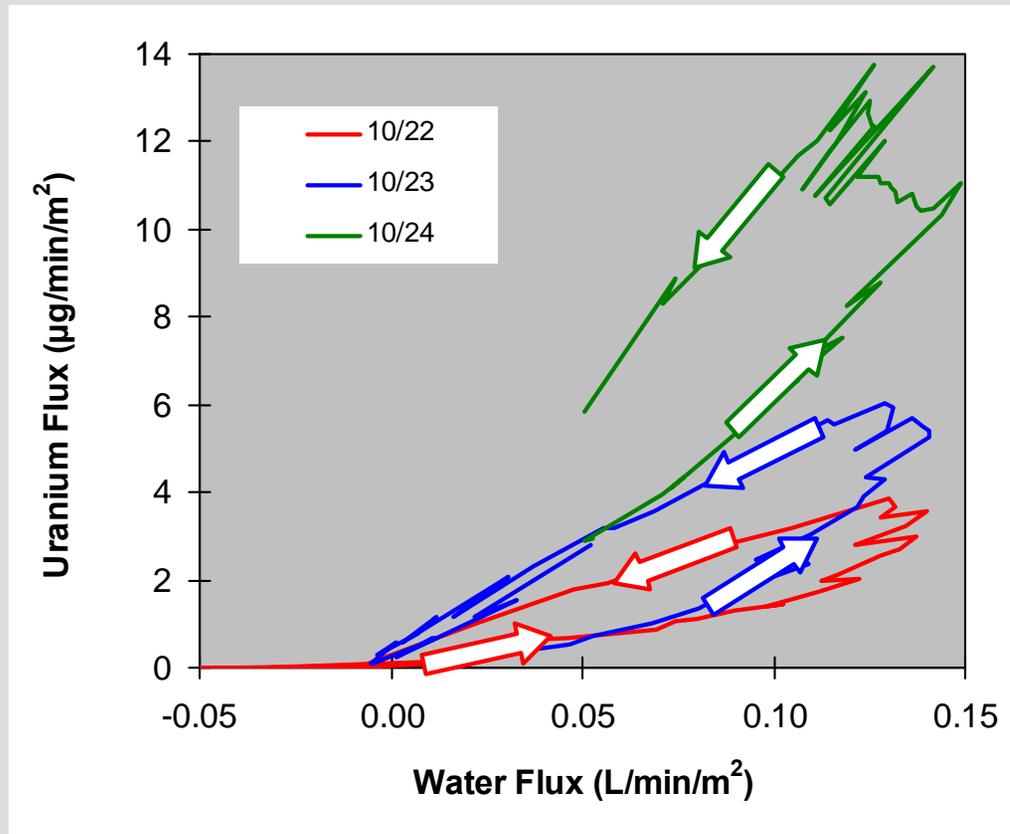
- ▶ Good correlation between two shallowest piezometers
- ▶ These two used to calculate an average uranium flux at each time step

Uranium Flux vs Water Flux

- ▶ Water flux function of aquifer and river elevation
- ▶ Uranium flux is not
- ▶ Uranium flux impacted by dilution in hyporheic zone from surface water intrusion

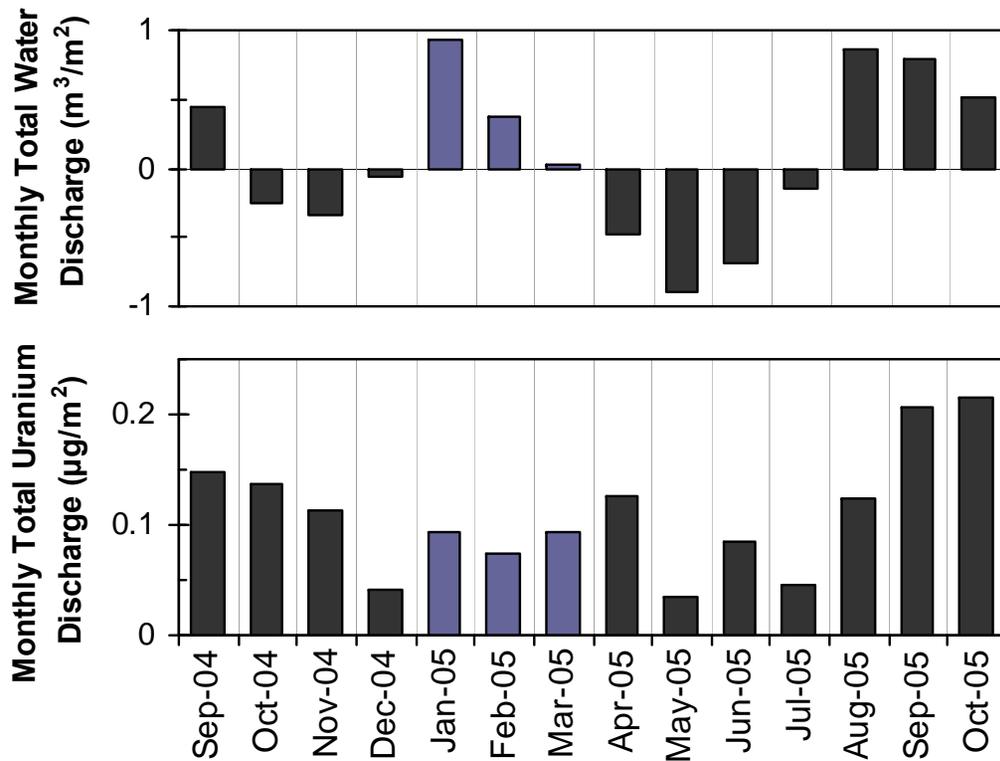


Uranium Flux Hysteresis



- ▶ Example data
 - October 2005
- ▶ Uranium flux higher at comparable water flux as time goes on
- ▶ Demonstrates dilution of uranium in hyporheic zone

Monthly Sums

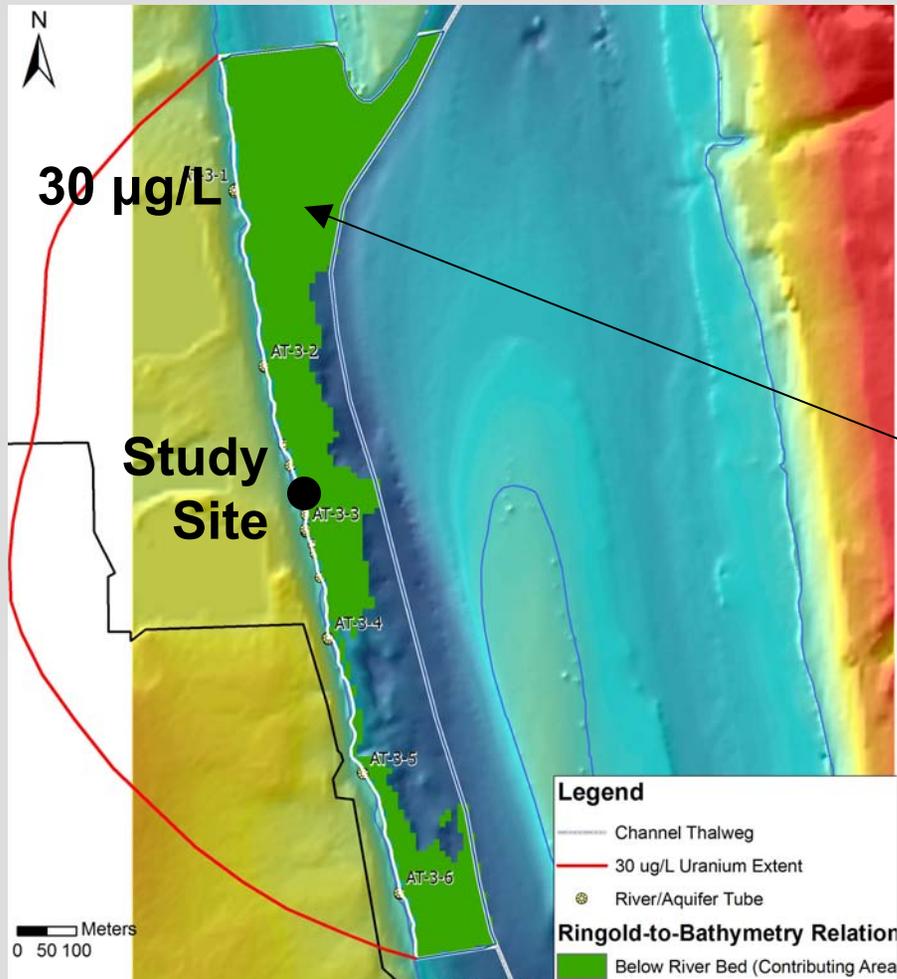


▶ High water flux \neq to high uranium flux

▶ For Example Jan, Feb, March '05

- Water discharge decreased each month
- U discharge \sim constant

Perspective



- ▶ Previous study calculated uranium discharge to river of 430 kg/yr
- ▶ Maximum potential uranium discharge area of 170,000 m²
- ▶ Annual total uranium discharge of 200 kg/yr (for 2005)

Conclusions

- ▶ Fluctuating river stage controls the system
 - Both directly and indirectly
- ▶ Uranium flux is reduced by dilution within hyporheic zone
- ▶ Uranium concentrations at the sediment-water interface vary on an hourly basis
- ▶ Tentatively, it appears that previous uranium flux estimates over estimated the total amount of uranium entering the Columbia River each year.

Acknowledgments

There are **MANY** people who's diligence and hard work made this study possible. Too many to list, but to them, I say thank you.