Effects of Columbia River Discharge on Groundwater Elevations, Central Hanford Site, Washington

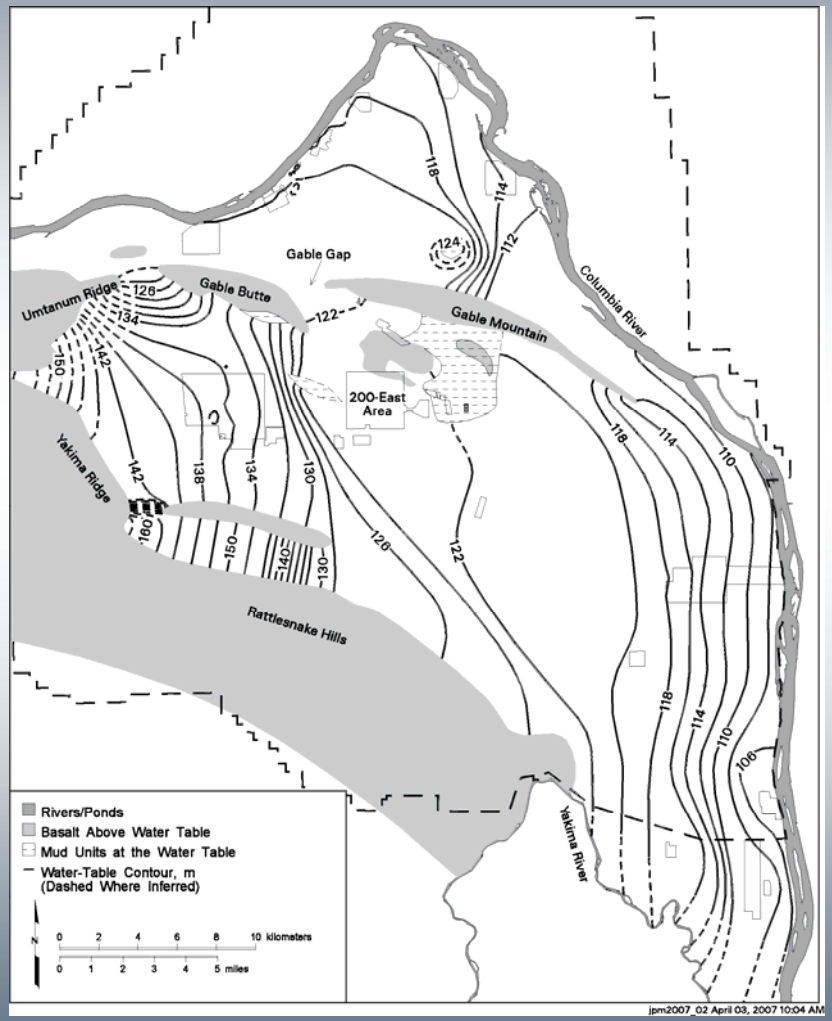
John P. McDonald

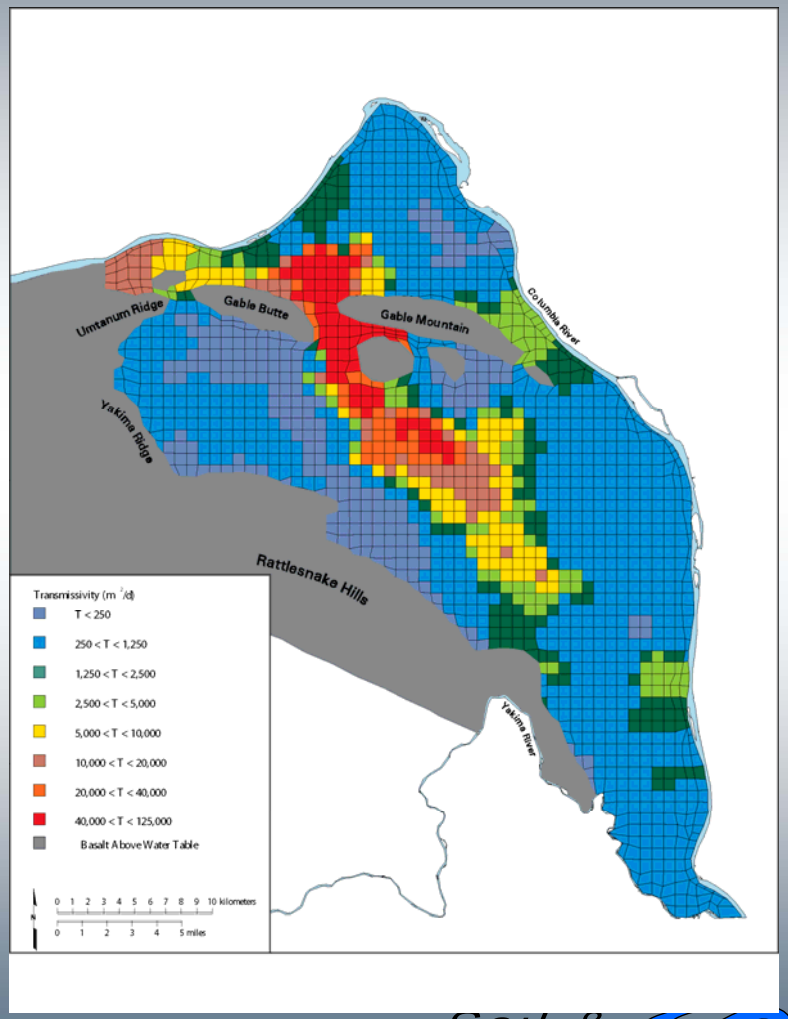
Fluor Hanford

Introduction

- A water-table fluctuation (increase) occurred in the central part of the Hanford Site (200 East Area) between 3/02 and 3/03
- Implication: may indicate a change to groundwater flow conditions within this contaminated area
  - Flow direction
  - Flow velocity/gradient
- Study objective: find the cause of the fluctuation

Hanford Site Water-Table Map and Transmissivity Distribution

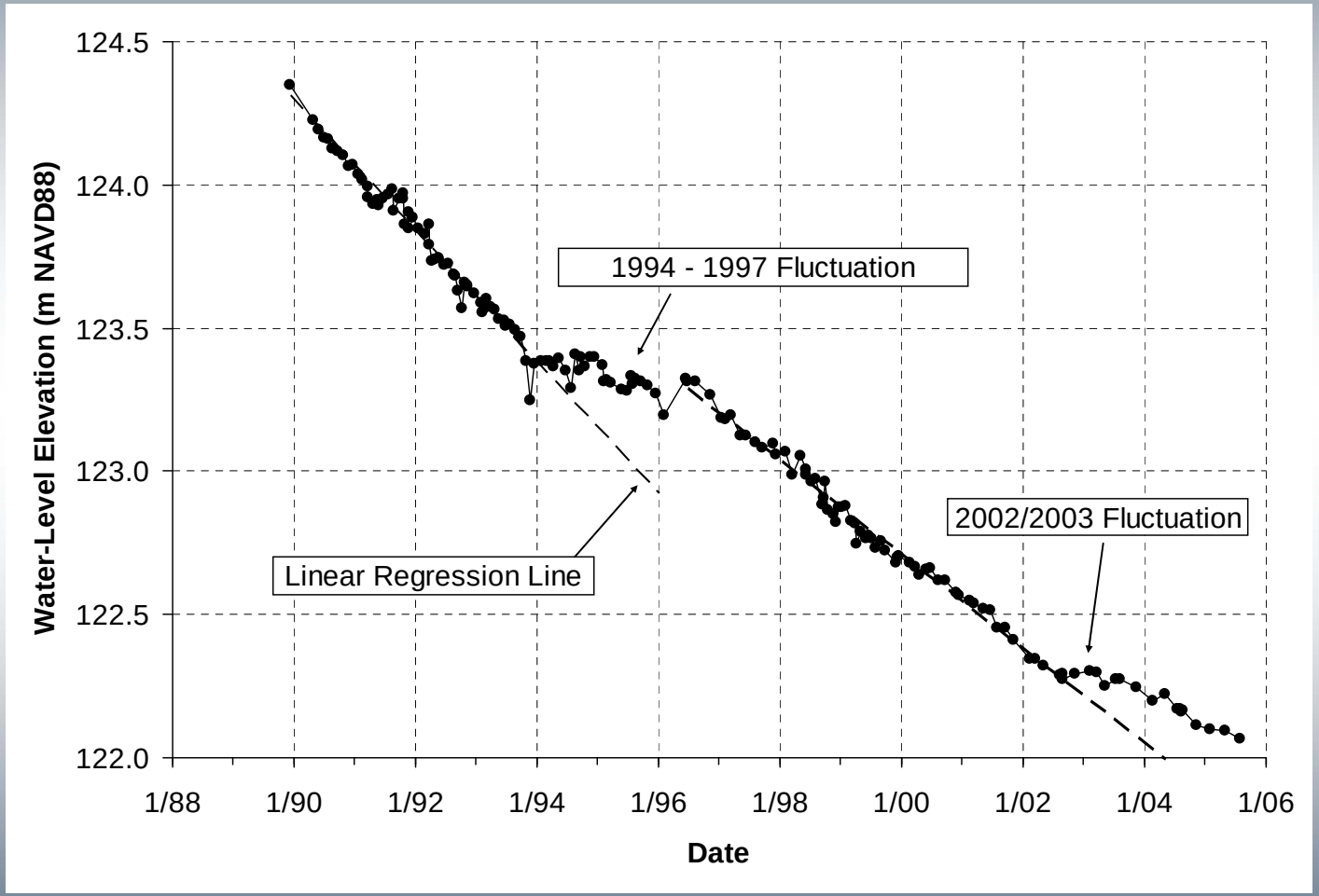




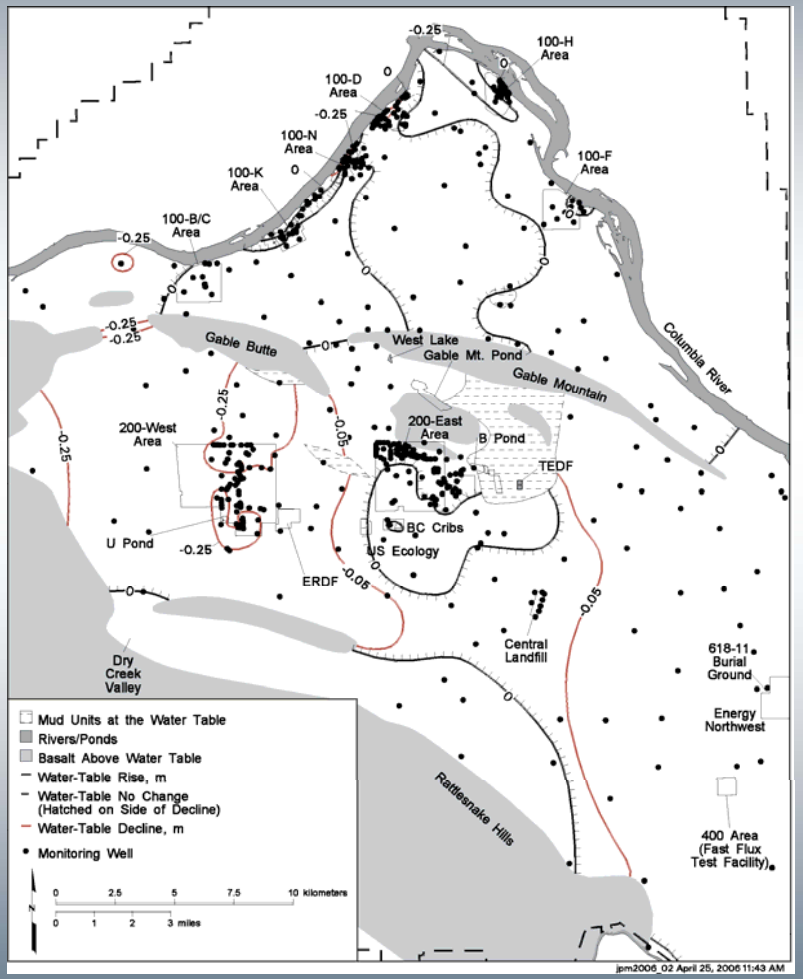
Fluor Hanford

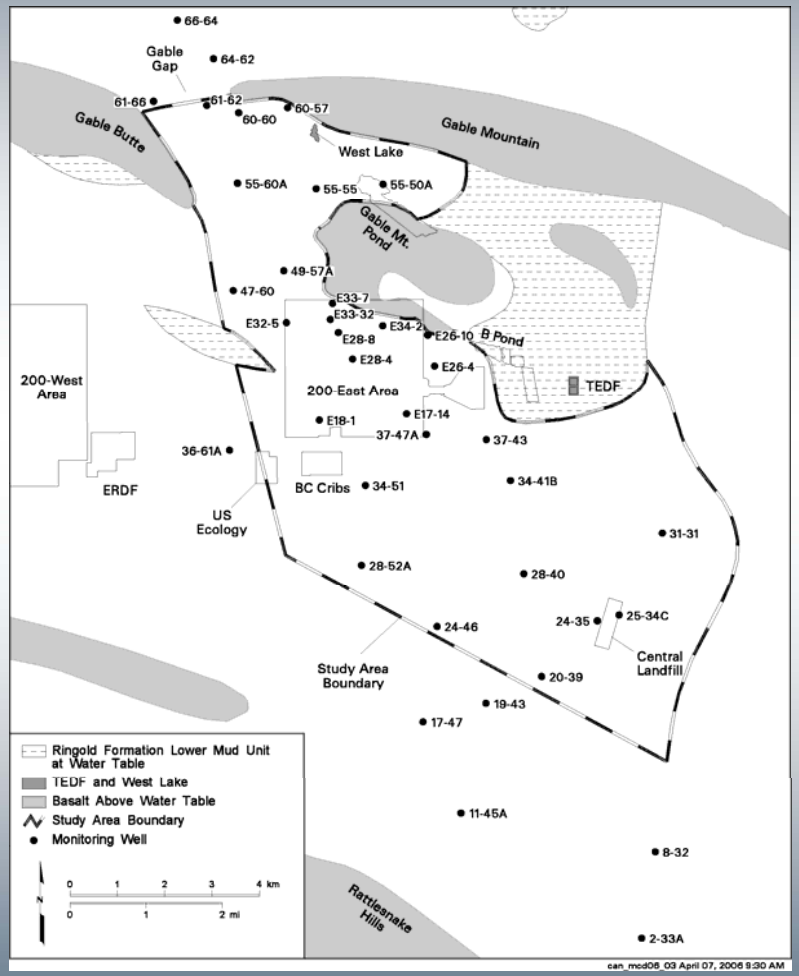
Soil & Groundwater Remediation Project

Well Hydrograph: Example of Water-Level Trend Change



Water-Table Change from 3/02 to 3/03 and Study Area Boundary





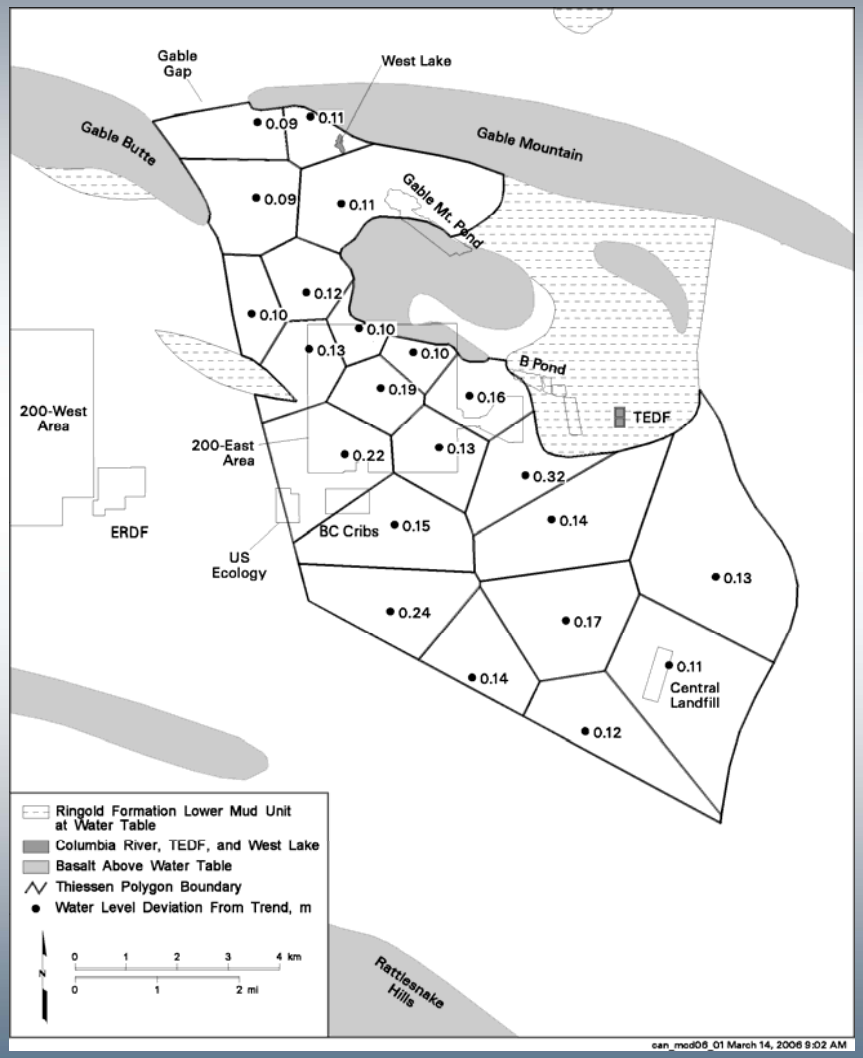
Fluor Hanford

Soil & Groundwater Remediation Project

Multiple Hypotheses Evaluated

- Increased Natural Recharge
  - Vadose zone
  - Rattlesnake Hills
- Increased Artificial Recharge
  - Water line leak (November 2002)
  - Waste Treatment Plant construction site
  - Treated Effluent Disposal Facility
- River Stage Effects (Columbia River)

Storage Change Estimate



- Developed Thiessen polygons using 22 wells
- Used linear regression to determine water-level deviation from normal trend at each well
- Range of specific yield: 0.1 to 0.2
- Result: “extra” water in storage ranged from 1.1×10^9 to 2.3×10^9 liters

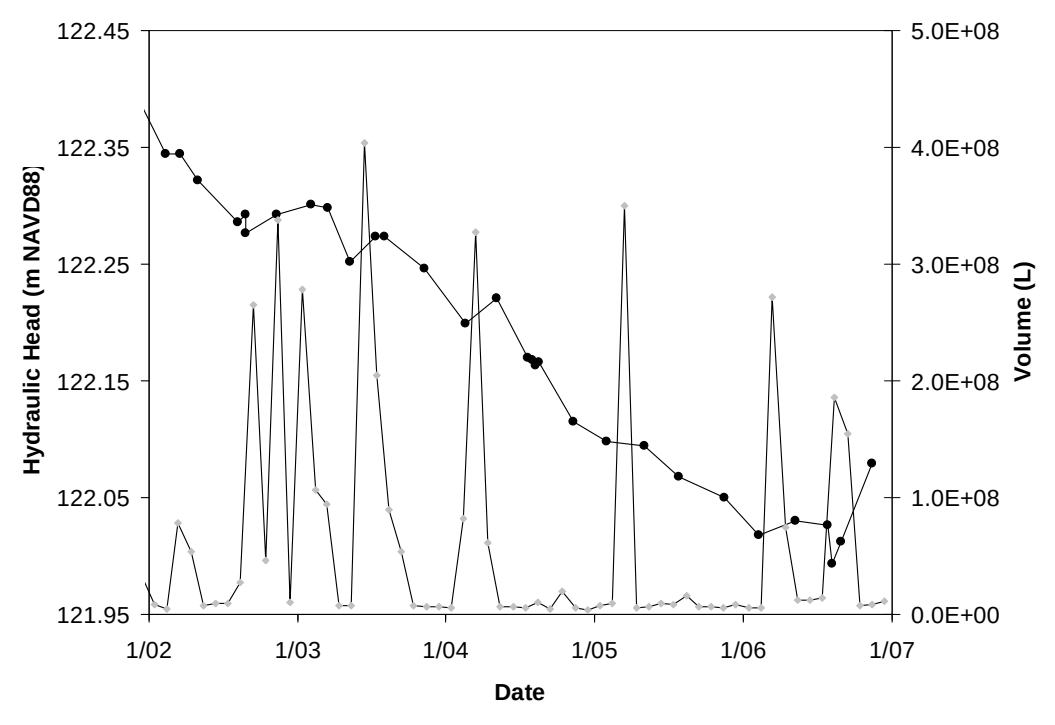
Fluor Hanford

Soil & Groundwater Remediation Project

Rejected Hypotheses

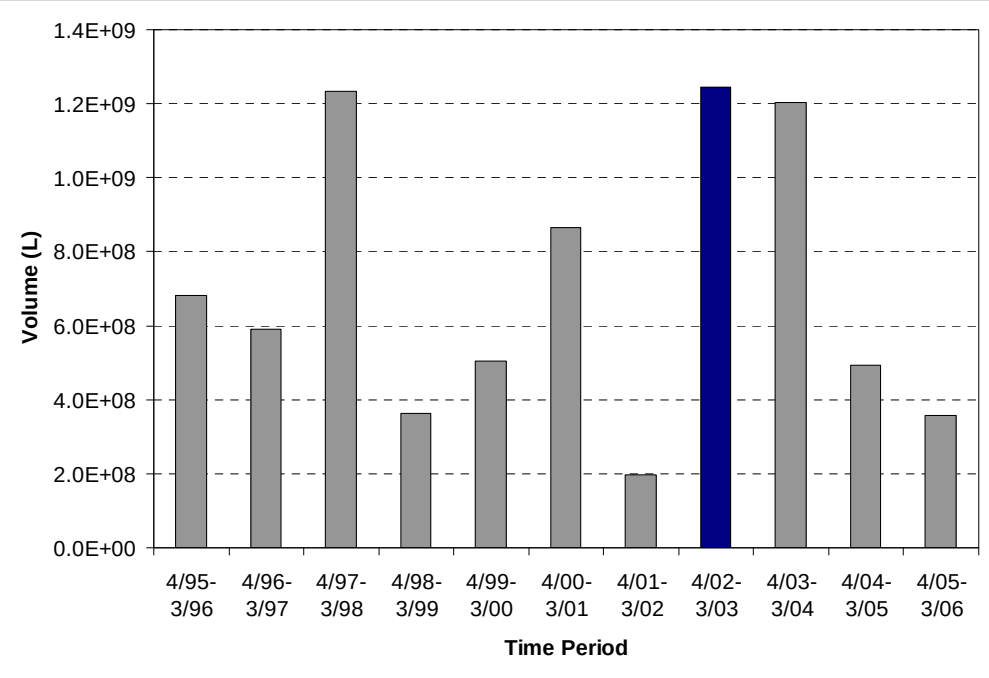
- Natural Recharge
  - Travel time through vadose zone is several decades (conservative calculation)
  - Increased Recharge from the Rattlesnake Hills Estimated to be 1.0×10^7 liters
- Artificial Recharge
  - Water line leak estimated to be 1.3×10^5 liters
  - Waste Treatment Plant construction site discharge volume during 2006 was 9.5×10^5 liters

Comparison of Treated Effluent Disposal Facility Discharges and the Water Table



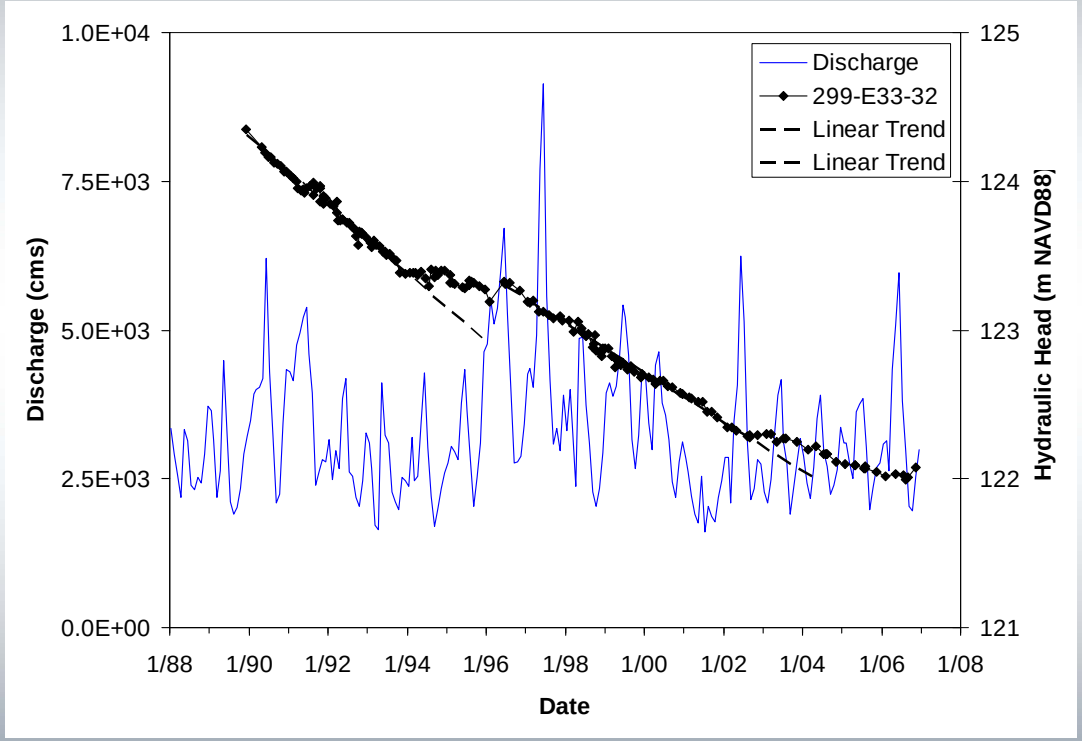
- Discharges are episodic
- High discharges appear to correlate with water-table responses
- Similar correlation seen at other 200 East Area wells

Annual Discharges to the Treated Effluent Disposal Facility



- Average discharge from 4/98 to 3/02 was 5.0×10^8 L/yr
- Discharge from 4/02 to 3/03 was 1.2×10^9 liters (7.0×10^8 liters above average)
- Increased discharge accounts for 30 to 65% of the storage change
- Suggests an additional cause

Comparison of Columbia River Average Monthly Discharge and the 200 East Water Table

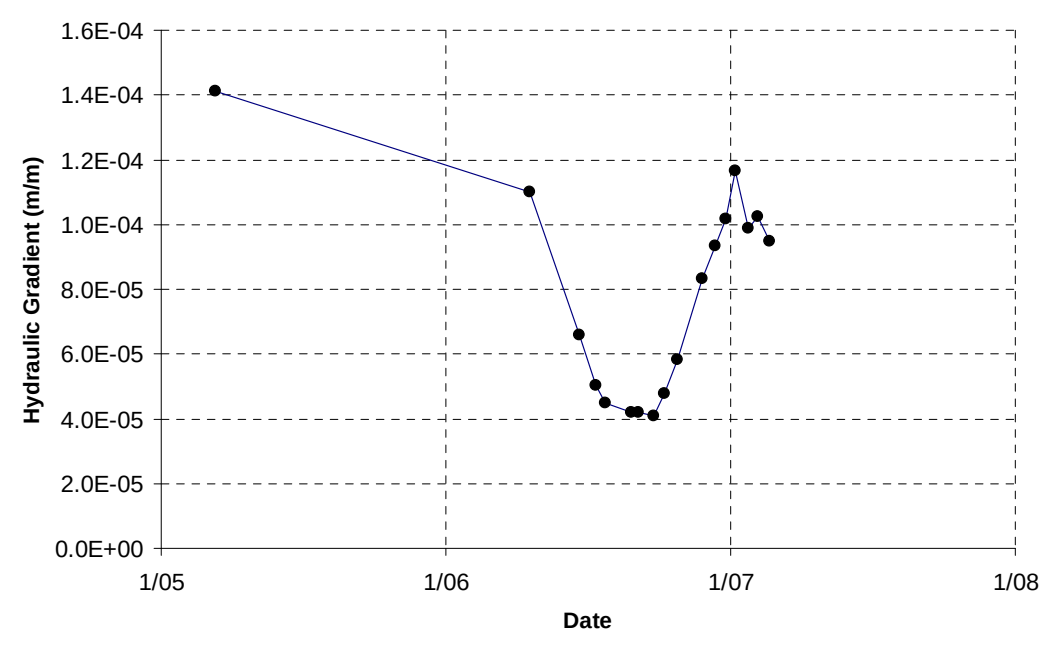


- Possible correlation between high river discharge and the water-table
- Prompted further investigation

Feasibility of River Stage Effects Hypothesis

- Ferris Method Analysis
  - Assumed a 1-meter sinusoidal change in stage (amplitude) over 1 year (frequency)
  - Results: 2 to 40 centimeter response depending on the storativity and transmissivity (limitations apply)
- Discharge Through Gable Gap
  - Estimated using Darcy's Law
  - Ranges from 3.1×10^9 to 9.6×10^9 liters depending on the hydraulic conductivity
  - Reducing this discharge could account for the extra water in storage

Hydraulic Gradient in Gable Gap



- Detailed water-level measurements in Gable Gap during study period not available
- Measurements collected in 2006
- Shows a decline in the gradient in response to high stage during 2006

Favorable Factors for River Stage Hypothesis

- Extra water in storage not fully accounted for by increased discharges to the Treated Effluent Disposal Facility
- Temporal correlation between high river discharge and the 2002 water-table fluctuation
- Theoretically possible for river stage to affect the water table (Ferris Method)
- Reduced discharge through Gable Gap could explain the extra water in storage
- Hydraulic gradient in Gable Gap does respond to river stage changes

Conclusion

- Causes of the Water-Table Fluctuation
  - Increased Treated Effluent Disposal Facility discharges
  - High Columbia River stage (not completely confirmed)
- Stresses to an aquifer in high conductivity sediments can affect portions of the aquifer far from the source of the stress