300-FF-5 Groundwater Operable Unit Limited Field Investigation

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Fluor Hanford

300-FF-5 Limited Field Investigation

- LFI OBJECTIVES
  - Reduce 3 uncertainties:
    - Distribution and amount of uranium in vadose and smear (surge) zone
    - Distribution and amount of uranium in the unconfined aquifer where water quality standards are exceeded including updating/revising site hydrogeology
    - Understanding of geochemical characteristics associated with uranium mobility in the vadose/aquifer (surge) interface.

LFI supports 300-FF-5 Feasibility Study –

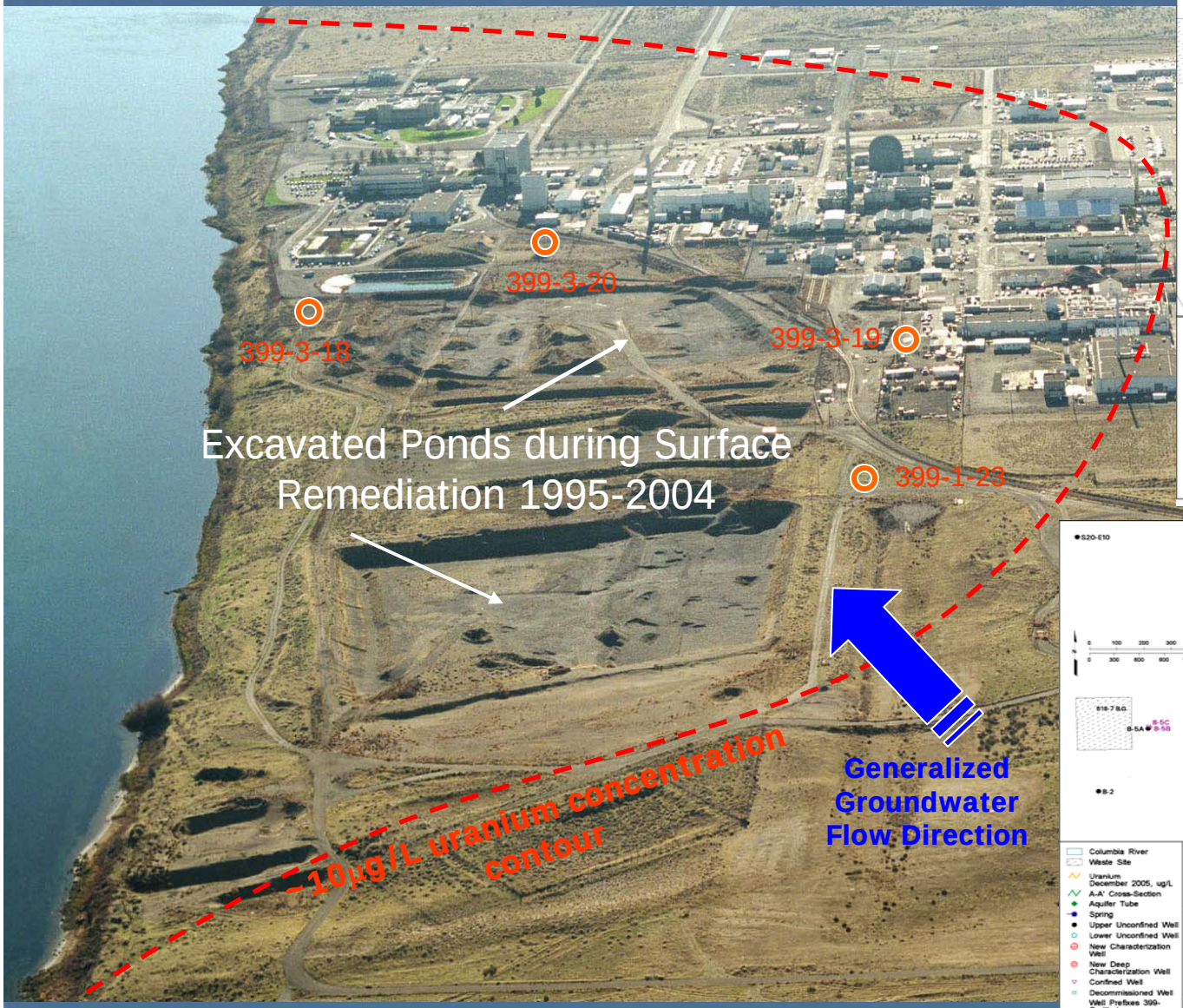
Re-evaluating remedy for persistent elevated uranium in 300 Area groundwater

300-FF-5 Limited Field Investigation

- LFI scope divided into two main parts
- Part I – Has been Completed:
  - 4 Boreholes were drilled in targeted (source) areas to identify the vertical distribution and limited lateral extent of uranium contamination that persists in the subsurface under the 300 Area.
  - Collected/analyzed uranium contaminated sediment core and depth discrete groundwater samples in support of ongoing geochemical and hydrogeologic investigations to understand uranium mobility (release mechanism) in the smear zone.

300-FF-5 Operable Unit

Uranium Plume before Surface Remediation in June 1988 --

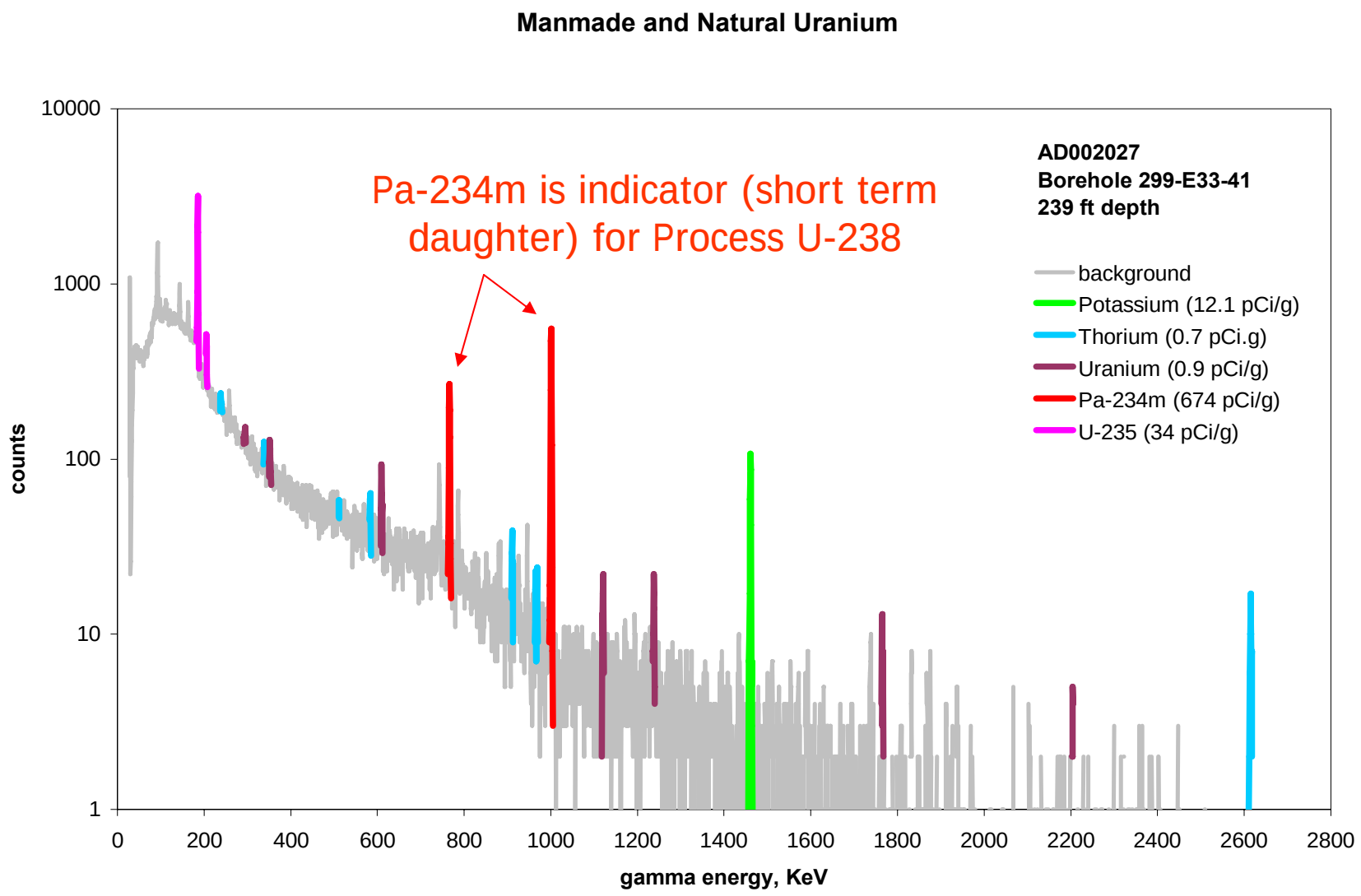


Uranium Plume after Surface Remediation in June 2005 --

300-FF-5 Limited Field Investigation, Part I continued...

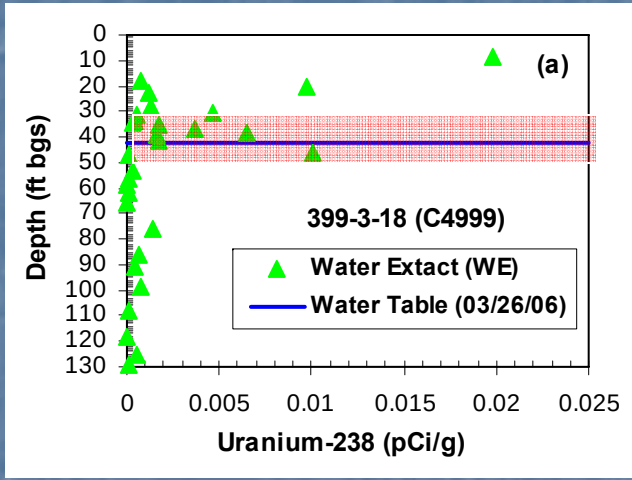
- As planned, the sediment and groundwater samples were submitted to labs following a 3-tiered analytical approach.
  - Onsite lab for radiological (uranium), inorganic constituent analysis
  - Offsite lab for additional contaminants of concern (eg., TCE, nitrates)
- To fulfill LFI objectives, uranium results in sediment and groundwater samples were quantified, compared and correlated with the vertical distribution of uranium identified in the geophysical log results.
- Comparison of uranium lab results with the geophysical logging results from the 4 boreholes formed the basis for not completing the Part II Direct Push Technology geophysical logging campaign.

Example Borehole Geophysical Detection of Process (Contaminant) Uranium

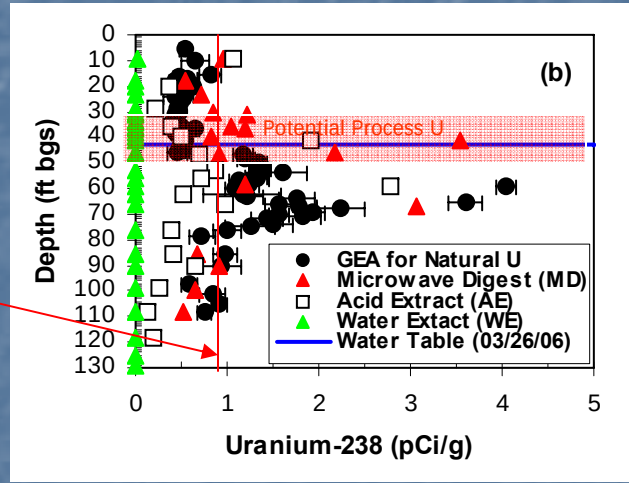


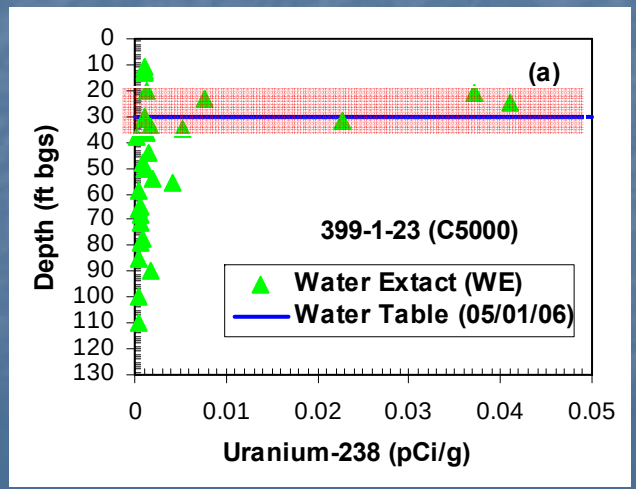
Determining Presence of Process Uranium

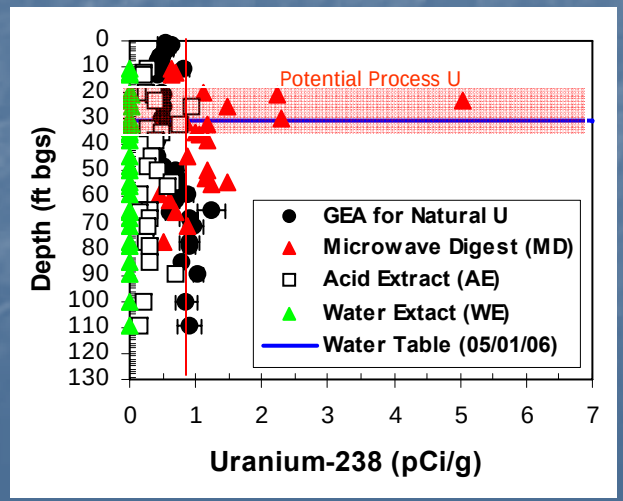
Water Extracts (a) and Extractable Uranium by WE, AE, and MD compared to GEA Data (b) in Sediments from Wells 399-3-18 (C4999) and 399-1-23 (C5000)



Published uranium-238 background concentration 0.763 pCi/g ± 0.216

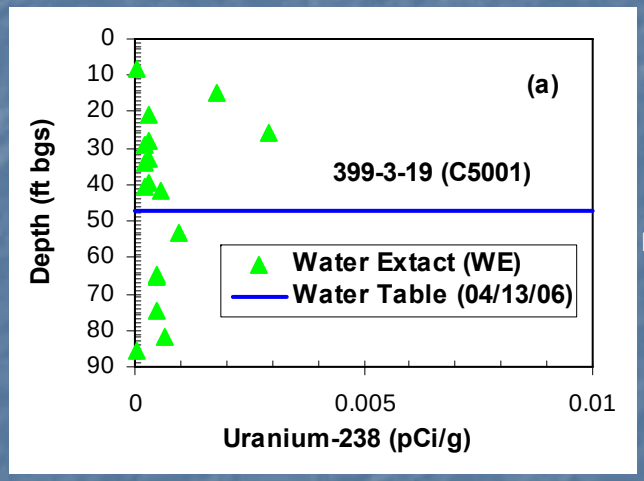






Determining Presence of Process Uranium

Water Extracts (a) and Extractable Uranium by WE, AE, and MD with GEA Data (b) in Sediments from Wells 399-3-19 (C5001) and 399-3-20 (C5002)



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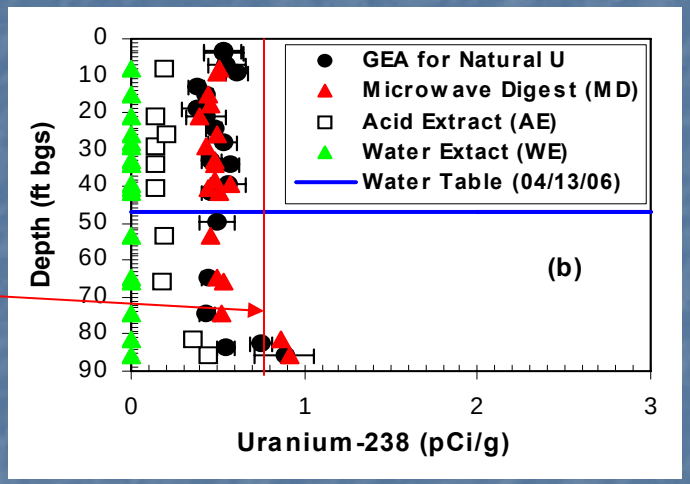
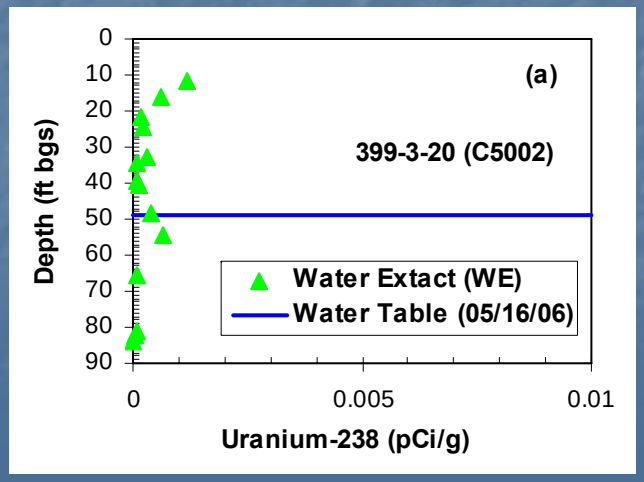
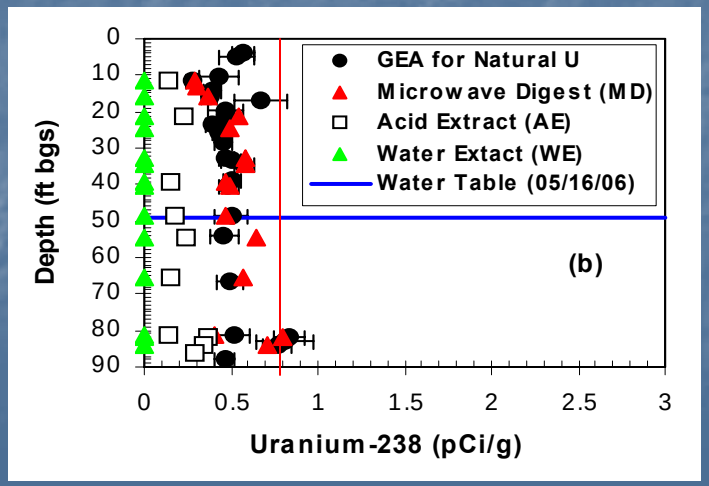
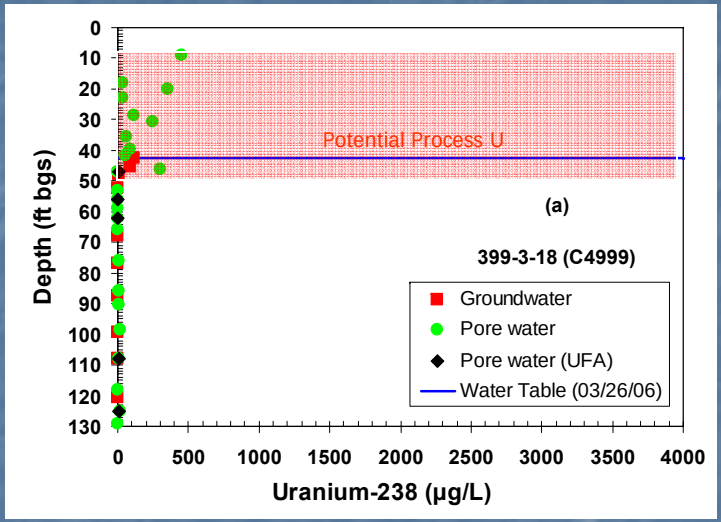


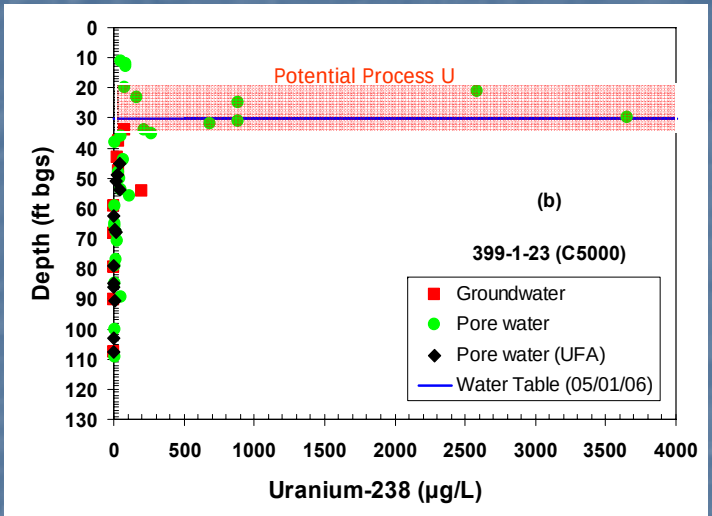


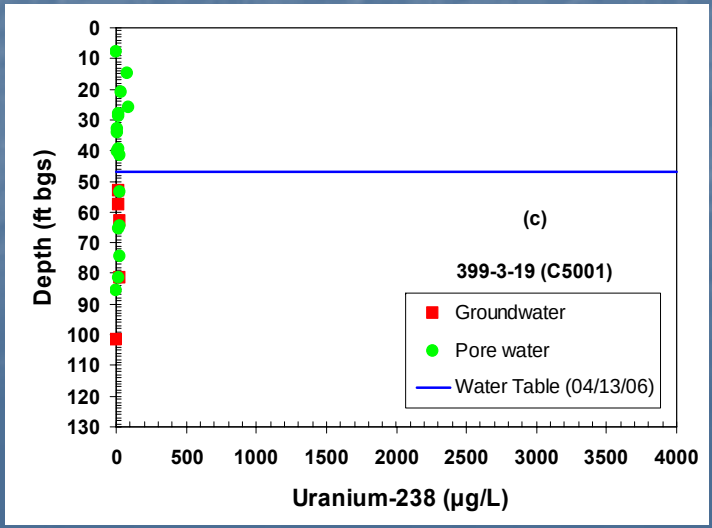


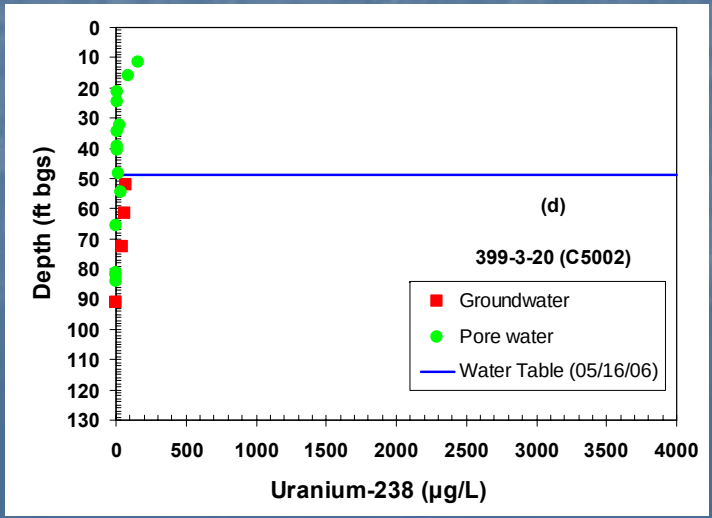
Determining Presence of Process Uranium

Vadose Porewater –vs- Groundwater Concentrations









300-FF-5 Limited Field Investigation

Uranium Analysis Conclusions

- Part II – Direct Push Technology was cancelled because geophysical logging can not detect the low levels of process uranium observed in the LFI confirmatory boreholes.
- Results from sediment analysis (GEA and 1:1 extract), groundwater analysis, and geophysical spectral gamma analysis conclusively reveal no high concentrations i.e., "uranium hotspots" exist in the areas investigated by the four boreholes.

300-FF-5 Subsurface Characterization Activities

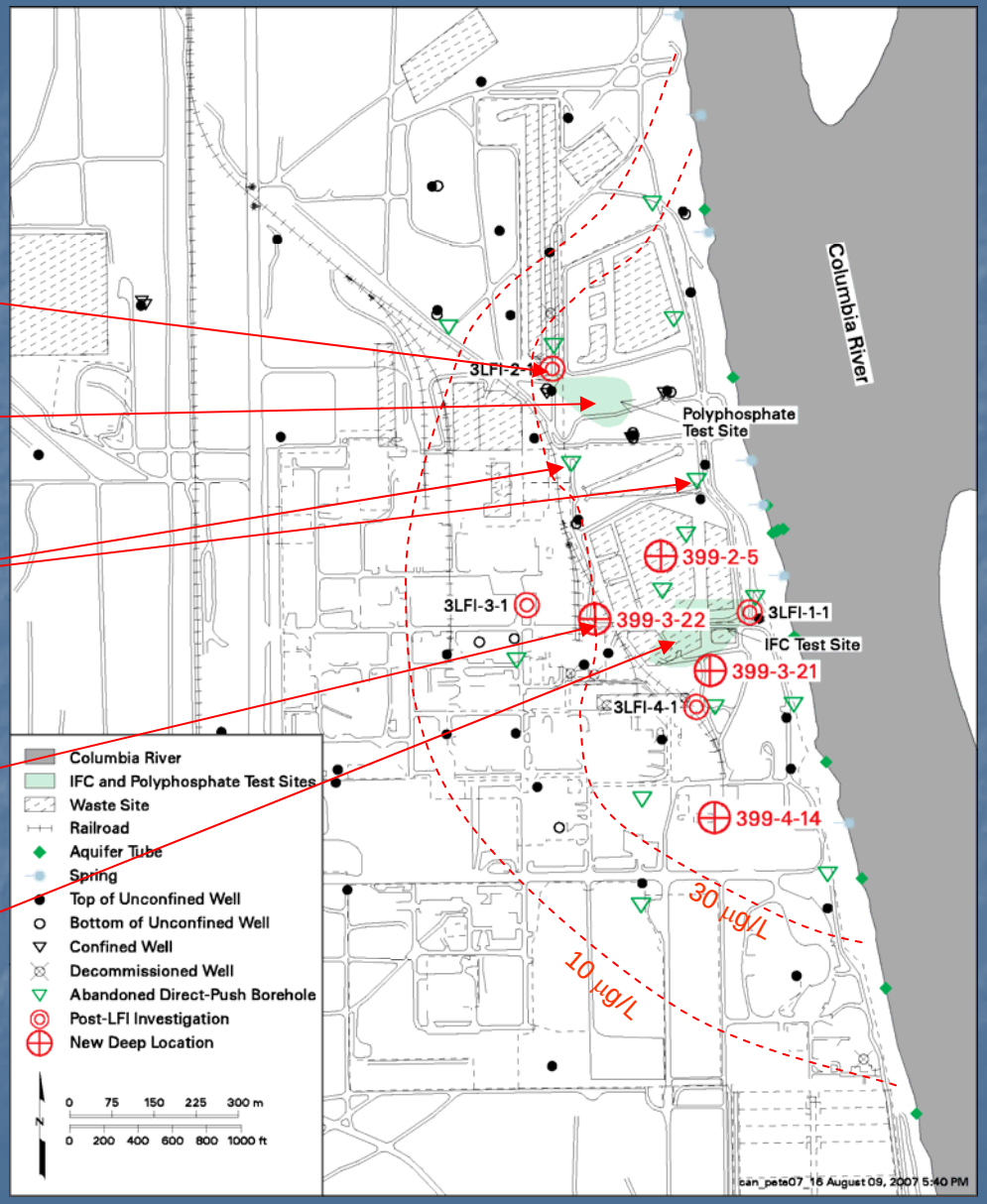
4 LFI Characterization Wells

Treatability Test Network (9+ wells)

Previously Planned Direct Push Borehole Locations (15 boreholes)

4 Proposed TCE Investigation Boreholes

21+ Planned IFC Boreholes

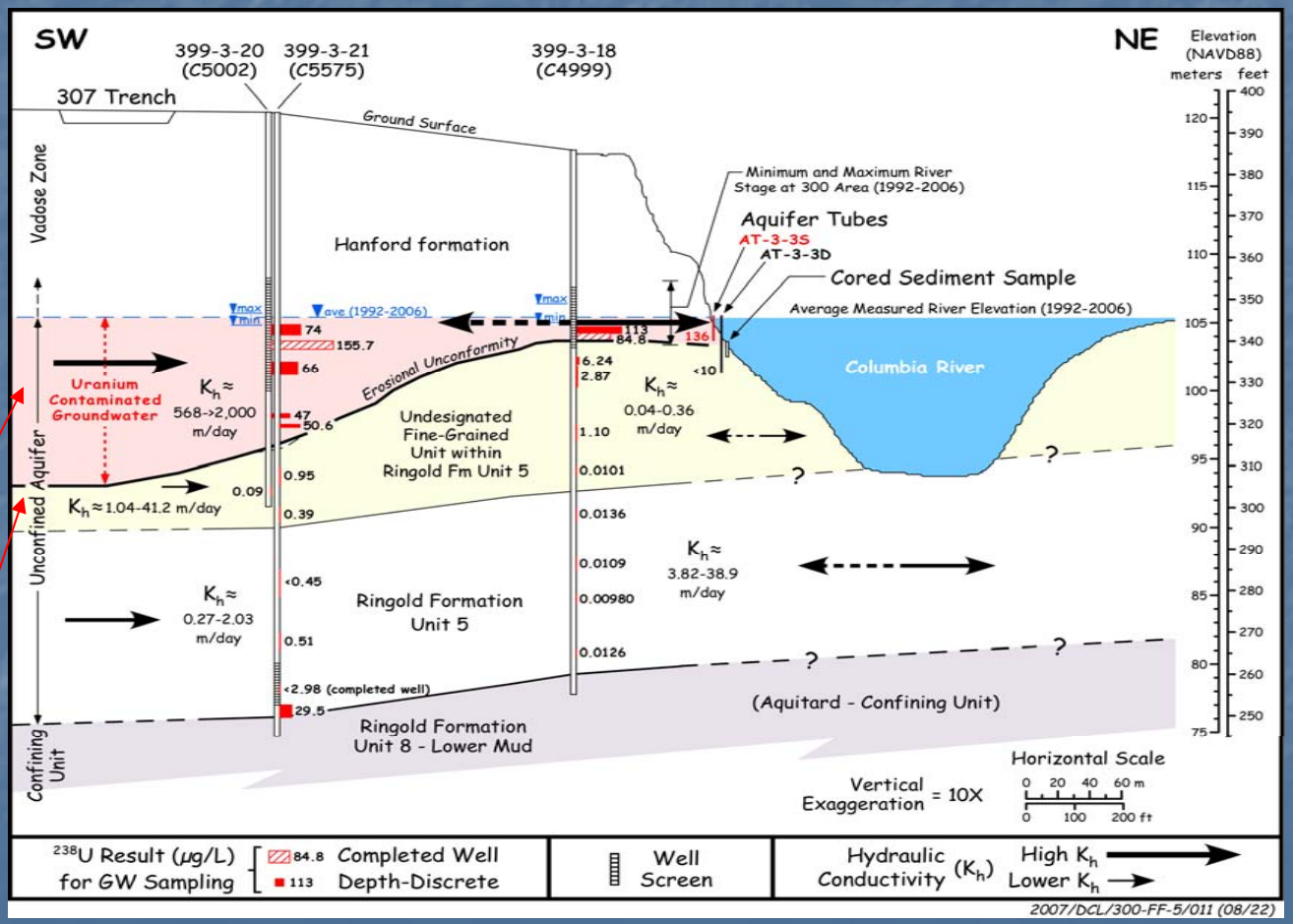


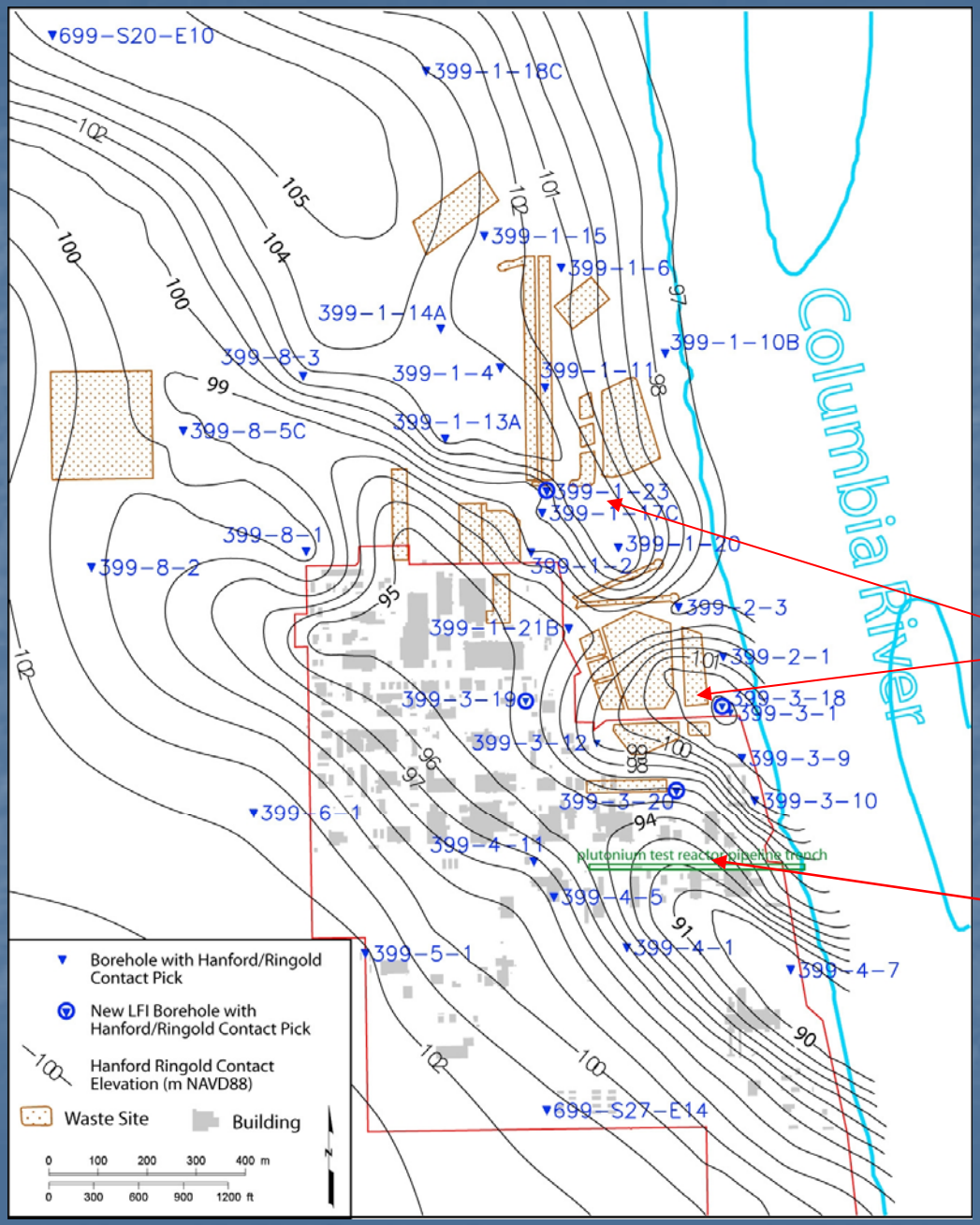
300 Area Revised Hydrogeology

- LFI Study Area = 300 Area uranium plume ($\geq$ 10 μg/L)
- New borehole characterization data:
  - Greatly improved our understanding of 300 Area hydrogeology
    - More precisely defined the Hanford/Ringold surface and improved our understanding of the aquifer boundaries and flow constraints.
    - Discovery of locally continuous Ringold Fm. fine grained unit containing residual VOC contamination
  - Improved understanding of aquifer hydraulic characteristics
    - Quantified discrete flow variations within aquifer related directly to hydrogeologic units.
  - Improved understanding of contaminant distributions and variations in aquifer geochemistry.
    - Detail distributions and flow constraints on uranium (and other COCs) vertically through the unconfined aquifer
    - Evidence for no deep migration of contaminants.

Uranium distribution in the unconfined aquifer, 300-FF-5

Hanford formation is significantly more permeable than the underlying, older Ringold Formation that is more compacted, variably cemented and geochemically altered.





The Hanford/Ringold contact which lies below most of the water table of the 300-Area conforms to a major subsurface trough or channel trending northwest to southeast. The trough is paralleled by a Ringold formation high, ridge-like feature to the east, parallel and adjacent to the Columbia River.

Uranium is elevated above MCL in groundwater in Hanford fm. above this contact.

The elevated ridge appears to be capped by low permeability Ringold Fm. fine grained sand.

Geochemical Relationships and Other Contaminants of Concern

- pH in vadose zone pore water ranges between 7.8 to 8.2.
- pH in groundwater ranges between 7.2 to 8.4
- Groundwater specific conductance in 399-3-18 is relatively lower than other three wells.
- Dissolved Oxygen in all wells is lower in deep Ringold Formation relative to shallower Hanford formation suggesting minimal mixing with River water.
- Deeper Ringold sediment is more reduced [redox status] than upper Hanford sediments.
- Nitrate and sulfate are elevated in shallow groundwater relative to deeper aquifer.
- Dominant cation in unconfined aquifer is calcium- likely in equilibrium with calcium carbonate minerals.

LFI Data Documentation

LFI Report - Summarizes all of the LFI activities and provides a data compilation of all the results, including borehole drilling, characterization, and construction data, and the Tier I and II analytical sediment/groundwater results.

300-FF-5 Feasibility Study Activities

- The LFI dataset (validated and verified) is being used to:
  - Update and refine the hydrogeologic conceptual model
  - Update and refine the Conceptual Site Model for Uranium
  - Update estimate of expected changes of groundwater uranium concentration (duration of plume).
  - Re-evaluate the risk assessment
  - Update groundwater flow and uranium fate and transport models
  - Further develop and test remedial technologies.
  - Develop a remedial alternative for uranium for the Phase III Feasibility Study.