

Hanford Advisory Board River & Plateau Committee Groundwater Update

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Groundwater and Deep Vadose Zone

200 West Area:

- Groundwater remediation is in place to address all existing past practice (CERCLA) and RCRA (Tank Farm) groundwater contamination
- All deep vadose contamination (except CCL-4) yet to be addressed

200 East Area:

- No groundwater remediation is currently in place
 - A treatability test to remediate Tc-99, U and nitrate is planned
 - All the deep vadose zone contamination (except for the perched water extraction and a treatability test in the BC Crib) yet to be addressed.
- *Annual Groundwater Monitoring Report: PHOENIX System* proving to be a great tool

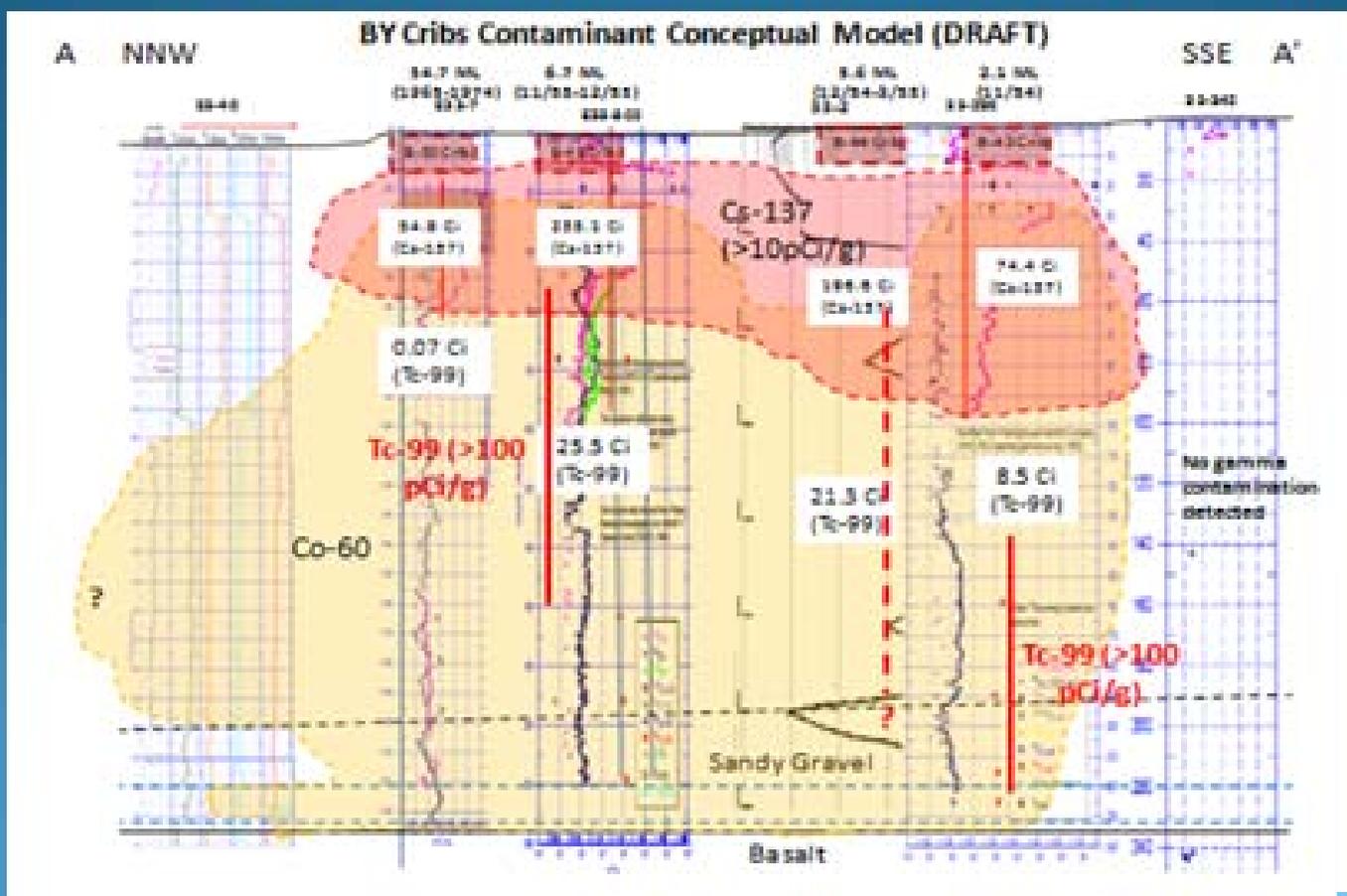
Magnitude of the Problem

- 550,000 Curies of Radioactivity
 - (Concentrations are measured in pCiL)
- 150 Million kilograms (165, 000 tons) of metals and hazardous chemicals

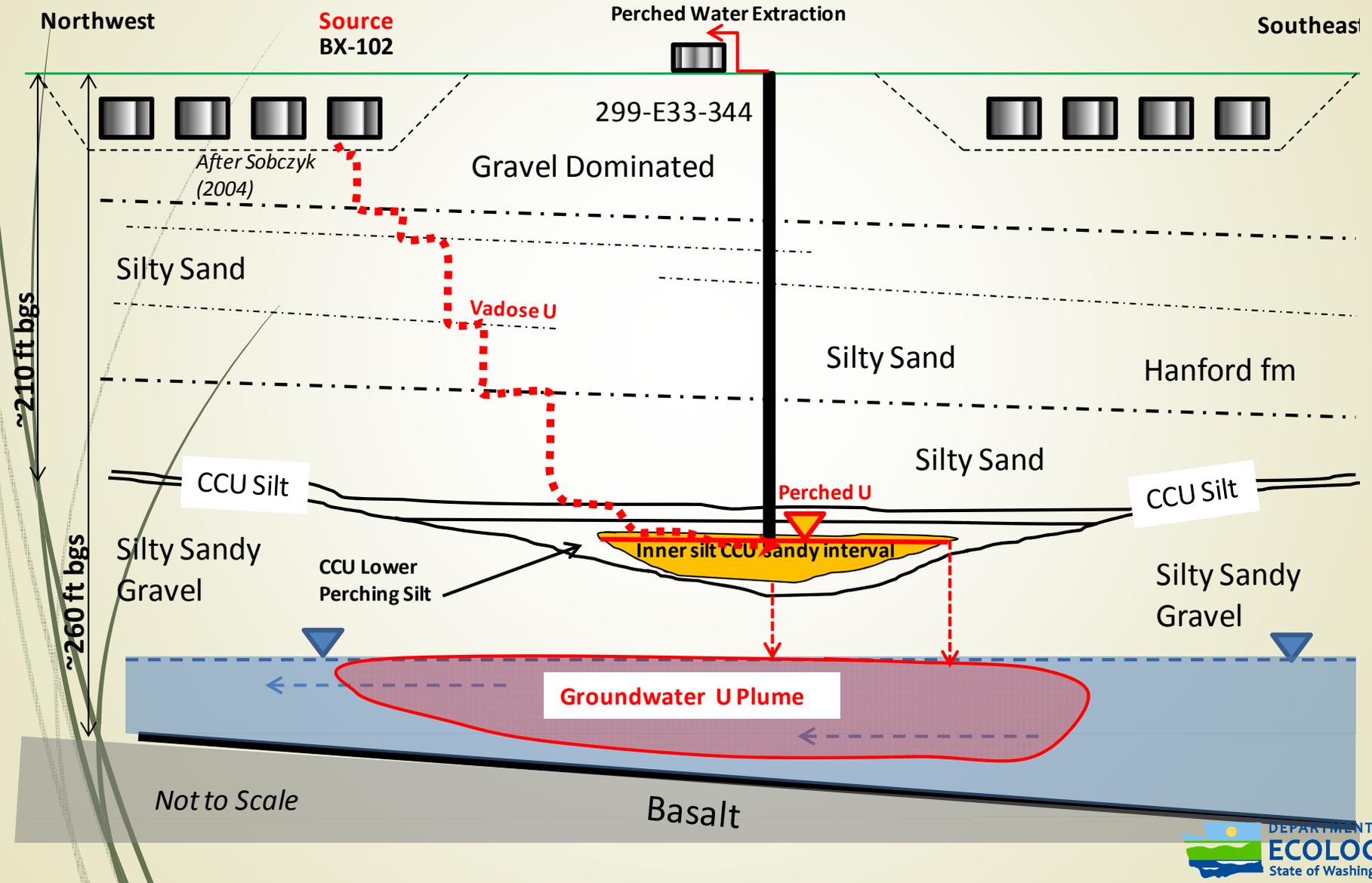
A significant portion of the above sits above the groundwater in the vadose zone

Vadose Zone Contamination: Category III

High Volume Liquid Discharge Site Contaminating the Entire Vadose Zone (~350 feet)



Cold Creek Unit Perching Zone Conceptual Site Model, B-Complex, 200 East Area



Lessons learned from the Perched Water Extraction: Performance and Sitewide Implications

Total Gallons Removed: ~200,000 gallon (~0.2 M Gal)

Tc- 99 Removed: 24.1E-03 Ci

Uranium removed: 42.0 kilograms

Nitrate removed: 405.6 kilograms

Most Successful cost effective mass removal at the Hanford Site.

Compare with UP-1 OU removed 42 Kg of U ~45 Million gallons (treating it at ETF, disposing at SALDS, etc., at a huge cost)

Suggested Path: Take advantage of state of the art existing treatment facility through its ~30 years of design life

Because of funding issues, no clear path for most of deep vadose zone

100 Area Groundwater and Vadose Zone

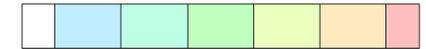
- ▶ **100 Area: Stop Sr-90 going to the River by 2016 (a TPA milestone):**
- ▶ **Not addressed adequately- expected to continue to contaminate the Columbia River for ~ 150+ years**

Northing

Total Ci of ⁹⁰Sr in Plume Sediments = ~88
 Total Ci of ⁹⁰Sr in Dark Shade Area = ~25
 Total Ci of ⁹⁰Sr within ~23 m (75 ft) of River = ~5

Dark shade represent the approximate area of the ⁹⁰Sr plume that will arrive at the Columbia River over the next 300 Years. At the present time, an estimated 25 Curies of Sr-90 is located within this shaded area. However, as the plume moves to the Columbia River, Sr-90 will decay away. Taking into account travel time and radioactive decay, of the estimated 25 Curies contained within shaded region, approximately 5 Curies will reach the river if the present day conditions remain essentially the same for the next 300 years

1995 ⁹⁰Strontium Plume Map



8 42 400 1000 3000 4000

pCi/L

State Plane Coordinates (meters)

Meters

0 100 200 300 400

Feet

0 300 600 900 1200

100-N Area

100 ⁹⁰Strontium Contour (pCi/L)

- N-71 Well Number (Prefixed with 199-)
- Well Location
- 100 Plotted Value
- ⁹⁰Sr Samples taken from 10/94 to 10/95
- MCL = 8 pCi/L

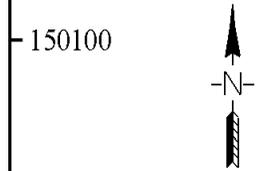
This contour map is intended to depict ⁹⁰Sr concentrations in the upper part of the aquifer. Therefore, the following wells were not considered in contouring:

- N-103 (771 pCi/L)
- N-105 (323 pCi/L)

These wells were not considered in contouring because their ⁹⁰Sr concentrations were anomalous when compared to other nearby wells.

- N-2 (137 pCi/L)
- N-76 (101 pCi/L)

573200



150100

149700

149300

148900

Easting

571200

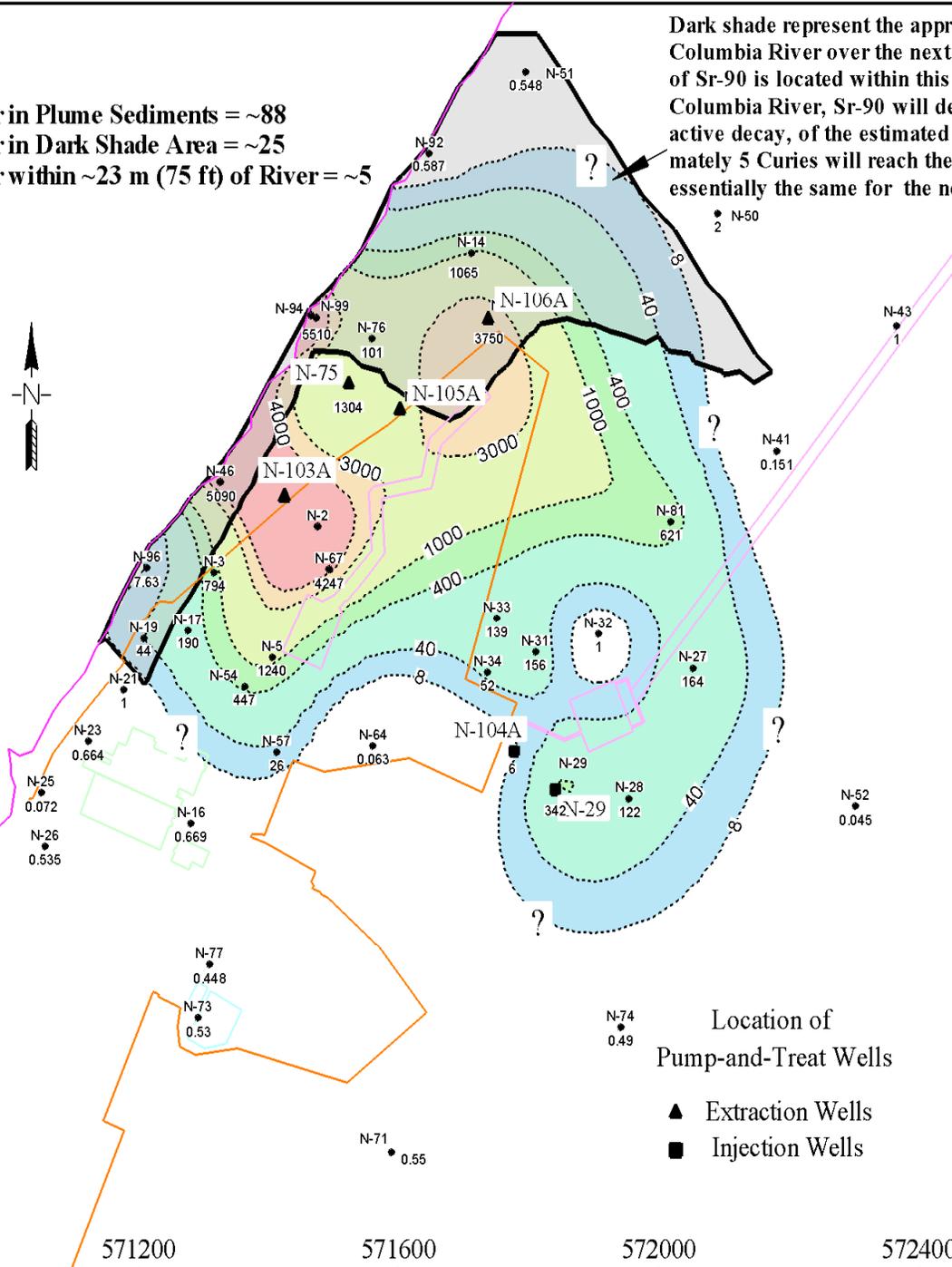
571600

572000

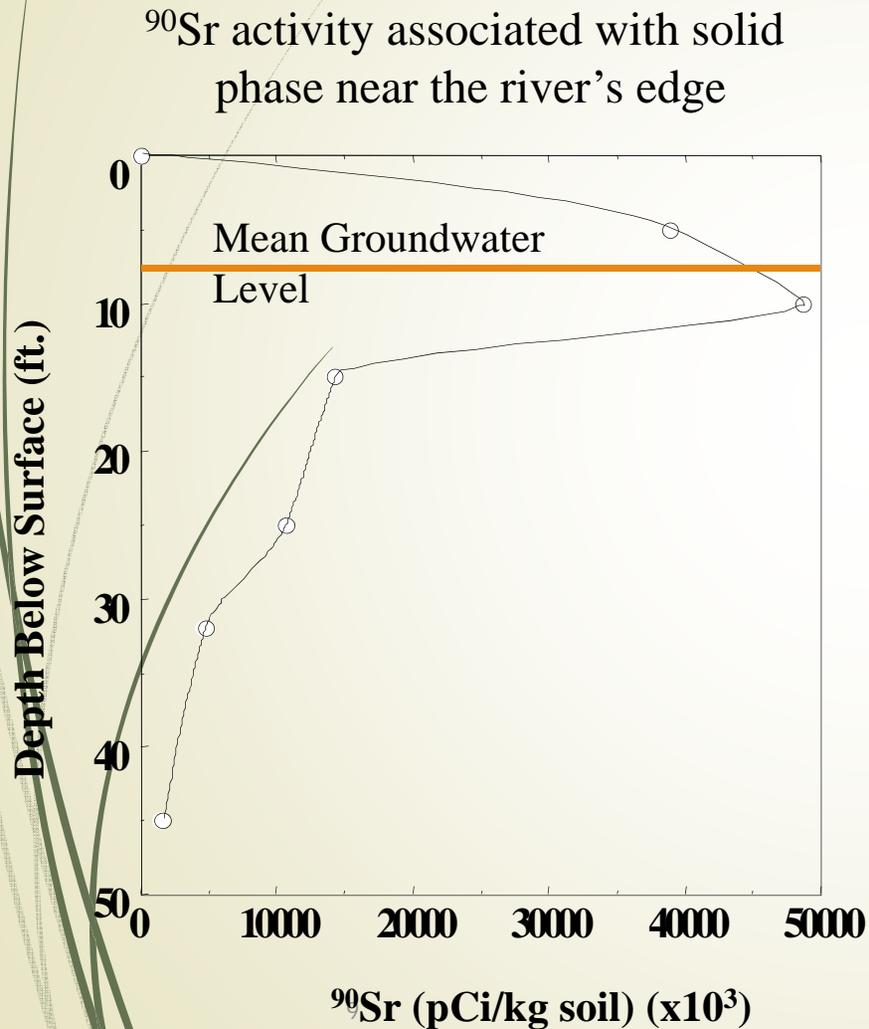
572400

Location of Pump-and-Treat Wells

- ▲ Extraction Wells
- Injection Wells



100-N Characteristics That Impact Phytoremediation Efficacy



- **100N Area River shore**
 - Rocky soil with poor fertility
 - Shallow vadose zone (1-2 m)
 - Fluctuating water level
 - Potential for prolonged root zone saturation
 - Climatic conditions
 - Presence of riprap
 - Uneven soil surface

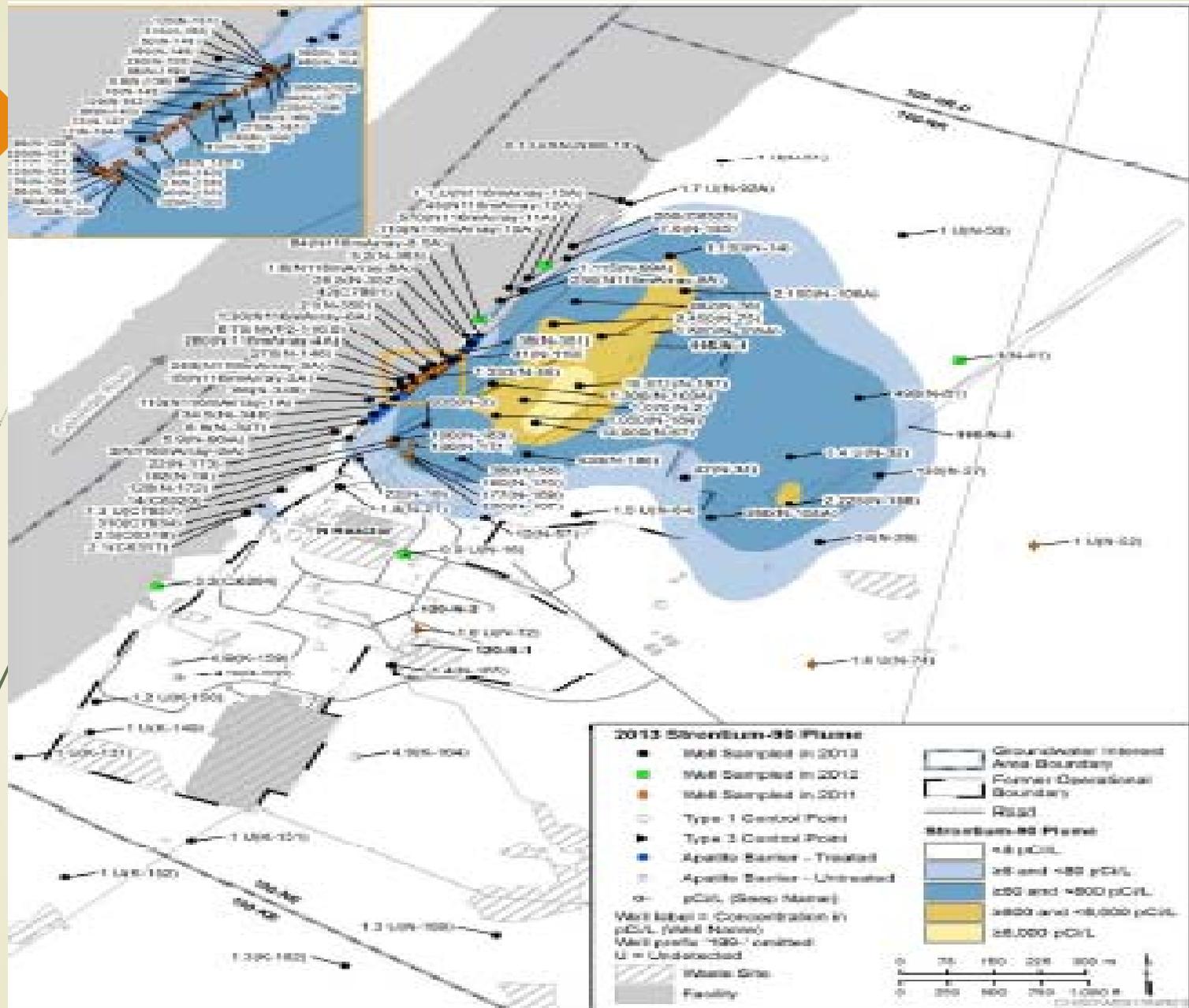


Figure 4-10. Strontium-90 Plume Map for the 100-N Area



Approximate area of
Apatite Injection

Apatite Barrier: Cost Breakdown

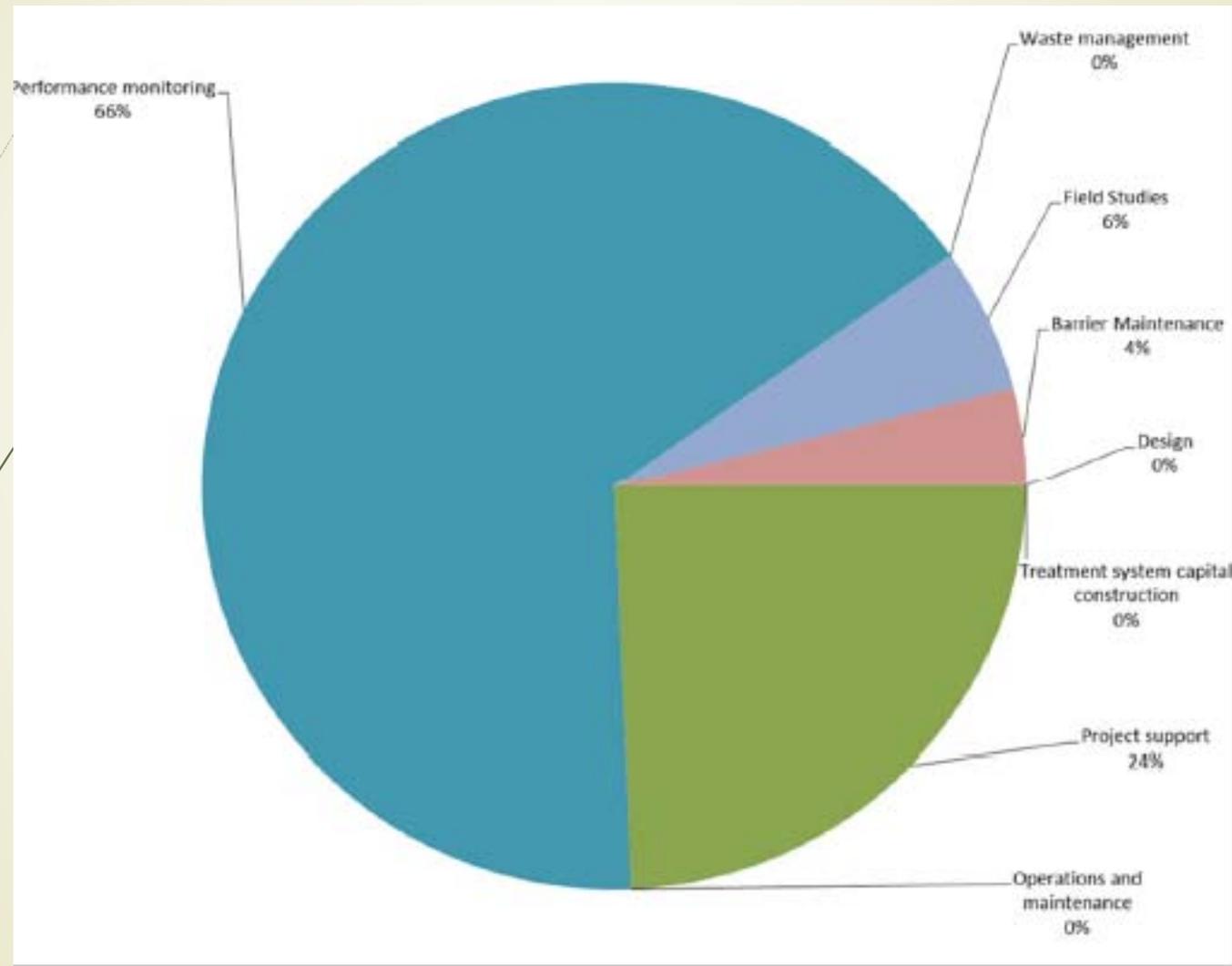
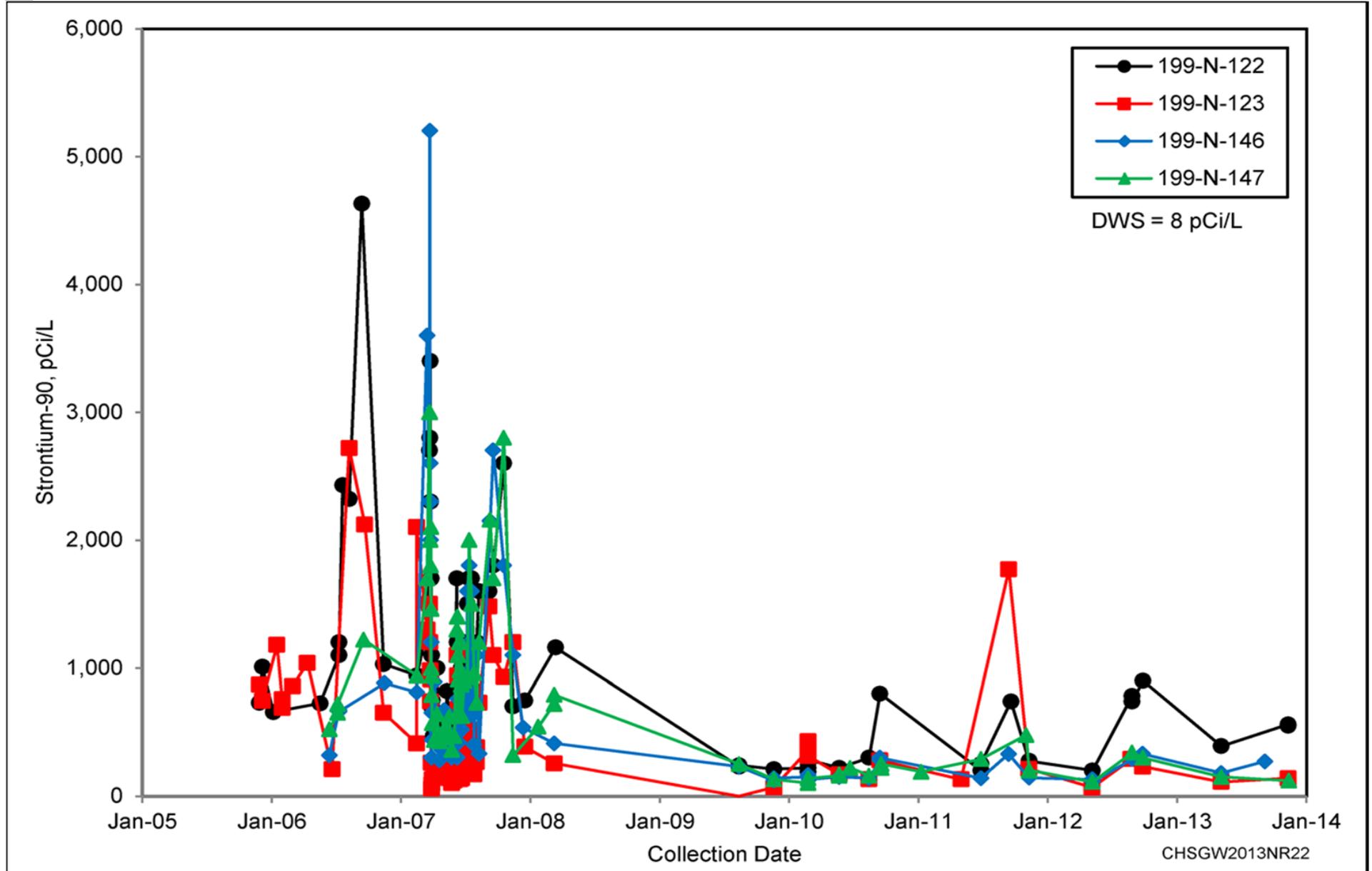


Figure 4-24. 100-NR-2 Apatite Barrier, CY 2013 Cost Breakdown (by Percentage)

Reduction of Sr 90 !!!



Reduction of Sr-90

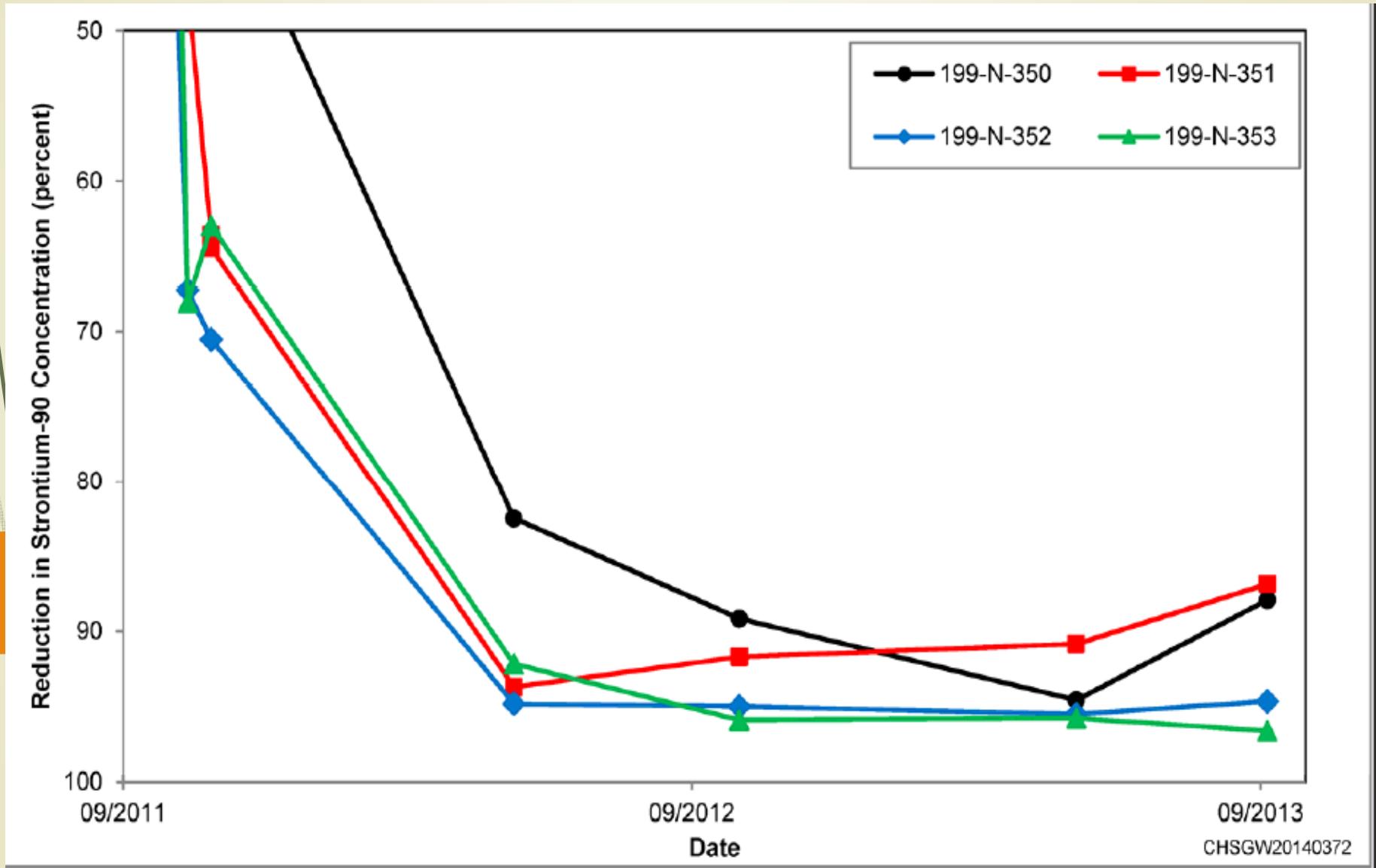


Figure 4-21. Downriver Apatite Barrier Extension Performance Monitoring Wells Percent Strontium-90 Reductions, 2013

Sr-90 Remedial Approach

- National Experts (~ 1998): Innovative technology application:
 - Phytoremediation with chemical barrier (apatite sequestration)
- Ecology formally proposed pilot scale testing of combined apatite AND phyto

15 years have passed:

- Implemented apatite sequestration technology
- Phytoextraction technology- No field scale demonstration but addressed a number of key issues

Phytoremediation by *Salix exigua*

Data Needs

- ▶ Efficiency of Sr uptake under the soil and water chemistry regimes common to the Columbia river shoreline.
 - ▶ **Addressed through greenhouse/growth chamber and field studies**
- ▶ Management practices for optimized biomass production and Sr removal (potential control of off-site transport)
 - ▶ **Addressed through greenhouse and field studies**
- ▶ Food chain transfer (Plant-Insect)
 - ▶ **Addressed through growth chamber studies**

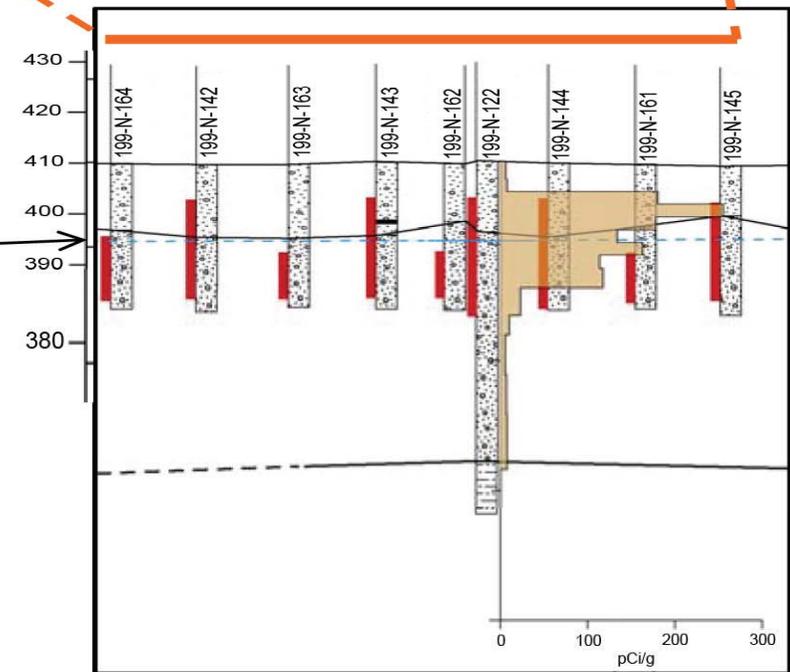


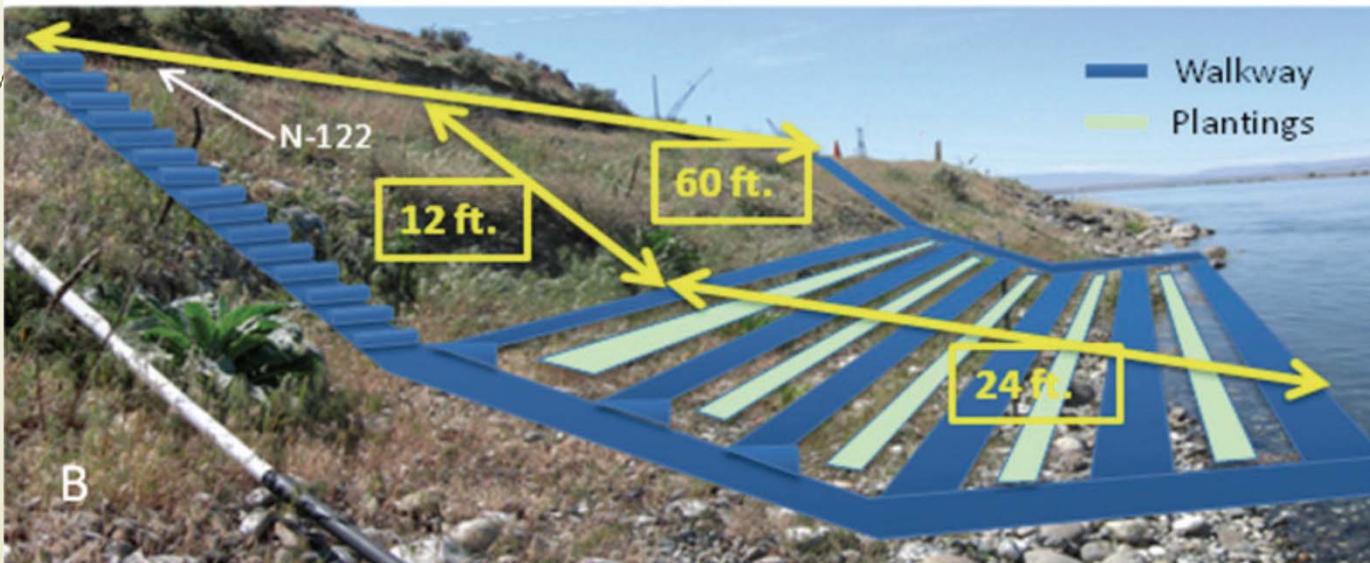
- Hanford formation sandy gravel
- Ringold "E" sandy gravel
- Ringold Formation silt
- thin silt interbed
- water level fall 2008
- screened interval

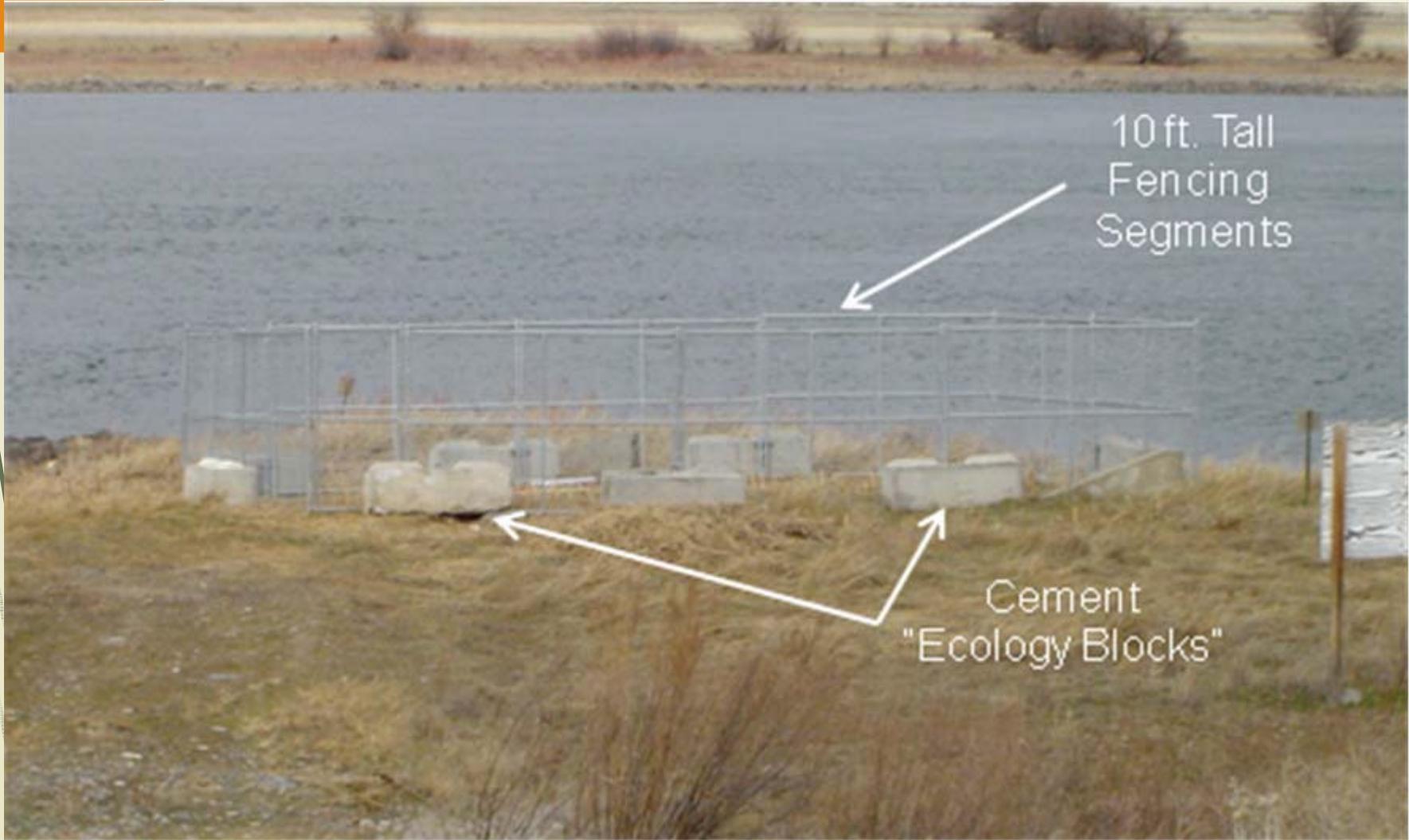
Mean Ground Level
410 Ft. Above Mean Sea Level
125 m Above Mean Sea Level

Water Level
Fall 2008

Sr-90 in sediments (pCi/g)



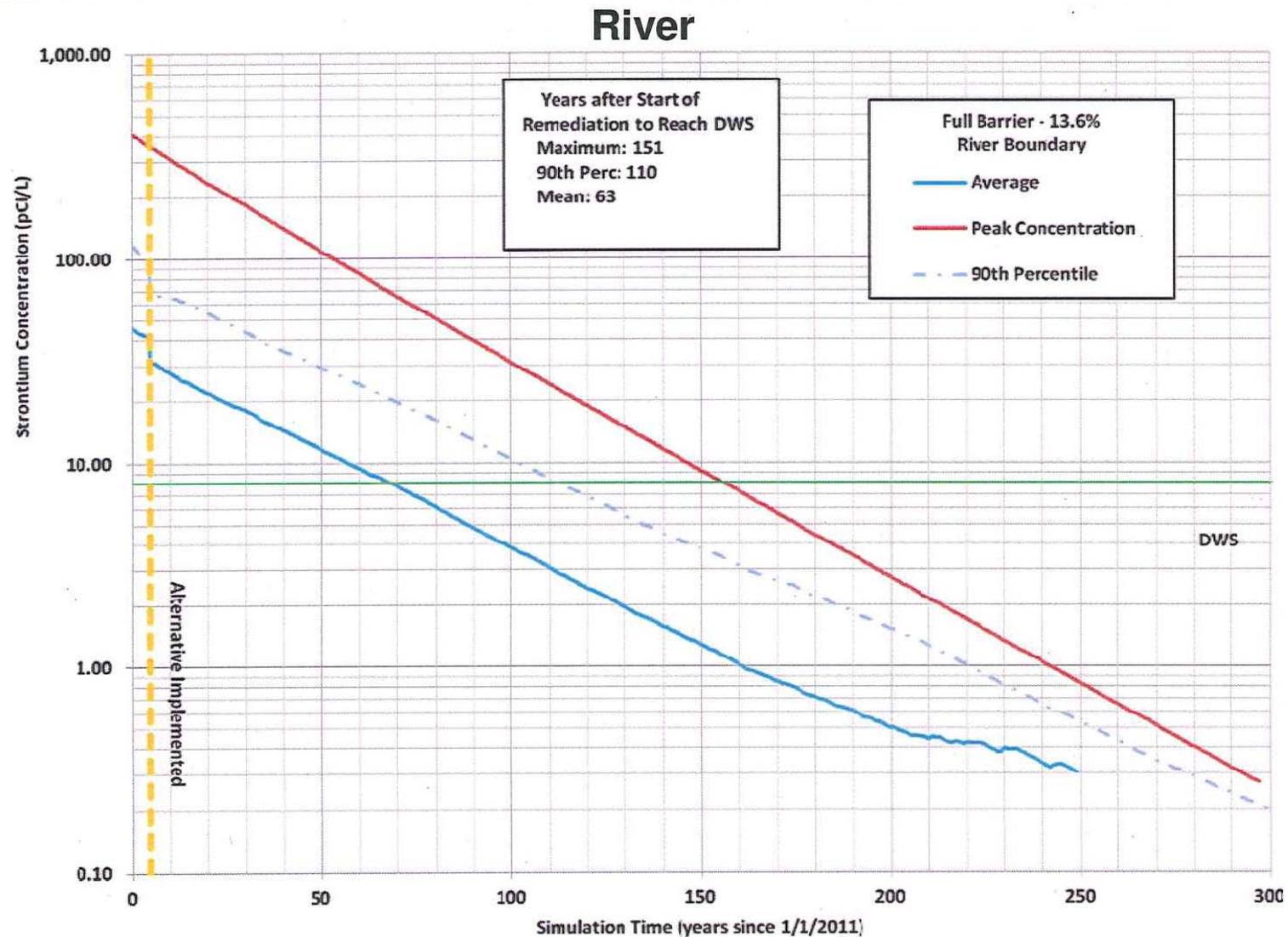




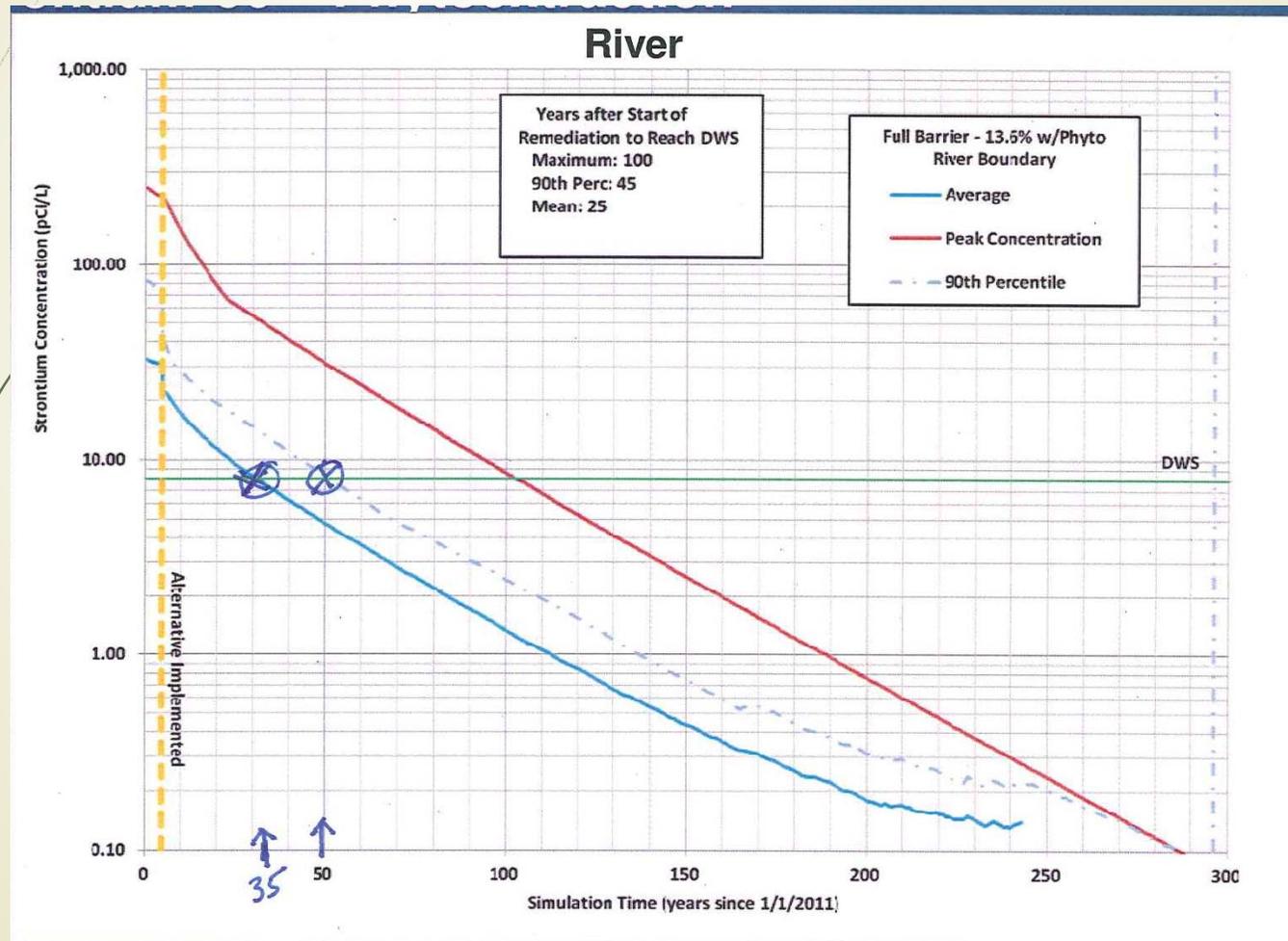
10 ft. Tall
Fencing
Segments

Cement
"Ecology Blocks"

Groundwater Modeling Showing Sr-90



Groundwater Modeling Showing Sr-90 with Phyto Remediation



Apatite Barrier and Phyto Remediation: Performance Assessment

- With 90% removal efficiency, contamination entering the barrier at and above 80 pCiL will continue to impact the Columbia River.
 - The inventory of Sr-90 is not expected to decrease in the riparian zone due to the additional Sr-90 coming through the apatite barrier.
 - Calculation of decay based on the current inventory between the barrier and the river is not applicable. Sr-90 is expected to continue to contaminate the river for a long time.
- Path Forward: A combination of enhanced (higher percentage along with the upgradient hot spot) injection of apatite barrier and phytoextraction is expected to protect the Columbia River within 35 years. The estimated cost to run a phyto test for about ~300 ft is will be within 1 million. (USDOE's cost 12 million for a 1000+ ft long phyto extraction).

Path Forward for Decision Making

- Modeling calculations and the conclusions should be based on data input from actual field data.
- Field/pilot scale demonstration of phytoremediation in the N-Area needs to be carried out to collect necessary data for proper evaluation and modeling.
- A phased approach in the proposed ROD (similar the 300 Area ROD) may be the right approach .
- Plan to involve independent technical experts, EPA remedy review board, etc.