Current & Potential Future Hanford Groundwater Impacts to the Columbia River

Proposed Prioritization of Science & Technology "Needs"

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Stakeholder Values Articulated by the HAB

- Protect the Columbia River
- Deal realistically and forcefully with groundwater contamination
- Get on with cleanup
- Do no harm during cleanup
- Use the most practicable, timely, available technology, while leaving room for future innovation

Hanford's Approach to Groundwater Remediation

1. Find and remediate source terms impacting groundwater
   - RTD 100/300 Area Liquid Waste Disposal Sites
   - RTD 100/300 Area solid waste burial grounds (potential future source)
   - Vapor extraction of CCl-4
   - Remove pumpable liquids from single-shell tanks
2. Eliminate conditions that mobilize VZ contaminants
   - Cut/cap or line pressurized water lines
   - Regrade SST farms to prevent run-on
   - Decommission old wells no longer in service
3. Implement and optimize remediation systems to protect the river, as required by Interim RODS
   - Pump-and-treat systems to intercept groundwater plumes
   - Pump-and-treat systems to reduce mass of contaminants
   - Geochemical stabilization
4. Complete CERCLA RI/FS Process leading to integrated source/GW RODs

Columbia River

- 2nd largest river in the Continental United States (120,000 CFS average flow).
- WA State Designation of Water Quality is “Class A Excellent” for the Hanford Reach.
- H-3, Sr-90, I-129, U-234, U-238, Pu-239/240 are generally measured in the Hanford Reach mainstream above minimum analytical detection techniques; all well below DWS, all have Hanford and non-Hanford sources.
- In general, only H-3, I-129 and occasionally U is measured at a statistically higher concentration below Hanford as compared to above Hanford in the mainstream of the river.
  - Hanford is the largest source of H-3 and I-129
  - Largest source of U is from irrigation returns
- Current discharges of Hanford Groundwater have insignificant adverse impacts on the mainstream of the Columbia River.
- Current potential impacts occur where receptors are exposed to contaminated groundwater - contaminated groundwater “upwells” into the river gravels and seeps from the shoreline springs during low river stages in the riparian habitat.

RADIONUCLIDES IN COLUMBIA RIVER

Source: State of Oregon Radiation Protection Services

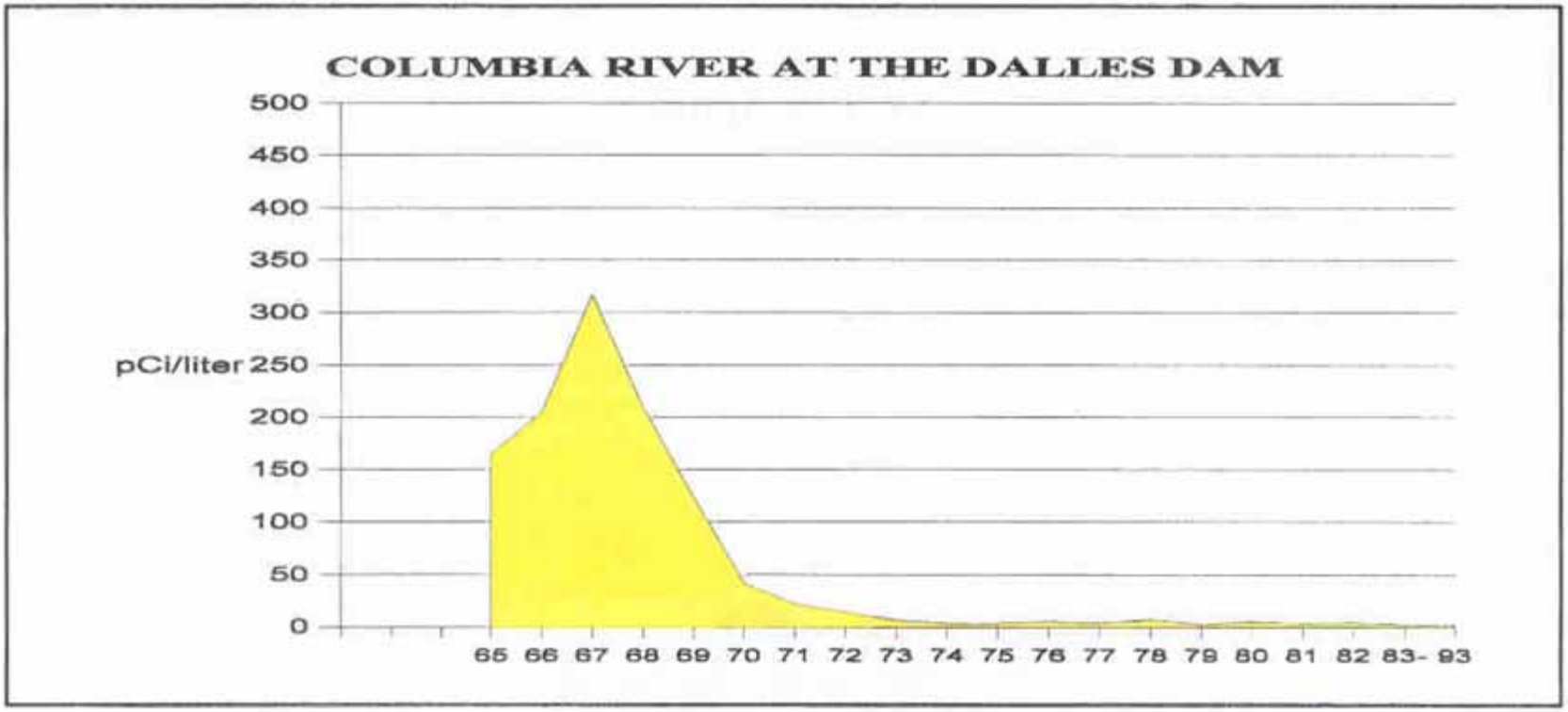


Figure 8. Average gross beta activity in surface water in pCi/liter at The Dalles Dam, 1965-1993.

Groundwater is water that is found underground in the cracks and spaces in soil, sand and rock. Groundwater is stored in--and moves slowly through--layers of soil, sand and rocks called **aquifers**. Aquifers typically consist of gravel, sand, sandstone, or fractured rock, like limestone. These materials are **permeable** because they have large connected spaces that allow water to flow through. The speed at which groundwater flows depends on the size of the spaces in the soil or rock and how well the spaces are connected.

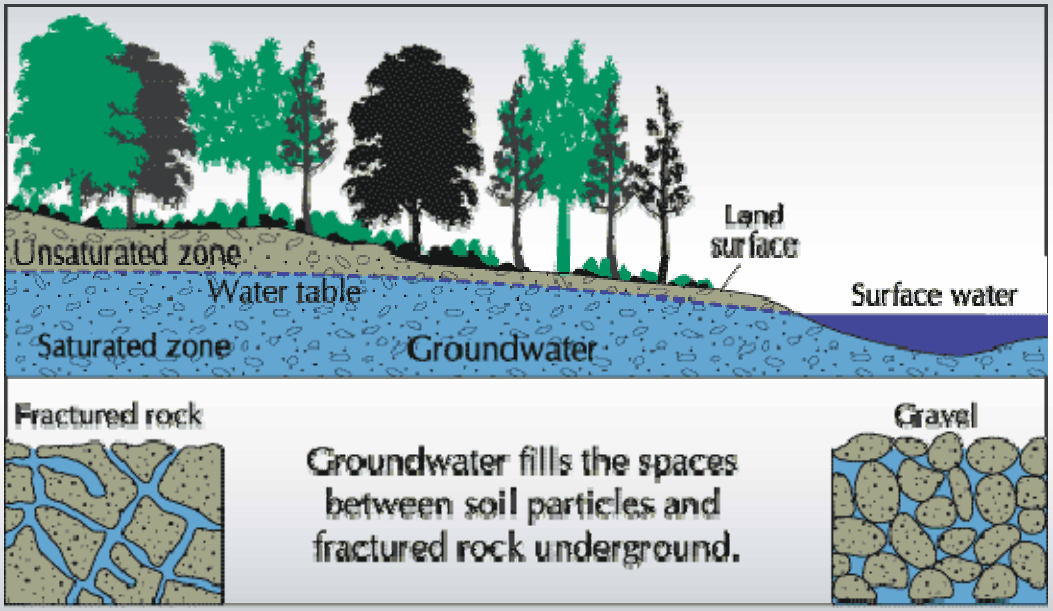
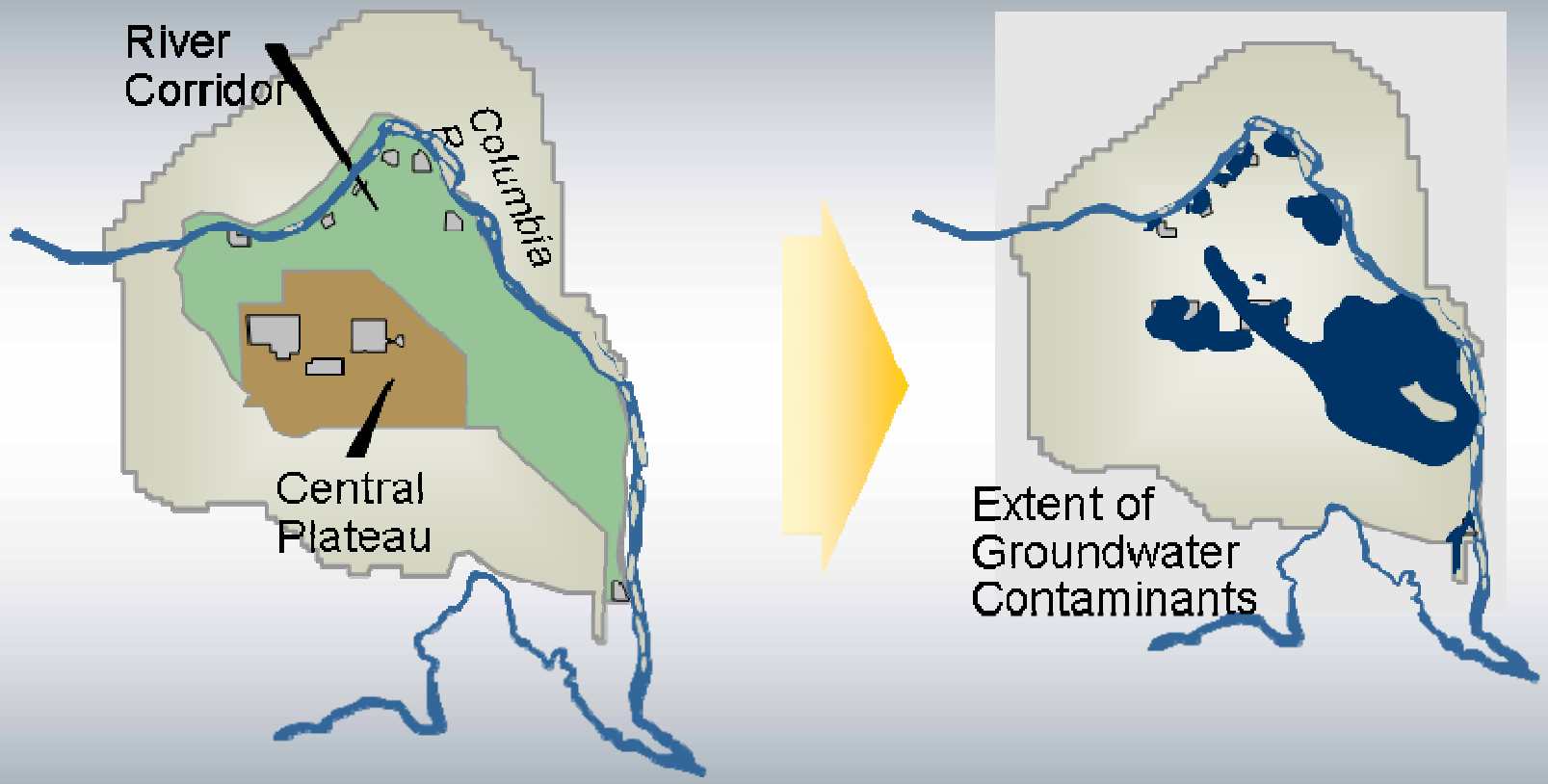


Image compliments of US Geological Survey, adapted by The Groundwater Foundation.

The area where water fills the aquifer is called the **saturated zone** (or saturation zone). The top of this zone is called the **water table**. The water table may be located only a foot below the ground's surface or it can sit hundreds of feet down.

Hanford Site Groundwater Overview

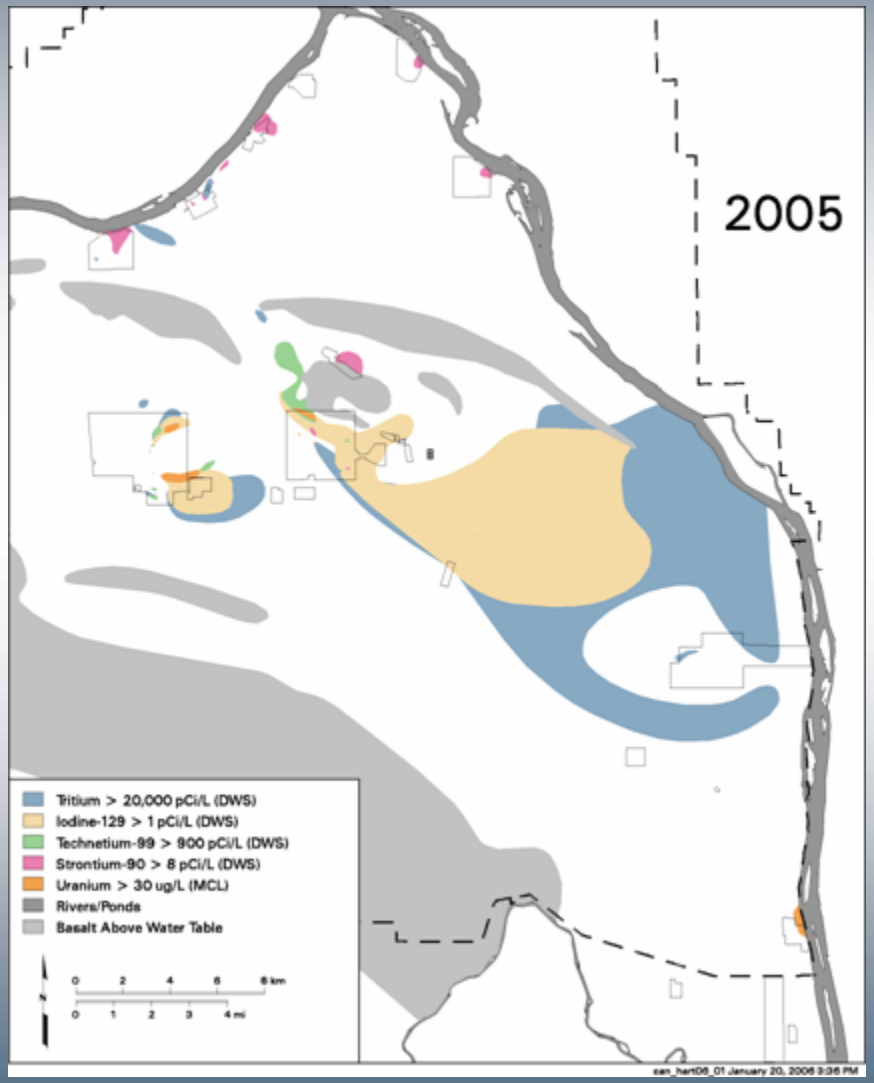
Current Extent of Groundwater Contamination



- Approximately 80 square miles of groundwater contaminated above drinking water standards
- Contaminants from 100/300 Areas and PUREX reach Columbia River

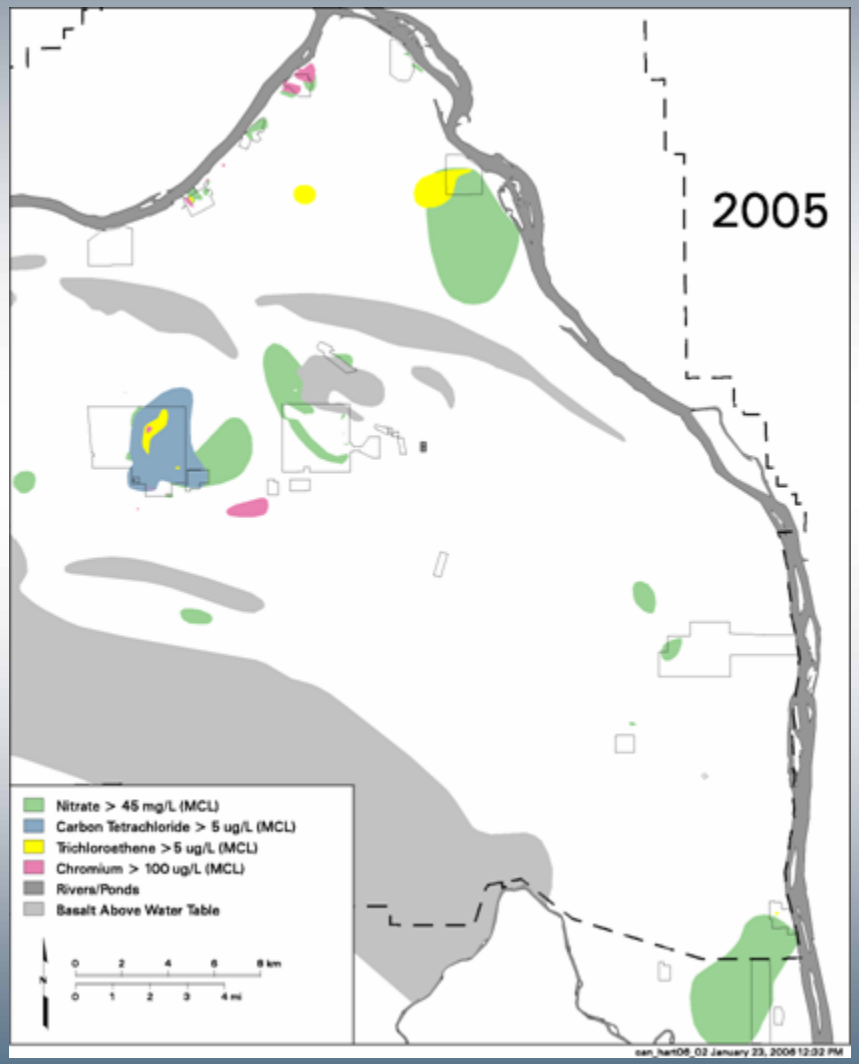
Radioactive Contaminants

- Tritium
- Iodine-129
- Technetium-99
- Uranium
- Strontium-90

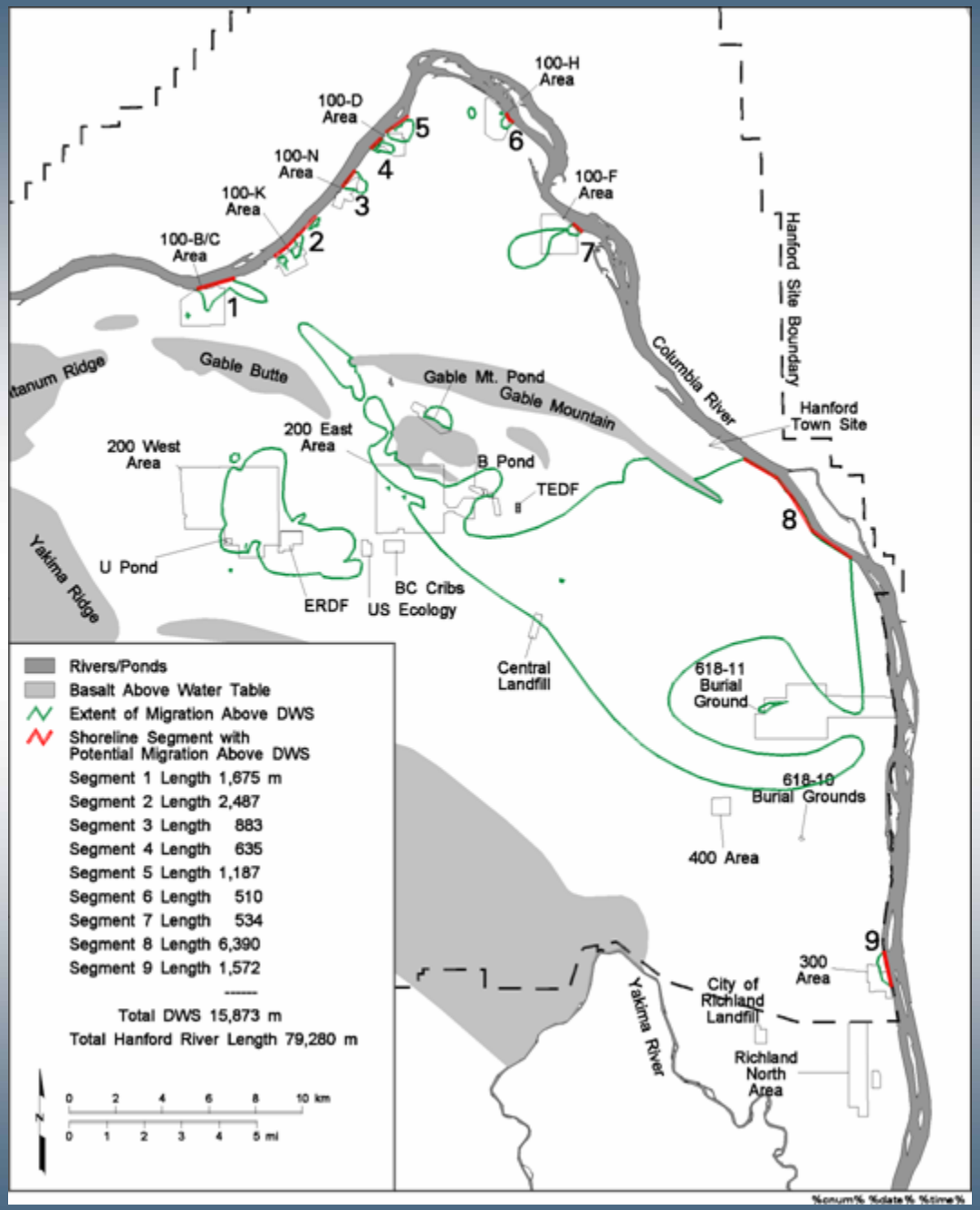


Chemical Contaminants

- Nitrate
- Carbon tetrachloride
- Trichloroethene
- Hexavalent chromium

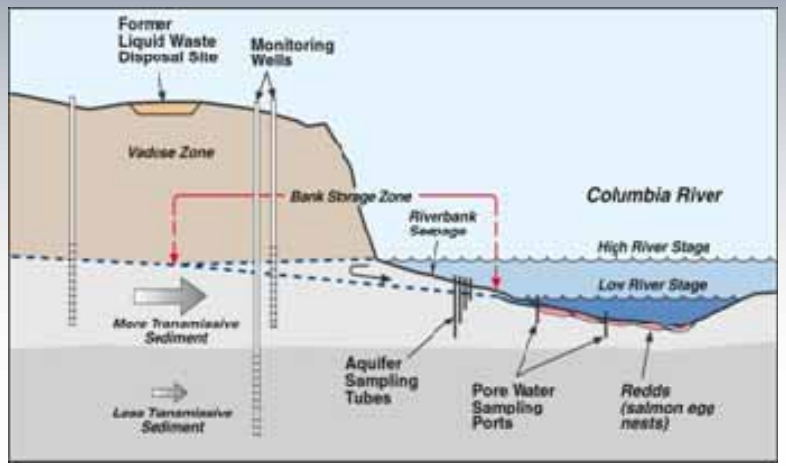


Approximately 16,000 meters of Columbia River shoreline receive contaminated groundwater



Current Exposure at the Columbia River From Hanford-Derived Contaminants to Humans and Other Biota is localized

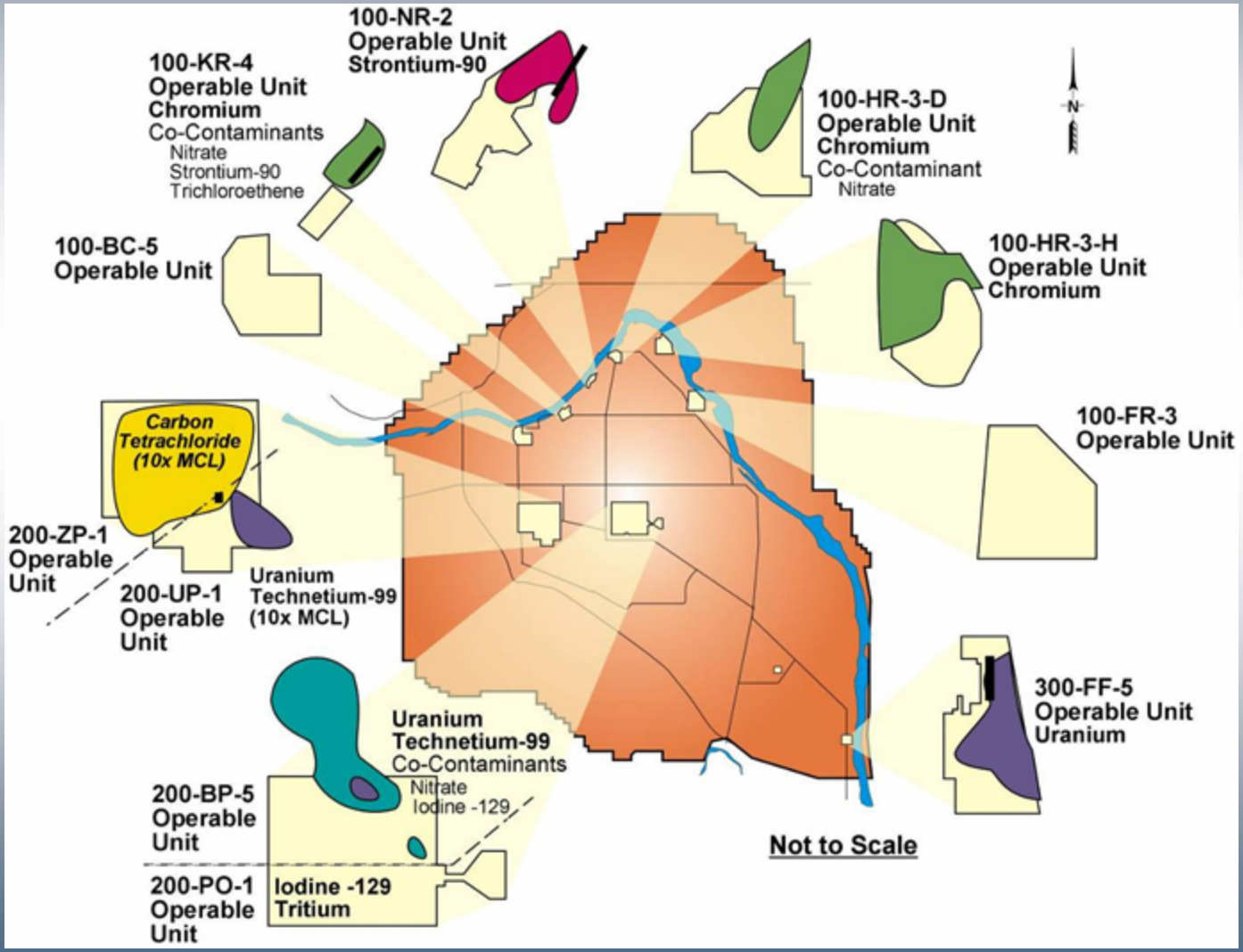
- Hyporheic Zone - contaminated groundwater upwells into the gravel bed of the river
- Riparian Zone - seeps containing a mixture of river water and groundwater



300 Area Seeps

Installation of Aquifer Sampling Tubes Using Air Hammer

Groundwater Plume Remediation
CERCLA Operable Units



2006 GAO Audit & Congressional Response

The conferees are concerned about DOE's efforts to protect contaminants from reaching the Columbia River. Technology used in several remedies is not performing satisfactorily, and there is a lack of new technologies to address contamination issues.

Key Hanford Contaminants Relevant to Congressional Concerns in CY 2006

- Contaminants Currently Entering the River
  - Hexavalent Chromium in the 100 Area
  - Strontium-90 at 100-N
  - Uranium at the 300 Area
  - Tritium from 200 East Area (PUREX)
  - Iodine-129 from 200 East Area (PUREX)
- Contaminants that may reach the River in the future from the 200 Area (Based on mobility, half-life & inventory)
  - Technitium-99
  - Uranium
  - Carbon Tetrachloride

FY 2006 Columbia River Protection Projects Funded by $10M Directed Funding

Hexavalent Chromium in the 100-D & 100-K Areas

- Inject Micron-size Iron into Deteriorating Portions of the In Situ Redox Manipulation (ISRM) Barrier
- Field Test Electrocoagulation for Accelerated Cleanup of the Northeastern Plume in the 100-D Area
- Accelerated Bioremediation (Biostimulation)
- Geochemical/Mineralogical Study of Chromium in the Vadose Zone
- Refine Location of the Chromium Source at the 100-D Area

Strontium-90 in the 100-N Area

- Sequestration of Sr-90 Subsurface Contamination in the Hanford 100-N Area by Surface Infiltration of an Apatite Solution
- 100-N Area Strontium-90 Treatability Demonstration Project: Phytoremediation along the 100-N Columbia River Riparian Zone

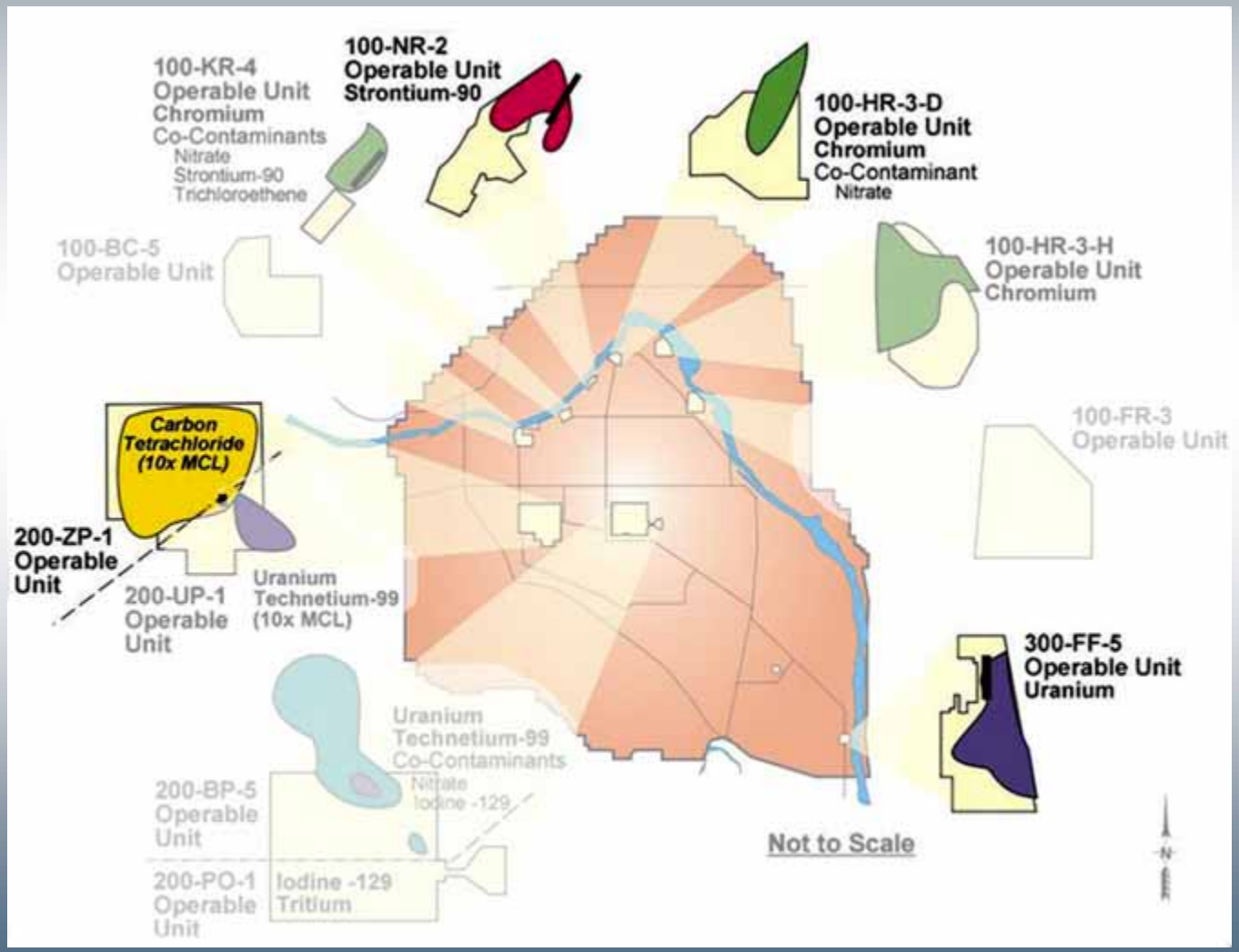
Uranium in the 300 Area

- 300 Area Uranium Plume Treatability Demonstration Project: Uranium Stabilization through Polyphosphate Injection

Carbon Tetrachloride in the 200 Area

- Carbon Tetrachloride and Chloroform Attenuation Parameter Studies: Heterogeneous Hydrolytic Reactions

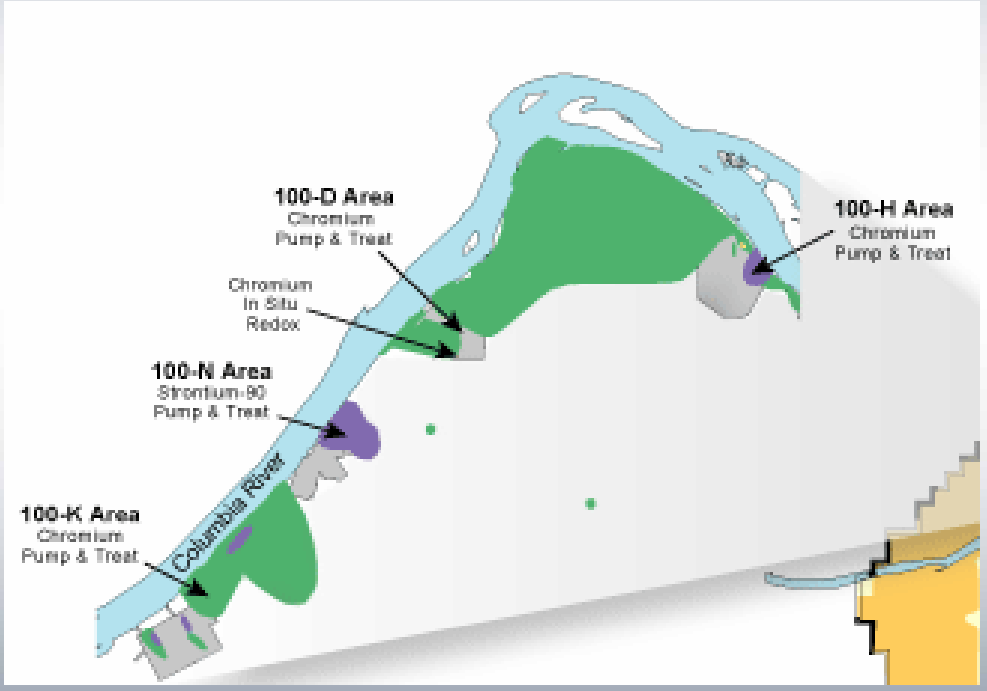
CERCLA Operable Units Impacted by the Nine Projects Funded in FY 2006



100 Area Chromium

Considerable effort is being expended on GW remediation technologies such as P&T expansion, alternative treatment technologies (EC), and reductive chemistry remediation (biostimulation). However, further opportunities are available for focused S&T application.

- VZ sources are difficult to find
- VZ sources require in-situ remedial technologies below excavation depths
- Cr in the “Horn”, a larger and more diffuse plume needs to be characterized and a remedial decision needs to be supported by technology evaluations



100-N Strontium-90

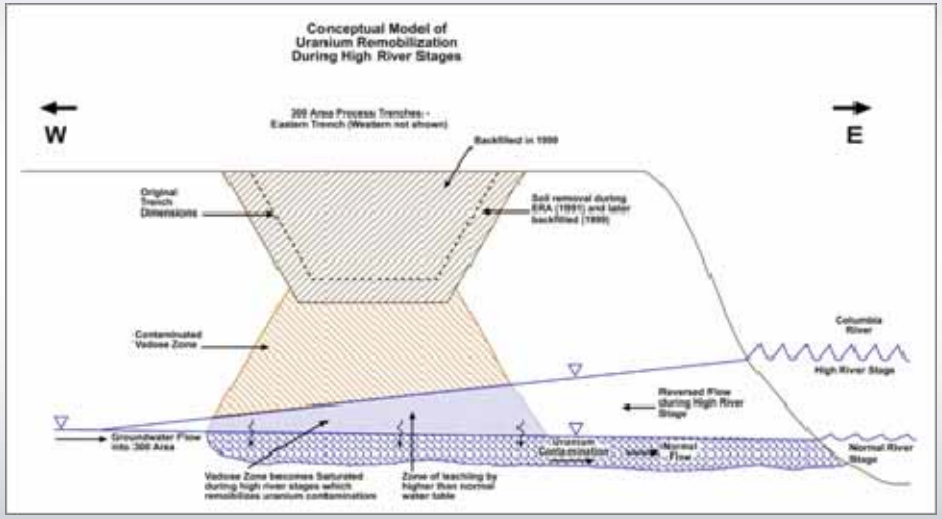
Apatite sequestration barrier is being constructed in saturated zone; FY 2006 projects selected to test VZ barrier construction and phytoremediation cold test to determine biomass potential

- Hot test for biological uptake (food-web) are unfunded
- Apatite/phyto interaction
- Petroleum plume

300 Area (U & TCE)

One GW remediation technology is being tested (polyphosphate); laboratory tests are highly encouraging; Office of Science is funding an "Integrated Field Test" at the 300 Area – will refine U geochemical and physical conceptual model; deep VZ source should be addressed so GW technologies can be fully effective.

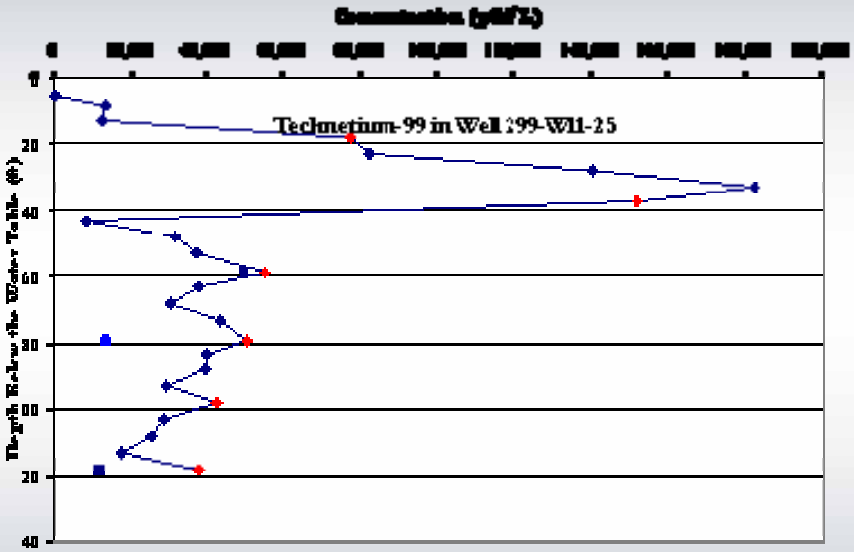
- Only 1 GW technology currently being tested for U
- Source of U is the deep VZ that is periodically rewetted by GW responding to river stage
- No VZ technology for U currently being tested
- Recent find of deep TCE in Ringold Fm needs to be addressed



200 Area

Mobile/long-lived contaminants with sufficient mass may migrate from the 200 Area if untreated; Large inventories of mobile/long-lived contaminants are deep in the VZ; Geological framework could be better defined

- Tc-99 is impacting GW at the T /TX/TY& S/SX Tank Farms
- U and Tc-99 are concerns in 200-BP-05 & 200-UP-01
- GW levels are dropping requiring geologic characterization
- Deep CCl-4 remediation



Hanford Groundwater Priorities
Are we in Agreement?

- Protection of the Columbia River is the primary short-term goal of Hanford groundwater cleanup.
  - Address GW contaminants and their sources, considering relative risk and technical feasibility, that are reaching the river first
  - Address inland contaminants that have the mass, mobility and half-life (recalcitrance) to reach the river
- Protection of the groundwater from further degradation from mobile/long lived contaminants in the vadose zone (100/200/300 Areas) should also be considered.
- Restoration of the aquifer (40 CFR 300.430(a)(1)(iii)(F)) is the long-term goal of Hanford groundwater cleanup.

Proposed Prioritization of Science & Technology "Needs" for Funding Consideration

- Priority A - Those "Needs" Affecting Contaminants Currently Entering Columbia River
- Priority B – Those "Needs" Affecting 200 Area Contaminants that could Reach Columbia River
- Priority C – These "Needs" that may be Deferred Until FY 2008

Proposed Priority A - S&T "Needs" Affecting Contaminants Currently Entering Columbia River

1(a). 100 Area vadose zone chromium remediation (100-H, 100-D, 100-K)

1(b). 300 Area vadose zone uranium remediation

2. 300 Area deep TCE characterization/remediation

3. 100-N phytoremediation S-90 (transfer into food chain, hot-zone test, compatibility with Apatite barrier)

4. Understanding hydraulics & chemistry of GW/Columbia River interaction for Cr, Sr-90 & U

5. 100-N petroleum remediation

Proposed Priority B - S&T “Needs” Affecting 200 Area Contaminants that could Reach Columbia River

1. Deep vadose zone Tc-99 remediation in the 200 Area
2. Gable Gab & Geohydrology between 200 Area & River
3. 200 Area uranium remediation (VZ & GW)
4. Tank Farm mobile contaminant release conceptual model
5. Residual Tank Waste Characterization/remediation
6. Surface Barrier Design/Testing
7. CCl-4 volatilization losses
8. Data visualization

Proposed Priority C - S&T “Needs” that may be Deferred Until FY 2008 Funding Allocation

- 1. S&T activities to support full-scale implementation of FY 2006/2007 projects
- 2. 100 Area chromium remediation between 100-D & 100-H (Columbia River "Horn")
- 3. Continued funding of abiotic CCl-4 degradation
- 4. Characterization/remediation of 200 Area pipelines
- 5. Inexpensive drilling/sampling technologies for extremely radiological "hot" samples

Ranking Criteria for Project Proposals

- Relevancy – Addresses GW contaminants and VZ source(s) that are (1) known to be currently entering the Columbia River, or (2) considered likely to enter the Columbia River due to proximity, mobility, quantity and persistence, or (3) VZ sources likely to significantly degrade future groundwater conditions.
- Risk Reduction – Addresses and mitigates risks – particularly health and ecological risks to the Columbia River and associated receptors (primarily based on risks identified in existing and pending RODs).
- Baseline Improvement – Addresses deficiencies in meeting ROD remedial action goals (primarily based on deficiencies identified in the CERCLA 5-yr review documents).
- Implementability – Can be implemented within 12 to 18 months, designed to allow measurable documentation of performance, and minimal risk of adverse collateral impacts
- Acceptability – Support by regulators, tribal and local governments and stakeholders.