# *The Hanford Site-Wide Risk Review Project*
# Interim Report Overview

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CRESP

Consortium For Risk Evaluation with Stakeholder Participation

November 4, 2015

# This is not the Omnibus Risk Review

The Omnibus Risk Review was carried out by direction from Congress with a national scope by an independent organization:

- Specific study scope was negotiated by DOE with Congressional staff.
- CRESP was asked by DOE to establish a committee to carry out the review independently.
- CRESP identified nationally recognized leaders with diverse expertise and experience to serve on the Committee.
- CRESP was the conduit for funding for the Omnibus Risk Review Committee.
- CRESP was provided the final report from the Omnibus Risk Review Committee and submitted it to Congress as directed by DOE.

➢ Questions should be directed to Prof. Michael Greenberg, Rutgers University, mrg@rci.Rutgers.edu

# Documents Now Available

- ***Interim Progress Report, Rev. 0***
  - Catalogue and characterization of 25 Evaluation Units
  - about ½ of remaining cleanup work; Tank Farms, Major Groundwater Plumes, some Operating Facilities, D&D and Legacy Sites
  - Summarized in main report by source type and receptor; more extensive discussion and information for each unit in appendices
- ***Methodology for the Hanford Site-Wide Risk Review Project, Rev. 0***
  - Extensively revised based on comments received
- ***Overview of Revisions Made to "Methodology…Rev. A, September 4, 2014"***
  - Over 300 comments received and considered
  - Summary level overview

# Hanford Risk Review Project Goal

- The goal of the Risk Review Project is to carry out a screening process for risks and impacts to human health and resources.
  - The results of the Risk Review Project are intended to provide the DOE, regulators, Tribal Nations and the public with a more comprehensive understanding of the remaining cleanup at the Hanford Site.
  - Intended to help inform (1) decisions on sequencing of future cleanup activities, and (2) selection, planning and execution of specific cleanup actions, including which areas at the Hanford Site should be addressed earlier for additional characterization, analysis, and remediation.
  - One of many inputs from many sources to help inform decisions.
- **Scope:** "to go" cleanup and waste management activities as of FY 2016

# Hanford Risk Review Project

**Specific Objectives** (for Interim Report)**:**

1. To **review hazards and existing environmental contamination** and determine the *potential for contaminants and also cleanup actions* to cause risks to receptors, and identify key uncertainties and data gaps;
2. To **provide relative ratings of risks to receptors** from hazards and existing environmental contamination, and **identify the most urgent risks** to be addressed.

# Context – Why?

- A lot has been achieved at Hanford

  The 2015 Vision is approaching completion, but…

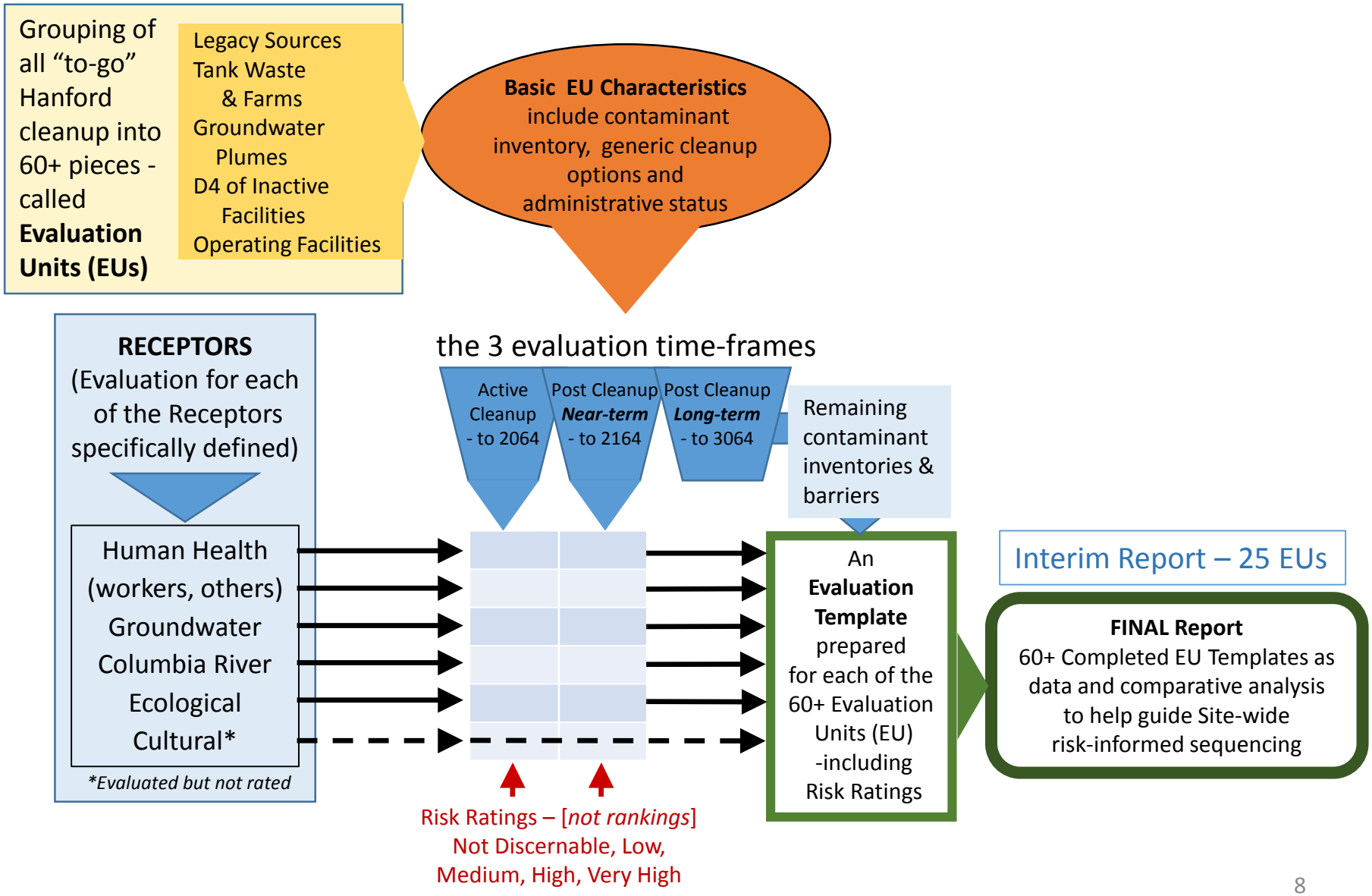
- > 50 years and > $100 Billion “to go” in Cleanup

- This is a multi-generational challenge

# What the Risk Review Project *is not*

- **The Risk Review Project is neither intended to substitute for, nor preempt any requirement imposed under applicable federal or state environmental laws or treaties or the Tri-party FFA/Consent Order**.
- **Cleanup actions considered completed by the Tri-Parties are not part of the Risk Review Project and therefore will not be evaluated.**
- **The Risk Review Project is focused on hazard and risk characterization, which is a necessary predecessor to risk management, but does not focus on risk management decisions.** The Risk Review Project considers a plausible range of cleanup actions to better understand the range of potential risks that may be caused by future cleanup actions.
- **The Risk Review is not carrying out a CERCLA risk assessment nor a Natural Resources Damage Assessment evaluation.** Evaluations of hazards, existing environmental contamination and rough order-of-magnitude estimates of risks to receptors using existing information will be the basis for developing groupings, or bins, of risk and identifying the most urgent risks to be addressed.

# Overall Methodology

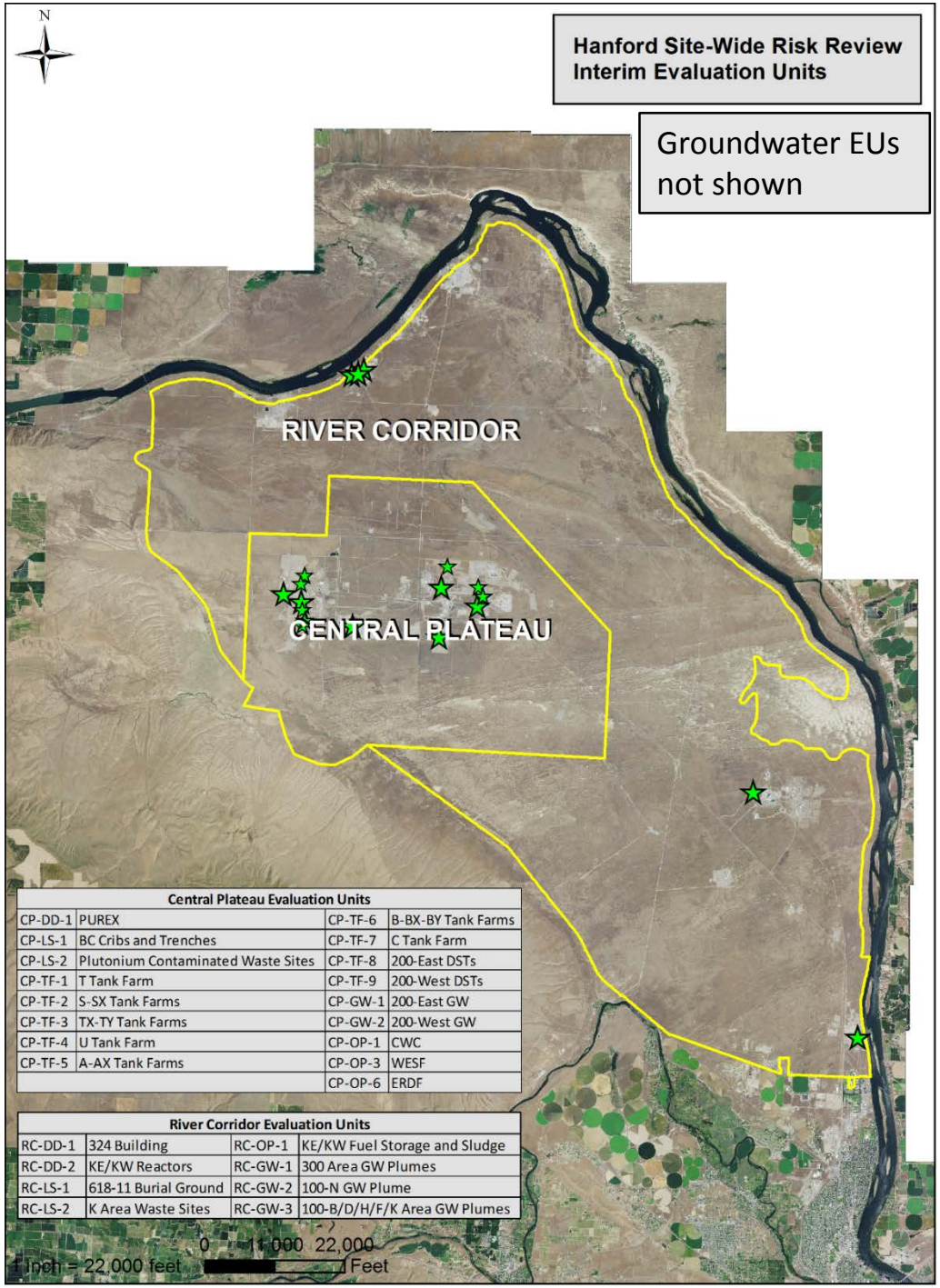


# How did CRESP address comments on the Methodology?

- All comments were reviewed – almost all resulted in changes in the methodology used.
- Major shifts
  - Clarification of project goals and objectives, as well as what the project will not do
  - Distinctions between *hazards* and *risks*
  - Focus on available data, thresholds and metrics (nuclear safety, groundwater, Columbia River, ecological resources); no longer model driven.
  - Cultural resources summarized, but not rated (input from Tribal Nations)
- CRESP reviewed revisions to the Methodology and their implementation in the Interim Report with Core Team (including DOE, WA Ecology & Health)

# What has been learned so far that suggests increased emphasis for specific aspects of the Hanford Site?

- PUREX – wood timber constructed tunnel (only processing canyon out of several that was evaluated in the Interim Report)
- Specific tanks and tank farms should be considered differently – hazards and risks are not uniformly distributed across tanks.
- Central Plateau East groundwater poses greatest groundwater threat which is not currently not be treated.
- Selected interim actions may reduce risk.
- Accumulation of waste inventory at interim storage points increases risk.
- Mercury hazards and risks have only been partially analyzed.




## Evaluation Units (EUs) included in the Interim Report:

- All 9 Tank Waste and Farms EUs
- All 5 Groundwater EUs
- 3 of 9 D&D EUs
- 4 of 21 Legacy Source Site EUs
- 4 of 16 Operating Facility EUs

# General Observation

In carrying out the Risk Review Project, the team has found that ***different hazard and risk considerations are important***:

a. **To inform sequencing of cleanup activities**, *nuclear, chemical, and physical safety* (i.e., hazards, initiating events and accident scenarios) *and the threats to groundwater* and the Columbia River *are the primary risk considerations*.

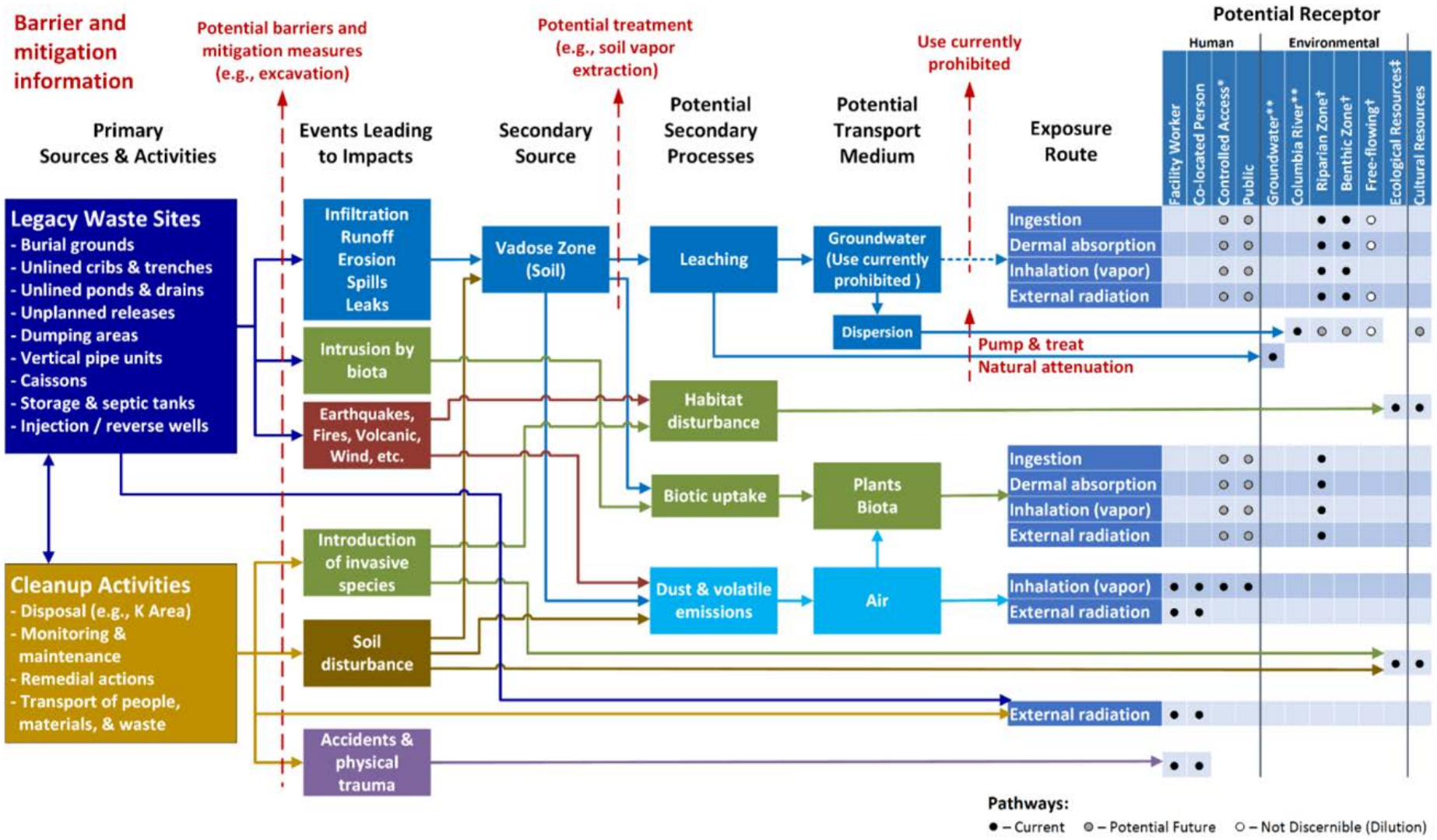
b. **To inform selection, planning and execution of specific cleanup actions**, *potential risks and impacts to worker safety, ecological resources and cultural resources are the primary risk considerations*.

c. **To inform cleanup criteria** (i.e., residual contamination levels), *future land use, protection of water resources, land ownership and control, and durability of institutional and engineered controls, and legal/regulatory requirements are the primary considerations that influence future human health risk estimates*.

   Risks to human health should be considered in combination with risks to environmental and ecological resources for establishing cleanup criteria.

**CRESP's primary focus is on items a and b, above;**
**CRESP will not be making recommendations on specific cleanup criteria**

# Legacy Source EU - Conceptual Site Model




* Activities by members of Tribal Nations are considered a Controlled Access group within human health, recognizing the potential for different exposures as a result of specific cultural practices.

** These are evaluated as protected resources, independent of use.

† Threats to the Columbia River specifically include potential contaminant impacts to the ecology of the Riparian Zone, Benthic Zone, and Free-Flowing River component.

‡ Threats indicated within Ecological Resources focus on habitant disruption and potential impacts to endangered and sensitive species.

# Human Health

## Specific Population Groups Defined & Used:

***Facility Worker*** – within defined EU facility's boundary based on DSA

***Co-located Person*** - at 100 m from facility boundary; based on "co-located worker" from DSA, but confusing when considering that people may be present for diverse reasons (non-facility workers, visitors, etc.)

***Controlled Access Person*** - within the site boundary

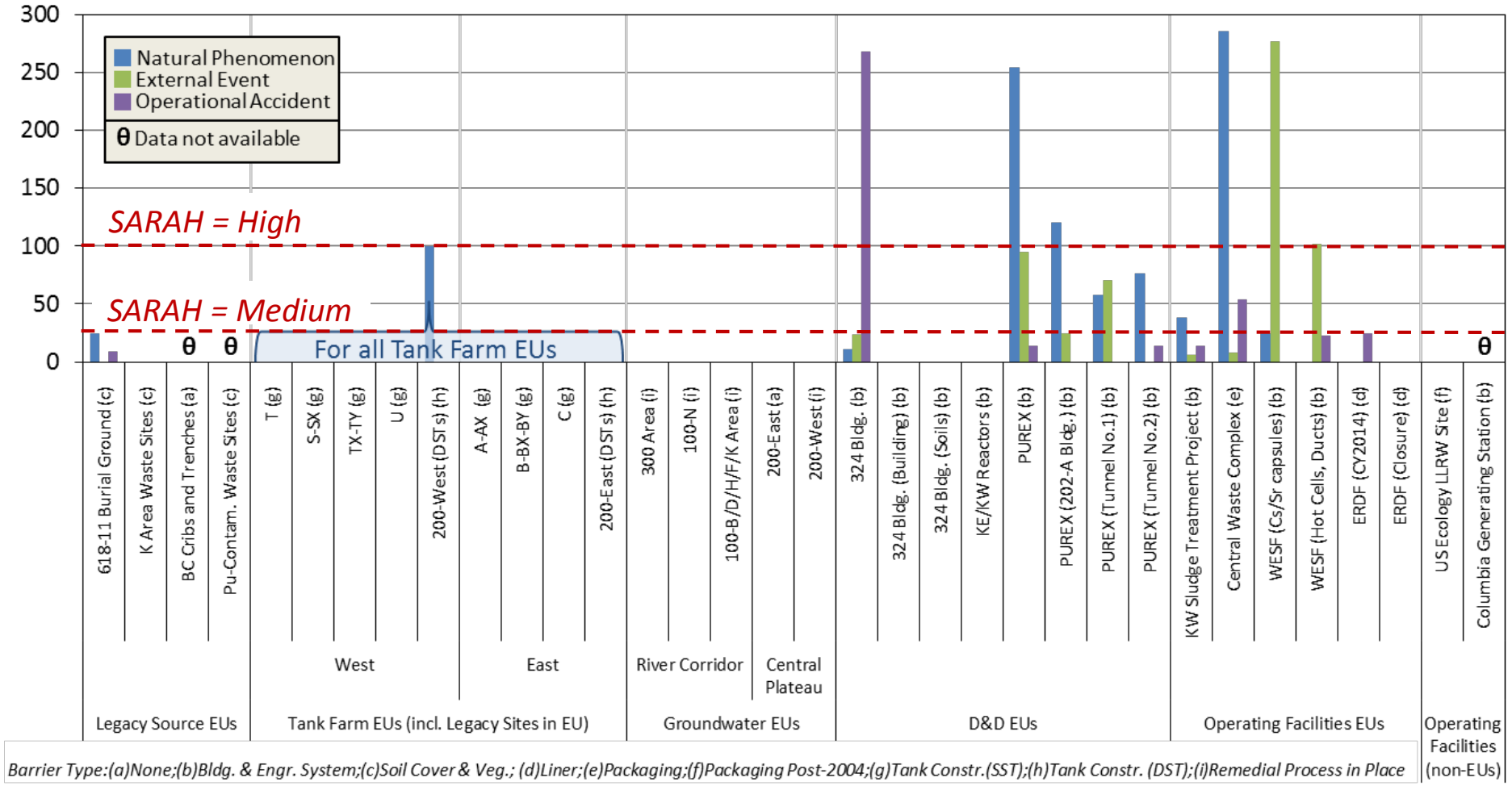
i. General population (e.g., for B-reactor, educational activities)
ii. Tribal uses
iii. Other groups

***Public*** - Uncontrolled access, present at the site access boundary

## Nuclear Safety Considerations

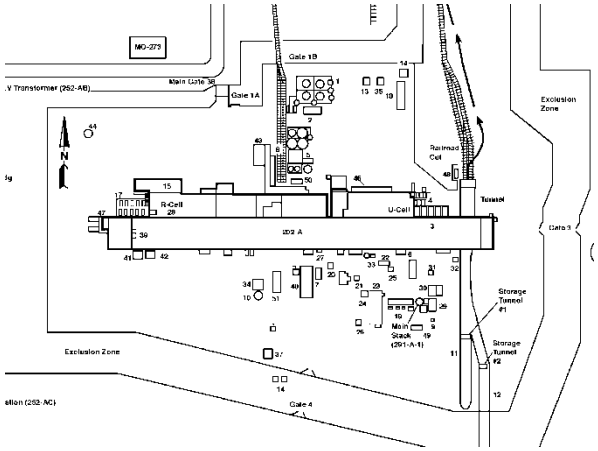
- Documented Safety Analysis (DSA) process and results used to evaluate accidents and acute upset events
- Unmitigated dose to co-located people considered a metric of hazard
- Mitigation measures also considered as part of evaluation

# Unmitigated Dose to Co-located Person [rem] as Human Health Metric



# CP-DD-1: Plutonium-Uranium Extraction (PUREX)

- Constructed between 1953 and 1955 and operated until 1990 to chemically separate plutonium, uranium and neptunium from Hanford Site nuclear reactor fuel elements. Nearly 70% of Hanford's uranium was reprocessed through PUREX.
- Rail tunnels constructed to dispose of surplus radioactive materials such as failed or outworn equipment. Tunnel #1 was constructed almost entirely of railroad ties in 1956. Tunnel #2 was constructed with stronger materials in 1967 as additional temporary storage and contains 28 railcars (largest amount, curies, of dispersible radioactive contaminants in PUREX complex subject to a structural collapse).
- Final D&D of PUREX building is expected to be similar to the "Close in Place-Partially Demolished Structure" alternative chosen for the U Canyon. Rail cars and contaminated equipment in two tunnels most likely to be grouted in place with backfill of the storage tunnels.



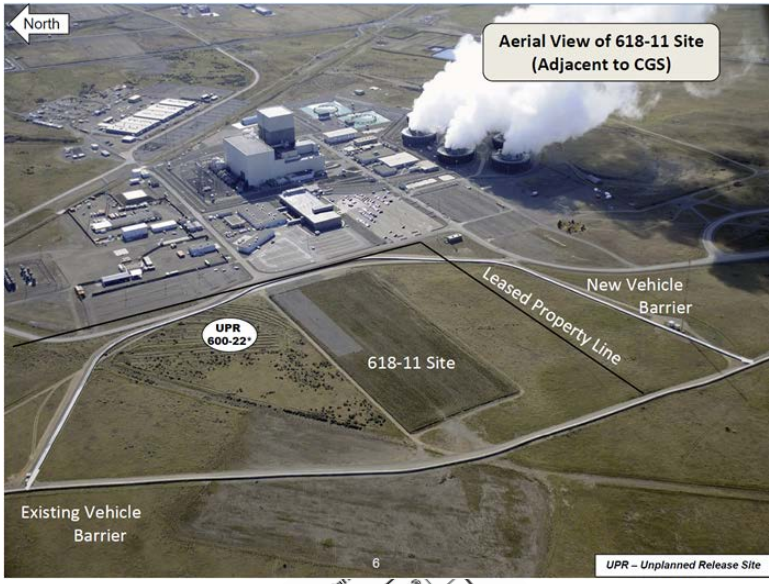
# Inventory and Potential Events

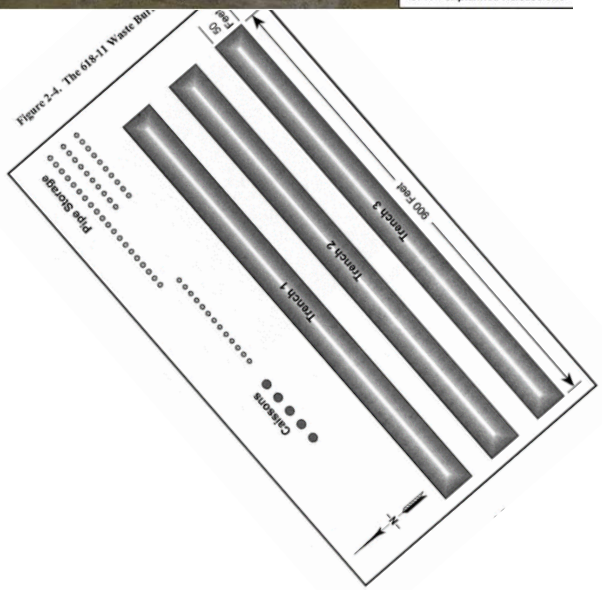
| Primary Contaminants | 202-A building, incl. Ventilation System | | Storage Tunnel #1 | | Storage Tunnel #2 | |
|---|---|---|---|---|---|---|
| | Grams | Curies | Grams | Curies | Grams | Curies |
| Total Pu (as 239) | 14,000 | 871 | 4,960 | 309 | 5,530 | 344 |
| Am-241 | 350 | 1,210 | 129 | 447 | 98 | 338 |
| Cs-137 | 126 | 11,200 | 116 | 10,300 | 3,790 | 337,000 |
| Sr-90 | 66 | 9,010 | 60 | 8,240 | 1,250 | 172,000 |

There are four events that would cause an unmitigated exposure of at least 25 rem to a non-worker located 100 meters away:

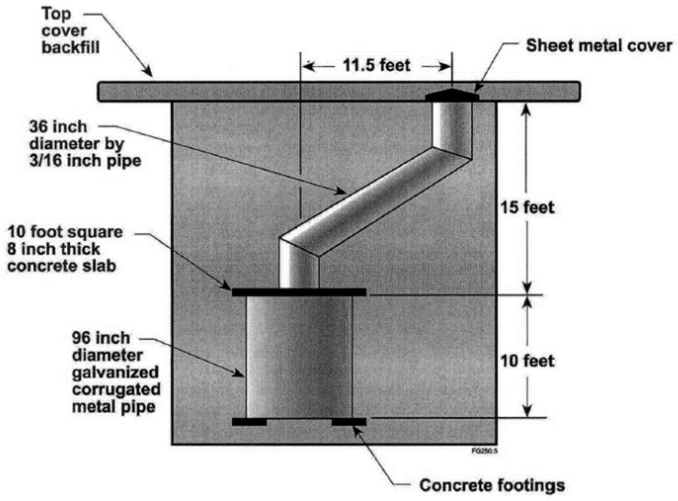
- An atmospheric dispersible event caused by a partial or complete failure of the PUREX structures. This would be a short acute ground release duration event without plume meander causing the following unmitigated exposures. Storage Tunnel No. 1 – 58 rem; Storage Tunnel No. 2 – 76 re; 202-A Building and systems – 120 rem.
- A fire in PUREX Tunnel #1 associated with its wooden structure could cause an unmitigated exposure of 70 rem.
- A partial collapse of the 202-A building roof could cause a 25 rem exposure.
- A fire in the N-Cell could cause an exposure of 25 rem because of the residual inventory in the gloveboxes, potential combustibles, and potential ignition from S&M operations.

# RC-LS-1: 618-11 Burial Ground

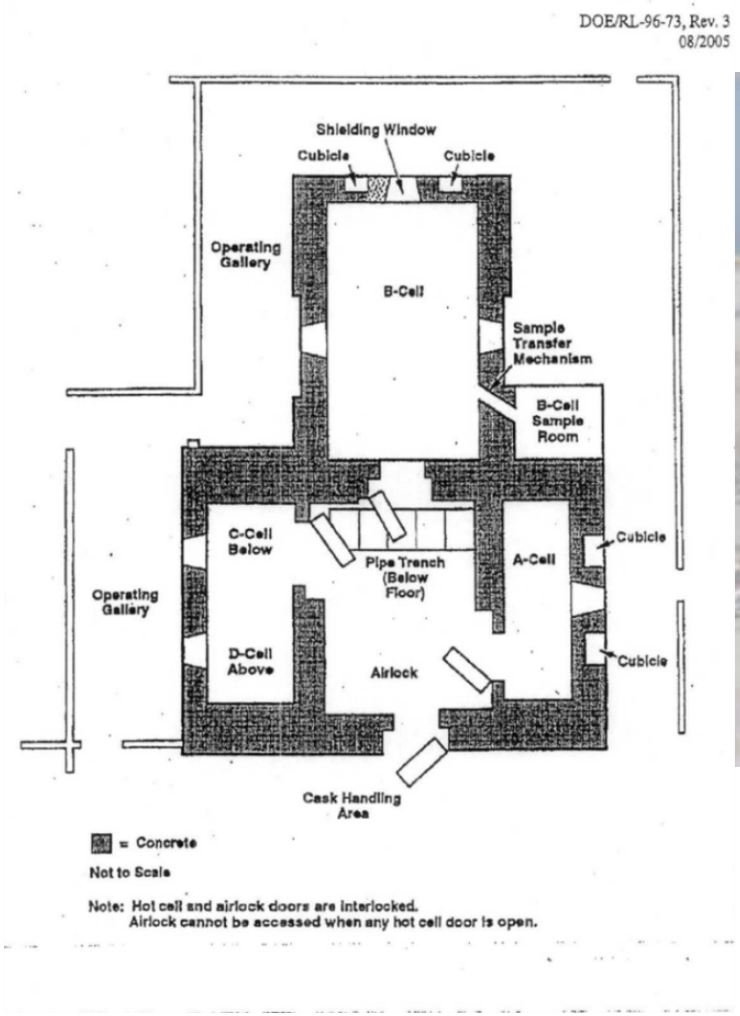



- Hazardous constituents include, lead shielding, ignitable metal turnings, Th oxide, salt cycle residues, and lithium aluminate targets with tritium (PNNL 2001).
- The inventory is not well documented. Presentation to the NRC (Dunham, 2012) listed an inventory for 618-11 as $^{90}$Sr (4200 Ci), $^{137}$Cs (5300 Ci), $^{241}$Am (226 Ci), $^{239}$Pu (132 Ci), $^{241}$Pu (639 Ci) and Beryllium (330 kg). Data from WIDS identifies only 1000 Ci $^{90}$Sr, $^{137}$Cs (1000 Ci), and $^{239-240}$Pu (623 Ci).



# 324 Building




- Spill and leak ($^{137}Cs$, $^{90}Sr$) through B-cell liner in 1986, discovered in 2009.
- Highly contaminated (11,700 Rad/hr max) around B-Cell foundation to depth of 4 ft to cobble layer (2014).
- No evidence of migration after B-Cell sealed.
- Largest risks from water infiltration (water main rupture) and retrieval actions.

# Ecological Resources Evaluation

- Field survey of EU (walk-through where possible) in 2014-15
- Analysis of % of each resource level in EU, using GIS information
- Comparison of EU and buffer with previous resource level rating
- Inclusion of data on sensitive species

**Evaluating Impacts**

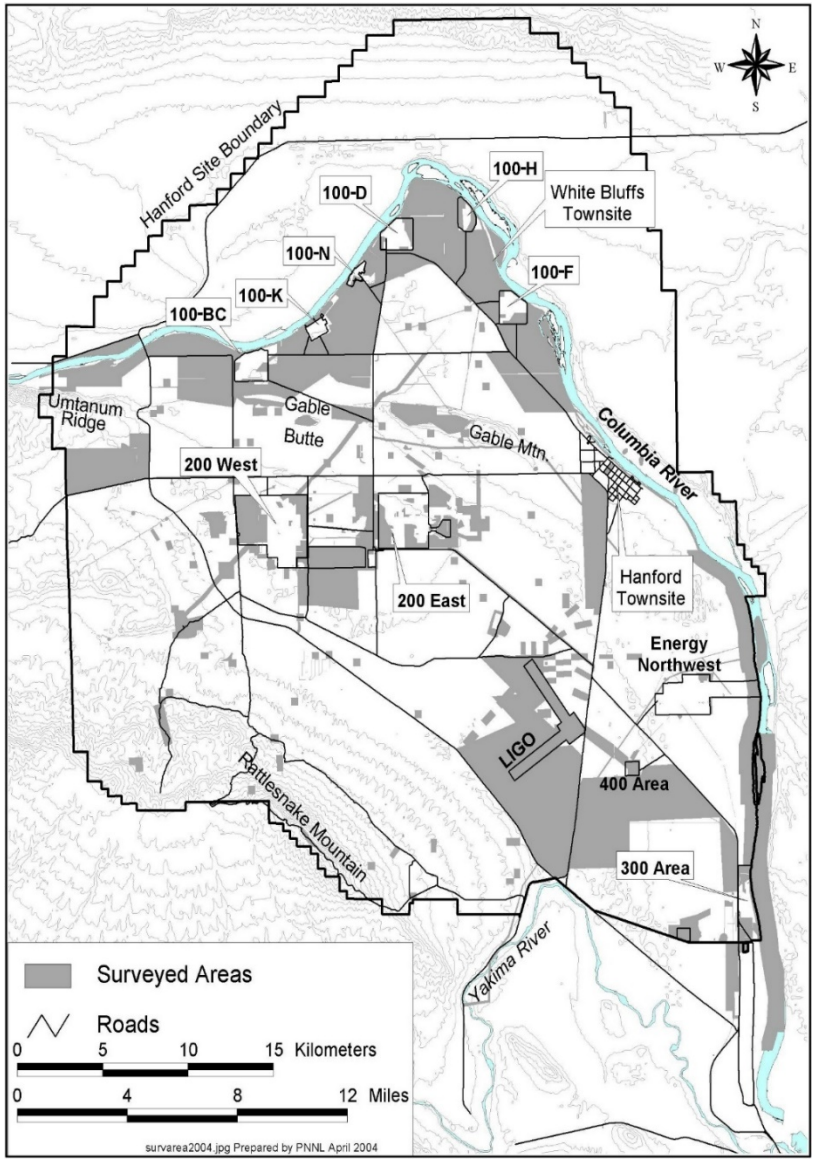
- Physical disruption
- Invasive species
- Consideration of multiple remediation options
- Consideration of role of contaminants

# Cultural Resources

- **Native American:** Pre-contact - 10,000 years to Present
- **Historic Pre-Hanford:** 1805 to 1943
- **Manhattan Project and Cold War Era:** 1943 to 1990

**Direct Impact**: resource is harmed or disturbed
**Indirect Impact**: visual or other impacts

***Unknown*** - uncertainty expressed (complete EU not evaluated; consultation may be necessary)
***Known*** - known cultural resources present
***None*** - mitigated, removed or none present



# Evaluating Risks *to* and *from* Groundwater

- Threats *to* Groundwater as a Protected Resource
  - Current groundwater contaminant plumes
  - Vadose Zone Contaminant Inventories
  - Tank wastes and other inventories in engineered systems

  ➢ ***Groundwater Threat Metric*** (GTM) - maximum volume of water that could be contaminated by the contaminant inventory if it was in the saturated zone at the water quality standard

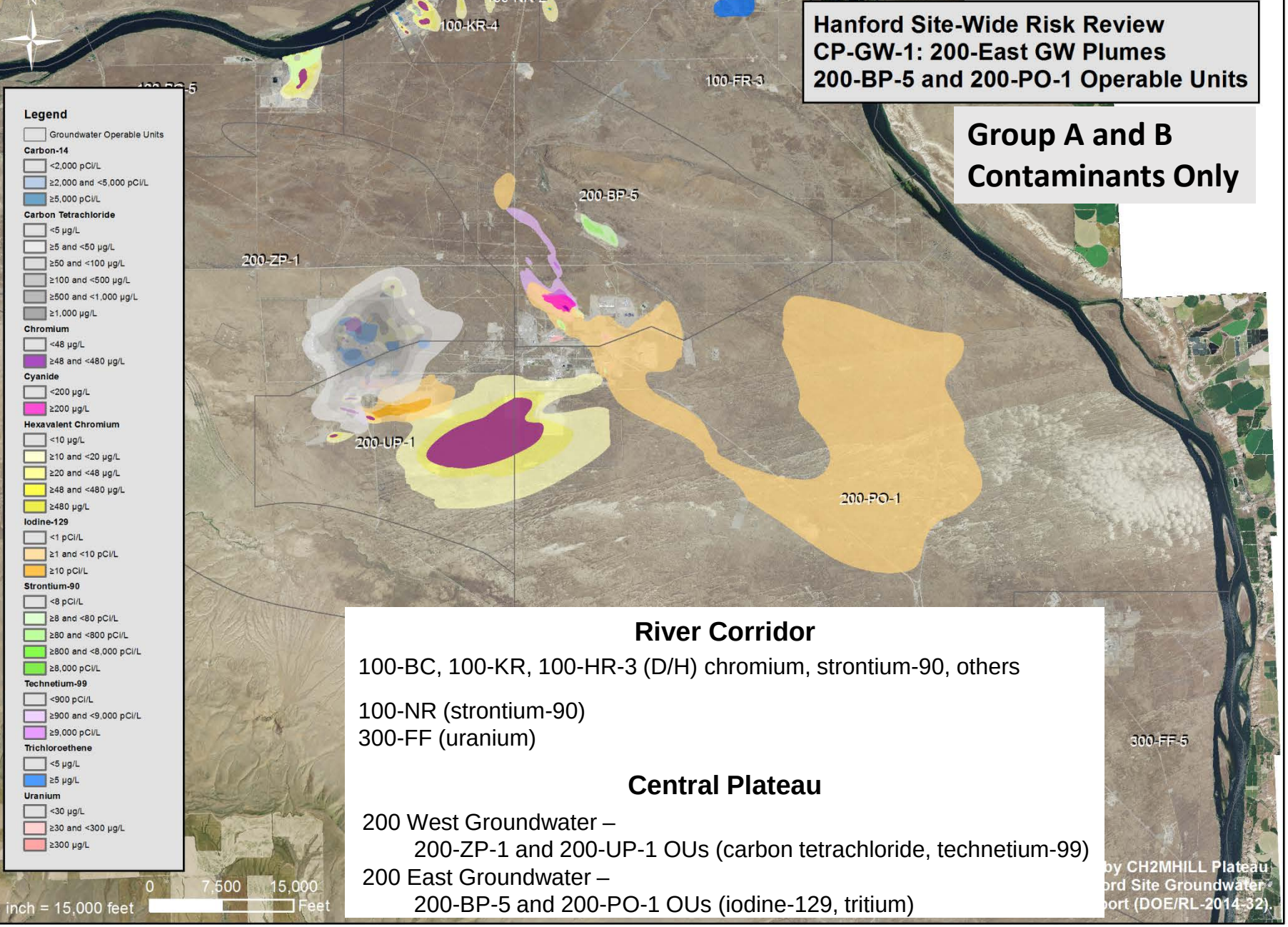
- Threats *from* Groundwater to the Columbia River
  - Riparian Zone – Impacted area & conc./threshold
  - Benthic Zone – Impacted river reach & conc./threshold
  - Free stream – Not discernable, dilution factor > 100 million

# Primary Contaminant Groups

| Persistence | Mobility* Low (R>500) | Mobility* Medium (5<R<500) | Mobility* High (R<5) |
|---|---|---|---|
| Low | | TPH-diesel | $^{3}H_2O$, $NO_3$ |
| Medium | Cs-137, Am-241 | Sr-90 | Cyanide, TCE |
| High | Pu, Eu, Ni (all isotopes) | $U^{(total)}$, $Cr^{(total)}$ | Tc-99, I-129, C-14, Cl-36, $Cr^{6+}$, Carbon Tetrachloride |

Group A Primary Contaminants
Group B Primary Contaminants
Group C Primary Contaminants
Group D Primary Contaminants

* Assume most mobile form of contaminant
R = retardation factor




## River Corridor

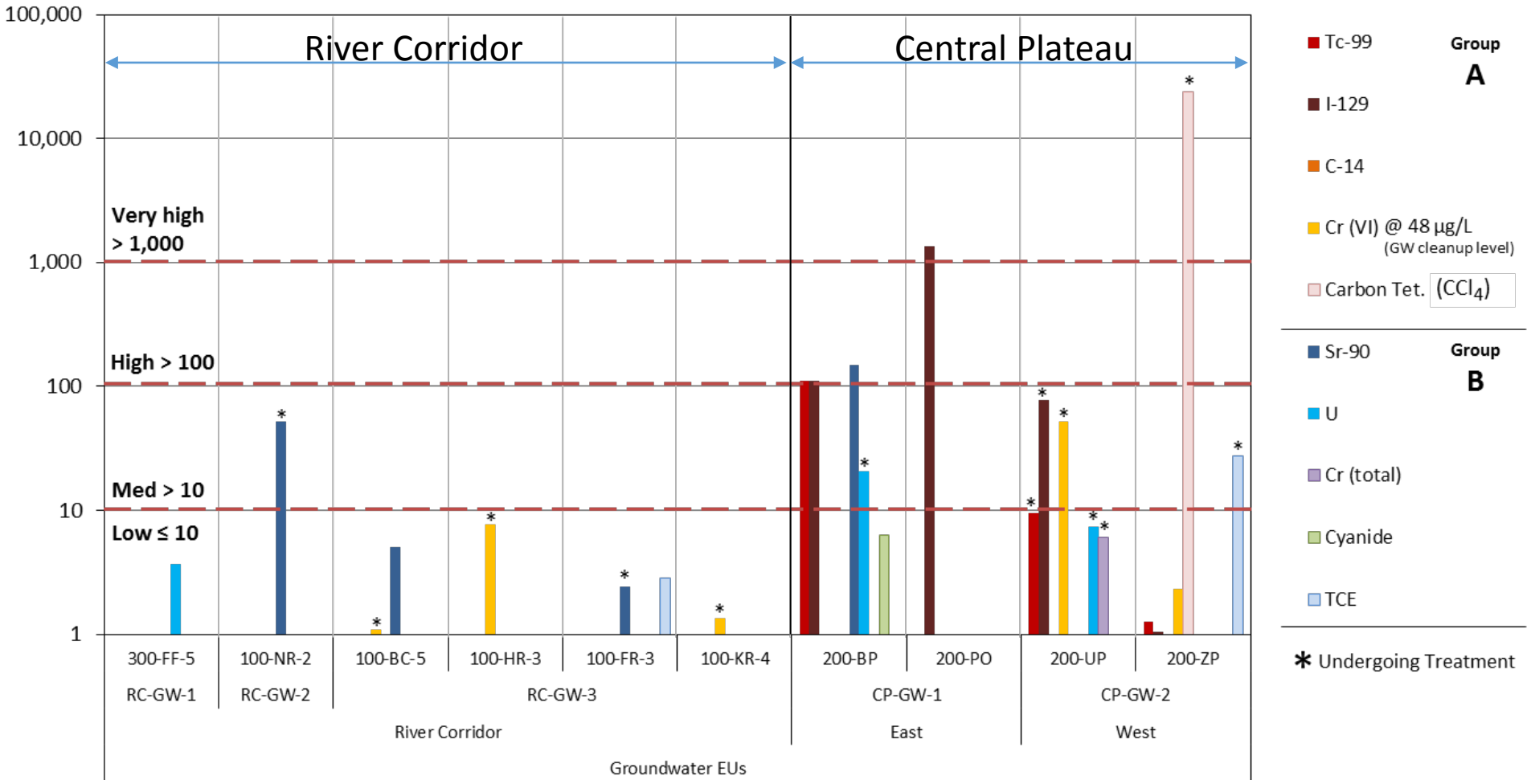
100-BC, 100-KR, 100-HR-3 (D/H) chromium, strontium-90, others

100-NR (strontium-90)
300-FF (uranium)

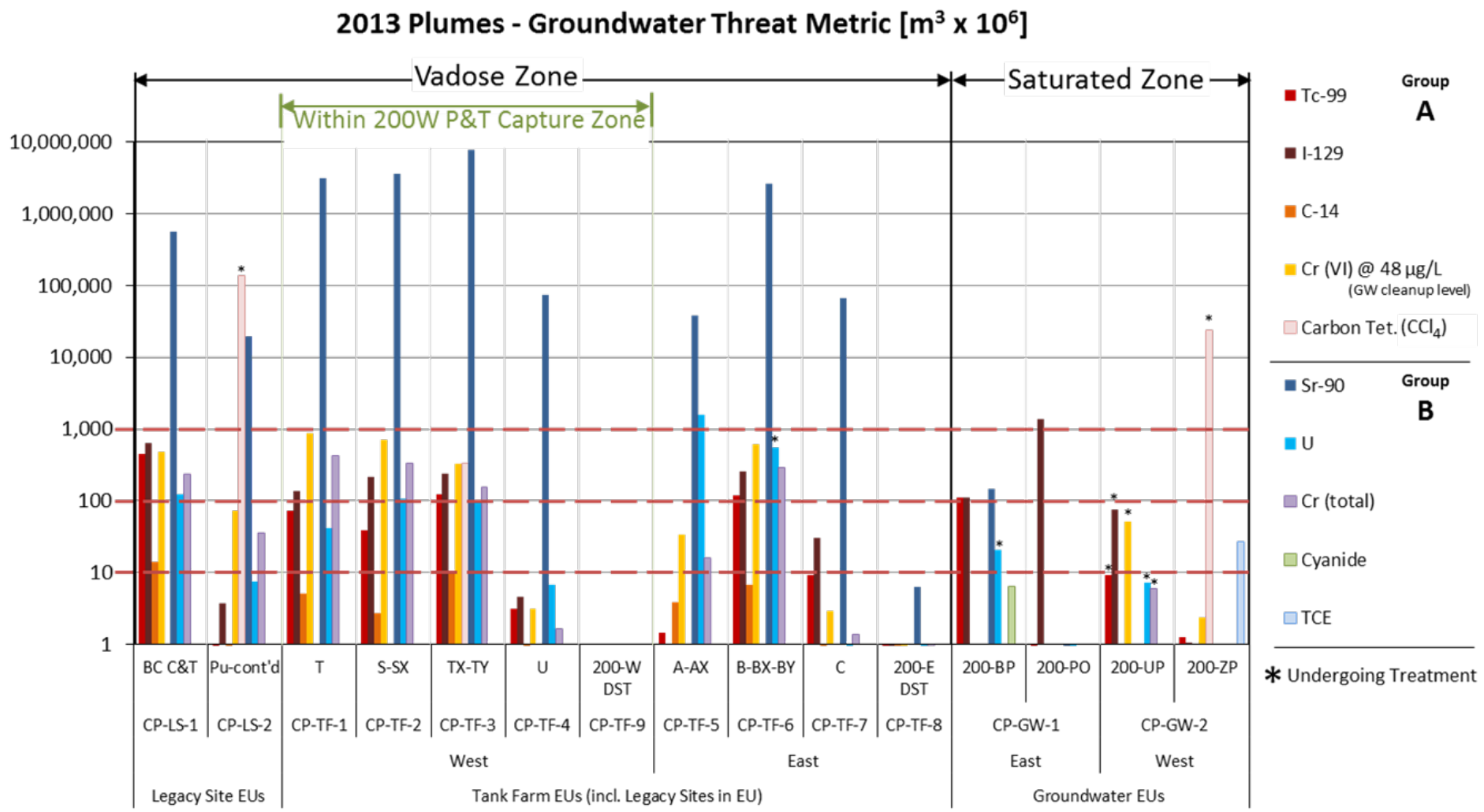
## Central Plateau

200 West Groundwater –
200-ZP-1 and 200-UP-1 OUs (carbon tetrachloride, technetium-99)
200 East Groundwater –
200-BP-5 and 200-PO-1 OUs (iodine-129, tritium)

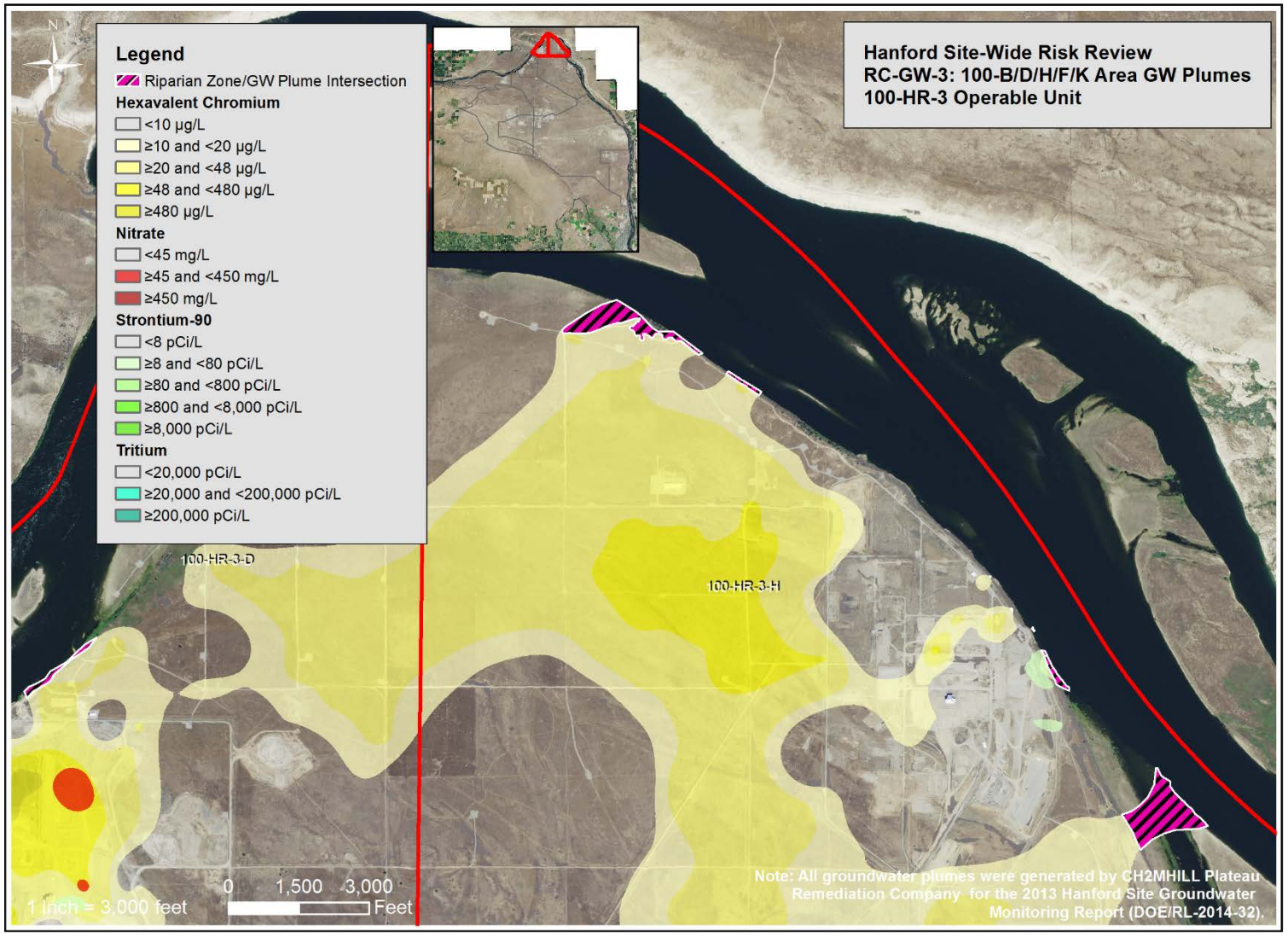
# 2013 Plumes – Saturated Zone Groundwater Threat Metric [$m^3 \times 10^6$]



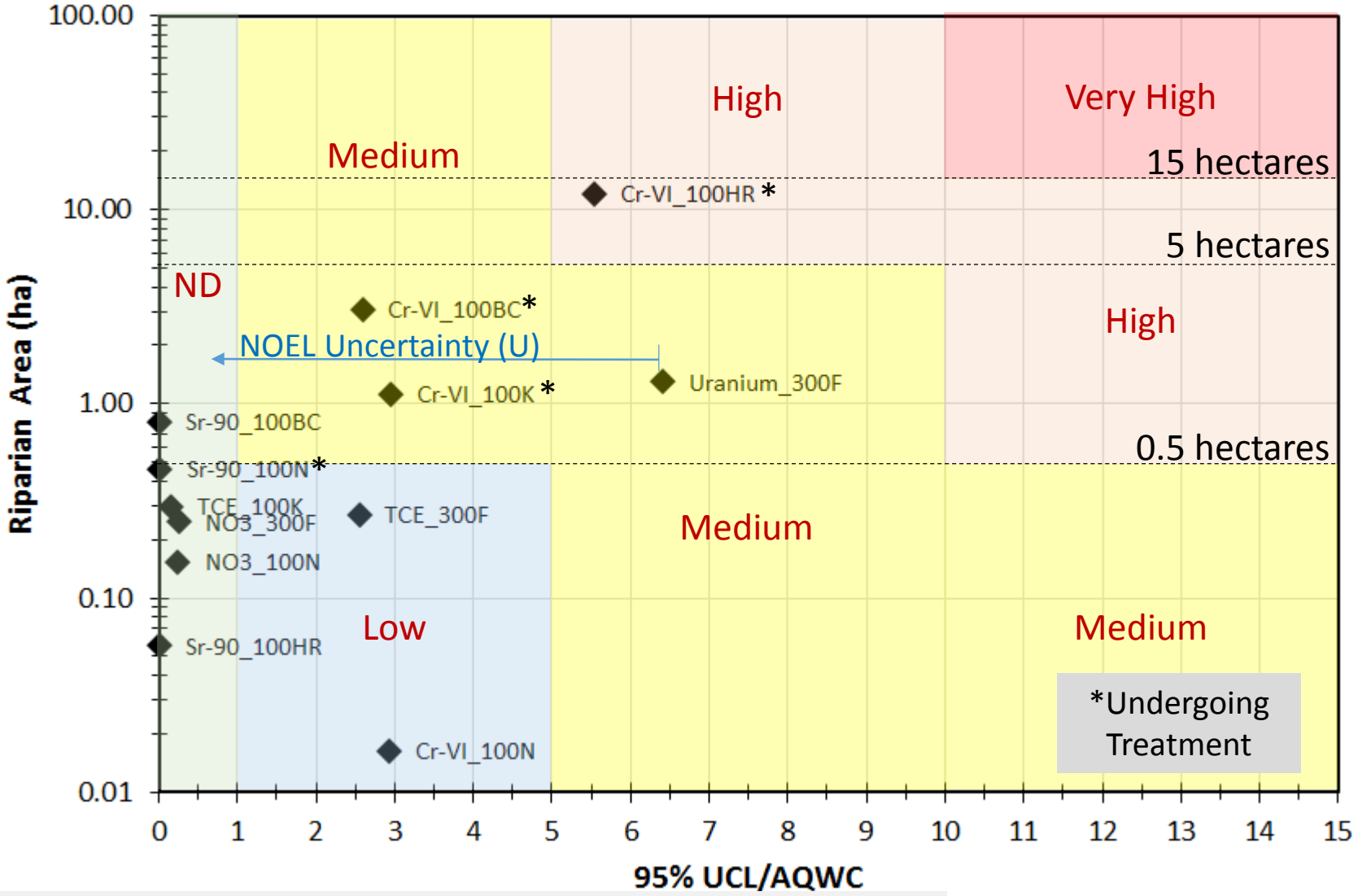
# 2013 Plumes – Vadose Zone & Saturated Zone Groundwater Threat Metric [$m^3 \times 10^6$]



# Threats to the Columbia River: Defining the Riparian Zone



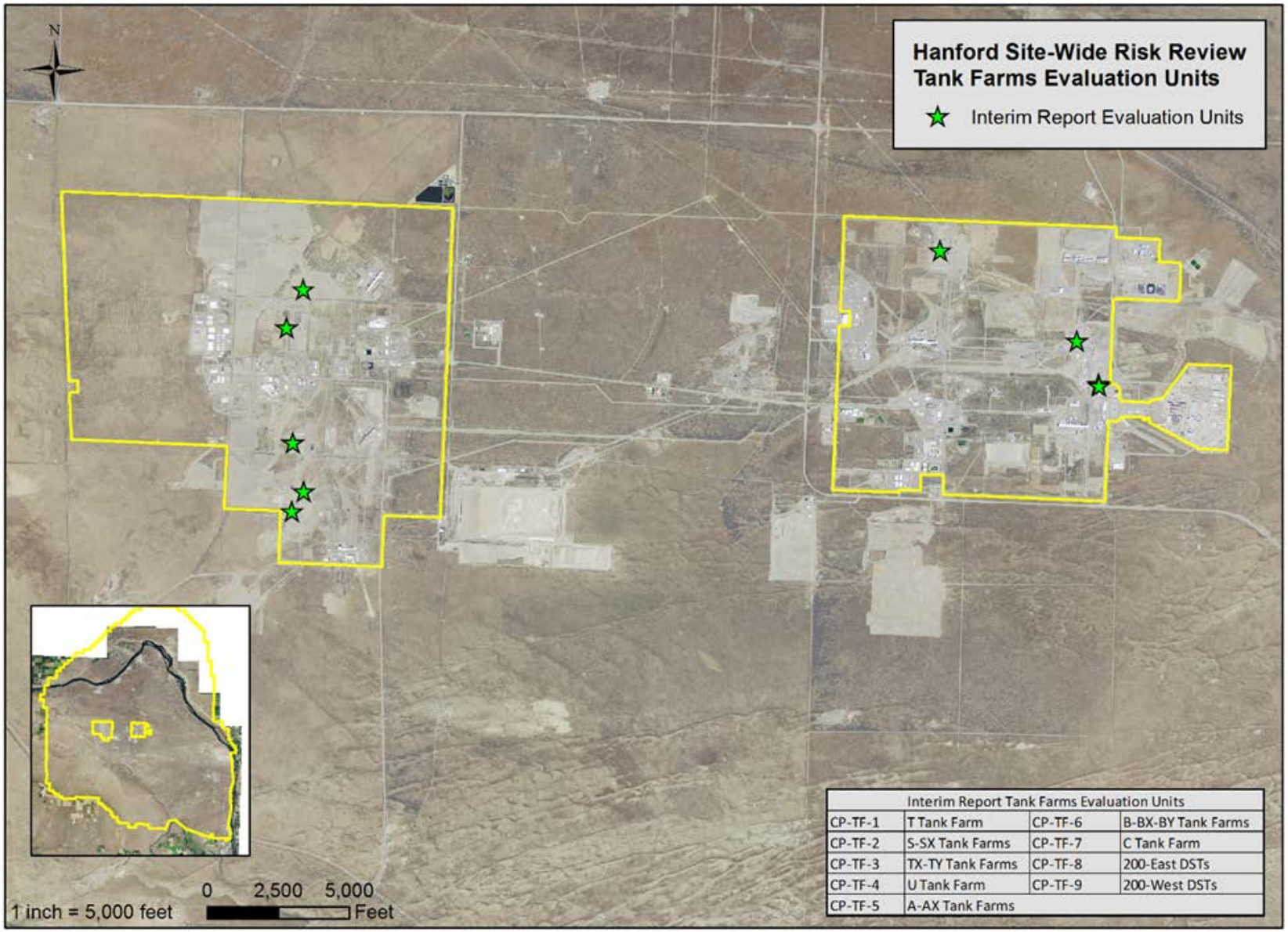
# Rating Groundwater Contaminant Threats to the Columbia River Riparian Zone




95% UCL – 95th percentile upper confidence limit on the log-mean plume concentration;
AQWC - Aquatic Life Ambient Water Quality Criterion

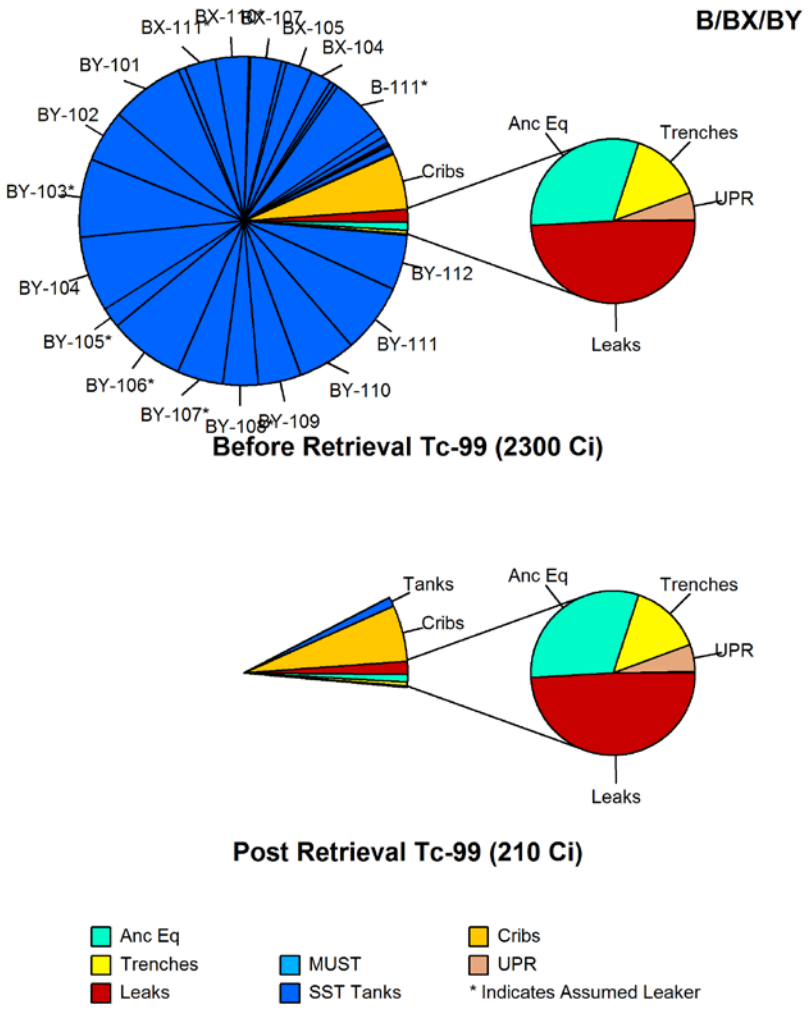
# Hanford Tank Farm Evaluation Units

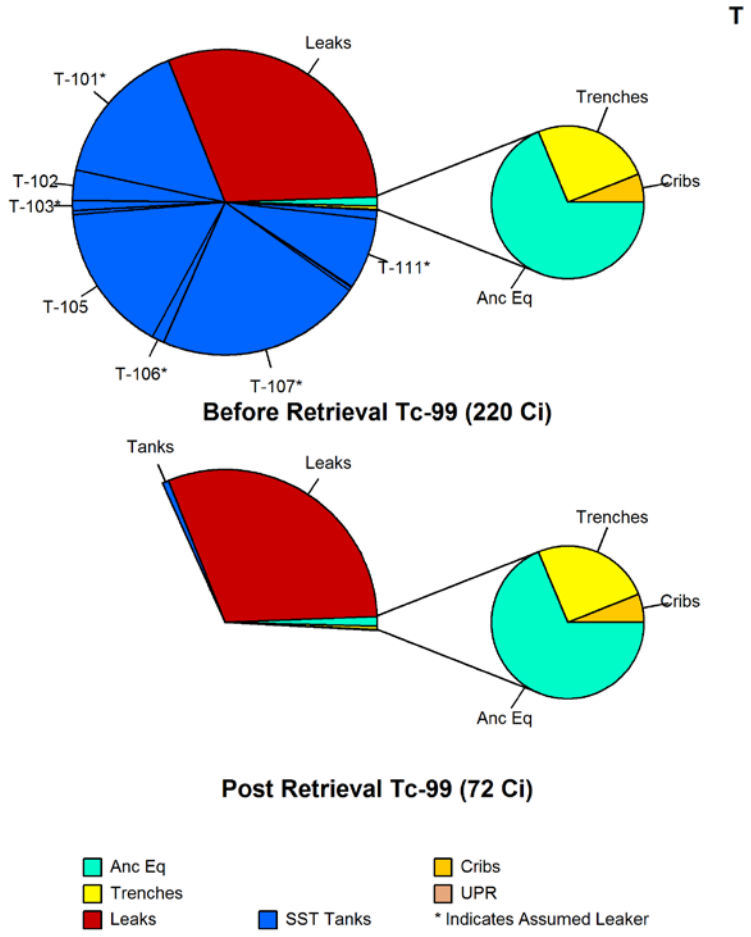
**Tank Farm EUs include tank wastes, ancillary equipment, unplanned releases and legacy waste sites**




| Interim Report Tank Farms Evaluation Units | | | |
|---|---|---|---|
| CP-TF-1 | T Tank Farm | CP-TF-6 | B-BX-BY Tank Farms |
| CP-TF-2 | S-SX Tank Farms | CP-TF-7 | C Tank Farm |
| CP-TF-3 | TX-TY Tank Farms | CP-TF-8 | 200-East DSTs |
| CP-TF-4 | U Tank Farm | CP-TF-9 | 200-West DSTs |
| CP-TF-5 | A-AX Tank Farms | | |

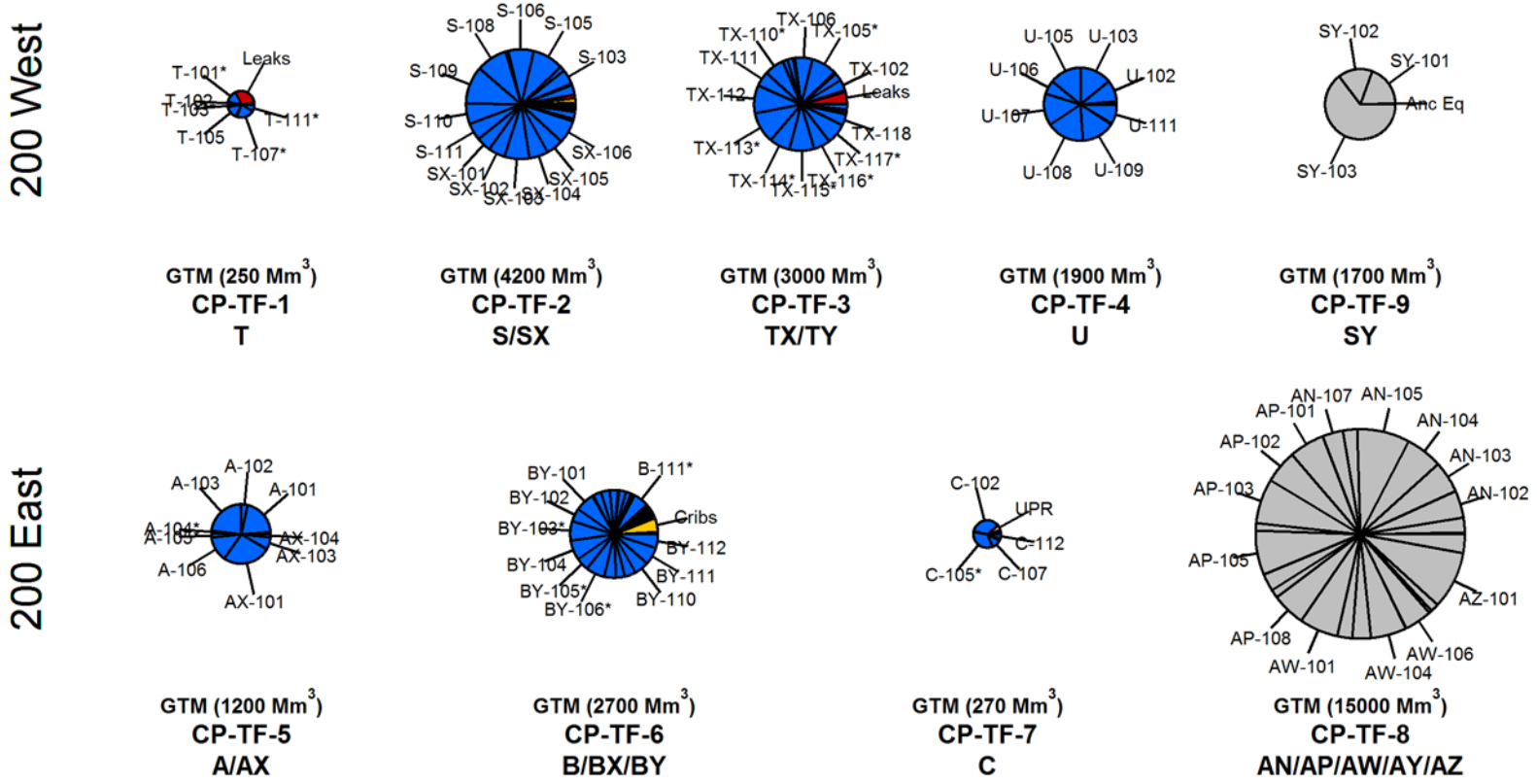
# Tc-99 Inventory – 2 Example Tank Farm EUs



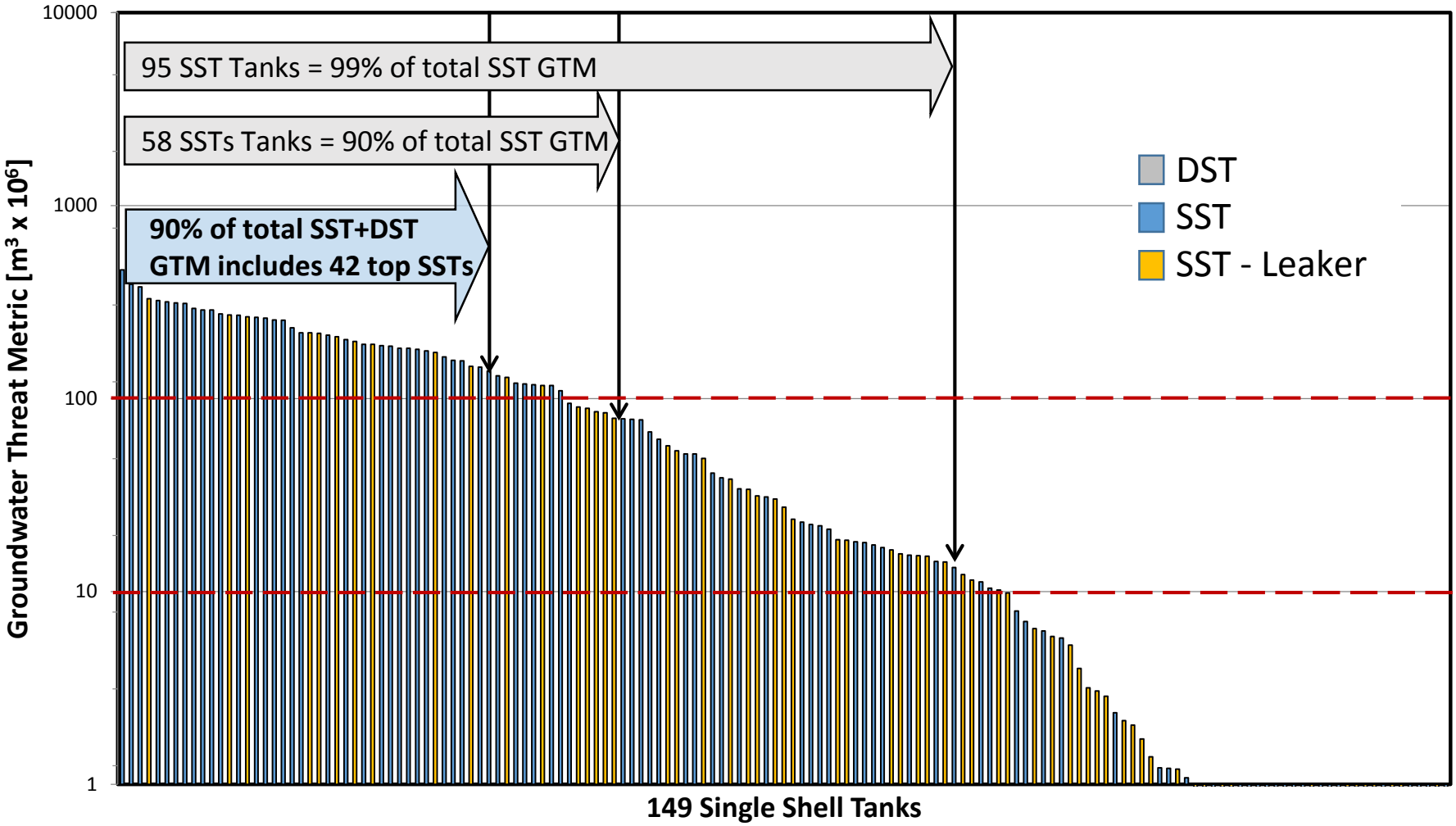
# Groundwater Threat Metric (GTM) – Tank Farms

## Max of Tc-99 and I-129 by EU, scaled by area relative to maximum GTM in EUs

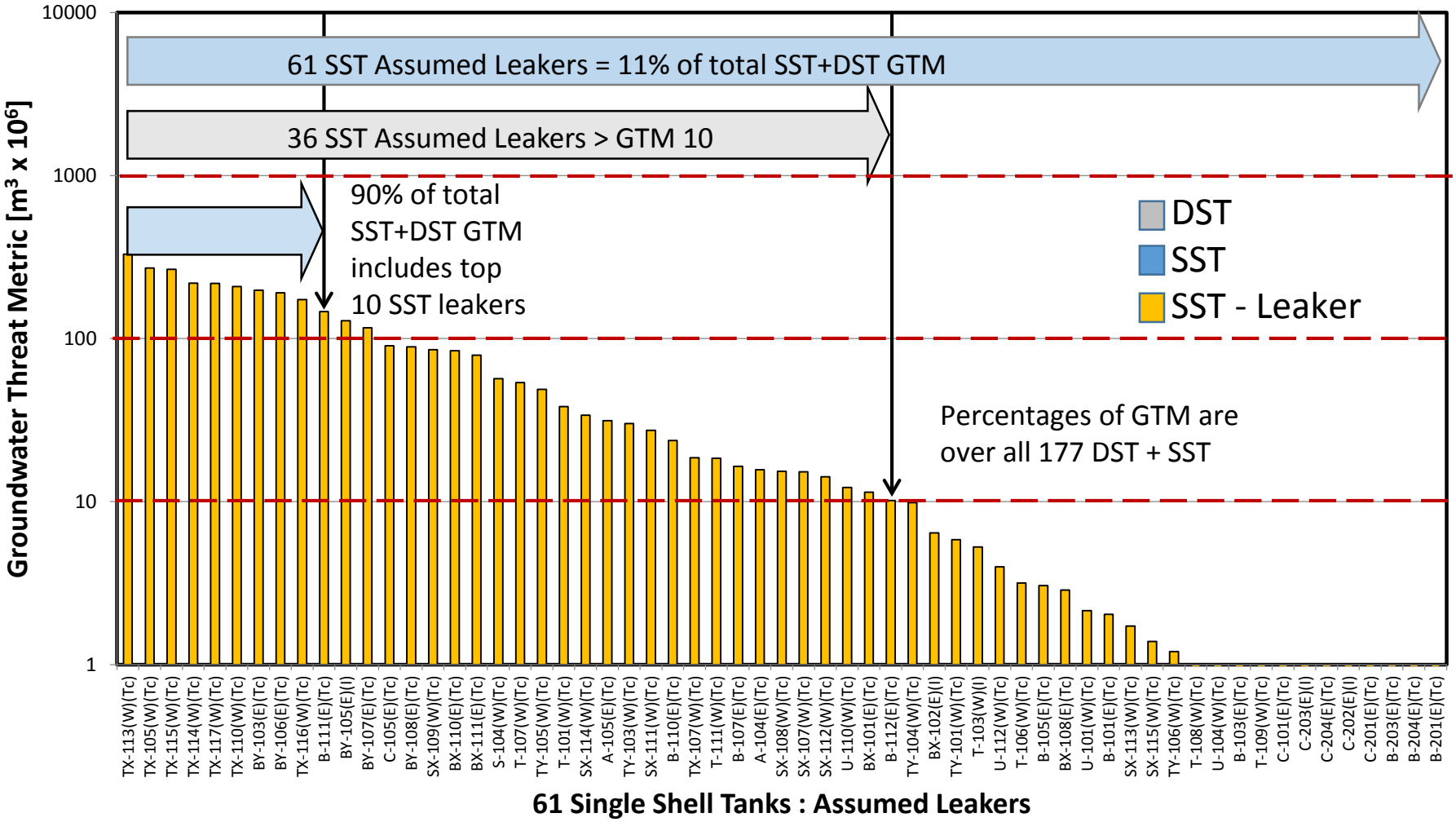



* Indicates SST assumed leaker

# Groundwater Threat – Which Single Shell Tanks are Important?



# Groundwater Threat – Which Assumed Leakers are Important?



# Interim Observations Informing Cleanup Sequencing

1. **Address Parts of Specific Evaluation Units Earlier.**

2. **Highest Priority Group Based on Evaluation of Potential Risks to Human Health and the Environment** (*not in any specific order, for EUs completed to-date*):

   A. **Reduction of threats posed by tank wastes.** Hydrogen gas generation, primarily related to Cs-137 and Sr-90 content of the waste, poses a threat to nuclear safety and human health through loss of tank integrity. Tank vapors may pose a threat to worker safety. Tc-99 and I-129, both being persistent and highly mobile in the subsurface pose threats to groundwater through leakage from tanks. This interim observation is consistent with the priority given by the agencies to treat low activity waste at WTP as early as possible ***if Cs-137, Tc-99 and I-129 separated from the waste are not returned to the tanks***. However, the risk profile will not be reduced significantly nor increased if Cs-137, Tc-99 and I-129 are returned to the tanks during LAW treatment.

   B. **Reduction or elimination of risks associated with external events and natural phenomena (severe seismic events, fires, loss of power for long duration).** Facilities affected are WESF (cesium and strontium capsules), Central Waste Complex, and PUREX waste storage tunnels.

   C. **Dependence on active controls (e.g., reliance on power, cooling water, active ventilation) to maintain safety for additional facilities with large inventories of radionuclides.** These conditions are (i) air handling ducts at WESF, and (ii) sludge at K-basins (sludge treatment project).

# Interim Observations Informing Cleanup Sequencing

**3. Cleanup Actions That Potentially May Cause Substantial Human Health Risks and therefore warrant consideration of interim actions and deferred cleanup:**

**A. Retrieval, treatment and disposal of contaminated soils underlying Building 324 and disposal of the building after grouting of the contaminated soils within the building.** Currently, no migration of soil contamination to groundwater has been indicated. As a result, approaches that allow for in-situ decay of the soil contaminants (Cs-137, Sr-90) warrant further consideration.

Interim risk mitigation measures should be considered (possible water main leaks, infiltration, monitoring)

**B. Retrieval, treatment and disposal of materials from 618-11 within caissons, vertical pipe units and burial grounds** because of the characteristics of wastes (high activity, pyrophoric, poorly characterized) to be retrieved. The close proximity to the Columbia Northwest Generating Station and its workforce jeopardizes continued operations and worker safety in the event of a fire and/or release from 618-11. The current cover over the buried wastes, except the caissons and vertical pipe units, is effective in limiting water infiltration to the wastes where the cover is present. This set of conditions warrants consideration of instituting interim mitigation measures and delaying waste retrieval until closure of the generating station.

# Interim Observations Informing Cleanup Sequencing

4. **Groundwater Threats.** Many of the threats and current impacts to groundwater are being interdicted and/or treated. The greatest threats and impacts to groundwater that are not currently being addressed are from:

   A. **Groundwater Plumes Not Currently Being Actively Addressed.** Tc-99 and I-129 already in groundwater in 200 East Area (200-BP-5; EU CP-GW-1). The 200-BP-5 I-129 plume extends to the southeast (200-PO-1; EU CP-GW-1) but may be too dispersed for effective remediation other than natural attenuation.

   B. **Vadose Zone Threats to Groundwater Not Currently Being Addressed.** Tc-99, I-129 and Cr(VI) in the vadose zone associated with BC Cribs and Trenches (EU CP-LS-1) and the legacy sites associated with B-BX-BY Tank Farms (EU CP-TF-6), both located in the 200 East Area. Infiltration control, such as capping, as well as other approaches, may be effective in reducing the flux of these contaminants from the vadose zone into groundwater. Uranium currently is being extracted from perched water in B-Complex.

   C. **At 324 Building Relatively Modest Actions Could Reduce Threat.** At 324 building, the largest risk for migration of Cs-137 and Sr-90 from the soils is from breakage of a main water pipe and infiltration of precipitation and runoff in close vicinity of the building. This risk may be mitigated through water supply modifications, infiltration controls, and additional groundwater monitoring.

   D. **At 618-11 Waste Site Relatively Modest Actions Could Reduce Threat**. At 618-11, the potential for release of additional contaminants to groundwater can be mitigated by providing a cover that prevents infiltration but maintains gas venting over the caissons and vertical pipe units (currently gravel covered area).

# Additional General Observations

- Currently, members of the public, whether located at the official Hanford Site boundary or at the controlled access boundary (River and Highways) usually have low to not-discernible risks, even if postulated radioactive contaminant releases are realized.
  - The potential impact of the Manhattan Project National Historical Park is unknown.
- Timing of cleanup of a specific EU **may reduce** worker risk (radioactive decay) **or may increase worker risk** (facility deterioration, trained workforce availability, repetitive or chronic exposures due to maintenance, potential for complacency)
  - Worker risk varies with respect to the nature of hazards, complexity, duration of project, technical approaches and controls or mitigation measures in-place to insure worker health and safety.
  - DOE and its contractors have accident rates approximately 2/3 less than comparable non-DOE work. On-going vigilance is needed to maintain this excellent record.

# QUESTIONS ?

CRESP WEBSITE:  www.cresp.org/hanford