The Hanford Site-Wide Risk Review Project

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CRESP

Consortium For Risk Evaluation with Stakeholder Participation

December 11, 2014

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

Hanford Risk Review Project Goal

- **To carry out a screening process to inform future cleanup sequencing at Hanford.**
  - Synthesizes information from diverse sources to characterize hazards (i.e. contained contaminant inventories, physical chemical forms) and existing environmental contamination which may result in contaminant travel along multiple pathways to create receptor exposure or impact (risk).
  - Risks are considered in the context of the current status, during cleanup activities and after cleanup activities. Includes taking into account current barriers to dispersion, the mechanisms of barrier failures, and the likelihood and magnitude of adverse consequences.
  - Receptors evaluated are the public, workers, groundwater and the Columbia River, and ecological and cultural resources (collectively referred to as “receptors”) at the Hanford Site.

Specific Objectives and Scope

Specific Objectives:

1. To review hazards and existing environmental contamination site-wide and determine the potential for contaminants and 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, in order to better enable the Tri-Parties (DOE, EPA, State of Washington) to make decisions on the sequencing of Hanford cleanup activities; and,
3. To provide context for understanding how the hazards, existing environmental contamination, current risks and risks posed by cleanup at the Hanford Site compare to existing risks and impacts posed by similar cleanup activities conducted at non-DOE sites located either on-site or nearby, as well as at other non-DOE, large-scale regional sites.

Scope: "to go" cleanup and waste management activities as of FY 2016

What the Risk Review Project *is not* *(1/2)*

- **The Risk Review Project is neither intended to substitute for, nor preempt any requirement imposed under applicable federal or state environmental laws**. And, as important, the Risk Review Project is not intended to make or replace any decision made under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) and/or the 2010 Consent Order.
- **The Risk Review is focused only on portions of the Hanford Site where cleanup or waste management activities are ongoing or where cleanup or waste management activities will occur beginning October 1, 2015 or later.** Cleanup actions considered completed by the Tri-Parties are not part of the Risk Review Project and therefore will not be evaluated.

What the Risk Review Project *is not* *(2/2)*

- **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.** Nonetheless, cleanup actions can cause risks to receptors, which are a part of risk management decisions. The Risk Review Project, however, will not analyze which cleanup option should be selected or the timing of cleanup. Instead, the Risk Review Project considers a plausible range of cleanup actions for different types of contaminant sources 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.** 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.

General Approach (1/2)

- Divide site into Evaluation Units (EUs) that are groupings of hazards & existing environmental contamination
  - Templates used for information gathering, presentation and evaluation
- Develop methodology for evaluating receptors (Public, Workers, Groundwater & Columbia River, Ecological Resources, Cultural Resources)
  - Pilot methodology using 6 preliminary Evaluation Units
  - Risk ratings *within* receptor categories of very high, high, medium, low, not discernible
  - Solicit broad input on Methodology; Refine methodology where appropriate

General Approach (2/2)

- Provide responses to comments received
- Interim Report with 25 Evaluation Units (EUs)
  - Solicit broad input on Interim Report
- Final Report with complete set of evaluation units and comparative analysis
  - Solicit broad input on Draft Final Report
- Core Team provides input and guidance throughout the process
  - Washington Depts. of Ecology and Health, EPA, DOE-RL, DOE-ORP, DOE-EM, CRESP leadership, PNNL liaison
- CRESP issues Final Report

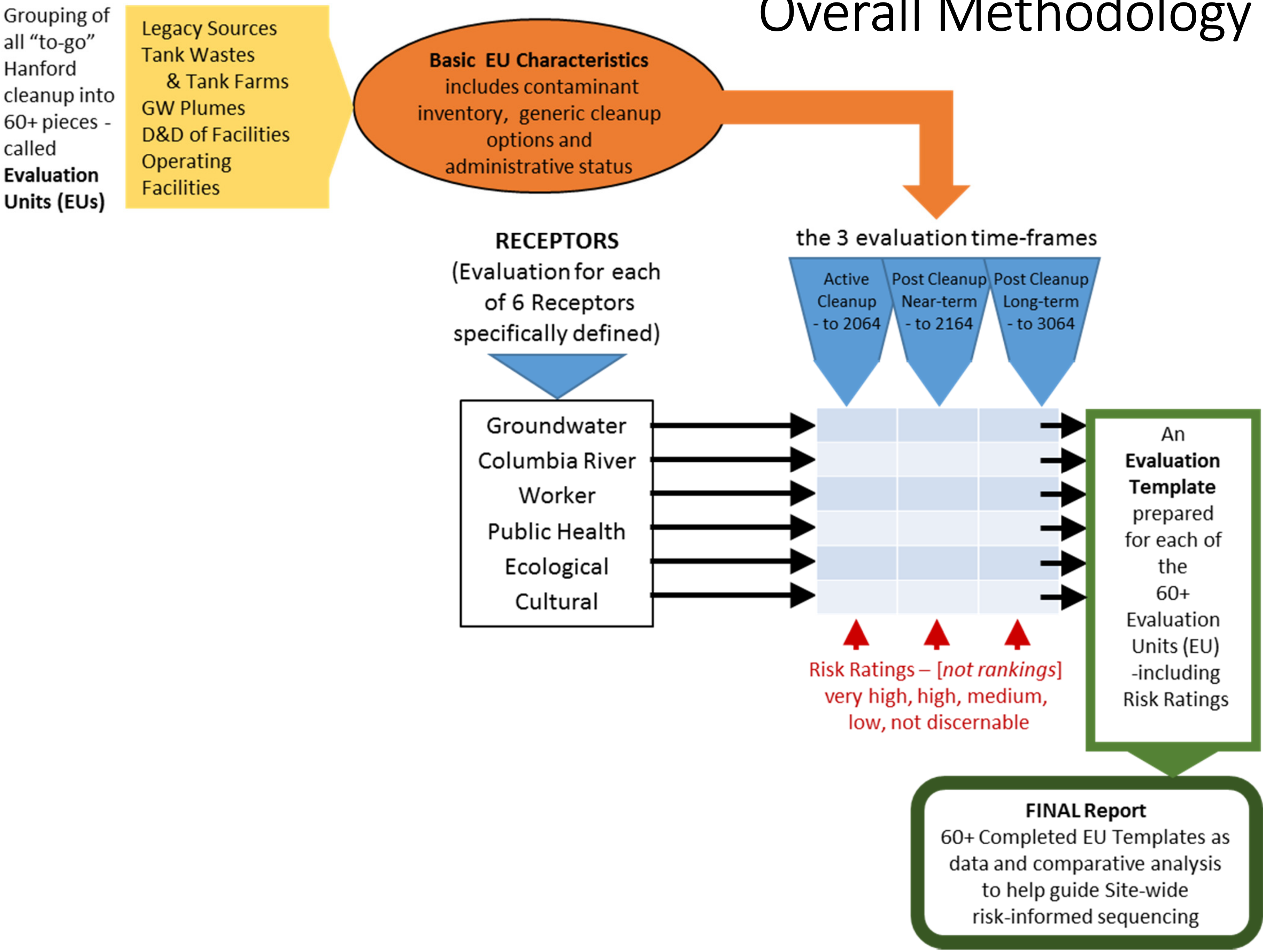
Terminology and Messaging

- “Risk-Informed Screening Process to assist with cleanup sequencing”
- “Hazards (i.e. contained contaminant inventories, physical chemical forms) and existing environmental contamination”
- “Contaminant travel along multiple pathways to create receptor exposure or impact (risk)”
- “Barriers to contaminant release/dispersion include engineered, natural, operational and institutional components”

Evaluation Time Frames in the Risk Review Project

Active Cleanup To 50 years (year 2064)	**Near-Term Post-Cleanup** To 100 years past end of Active Cleanup (year 2164)	**Long-Term Post-Cleanup** From 100 to 1,000 years past end of Active Cleanup (year 3064)
A. Risks from current condition for up to 50 years. No-Action scenario. Impact of delay in cleanup. “Need for Action”.	**C. Risks from completion of the potential range of cleanup actions that achieve defined endpoints.** Institutional controls assumed to remain effective up to 100 years after transfer of land from federal control.	**D. Risks from completion of the potential range of cleanup actions that achieve defined endpoints.** Residual inventories and risk pathways. Institutional controls may no longer be effective.
B. Risks from conducting *potential range of remediation actions*. Includes increased impacts to workers, ecosystems, cultural resources, and potential for accidental releases.		

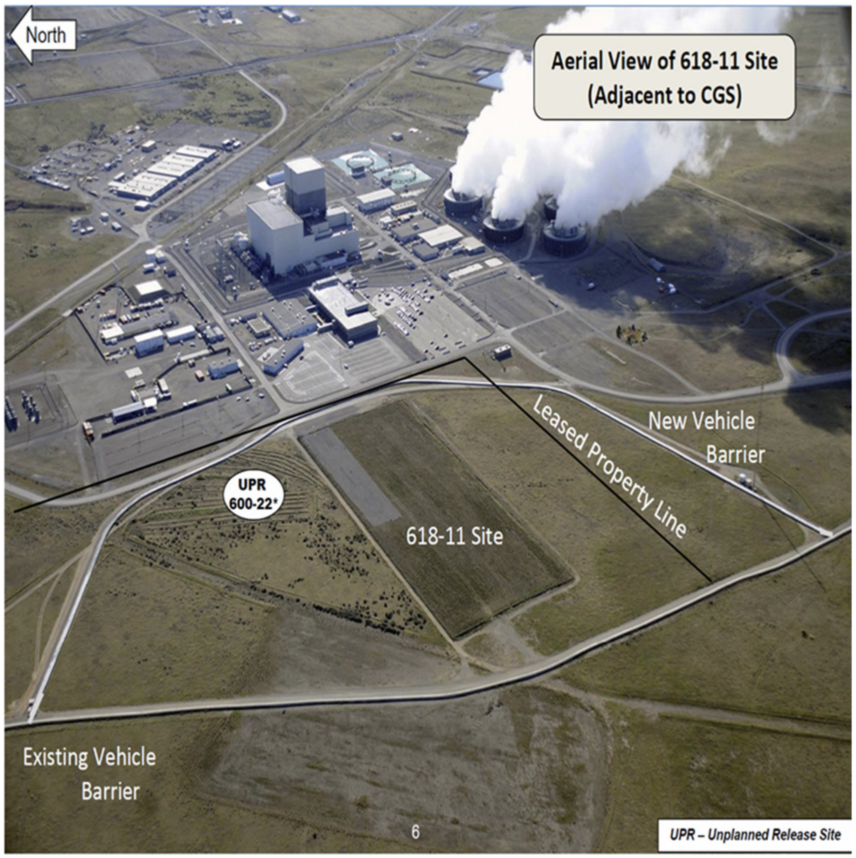
Overall Methodology



Evaluation Unit Categories

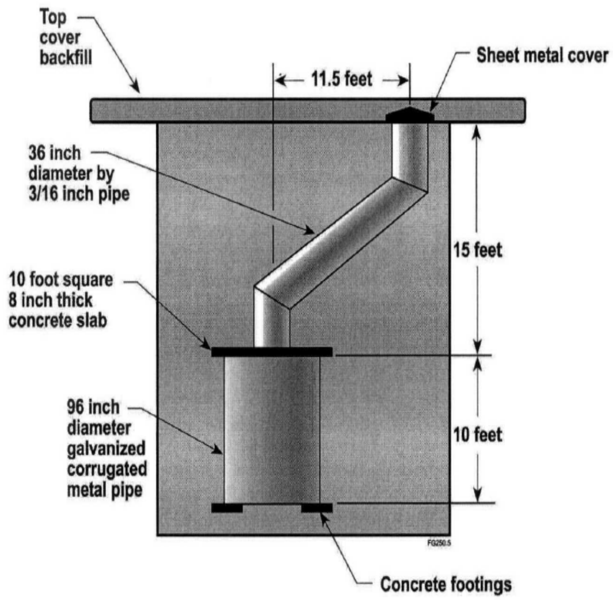
Legacy Source Sites	Tank Wastes & Tank Farms	Groundwater Plumes	D&D of Inactive Facilities	Operating Facilities
• Past practice liquid waste disposal sites • Buried solid waste sites • Unplanned releases • Underground piping and infrastructure • Near surface and vadose zone contaminated sediments	• Single-shell and double-shell high-level waste tanks • Related legacy waste sites (e.g., cribs, unplanned releases) • Near surface and vadose zone contaminated sediments	• Existing groundwater plumes (> MCLs) • Aligned with groundwater operable units • Includes pump & treat operations • Potential contributing sources handled in other EUs	• Major processing complexes or key facilities with a common history of operations • Near surface and vadose zone contaminated sediments	• Solid Waste Facilities • Liquid Waste Facilities • Supporting Facilities

618-11 Near Surface Burial Site



- Adjacent to Energy Northwest nuclear power generating station
- Estimated Inventory:
  4,200 Ci Sr-90 5,300 Ci Cs-137
  226 Ci Am-241 132 Ci Pu-239
  639 Ci Pu-241 330 kg Beryllium
- 3 Trenches, 50 vertical pipe units, 4-6 caissons
- Poorly characterized fissile & pyrophoric materials, tritium targets, high dose rate wastes
- Tritium & nitrate plume estimated to attenuate to below drinking water standard prior to reaching Columbia River
- Greatest risks during cleanup actions

Figure 2-5. A 618-11 Site Caisson.



CP-14592 Rev. 0

Figure 2-3. A 618-10 and 618-11 Site Vertical Pipe Unit.

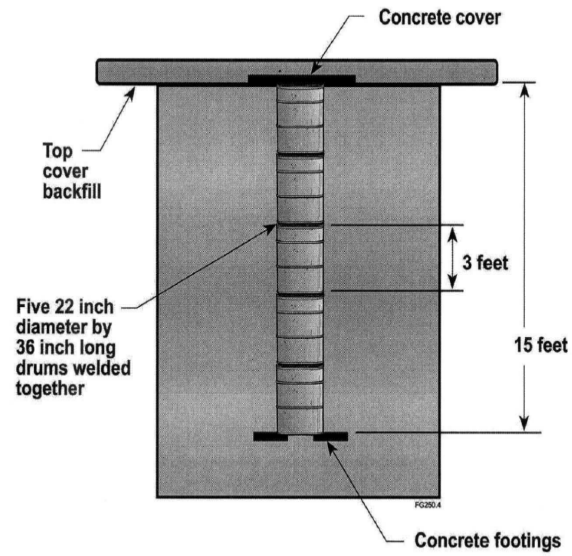


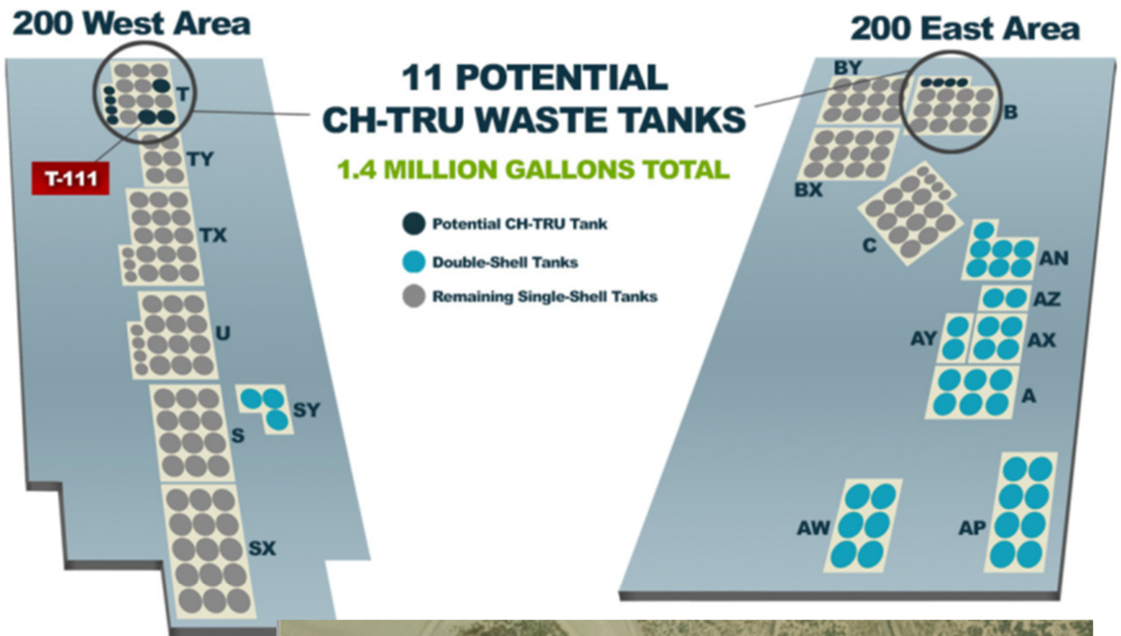
Figure 2-19: Covering and Driving Over Filled Trench

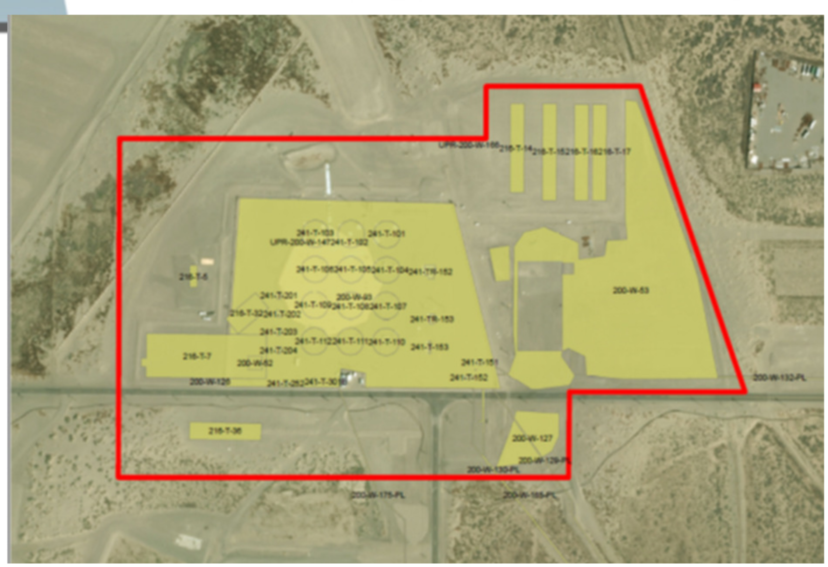
2-31

HNF-EP-0649, Rev. 0

- Vertical pipe units - five 55 gallon drums welded together
- Caissons 8 ft diameter pipe with chute offset to limit radiation shine
- Trenches received varied waste packages

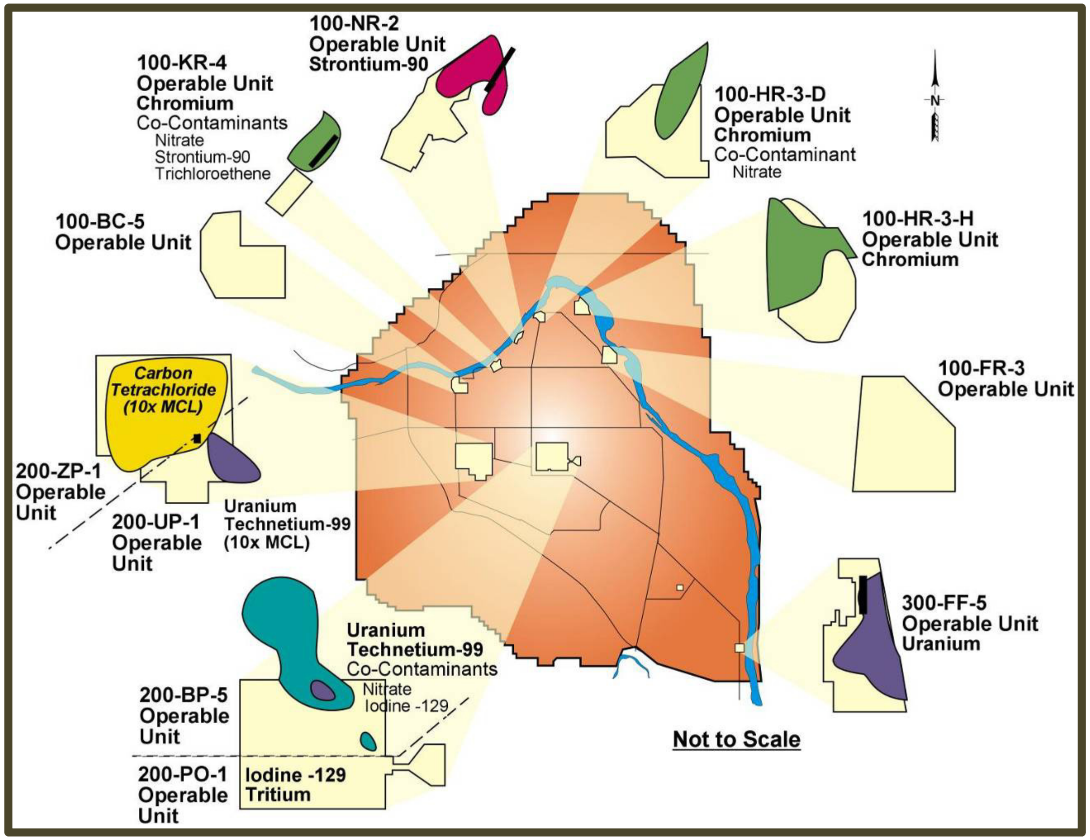
T Tank Farm Evaluation Unit





- 16 high-level waste (HLW) tanks, ancillary structures, associated liquid waste sites, and soils contamination (cribs, trenches, graves, unplanned releases)
- Cr, I-129, Tc-99, nitrate vadose zone contamination and groundwater plumes

Groundwater Plumes



River Corridor

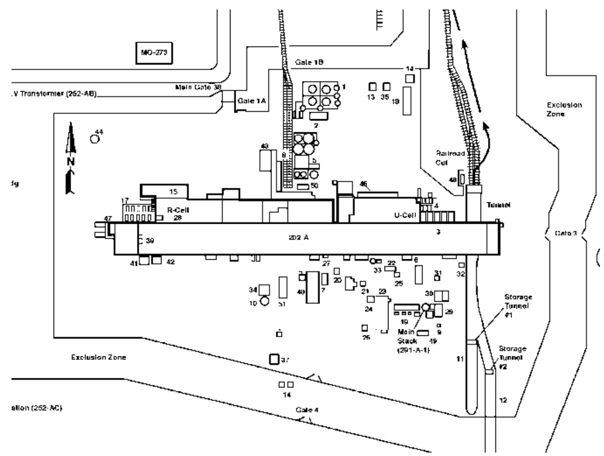
100-BC, 100-KR, 100-HR-3 (D&H)
primarily chromium
100-NR (strontium-90)
300-FF (uranium)

Central Plateau

200 West Groundwater
(200-ZP-1 and 200-UP-1)
200 East Groundwater
(200-BP-5 and 200-PO-1)

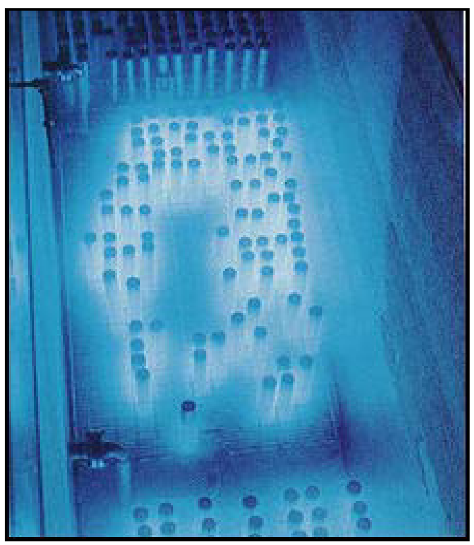
CP-DD-1: Plutonium-Uranium Extraction (PUREX)

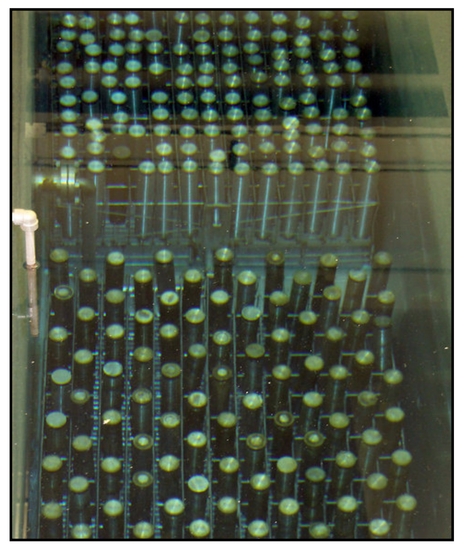
- Constructed between 1953 and 1955 and operated until 1990 to chemically separate plutonium, uranium and neptunium from Hanford Site nuclear reactor fuel elements. Nearly 70% of Hanford's uranium was reprocessed through PUREX.
- Two adjacent rail tunnels constructed to dispose of surplus radioactive materials beginning in 1960, such as failed or outworn equipment.
- 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. RI/FS Work Plan scheduled to be submitted by DOE in September 2015.



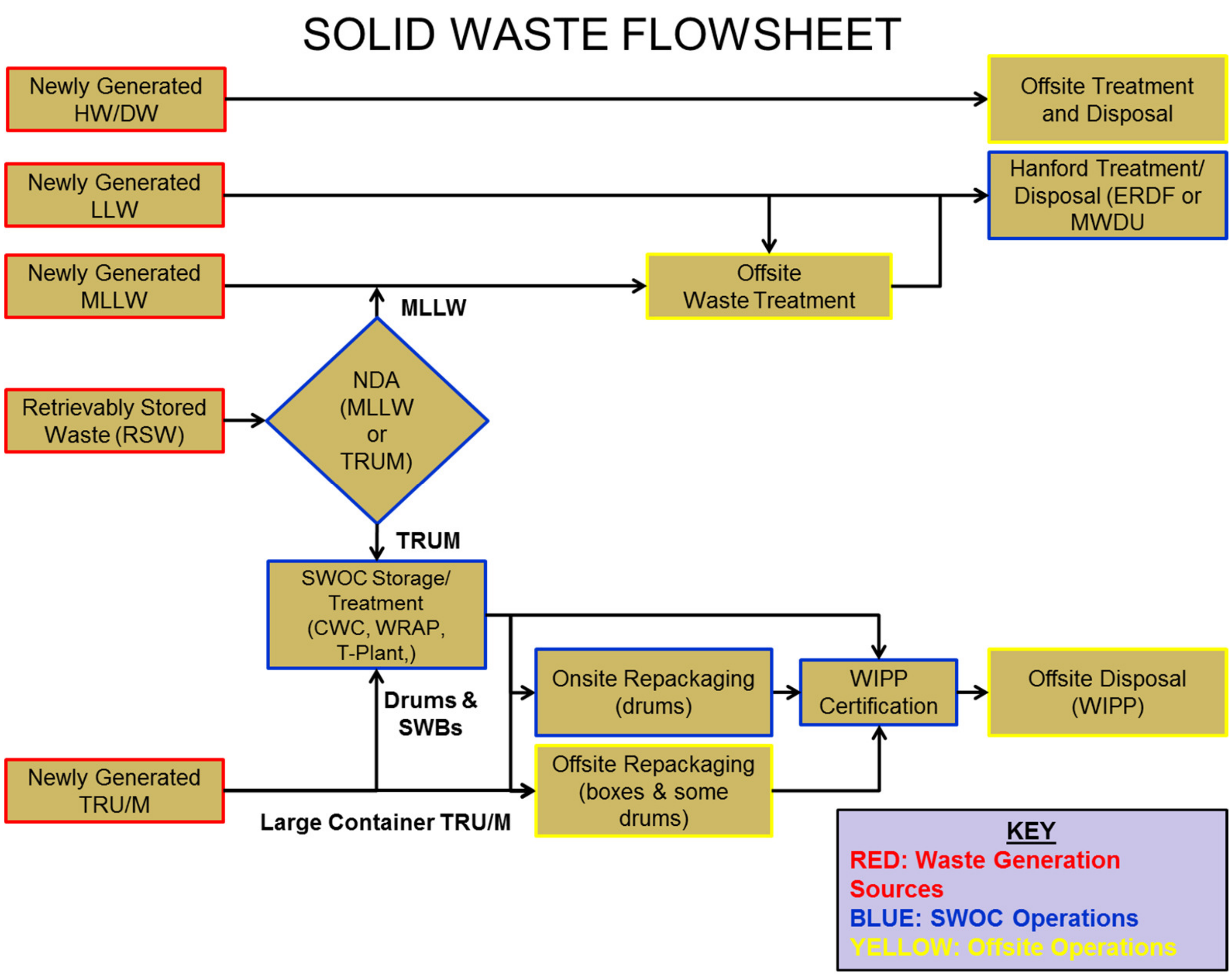
CP-OP-3, Waste Encapsulation and Storage Facility (WESF)

- Current Operation: Safe storage of Cs/Sr capsules
- Phase 1 Building Upgrades: Grout hot cells, subsurface ventilation ductwork, K-3 HEPA filters
- Phase 2 Capsule Transfer to Dry Storage: Transfer Cs/Sr capsules into dry storage containers and place onto a concrete pad nearby WESF facility (Exact Location TBD)
- Present Typical Operations Include:
  - Active monitoring, inspection, testing, inventorying , and cooling of capsules in pool cells
  - Building maintenance





Operating Facilities – Solid Waste Operations



TRU, hazardous and mixed waste operations

- Buried waste retrieval operation
- WRAP
- Central Waste Complex
- T Plant (operations)

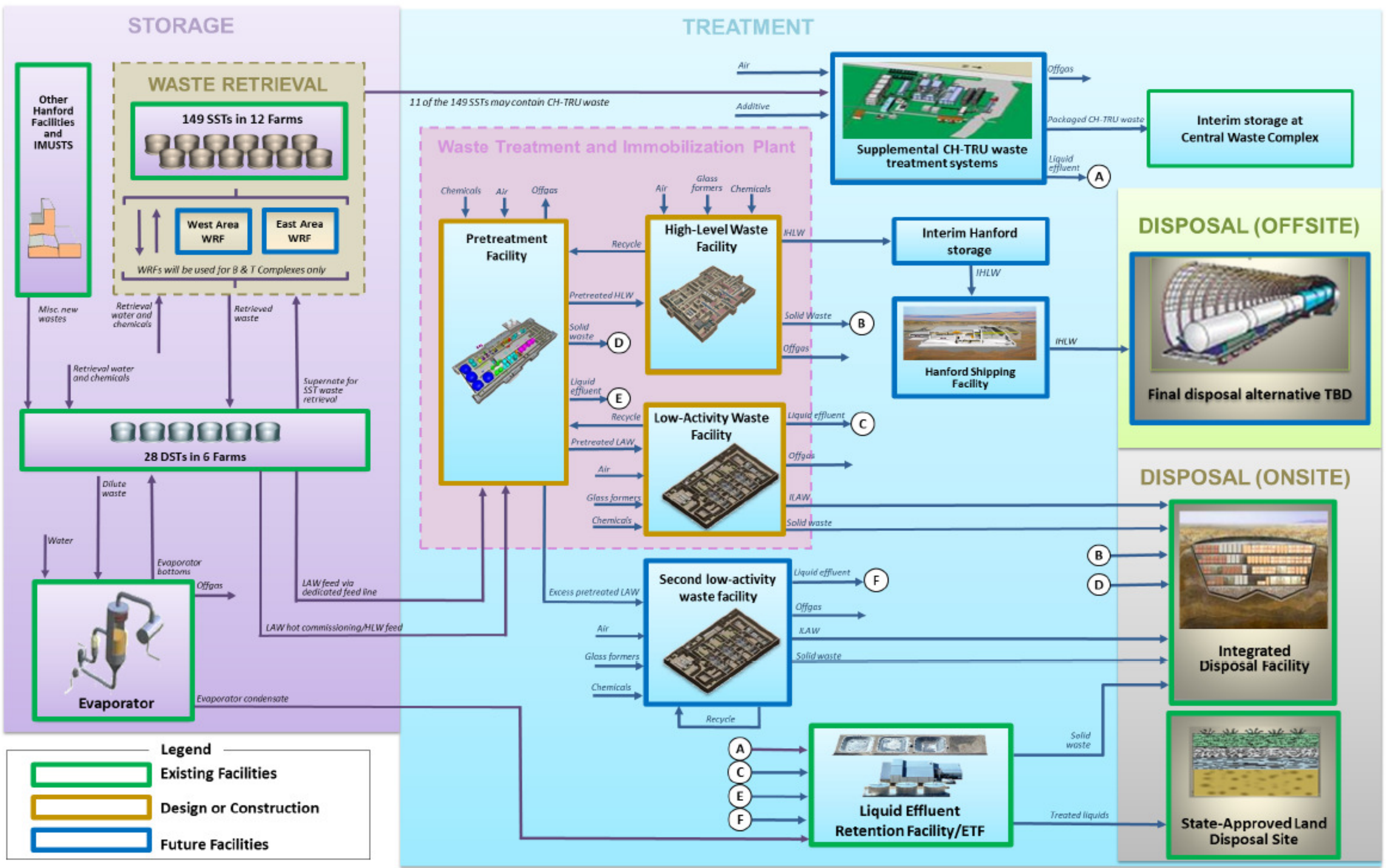
Storage of fuel and nuclear materials

- Canister Storage Building (with ISA)
- WESF and Capsules

LLW and MLLW disposal facility operations

- Mixed waste disposal trenches (31 &34)
- ERDF
- IDF (future)
- Naval Reactor Compartment Disposal Trench
- US Ecology Low-Level Waste Disposal Facility

Operating Facilities – Liquid Waste Operations



Liquid Waste Treatment and Disposal Facilities

- Evaporators
- LERF & ETF (including upgrades for WTP effluents)
- TEDF
- SALDS
- WTP (Future)

TEMPLATES FOR EVALUATION UNITS

- Executive Summary
- Administrative information
- Summary description
- Unit description and history
- Waste and contamination inventory
- Potential risk/impact pathways and events
- Risk and potential impacts rating
- Supplemental information and considerations

324 building

Human Health

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

Specific population groups defined & used:

I. Facility workers – within defined EU facility's boundary based on DSA

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

III. Controlled Access within the site boundary
   i. General population (e.g., for B-reactor, educational activities)
   ii. Tribal uses for cultural activities

IV. Public - Uncontrolled access, present at the site boundary for controlled access

Types of Events Leading to Potential Human Health Exposures

Type I: Acute events, disasters of natural or non-natural origin (quakes, fires, collapses, etc.) resulting in release of radiologic or chemical hazards, may extend to 'co-located' population at 100 m or beyond, even to Hanford site boundary.

- Analyzed in DSA or Hazard Assessment with regard to probability and consequence
- Preventive or mitigation measures included in DSA

Type II: Radiologic or chemical exposure to site-specific hazards. Usually detected and prevented by radiation protection and/or industrial hygiene practices under DOE Integrated Safety Management program.

Type III: Industrial type accidents (slips, trips, falls, struck-by, vehicular, equipment). Analyzed as part of DSA if there is major radiologic or chemical release potential. Otherwise prevented by industrial safety under DOE Integrated Safety Management program.

Initiating Events Methodology (1/2)

- Approach – Provide a standardized method which:
  - Provides a basis for assigning the likelihood of an Initiating Event resulting in the loss or degradation of barriers.
  - Provides guidance for assigning impacts (consequences) due to the loss of barrier based on the event being considered.

Initiating Events Methodology (2/2)

Hierarchy of Information:

- EU-specific
  - DSA
  - Preliminary DSA
  - Hazards Analysis
- Analogous Information from Hanford Site
- Analogous Information from other DOE Sites

➢ **Critical infrastructure is assumed to be maintained**

- Supports operations and emergency response
- Assumption treated as an uncertainty

Nuclear Hazard Categories

Category 1 Hazard: The Hazard Analysis shows the potential for significant off-site consequences.

Category 2 Hazard: The Hazard Analysis shows the potential for significant on-site consequences.

Category 3 Hazard: The Hazard Analysis shows the potential for only significant localized consequences.

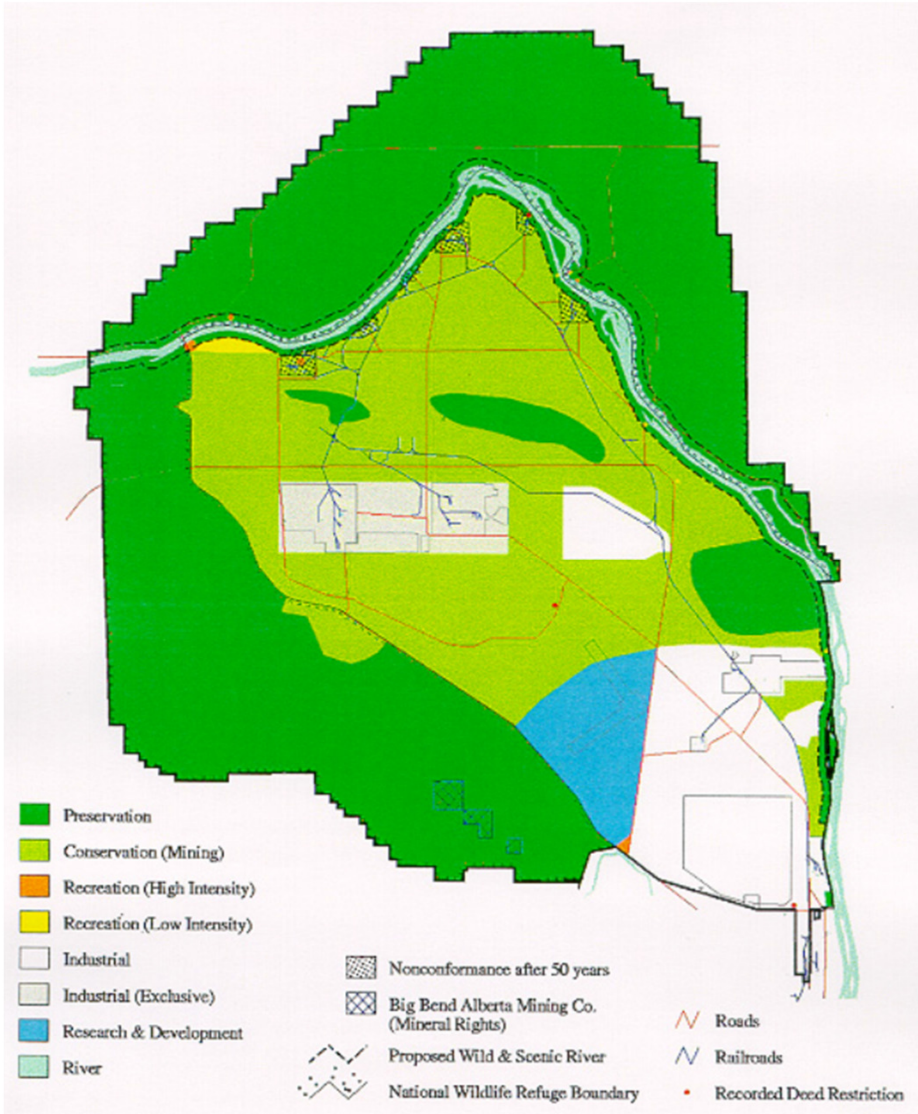
- Assignment of Nuclear Hazard Categories is part of the Documented Safety Analysis (DSA) process

Public Health

- Groundwater evaluated separately from land use
  - Groundwater considered protected resource by State of WA
  - Screening threshold is applicable drinking water standard (aquatic standards may be more stringent with respect to riparian zone and benthic organisms)
  - Groundwater use can (and often is) managed separately from land use
- Current status & during cleanup
  - Controlled access limits potential public health risks to workers not affiliated with DOE mission and “stealth intruder”
  - Precluded or impaired land use should not be confused with current health risk
  - Controlled access for specific purposes (tribal practices and limited uses for general population)
- Post-Cleanup status
  - Comprehensive Land Use EIS and ROD (CLUP) to serve as basis for future use exposure scenarios, however…
  - Lack of exposure scenario definitions tied to CLUP land use designation largely renders CLUP mute with respect to remediation standards and leads to confusion; WA recognizes only Industrial and unrestricted use exposure scenarios
  - Stealth intruder & stealth farmer (failure of institutional controls)

FUTURE LAND USE DESIGNATIONS FROM THE CLUP

(DOE/EIS-0222-F, Figure 3.3)



Worker Risk

- Types of worker risk
  1. Worker exposure to site-specific radiologic or chemical hazards – Acute
  2. Worker exposure to site-specific radiologic or chemical hazards – Sub-acute
  3. Accidents and injury unrelated to site-specific contamination (identified here as “industrial accidents”)
- DOE and its contractors have accident rates approximately 2/3 less than comparable non-DOE work
- Worker risk varies with respect nature of hazards, complexity and duration of project
- 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, complacency)

Worker Risk

- Risk rating structure based on *Safety Analysis and Risk Assessment Handbook* (DOE 2012)
  - Unmitigated dose to co-located people considered a metric of hazard
  - Mitigation measures also considered as part of evaluation
- Evaluations consider current status, during cleanup activities, near-term post-cleanup (i.e., surveillance and maintenance)
- Primary risks during cleanup activities or operations
  - Hazard Assessments and Documented Safety Analyses for the EU or analogous units/experience
  - First of a kind activities considered higher risk

Human Health - Co-located People and Public
Current Status and During Active Remediation Period

Co-located People and Public:

- Type I events: may reach > 100 m from facility
- Type II & III events: no impact ≥ 100 m from facility

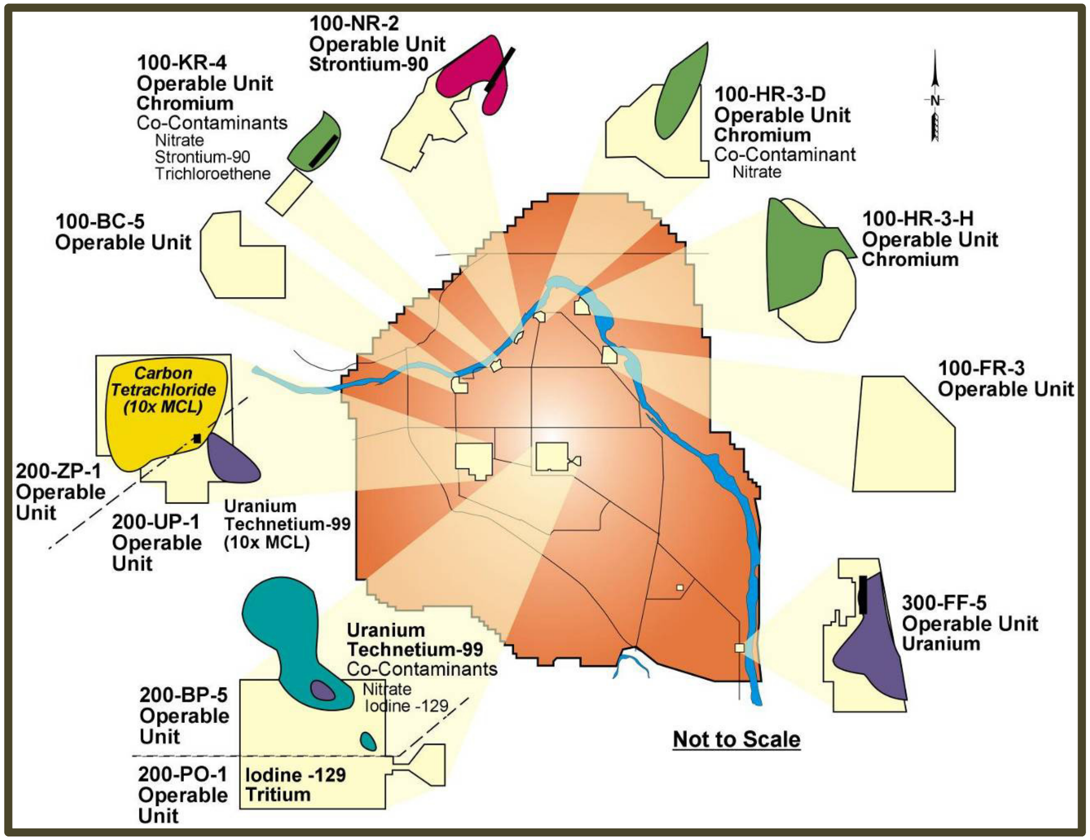
Controlled Access:

- Limits on geographic area and activities consistent with risk mitigation plans

Public:

- No uncontrolled access to 200 Area
- Possible proximity to River Corridor facilities
- No uncontrolled use of groundwater

Groundwater Plumes



River Corridor

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Central Plateau

200 West Groundwater
(200-ZP-1 and 200-UP-1)
200 East Groundwater
(200-BP-5 and 200-PO-1)

Methodology Context

- 1.7+ trillion gallons of liquid waste (including radionuclides and hazardous chemicals) discharged into the ground at Hanford
  - ~80 mi^2 above drinking water standards for chemicals (NO_3, Cr, total U, carbon tetrachloride) and radionuclides (U isotopes, Tc-99, H-3, Sr-90, I-129)
  - Contamination poses risk to GW (*as resource*) and River (*as pathway*)
  - Subsurface, recharge, and water movement are complex
  - Contaminants in sources, held in vadose zone; some have reached GW, and some have reached the River via the GW pathway
  - Work is actively underway to stop or reduce further contamination
  - Groundwater and Columbia River are being monitored
- DOE and contractors perform the cleanup work
  - Washington State Ecology and EPA oversee GW cleanup at Hanford Site
  - The three agencies work through a cooperative agreement (Tri-Party Agreement) that sets deadlines and cleanup targets

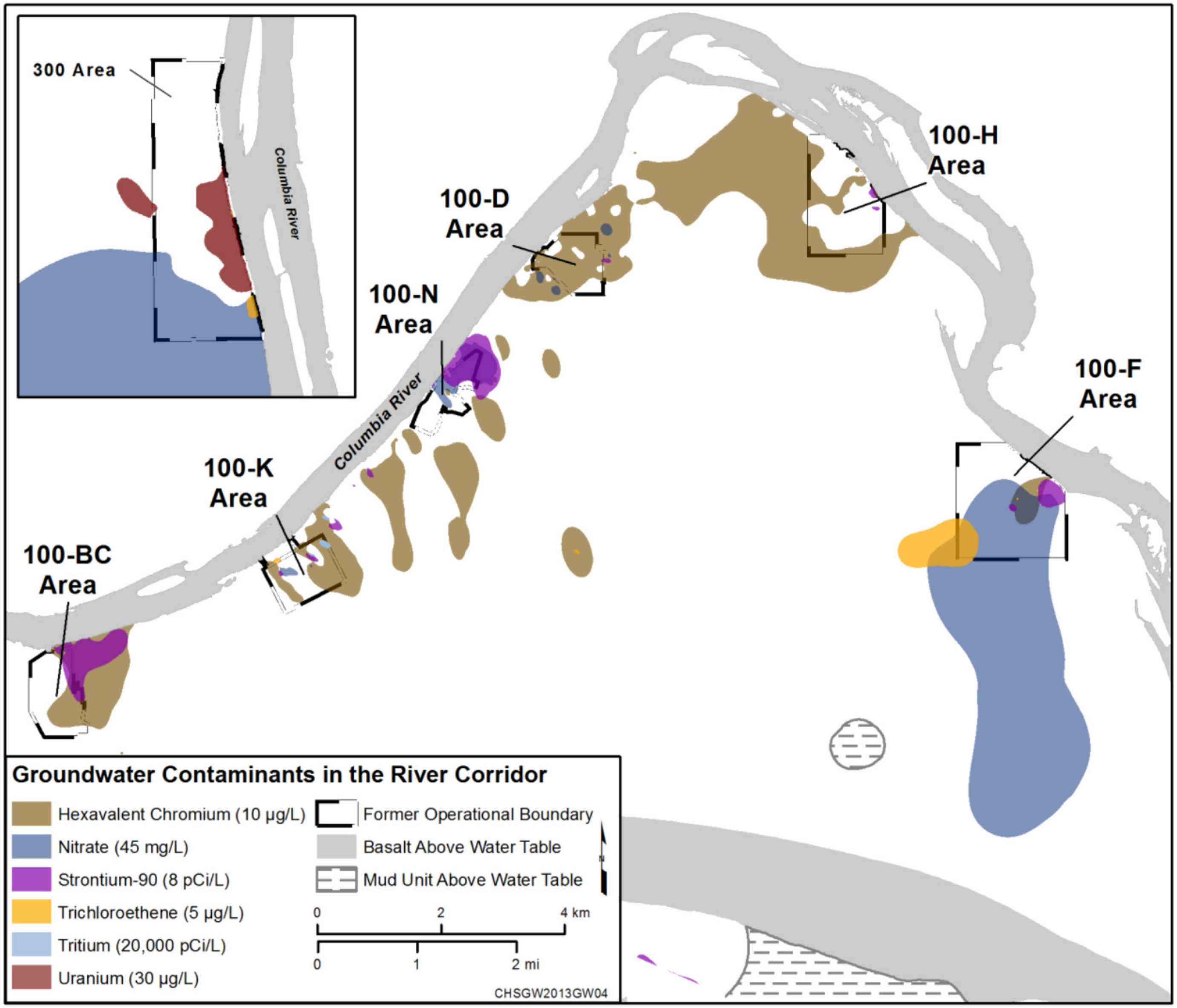
Evaluating Impacts to the Columbia River

- **The Columbia River currently is and is expected to remain safe for all uses**
- Historic contaminant discharges from Hanford dominated by direct, high volume discharges with additional discharges by groundwater
- Current contaminant discharges from Hanford almost exclusively through groundwater upwellings
  - Predominantly chromium plumes along River Corridor (several sites)
  - Predominantly Sr-90 plume in N-Area
  - Predominantly uranium plume in 300 Area
- Multiple additional contaminant discharges upstream and downstream by mining, agriculture, industry, etc.
- Impacts most likely through direct benthic effects and food chain uptake because of river flow and rapid free stream mixing/dilution

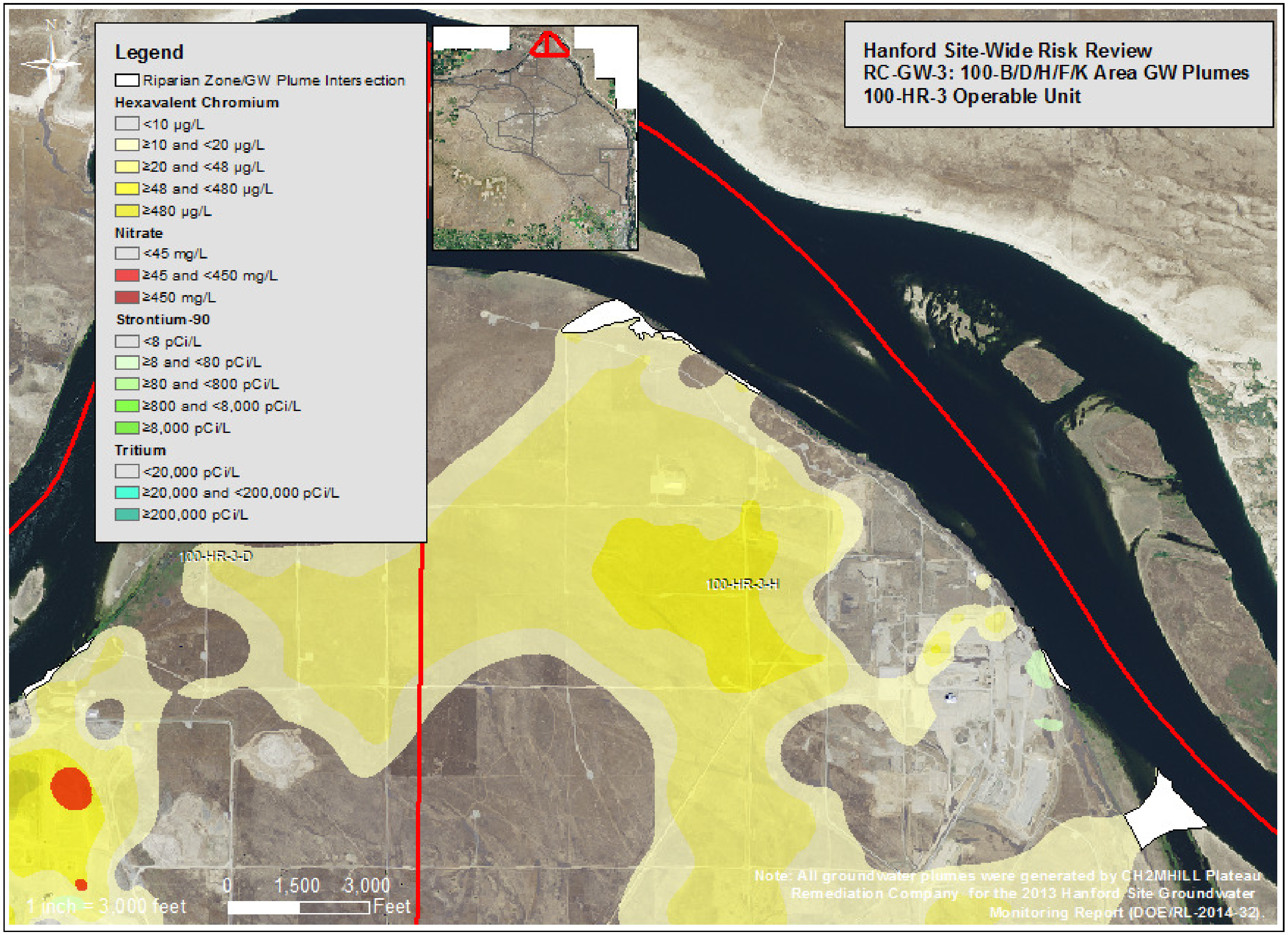
Columbia River

- Limited current direct discharges; primary potential impacts from groundwater discharge of contaminants (e.g., Sr-90, Tc-99, I-129, Cr, U, nitrate)
- Evaluation metrics for groundwater plumes
  - Time to reach/discharge to Columbia River
  - Area (river reach) impacted (> 100 m or < 100 m)
  - Contaminant characteristics
  - Riparian zone impacts
- Consideration of screening thresholds
  - Free stream ecology
  - Benthic ecology
  - Fish consumption assumptions (regulatory basis) undergoing change

Columbia River Corridor Plumes



Defining the Riparian Zone



Evaluating Impacts To Groundwater and By Groundwater

- **Groundwater has “multiple personalities”**
  - Protected natural resource (screening thresholds based on drinking water standard)
  - Potential future use (considering multiple uses, some potentially more stringent than drinking water; all currently precluded)
  - Potential for more extensive groundwater contamination through transport and dispersion (i.e., plume spreading)
  - Potential for contaminant uptake by flora and fauna in riparian zone
  - Potential for contaminant discharge to and uptake within the Columbia River (benthic and free stream ecology)
- **Multiple known and potential sources of groundwater contamination**
  - Inventories in engineered facilities and tanks
  - Legacy disposal sites (near surface)
  - Vadose zone contamination

Primary Contaminant Groups

		Mobility		
		Low	**Medium**	**High**
Persistence	**Low**			$^{3}H_2O$, NO_3
	Medium		Cs-137, Sr-90, TCE	Cyanide
	High	Pu	U, Cr^{3+}	Tc-99, I-129, Cr^{6+}, Carbon Tetrachloride

Group A Primary Contaminants

Group B Primary Contaminants

Group C Primary Contaminants

Group D Primary Contaminants

Revisions to Framework and Metrics

Sources (changes)

- *PC Inventory* – differentiates sources
- *Discharge type* – ponds >> cribs >> trenches >> leaks – leads to current depth in VZ & effectiveness of options

Vadose Zone (changes)

- *VZ Water travel time* – not differentiating in Central Plateau
- *PC travel time* – differentiating (region) based on near-field stratigraphy & K_d
- *Dispersion/dilution* – differentiating (by region)

Summary of Changes

- Other necessary factors (e.g., travel times, dilution / dispersion) can be discriminated regionally
- Discharge type added because of impact on VZ depth of contamination

Simplification

- Path from Central Plateau ONLY from 200W to 200E and 200E to River (based on well data & changes in water table)

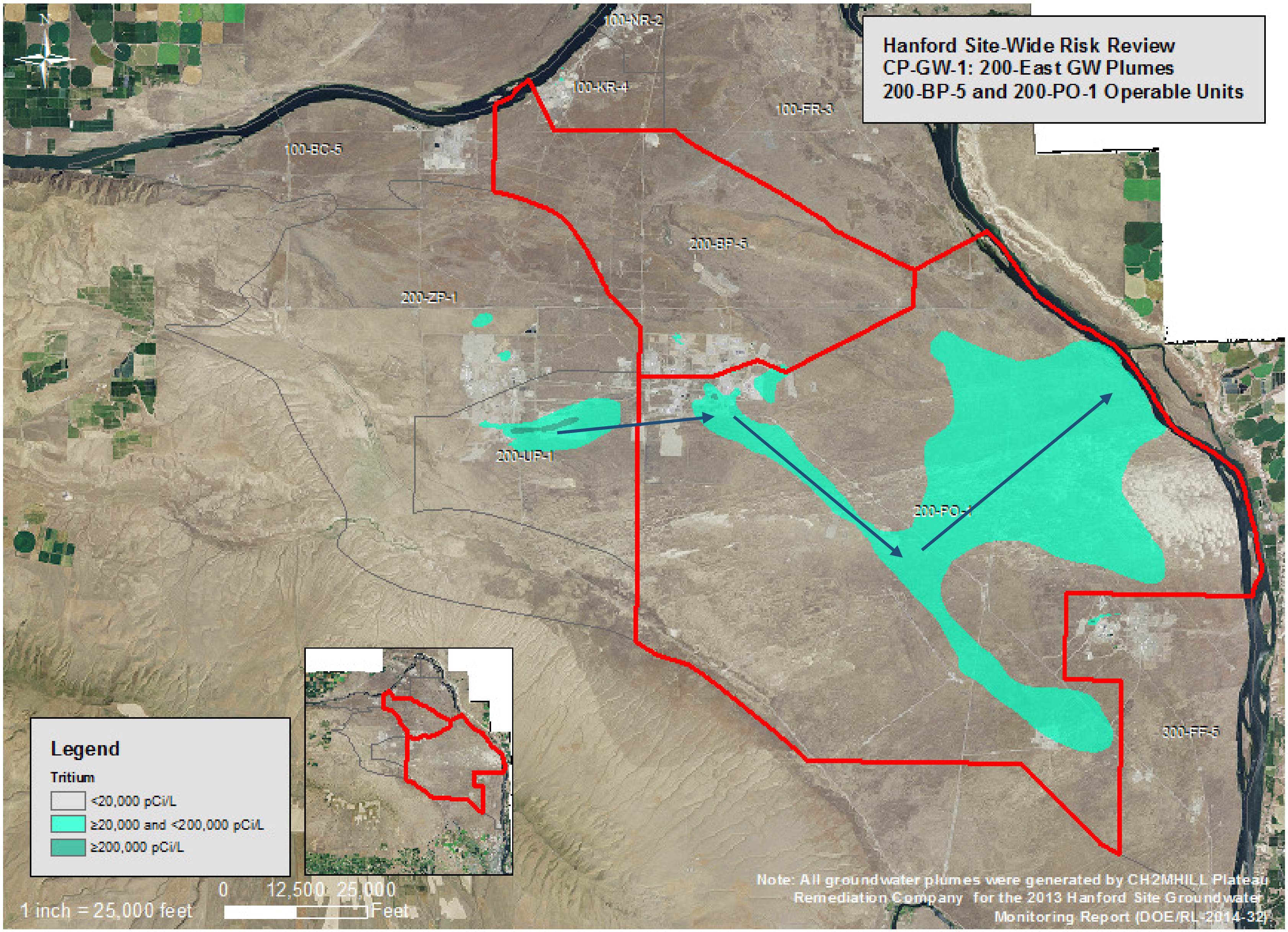
Saturated Zone (changes)

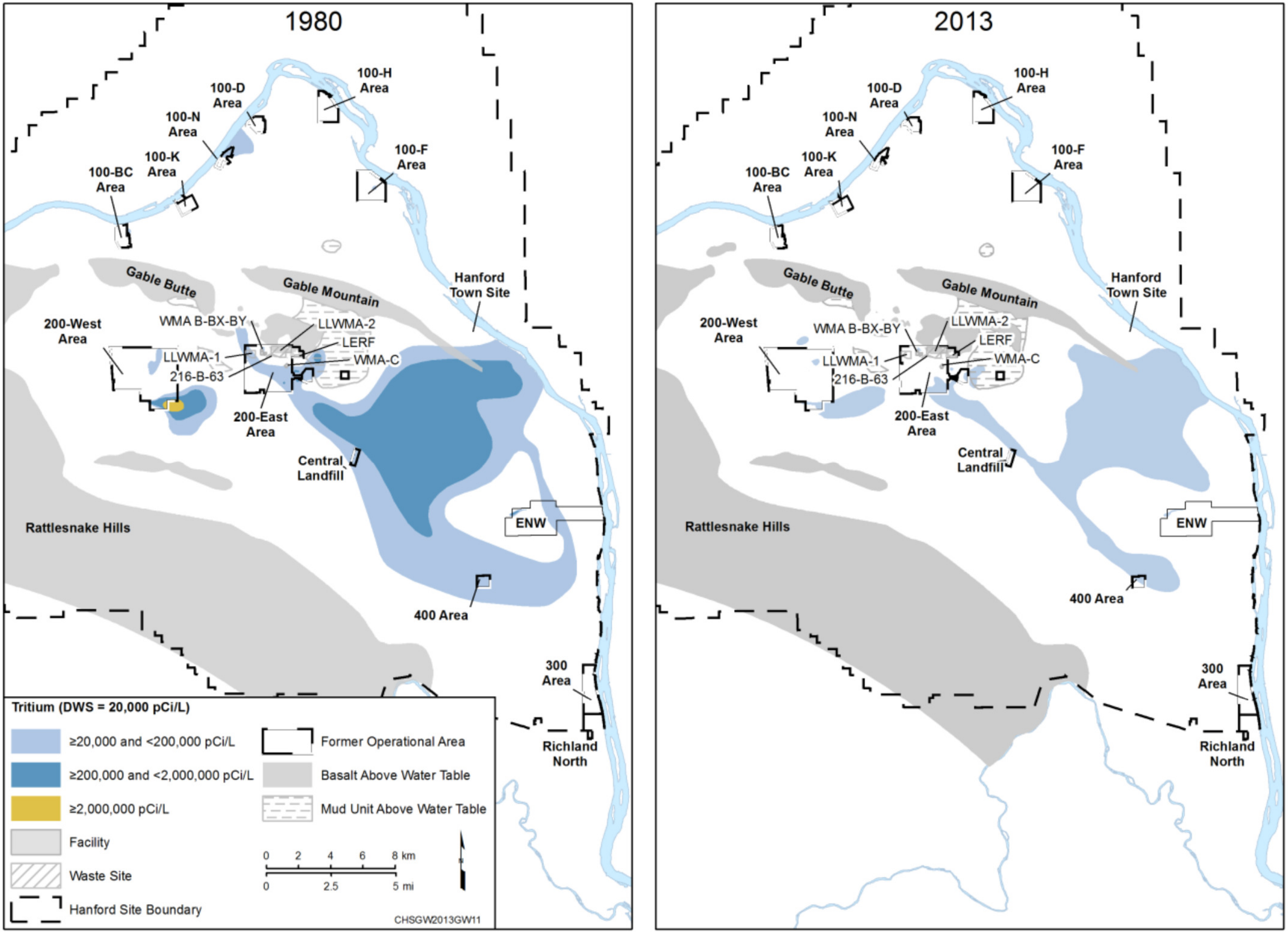
- *SZ Water travel time* –differentiating (based on well data)
- *PC travel time* – differentiating (region) based on far-field stratigraphy & K_d
- *Dispersion/dilution* – differentiating (by region)

New Examples

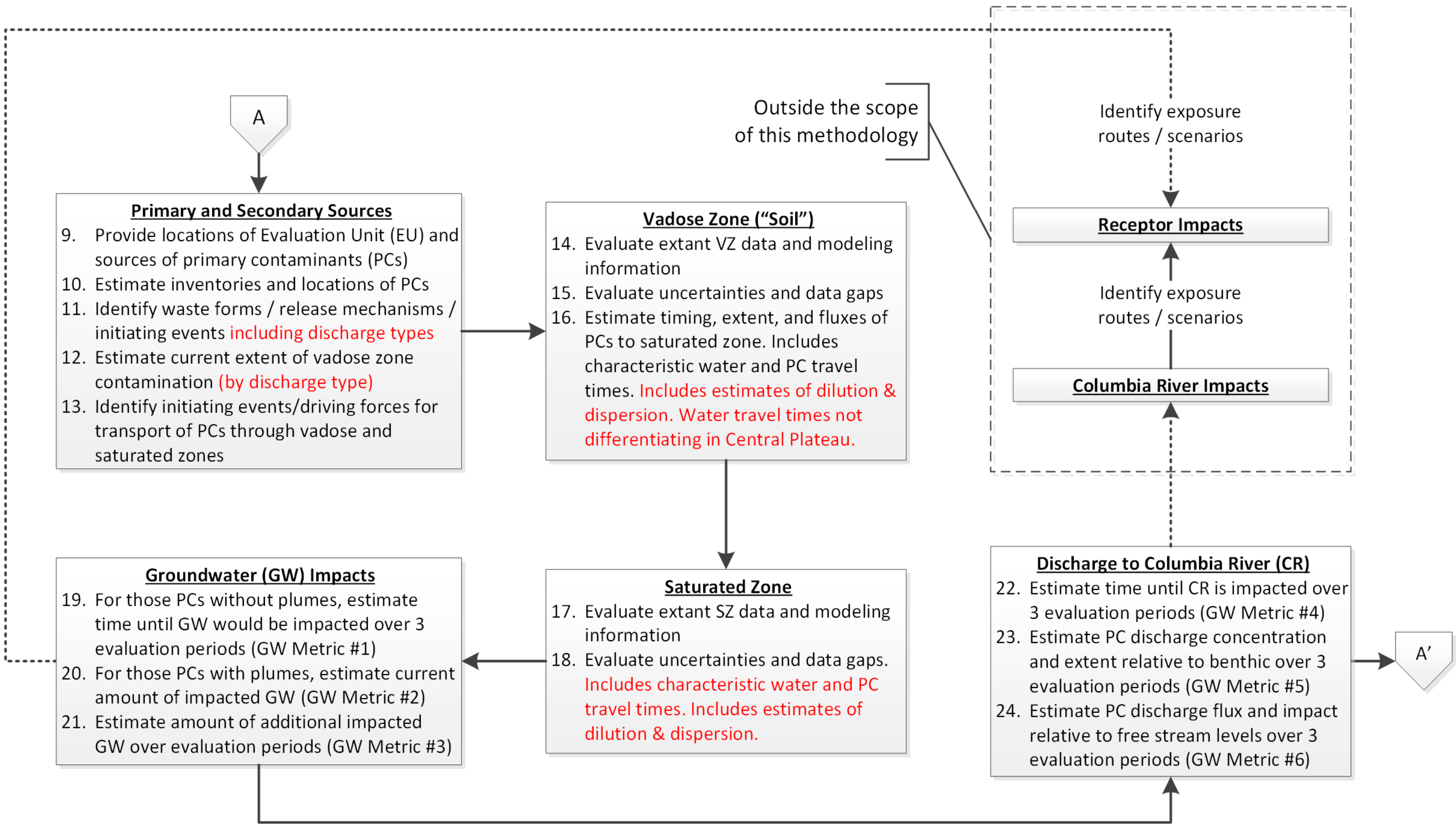
- Cribs and leaks in 200-E and 200-W areas
- Additional EUs assessed

Estimating Movement of 200 Area Plumes




1980
2013
100-H Area
100-D Area
100-N Area
100-K Area
100-BC Area
100-F Area
Hanford Town Site
Gable Butte
Gable Mountain
200-West Area
WMA B-BX-BY
LLWMA-2
LERF
LLWMA-1
WMA-C
216-B-63
200-East Area
Central Landfill
ENW
Rattlesnake Hills
400 Area
300 Area
Richland North
Tritium (DWS = 20,000 pCi/L)
≥20,000 and <200,000 pCi/L
≥200,000 and <2,000,000 pCi/L
≥2,000,000 pCi/L
Facility
Waste Site
Hanford Site Boundary
Former Operational Area
Basalt Above Water Table
Mud Unit Above Water Table
0 2 4 6 8 km
0 2.5 5 mi
CHSGW2013GW11

Groundwater Framework and Metrics



Example of Groundwater Evaluation Input

EU	Location	PC Max Conc. (DWS)	Discharge	Vadose Zone	Saturated Zone	Columbia River
CP-GW-1 (200-E)	CP 200-BP	*Well data* NO_3 1,680 mg/L (45) I-129 7.54 pCi/L (1) Tc-99 36,000 pCi/L (900) U 3,300 µg/L (30) Sr-90 980 pCi/L (8) CN 1,520 µg/L (200) H-3 2.2E4 (2E4)	Pond (very high) Crib (high) Trench (mod) Leak (low)	Water travel – fast *PC travel* NO_3 – fast I-129 – fast Tc-99 – fast U – low to mod Sr-90 – low to mod CN – fast H-3 – fast	*Plumes (Case I)* NO_3 7.9 km^2 (M) I-129 4.5 km^2 (VH) Tc-99 2.4 km^2 (VH) U 0.5 km^2 (H) Sr-90 0.6 km^2 (H) CN 0.4 km^2 (*L?*) H-3 0.2 km^2 (M) *P&T: B Complex perched*	*Shoreline impacts* TBD
	200-PO	H-3 4.9E5 µg/L (2E4) I-129 9.1 pCi/L (1) NO_3 126 mg/L (45) Sr-90 15 pCi/L (8) Tc-99 4,200 pCi/L (900) U 58.8 µg/L (30)	Pond (very high) Crib (high) Leak (low)	 Disp/dilution – mod	H-3 83.4 km^2 (M) I-129 52.1 km^2 (VH) NO_3 3.7 km^2 (M) Sr-90 0.01 km^2 (M) Tc-99 0.03 km^2 (H) U 0.02 km^2 (M) *CERCLA – FS is next step* Water travel – fast PC travel – low to fast Disp/dilution – mod	TBD

Approach for Ecological Risk Evaluation

Compare Hanford Habitat To Columbia Basin Ecoregion

IDENTIFY Ecological Resources On Evaluation Site Using Resource Level Maps

Evaluate Ecological Resources Using Modifiers

Invasive Species Patch Size and Shape Connectivity

Field Ground-truthing

Describe Ecological Resources

During Cleanup Ecological Risk Matrix

+

100 years Post-cleanup Risk Matrix

Consider Potential Initiating Events

Consider Functional Remediation

Evaluate Future Land Use Effects on Ecological Resources

Chinook Salmon

Changes in habitat types from historical records to 2001 for the Hanford Site and the Columbia Basin ecoregion

Cover Type	Historic Ecoregion Area (ha)	Current Ecoregion Area (ha)	Historic Hanford Site Area (ha)	Current Hanford Area (ha)	% Change in Ecoregion	% Change in Hanford Site
Bluebunch wheatgrass steppe	1,028,900	431,400	612	1602	-58.1%	161.8%
Idaho fescue steppe	436,700	122,200	0	0	-72.0%	No change
Bitterbrush steppe	118,600	78,100	915	904	-34.1%	-1.2%
Big sagebrush steppe	4,096,900	1,662,400	148,902	137,834	-59.4%	-7.4%
Juniper/sagebrush	110,300	109,100	508	508	-1.1%	No change
Threetip sagebrush	746,000	0	16	0*	-100%	-100%
Black greasewood	134,900	0	503	0*	-100%	-100%
Conifers/Idaho fescue	225,000	0	0	0	-100%	-100%
Ponderosa pine	302,900	335,100	102	102	10.6	10.6%
Water	71,100	71,100	25	25	No change	No change
Other	205,500	4,667,400	0	10,612	2,171%	
Total	7,476,800	7,476,800	151,583	151,587		

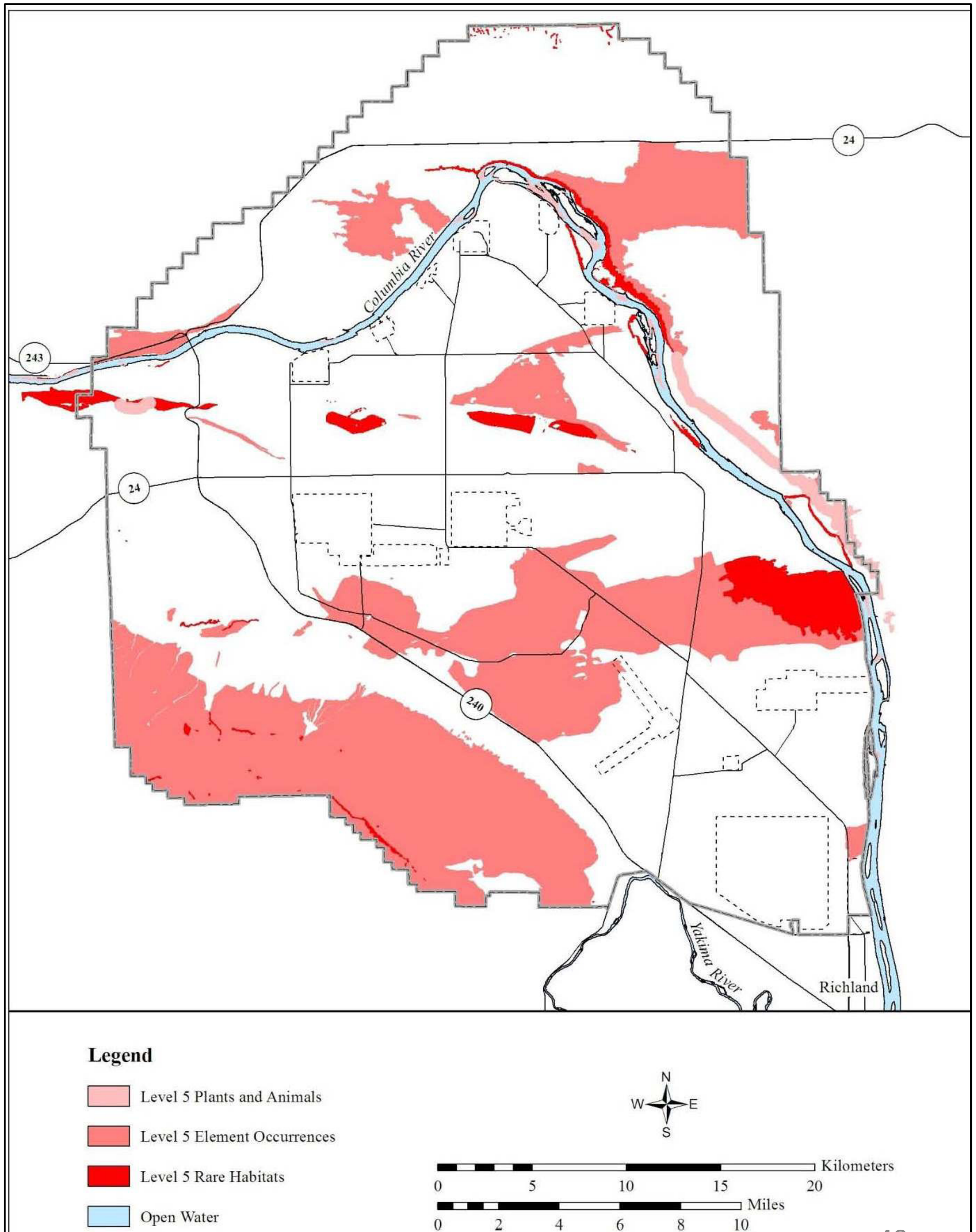
*This disappearance is likely due to not being documented in later years.
100 % decrease means it went from some amount to none (or it was not measured).

LEVELS OF ECOLOGICAL RESOURCES
(DOE/RL-96-32, 2013)

Level 5 = irreplaceable habitat or federal threatened and endangered species (including proposed species and species new to science or unique to WA).
Level 4 = Essential habitat for important species
Level 3 = Important habitat
Level 2 = Habitat with high potential for restoration
Level 1 = Industrial or developed
Level 0 = Non-native plants and animals

Level 5
Species / Habitat

Sage Grouse



OVERALL APPROACH TO EVALUATION OF ECOLOGICAL RESOURCES IN EUs

Major Changes from Review Comments:

- Simplified methods
- Include evaluation of risk from contaminants (current status, during cleanup, post-cleanup)
- Modified field protocol for 2014 conditions
- Modified rationale to be consistent with remediation options for EUs

MODIFIED FIELD PROTOCOLS

- 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

BINNING

- Expanded consideration of role of contaminants
- Expanded consideration of multiple remediation options

EXAMPLE RESULTS FROM 2014 FIELD EVALUATIONS OF ECOLOGICAL RESOURCES

Evaluation Unit Name	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Percentage of Resources Level 3 or Greater within EU
CP-DD-1 PUREX	84.30% (37.6 ac)	0.00% (0 ac)	10.76% (4.8 ac)	4.93% (2.2 ac)	0.00% (0 ac)	0.00% (0 ac)	4.93%
RC-LS-1 618-11 Burial Ground	30.26% (41.4 ac)	8.41% (11.5 ac)	51.24% (70.1 ac)	10.09% (13.8 ac)	0.00% (0 ac)	0.00% (0 ac)	10.09%

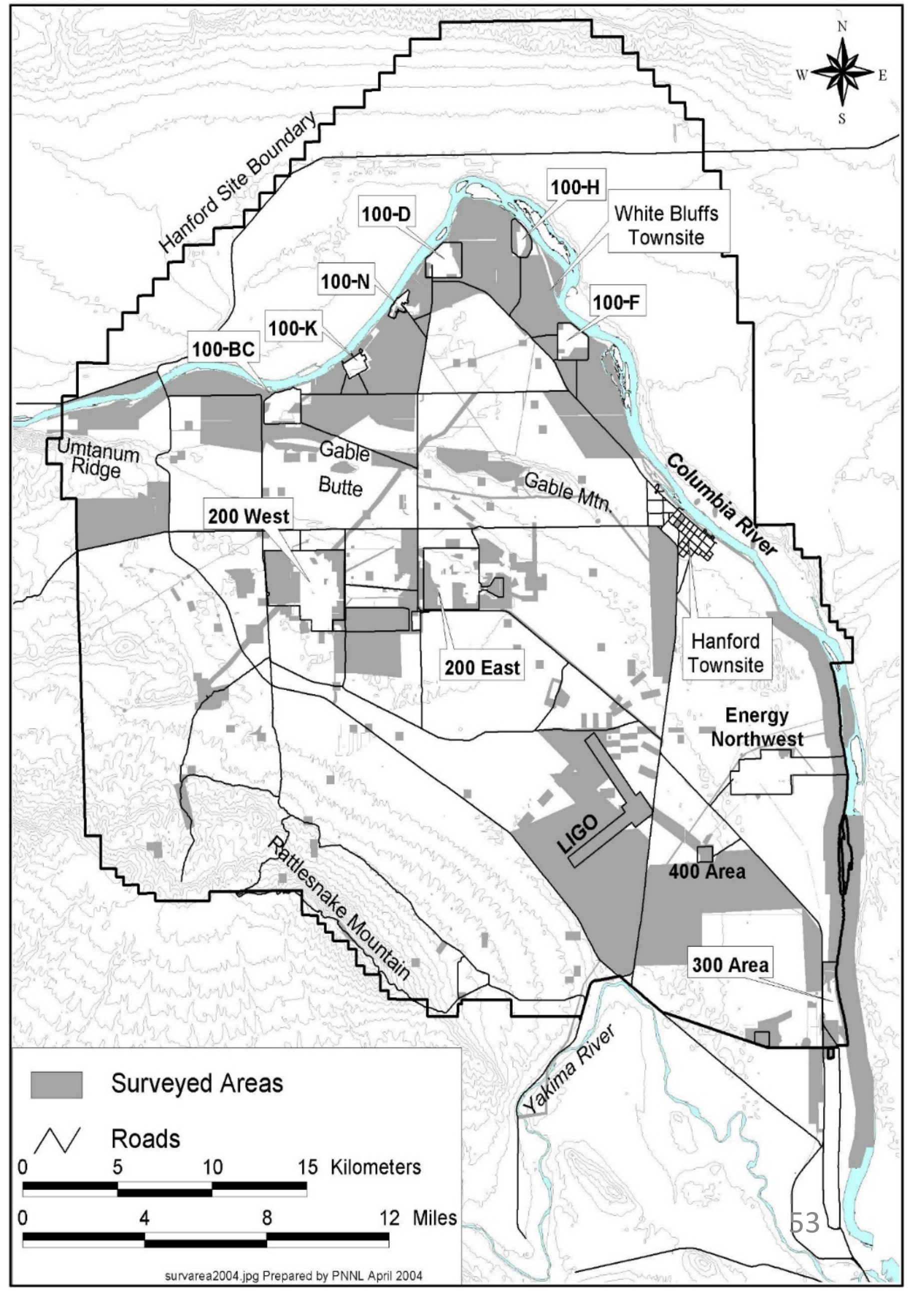
Level 0: Non-native plants and animals
Level 1: Industrial or developed
Level 2: Habitat with high potential for restoration
Level 3: Important habitat
Level 4: Essential habitat for important species
Level 5: Irreplaceable habitat or federal threatened and endangered species (including proposed species, and species that are new to science or unique to Washington State)

EXAMPLE RESULTS FOR ECOLOGICAL RESOURCES

EU Name	Evaluation Time Period	Risk or Impact Rating	Comments
CP-DD-1, PUREX	Current	ND to Low	**Generally ND** on EU because there are few ecological resources (5 % Level 3 resources), **Low** because of possible contamination to ecological receptors on buffer area (31 % Level 3 and 4 resources)
	Active Cleanup	Low to Medium	Few high level resources in EU (5 % Level 3 resources), but **Low to Medium in buffer area** because of high value resources (nearly a third of area has Level 3 and 4 resources).
	Near-term Post-Cleanup	ND to Low	Remote chance of penetration of roots into contaminated site, allowing exposure to residual contamination.
RC-LS-1, 618-11 Burial Grounds	Current	ND	**ND** because currently there is no disturbance to site, although 10% of EU is Level 3 resources and over half of buffer area is Level 4 resources
	Active Cleanup	Low to Medium	**Low in EU** because only about 10 % is Level 3 resources (none higher), but **Low to Medium in buffer zone** because 65 percent is Level 3 and 4 resources. Disturbance could result during soil removal.
	Near-term Post-Cleanup	Low to Medium	Re-vegetation in EU will result in some additional Level 3 and 4 resources potentially at risk because of disturbance, especially from invasive species and change of species composition. Similar effects in buffer zone.

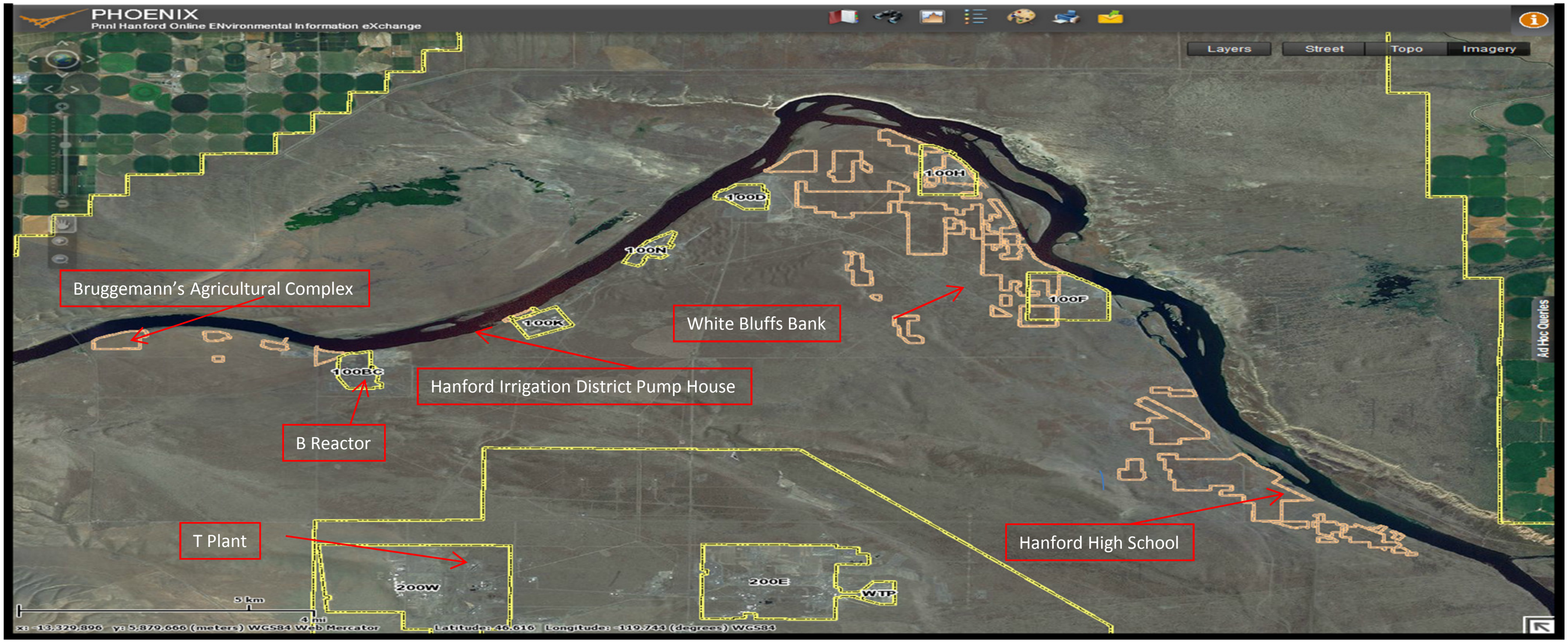
CULTURAL RESOURCES

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



Manhattan Project National Historical Park

– Six Resources Explicitly Mentioned in Legislation

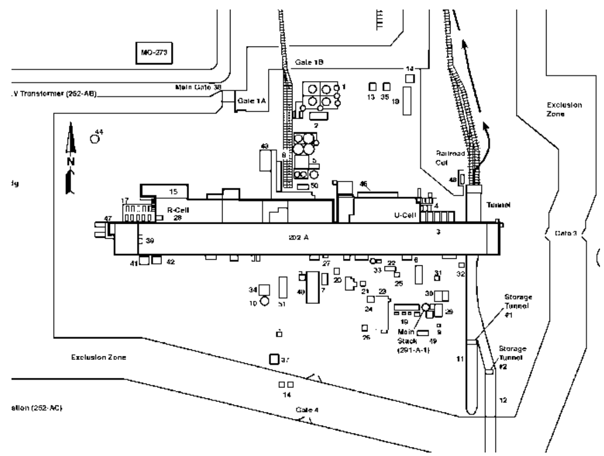


OVERALL APPROACH TO EVALUATION OF CULTURAL RESOURCES

- Entire Methodology redrafted based on comments received
- Tribes do not distinguish one resource from another and believe that both direct and indirect resources important to their Tribe are present within entire site
- Professional archaeologists prepared summaries for each EU using existing literature, databases (DOE and State); additional information to be sought from tribes/historical societies
- Direct (e.g., artifact) and indirect (e.g., view shed) effects identified (current and during cleanup)
- Evaluation of risks from contamination included (current, during cleanup/left in place)
- Resources identified from three landscapes: Native American; Pre-Hanford Era (1805-1943); and Manhattan/Cold War Era (1943 to 1990)
- Resources expressed in terms of descriptors with respect to presence/absence/unknown within EU for each of the three landscapes. No longer using a rating (e.g., low, medium, high)

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.
- Two adjacent rail tunnels constructed to dispose of surplus radioactive materials beginning in 1960, such as failed or outworn equipment.
- 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. RI/FS Work Plan scheduled to be submitted by DOE in September 2015.



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 rems 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 rems; Storage Tunnel No. 2 – 76 rems; 202-A Building and systems – 120 rems.
- A fire in PUREX Tunnel #1 associated with its wooden structure could cause an unmitigated exposure of 70 rems.
- 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 rems because of the residual inventory in the gloveboxes, potential combustibles, and potential ignition from S&M operations.

Major Postulated Cleanup Options and Impacts

- **Disposition PUREX Canyon Building/Associated Waste Sites:** Several action memoranda are in place to remove contaminated soil, structures, and debris from waste sites with disposal at ERDF. CERCLA RI/FS process being followed, on a case-by-case basis for the five major canyon buildings. 221-U Facility selected as a pilot project, and is using a "Close in Place-Partially Demolish Structure" approach. Equipment on the canyon deck is consolidated into the process cells and hot pipe trench, and equipment, process cells, and other below ground areas filled with grout. The structure will later be partially demolished, and the remaining structure buried under an engineered barrier.
- **Disposition PUREX Storage Tunnels:** No cleanup decisions have been made for the PUREX Storage Tunnels.
- **Worker Risk**: *Low-Medium;* No workers are expected to enter the process cells. Movement of equipment on the deck and into the cells may require size reduction and will require lifting and movement with overhead or portable cranes. There were no accidents or injuries during the U Canyon D&D work. Radiological, chemical and industrial related risks during D&D of the two tunnels should be low if the rail cars and equipment are grouted in place and the tunnel walls used as a permanent cover.
- **Co-located people (100 m):** *ND-Low*; Largest risk is a major seismic event causing structural failure.
- **Public:** *ND*
- **Ecological**: *Low to Medium*; High level resources in buffer area (nearly a third of area has level 3 and 4 resources).
- **Cultural:** Area has not been investigated either on the surface or subsurface, archaeological investigations may need to occur within pockets of undisturbed land if any prior to remediation. Potential for intact archaeological material to be present is very low.

Additional Important Observations

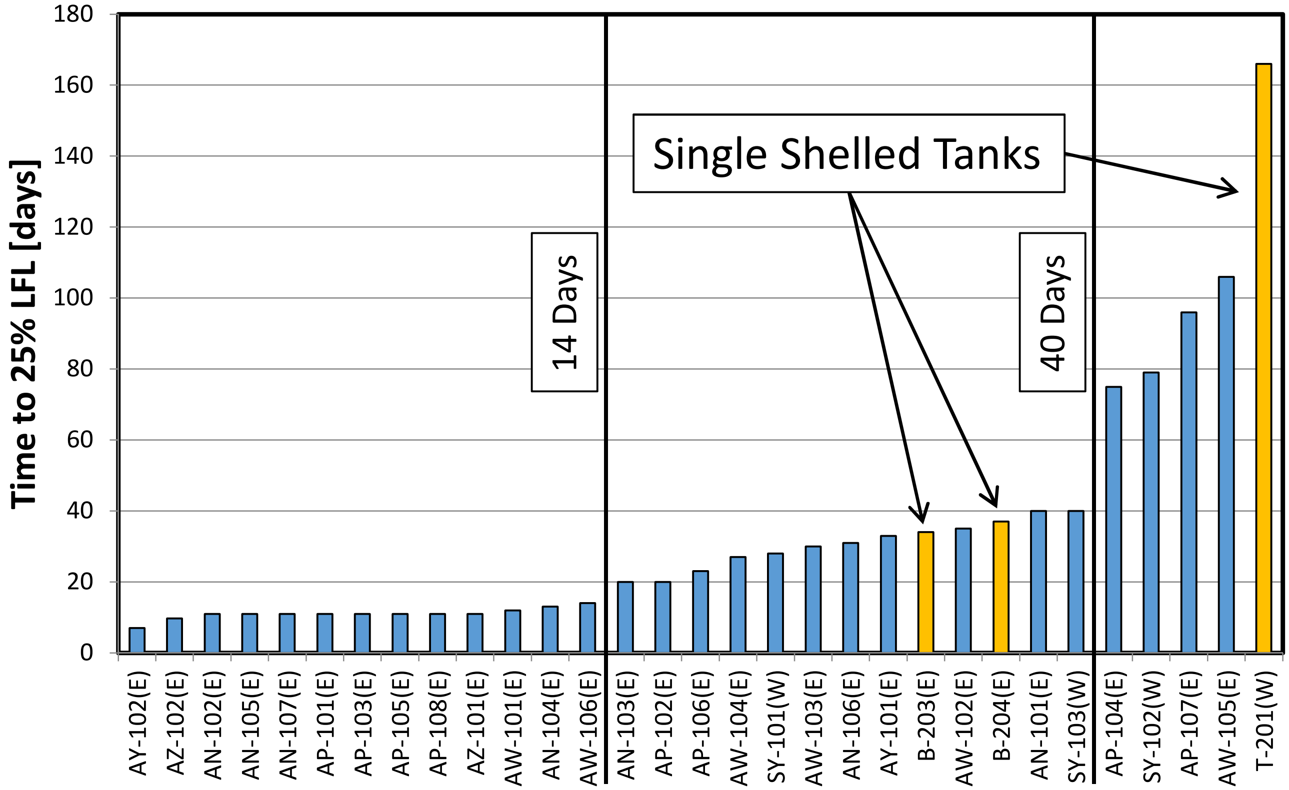
PUREX D&D has four major sources of contaminants, and sequence and timing of D&D should be considered relative to changing structural risk profiles.

- Tunnel #1 was constructed almost entirely of railroad ties in 1956. Ongoing degradation is occurring from continued exposure to the gamma radiation from equipment being stored there. It estimated that the strength of the timbers were 60% of their original strength in 2001. This study indicates that standard factor of safety will be reached at 47.5% of original value in about 2040.
- Tunnel #2 was constructed with stronger materials as additional temporary storage in 1967. 28 railcars contain largest amount (in Curies) of dispersible radioactive contaminants in PUREX complex subject to a structural collapse.
- Contaminated equipment and building surfaces above Canyon Cell decks represent significant exposure risk to a co-located people located 100 meters from the building in the event of a seismic event. Moving this equipment into the Cells and grouting in place would significantly reduce this risk.

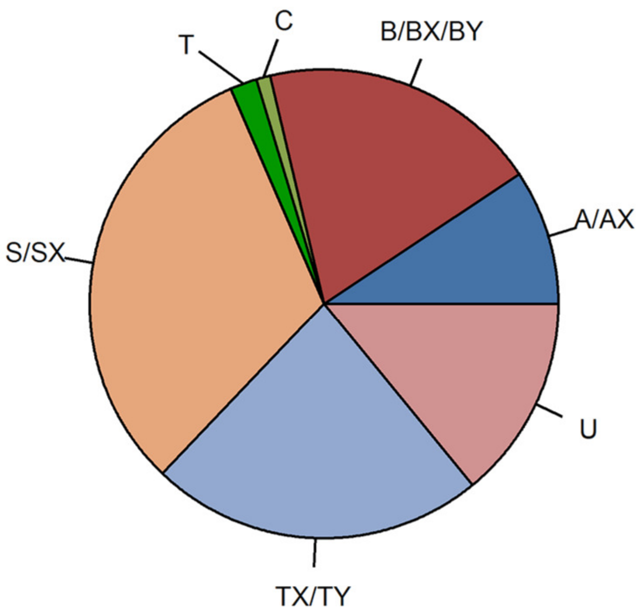
Integration

- Focus on distinguishing features
- Use of key metrics to illustrate relative

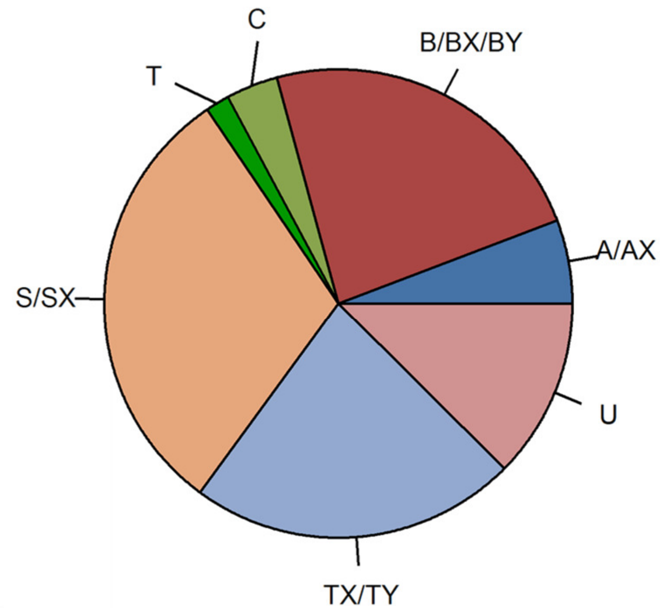
Time to 25% Lower Flammability Limit for Tanks with Less Than 6 Months



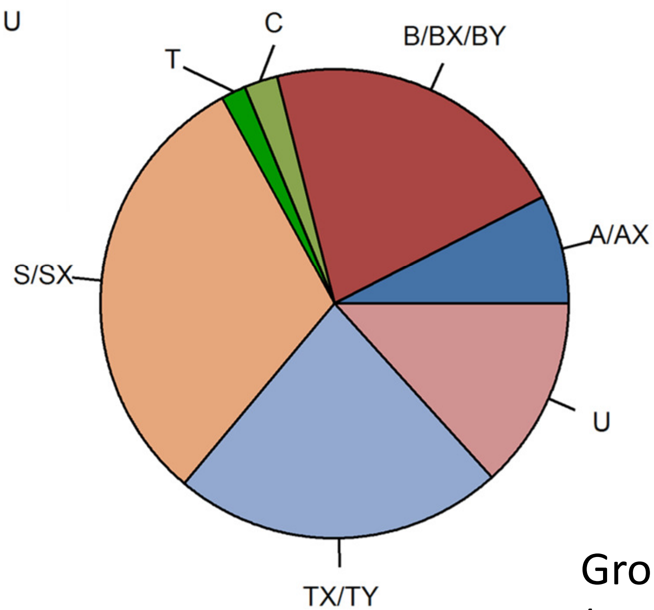
Tc-99, I-129, and Groundwater Hazard Metric by Tank Farm (SSTs)



Tc-99 (12,000 Ci)



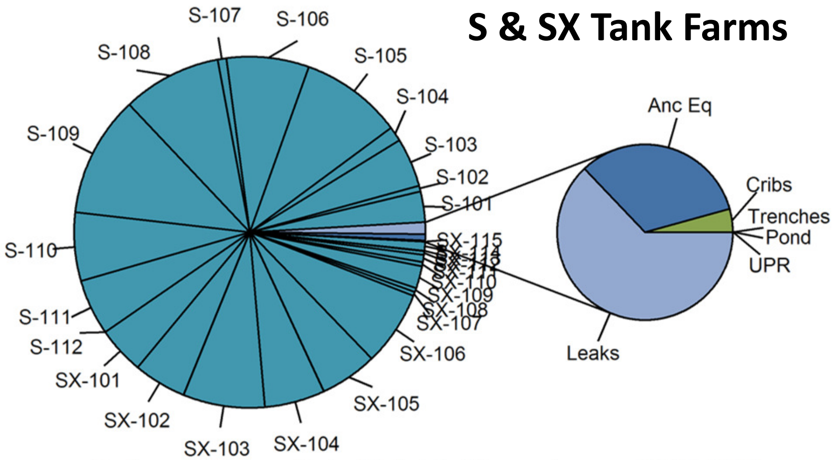
I-129 (14 Ci)



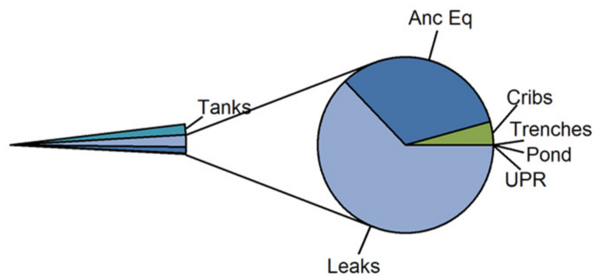
Groundwater Hazard Metric
(Tc-99 + 900*I-129)

Tc-99 Comparison High/Low

S & SX Tank Farms



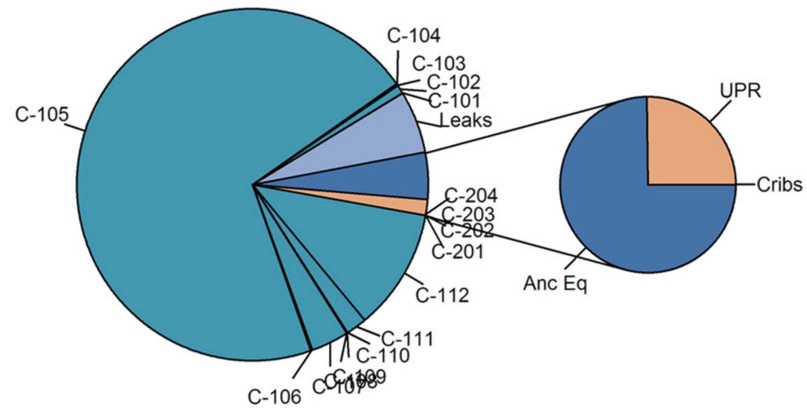
Before Retrieval Tc-99 (Total Inventory = 3800 [Ci])



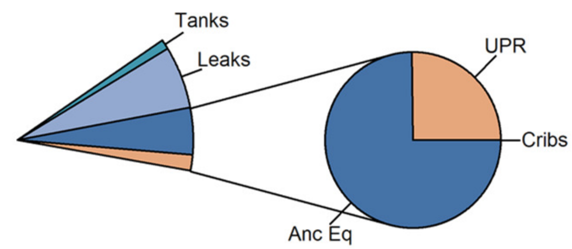
Post Retrieval Tc-99 (Total Inventory = 100 [Ci])

UPR
Cribs
Anc Eq
Trenches
Tanks

C Tank Farm



Before Retrieval Tc-99 (Total Inventory = 120 [Ci])

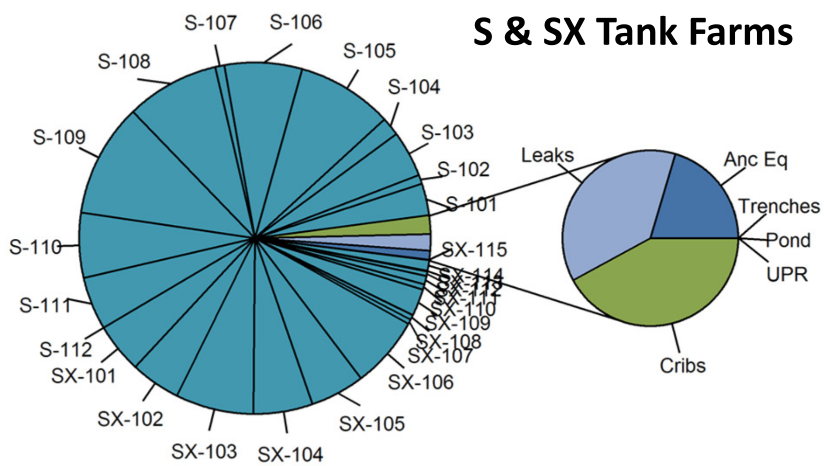


Post Retrieval Tc-99 (Total Inventory = 14 [Ci])

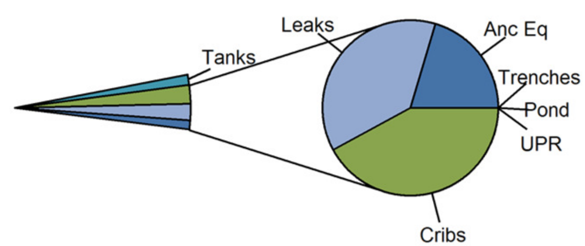
Cribs
Leaks
UPR
Anc Eq
Tanks

Groundwater Hazard Metric Comparison High/Low

S & SX Tank Farms



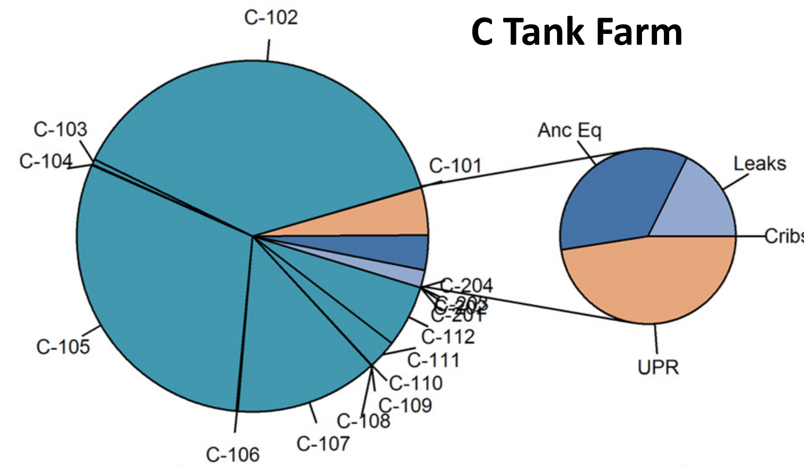
Before Retrieval Groundwater Hazard Metric (Tc-99 + 900*I-129) (Total = 7400)



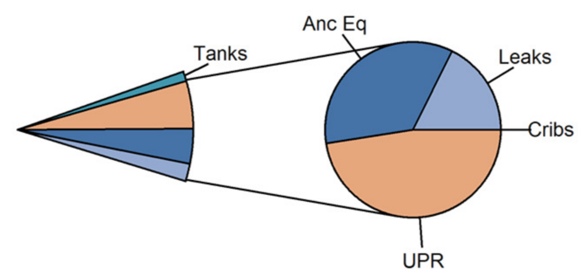
Post Retrieval Groundwater Hazard Metric (Tc-99 + 900*I-129) (Total = 370)

UPR
Anc Eq
Leaks
Trenches
Tanks

C Tank Farm



Before Retrieval Groundwater Hazard Metric (Tc-99 + 900*I-129) (Total = 550)

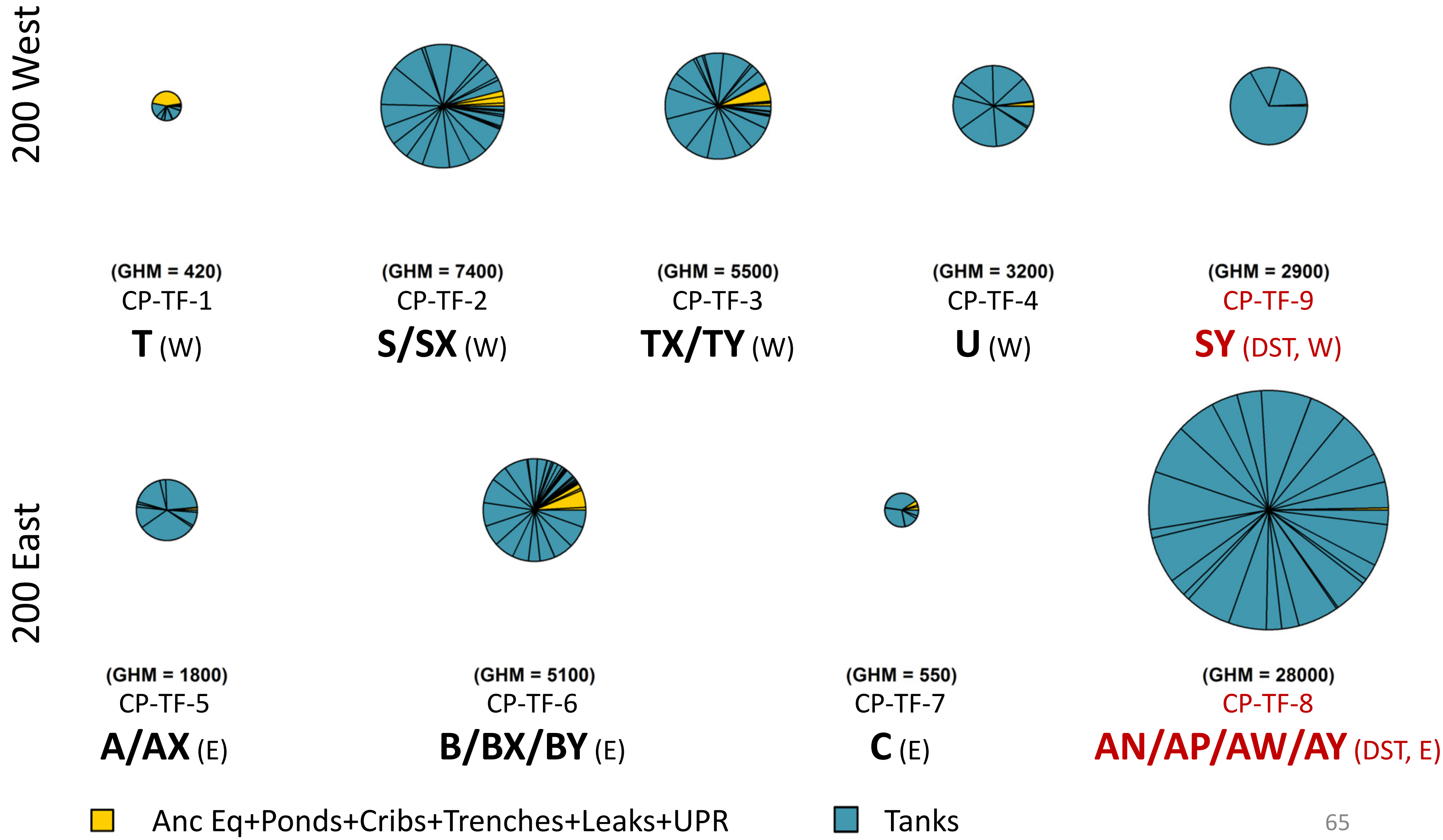


Post Retrieval Groundwater Hazard Metric (Tc-99 + 900*I-129) (Total = 55)

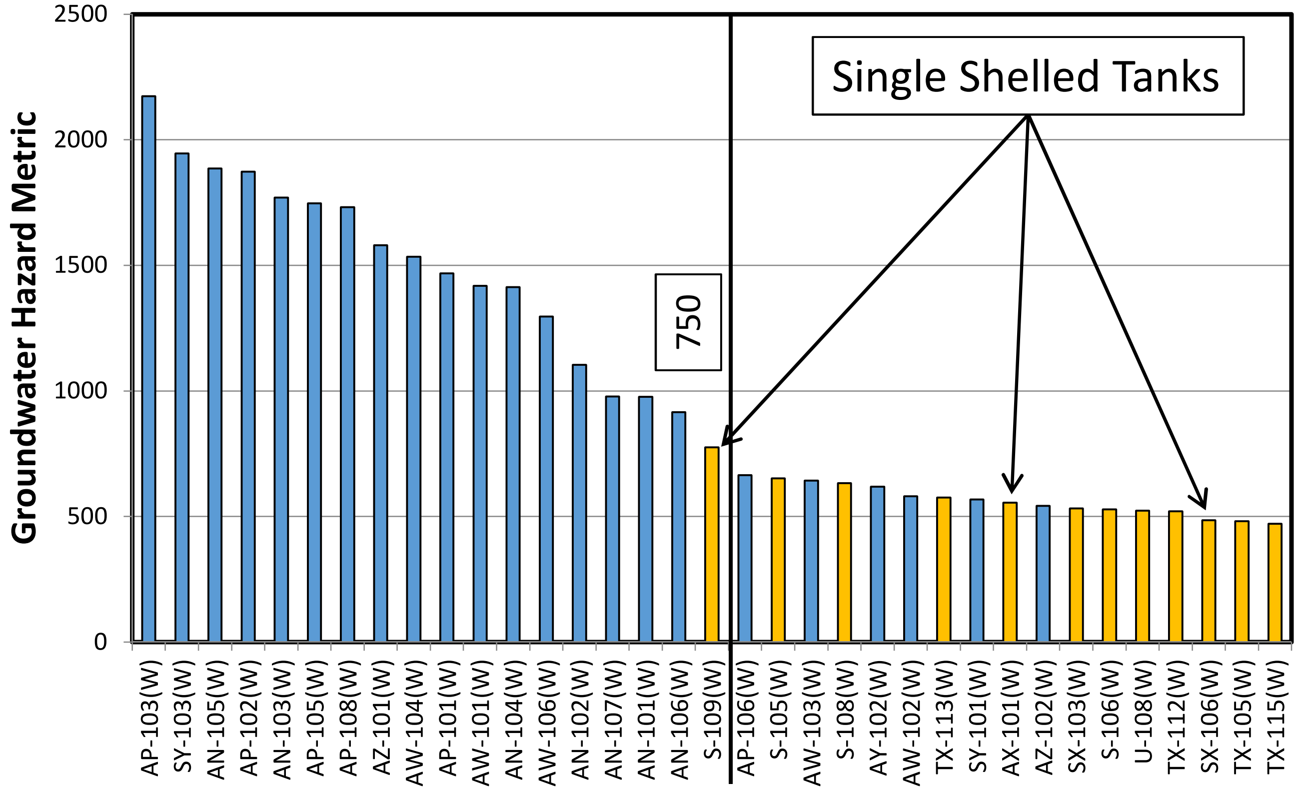
Cribs
UPR
Leaks
Anc Eq
Tanks

Groundwater Hazard Metric (Tc-99 + 900*I-129) by EU

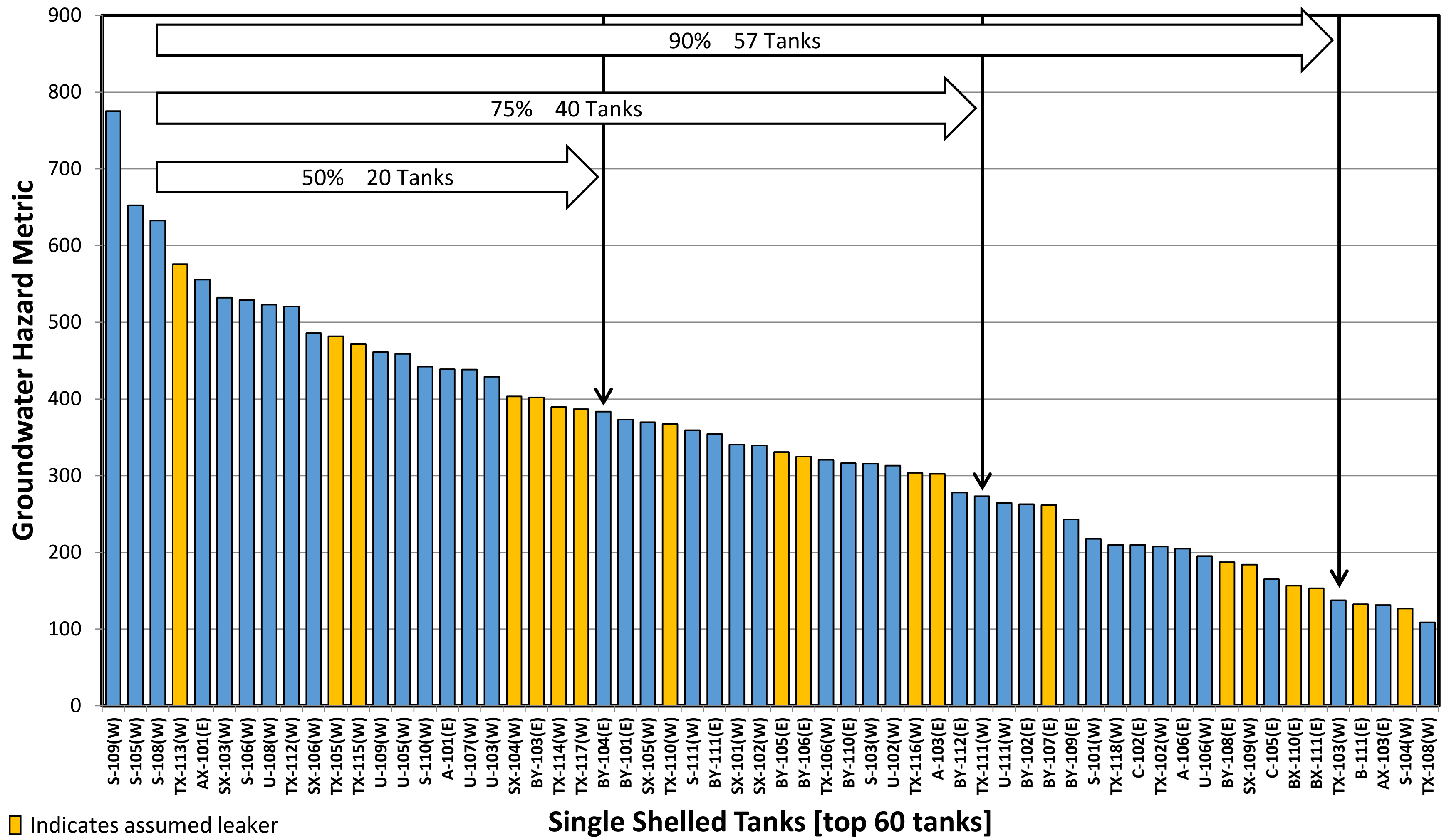
(Scaled by Area Relative to Total GHM in EUs)



Groundwater Hazard Metric (Tc-99 + 900*I-129) for Tanks with a Value Greater Than 500



SSTs (top 60) Accounting for 50%, 75%, and 90% of Groundwater Hazard Metric (Tc-99 + 900*I-129)



NEXT STEPS

- Response to Comments & revised Methodology Report
- Interim Progress Report
  - Comments solicited
- Draft Final Report – submitted December 2015 (written comments solicited on draft)