APPENDIX H.5

WASTE ENCAPSULATION AND STORAGE FACILITY (WESF)
(CP-OP-3, CENTRAL PLATEAU)
EVALUATION UNIT SUMMARY TEMPLATE

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PART I. EXECUTIVE SUMMARY

EU LOCATION

General Hanford Area: 200 East; Building Alias: 225-B

RELATED EUS

- EU Designation: CP-DD-2
- EU Name: B Plant
- EU Group: D&D
- General Hanford Area: 200 East
- Building Alias: 224-B
- EU Relationship to EU under Evaluation: WESF capsules must be moved into dry storage before B Plant D&D can begin

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES:

There are only a few primary contaminants for WESF: Cesium-137 (Cs-137), strontium-90 (Sr-90), and ingrown decay products (e.g., barium 137 [Ba-137m, Ba-137] from Cs-137, yttrium-90 [Y-90] from Sr-90). These contaminants reside in 3 locations within WESF that present potential signification human impacts (see Part V. Waste and Contamination Inventory for detailed lists): (1) capsules within pool cells (vast majority with total radioactivity of ~98 MCi); (2) contamination within hot cells, hot cell-connected ventilation ductwork, and hot cell-connected HEPA filters (combined total activity of ~300 kCi); (3) pool water cleaning ion exchange module [WIXM] (varying radioactivity with maximum at 56 kCi).

BRIEF NARRATIVE DESCRIPTION

Current WESF operations consist of essentially one task: safely storing cesium and strontium capsules within a series of interconnected pools within the WESF building (described in the documented safety analysis[1]). The majority of the radiological risk is driven by the high levels of radioactivity within the capsules at all phases of the presently planned WESF work scope. The safe containment of the cesium chloride and strontium fluoride within the capsules could be compromised under design basis accident- and beyond design basis accident-conditions if loss of water from the pool cells were to occur. The current scope of the WESF mission is limited to facility maintenance activities: inspection, decontamination, and movement of capsules; and storage and surveillance of capsules. Future plans are divided into two phases. The first phase of which is to upgrade the ventilation system and stabilize the hot cell contaminants. Upgrading the ventilation system does not directly relate to operations that affect the storage of the capsules, *per se*, but are required to keep the facility in an operable state that complies with various requirements (regulatory, operational, etc.). Stabilization by grouting of the majority of the hot cells will be performed by grouting in place all waste and remaining equipment[2]. A supplemental Hazards Analysis[3] was performed to understand any new or obsolete hazards that would be associated with these actions. There were new types of hazards identified[4] with the temporary operations to support building upgrades. The long-term, tentative plan is to remove the Cs and Sr

[1] [HNF-8758 (Rev9)]
[2] [CHPRC-02203 (Rev0) pg. 10]
[3] [CHPRC-02203 (Rev0)]
[4] [CHPRC-02203 (Rev0) pg. 10]

capsules from the pools by packaging the capsules into dry storage overpacks and storing them on the Hanford Site. This movement into dry storage will allow the adjacent building (B Plant) to move forward with D&D plans that are tied to a Tri-Party Agreement Milestone.

SUMMARY TABLE OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table H.5-1 provides a summary of nuclear and industrial safety related risks to humans and impacts to important physical Hanford site resources.

Human Health: A Facility Worker is deemed to be an individual located anywhere within the physical boundaries of the WESF Building or immediate areas around the outside of the building; a Co-located Person (CP) is an individual located 100 meters from the WESF Facility boundary; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control, which in this instance is the State Highway 240 approximately 8,300 m (27,230 ft) east of the facility. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from Not Discernible (ND) to High. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, is shown in parentheses.

Groundwater and Columbia River: Direct impacts to groundwater resources and the Columbia River, have been rated based on available information for the current status and estimates for future time periods. These impacts are also expressed in a range of from Not Discernible (ND) to Very High.

Ecological Resources: The risk ratings are based on the degree of physical disruption (and potential additional exposure to contaminants) in the current status and as a potential result of remediation options.

Cultural Resources: No risk ratings are provided for Cultural Resources. Table H.5-1 identifies the three overlapping Cultural Resource landscapes that have been evaluated: Native American (approximately 10,000 years ago to the present); Pre-Hanford Era (1805 to 1943) and Manhattan/Cold War Era (1943 to 1990); and provides initial information on whether an impact (both direct and indirect) is KNOWN (presence of cultural resources established), UNKNOWN (uncertainty about presence of cultural resources), or NONE (no cultural resources present) based on written or oral documentation gathered on the entire EU and buffer area. Direct impacts include but are not limited to physical destruction (all or part) or alteration such as diminished integrity. Indirect impacts include but are not limited to the introduction of visual, atmospheric, or audible elements that diminish the cultural resource's significant historic features. Impacts to Cultural Resources as a result of proposed future cleanup activities will be evaluated in depth under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

Table H.5-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parentheses (e.g., "Very High (Low)")[b]

Population or Resource		Evaluation Time Periods	
		Current Operations Safe Storage of Cs/Sr Capsules	**From Cleanup Actions** Near-Term Building Upgrades
Human	Facility Worker (FW)	High (High)	High (Not Evaluated)
	Co-Located Person (CP)	High (Low)	Medium (Not Evaluated)
	Public as the Maximally Exposed Offsite Individual (MOI)	Low (Low)	Low (Not Evaluated)
Environ-mental	Groundwater	Not Discernible (ND)[c]	ND[c]
	Columbia River	ND[c]	ND[c]
	Ecological Resources[a]	ND	ND
Social	Cultural Resources[a]	**Native American:** Direct: Unknown Indirect: Unknown **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known	**Native American:** Direct: Unknown Indirect: Unknown **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War:** Direct: Known Indirect: Known

a. For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report.
b. The highest rating from the set of accident scenarios and resultant unmitigated impacts were used in this table (see section below on the current condition of WESF.
c. WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU.

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH TIME PERIOD

Human Health

Current Condition:

Building and Facility: The safe storage of the cesium/strontium capsules and other radiological contamination can be impacted by the following accident and natural phenomenon hazards:

Loss of Pool Cell Water Event: The loss of pool cell water is a design basis event but has multiple potential causes that include man-made errors, natural events, and external events[5]. One of the potential initiating events for the loss of pool cell water is the design basis event (DBE) – earthquake. The design basis earthquake cannot cause the loss of pool cell water by itself; a combination of operational (man-made) errors and conditions required is, in effect, a ***beyond*** design basis event (BDBE)[6]. The BDBE earthquake could create conditions that produce failure of the pool cell structure and the BDBE earthquake is analyzed separately from the WESF DSA. The WESF DSA events are the described throughout this document with notes on the BDBE when appropriate. The safe containment of the cesium chloride and strontium fluoride within the capsules could be compromised due to thermal loading under design basis accident- and beyond design basis accident-conditions if the loss of water from the all pool cells were to occur.

Unmitigated Risk[7]: FW – High; CP – High; MOI – Low.

Mitigation: The open pool cell air dilution ports are identified as a design feature in active pool cells to allow for overflow of water if the Pool Cell 12 fill pipe is used and the transfer ports are closed. A defense-in-depth TSR-level AC on configuration management of the TSR design features will ensure this safety function is maintained. Damaged capsule(s) could result in very high radiation levels in the pool cell area. An additional TSR level control for mitigation of worker consequences is identified. This control requires an operable area radiation monitor ARM (permanently installed or portable) and an operable pool cell beta monitor in each active pool cell to protect workers from potential radiation hazards. The ARM protects workers from radiation hazards resulting from a large leak that occurs quickly and the beta monitors protect workers from slow developing radiation hazards (e.g., capsule leaks due to corrosion). Non-credited defense-in-depth facility equipment and processes exist that would help to mitigate the release of radioactive material and exposure to the onsite and offsite receptors[8]

Mitigated Risk[9]: FW – High; CP – Low; MOI – Low.

Hydrogen Explosion in Hot Cell G and K3 Duct: The second most potentially significant event that could impact human health is a hydrogen explosion in Hot Cell G and the connecting K3 duct that releases contamination from the hot cells and connecting contaminated ventilation ducts and thereby releases contaminants that become airborne and also cause external gamma radiation doses.

Unmitigated Risk[7]: FW – High; CP – High; MOI – ND to Low.

Mitigation: Active safety controls are used (backup power for ventilation systems and the hot cell ventilation system itself). The maximum cesium capsule inventory of 150 kCi and maximum strontium capsule inventory of 150 kCi in a single hot cell is a Specific Administrative Control (SAC).

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[5] [HNF 8758 (Rev9), Pg. 3-141, Figure 3-4]

[6] The similarity between the worst DBE Loss of pool cell water and the BDBE earthquake is that the result of loss of pool cell water occurs. The same number of capsules is assumed to fail (1,162 capsules) in each scenario; however, the difference between the scenarios is that estimated human health impacts differ because the estimated source term that is released differs: 3,400 Ci released in the DBE Loss of Pool Cell Water vs. the 38,000,000 Ci released due to the BDBE Earthquake and the co-located person dose is increased from 277 rem in to 380 rem (38 MCi vs. the ~98MCi that is currently estimated for the Cs/Sr capsules). The similarity of the DBE earthquake and BDBE earthquake is obviously, the root cause is a seismic event. The difference is that the DBE earthquake only releases material from the hot cells and connection ventilation system and the BDBE earthquake releases material from the capsules stored within the capsules.

[7] Facility Worker qualitative rating was taken from Hazard Analysis [CHPRC-01352 (Rev2)]; Co-located person and MOI quantitative values were taken from the DSA [HNF 8758 (Rev9)].

[8] [HNF 8758 (Rev9), Pg. 3-31]

[9] The mitigated dose consequences were not provided in the DSA so the CRESP dose consequence levels could not be assigned. The consequence levels from the Hazards Analysis [CHPRC-01352 (Rev2)] were used.

Mitigated Risk[9]: FW – Not reported in Hazards Analysis; CP – Not reported in Hazards Analysis; MOI – Not reported in Hazards Analysis.

Hydrogen explosion in Ion exchange Module [WIXM]: As the resin in a WIXM becomes loaded with radioactive material, the ionizing radiation results in radiolysis of the resin/water and produces hydrogen. If hydrogen were to accumulate inside the WIXM vessel to sufficient quantities the hydrogen can become flammable and eventually detonable if combustion source exists. Such a combustion event could result in the release of contaminated resin and water. For such accident conditions to exist, the excess water in the WIXM vessel would have to be drained (allowing a void volume). Hydrogen would then accumulate in the head space of the vessel above the resin bed. An ignition source could potentially be provided by a static charge inside the vessel or possibly by a spark introduced by some outside activity (e.g., a worker's tool).[10]

Unmitigated Risk[7]: FW – Medium; CP – Medium; MOI – ND to Low.

Mitigation: The credited SSC for this accident scenario is to fill the void space of the WIXM to prevent hydrogen generation. Limiting the maximum radionuclide content within the WIXM is a credited TSR and would help prevent excess hydrogen generation and accumulation.[11]

Mitigated Risk[9]: FW – Low; CP – Low; MOI – Low.

Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter (Current Operations): The DBE earthquake would result in the release of hazardous material from the hot cells and the K3 exhaust ducting. Some of the contamination in the hot cells and K3 duct is postulated to become suspended as a result of the shock of the DBE which may involve structural failure of the stack or A Cell due to failure of the 221-B Building end wall which is not qualified to survive the 0.25 g DBE associated with WESF. The same isotopes are present in the K3 exhaust ducting downstream of the hot cells and would also be subject to shock-vibration release in a DBE. The radioactive material in the truckport and in capsules located in the pool cells, F Cell, or G Cell would not be impacted by the immediate effects of the DBE. The hot cells (excluding A Cell which is assumed to fail from the collapse of the B Plant end wall), canyon, and truckport would survive the DBE.

Unmitigated Risk[7]: FW – High; CP – Medium; MOI – ND.

Mitigation: There are no credited active safety controls for the DBE earthquake accident. There a number of building infrastructure components that are credited passive SSCs[12]. Area 2 is also a credited SSC structure and includes the hot cells and canyon. Operational and institutional controls are in place[13] such that F Cell and G Cell each contain a maximum capsule inventory of 150,000 Ci Cs-137 and 150,000 Ci Sr-90, and capsules are located a minimum of 20 cm (7.9 in.) from any hot cell structural surface to protect against degradation of the concrete structure.

Mitigated Risk[9]: FW – High; CP – Low; MOI – Low.

Beyond Design Basis Earthquake Leads to Loss of Cooling and Shielding Water from All Pool Cells and Release of Cs/Sr from Overheating; Cs and Sr Capsules (Current Operations): As part of its response to the events that occurred at Fukushima, DOE had sites and operating contractors evaluate facility

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[10] [HNF-8758 (Rev 9), Pg. 3-109]

[11] Radionuclide limited to 25,000 Ci Sr-90 or 31,000 Ci Cs-137 with no less than 150 kg resin material. For combinations of Cs-137 and Sr-90, a maximum of 35,000 Ci Sr-90 and Cs-137 with no less than 150 kg resin material. [HNF-8758 (Rev 9), Pg. 3-117]

[12] [HNF-8758 (Rev 9) Pg. 3-64]

[13] AC = Administrative Control [HNF-8758 (Rev 9) Pg. 3-64]

and site responses to beyond design basis events (BDBEs). One of the facilities that garnered particular attention was WESF, due to its similarity to a commercial reactor spent nuclear fuel pool.

In the scenario that was used for the basis of the DSA calculations, it was assumed that 1,162 capsules would fail that would release 38 MCi (of the 98 MCi estimated radioactivity of February 2014 within the Cs/Sr capsules). During a BDBA, the building structure is assumed to fail. Hot cell contamination is released due to impact from debris or vibration. The below grade pool cell structure is assumed to fail and releases pool cell water (water may be contaminated if capsules were damaged by debris). Once the water is gone, the capsules fail over time due to stress cracking or corrosion and material is released from pool cells via evaporation. Pool cell above grade structure is assumed to survive because this results in the largest consequence. Failure of the above ground pool cell area structure provides cooling for the capsules upon a loss of pool cell water and significantly reduces the release of capsule material due to evaporation.

Unmitigated Risk: FW – Not Evaluated in Separate BDBE Analysis; CP – High; MOI – Low.

Mitigation: In the CHPRC response to this DOE tasking a plan of action involved nine (9) actions to address issues at WESF. The major concern evaluated was a loss of water, and thus cooling, to the pool which presently provides both cooling to the capsules and shielding for personnel in the facility and surrounding area. WESF-specific actions included: revision of emergency planning/management procedures to better document actions to be taken to keep adequate water level in the pools; re-arrangement of capsules in the pools to reduce the net heat generation rate; and conduct of drills to demonstrate the ability of emergency response personnel to locate, identify and use emergency fill connections.

Further, the analysis of the seismic BDBE identified that about half of the calculated radiation exposure was due to the release of contamination from ventilation piping in areas of WESF no longer required for the present safe storage mission, of for potential future work, such as capsule movement for packing and dry storage. Thus a project was initiated to retire those portions of the ventilation system that are no longer required for present and anticipated missions, and stabilize the contamination (via grouting in-place); this work will be conducted in parallel with already planned ventilation modifications to be consistent with DOE commitments responding to DNFSB Recommendation 2004-2, Confinement Ventilation.

For a BDBA, the unmitigated frequency of occurrence for Natural Phenomena events cannot be reduced. As this was a BDBA, the contractor was to determine the unmitigated consequences only and not pursue control selection or mitigated consequence evaluation; therefore, no controls were identified to prevent/mitigate the BDBA. The evaluation does recognize that there are current credited design features, exhaust ventilation, and area radiation monitors that are operable and capable of performing their safety functions and that TSR surveillance are current.

There were listed “Existing Facility Controls That Might Help Prevent/Mitigate Event” that included a “Source Inventory Control” that allows for water addition to pool cells from outside facility if radiation levels in pool cell area are high.

Mitigated Risk: FW – Not Evaluated; CP – Not Evaluated; MOI – Not Evaluated.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches:

Future operations and activities that are presently planned relate to building upgrades to the hot cell ventilation system and stabilizing the hot cell areas (Hot Cell A through F). The potential impacts of these activities have been analyzed within the Hazards Analysis[14] and a revised Documented Safety Analysis has not been performed for this phase of work. The Hazards Analysis includes descriptions of impacts and the applicable accident conditions and have been identified. New types of hazards were identified for operation of the replacement ventilation system. Radiation exposure to the facility worker from material on the aboveground (vice present below-grade filters) HEPA filters, external fire involving aboveground HEPA filters, and failure of the aboveground HEPA filters due to impact were identified as Risk Class III events[15]. There were also new types of hazardous conditions identified for performance of the stabilization activities (e.g., hydrogen explosion in the hot cells, structural failure of the hot cells due to heat, and a mobile crane drop on the canyon/hot cells) which were classified as a Risk Class II unmitigated events for the co-located person and will require additional analysis and potentially new controls

Building and Facility: The safe storage of the cesium/strontium capsules and other radiological contamination can be impacted by the following accident and natural phenomenon hazards:

Design basis earthquake with Ventilation Stack Collapse causes Damage Pool Cells and Capsules: If the stack falls over the pool cells, debris could damage capsules and there could be a loss of pool cell cooling or a loss of water. The WESF DSA[16] analyzes significant failure of roof/walls caused by hydrogen explosion in the pool cell area which causes failure of capsules. The unmitigated doses of this accident scenario were added to the unmitigated design basis earthquake impacts in the DSA for current operations[17].

Unmitigated Risk: FW – High; CP – Medium; MOI – Low.

Mitigation: Passive safety controls will be considered (design of the WESF building, stack, and capsules). Operational and institutional controls will be used (radiation protection measures, initial testing and in-service surveillance and maintenance, operational safety measures, procedures and training, and emergency preparedness)

Mitigated Risk: Not Evaluated

Crane drop through roof and impacts canyon and limited number of capsules in Hot Cell G failure: Human error or equipment failure could cause a moving mobile crane or the load to be dropped over Area 2 and could impact the canyon and aqueous makeup unit to the pool cells. Roof failure could cause debris and crane load to fall to canyon floor. The crane load would lose much of its energy breaking through the roof and it would be very unlikely for the debris and crane load to break the 30-inch high density concrete hot cell cover blocks. If the hot cell cover blocks do fail, it is assumed that there are a limited number of capsules located in Hot Cell G. The limited number of stored capsules within Hot Cell G would completely fail. The impacts would be a combination release of contamination from the Hot Cell G and limited capsule release[18].

Unmitigated Risk: FW – High; CP – Medium; MOI – Low.

Mitigation: Passive safety controls will be considered (design of the WESF building and capsules). Operational and institutional controls will be used (prohibiting movement of heavy loads over pool cell

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[14] [CHPRC-02203 (Rev0)]
[15] Risk Class ratings are assigned by the designations of the Hanford SARAH Document [HNF-8739 (Rev2)].
[16] [HNF-8758 (Rev9)]
[17] [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]. The specific [HNF-8758 (Rev9)] section that describes the hydrogen explosion in the pool cell is within Section 3.4.2.4.3.
[18] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]

area, radiation protection measures, initial testing and in-service surveillance and maintenance, operational safety measures, procedures and training, and emergency preparedness)

Mitigated Risk: Not Evaluated

<u>Hydrogen explosion K3 Filter Housing:</u> The WESF DSA[19] analyzes a K3 filter hydrogen explosion and unmitigated consequences are moderate for the co-located person (CP; 58 rem) and low for the maximally-exposed offsite individual (MOI; 0.018 rem). The inventory assumed in this analysis is significantly higher than expected for the new system because the new system will ventilate the canyon and G cell only and there would be an insignificant inventory available in the facility to accumulate on the filters. However, the new system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the MOI.

Unmitigated Risk: FW – High; CP – Medium; MOI – Low.

Mitigation: Active safety controls will be used (backup power for ventilation systems and ventilation system itself). Passive safety controls will be considered (design of filter system). Operational and institutional controls will be used (remove ignition sources).

Mitigated Risk: Not Evaluated

Groundwater

WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 150 years. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by WESF due to the distance between the facility and the river. This leads a ND rating.

Ecological Resources

<u>Current</u>
No resources on EU or buffer, mainly level 2 or below.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>

No resources on EU or buffer to be disturbed during active cleanup.

Cultural Resources

<u>Current</u>
This EU is located within a Manhattan Project/Cold War significant resource that has already been mitigated. There are no archaeological resources known to be located within this EU. Traditional cultural places are visible from this EU.

<u>Risks and Potential Impacts from Selected or Potential Cleanup Approaches</u>
Because no ground disturbance will occur, there should be no impact to archaeological resources.

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[19] [HNF-8758 (Rev9)]

Considerations for timing of the cleanup actions

Present Configuration: WET STORAGE: Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules.

Near-Future Configuration: BUILDING UPGRADES**:** Impacts of delays to ventilation upgrades and stabilization actions are described in Section VI, "Additional Risks and Potential Impacts if Cleanup is Delayed".

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area**:** Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules. The timeliness of moving capsules out of WESF *does* impact the progress of the D&D timeline of B plant and milestone TPA M-092-05.

Near-Term, Post-Cleanup Risks and Potential Impacts

N/A for Operating Facilities Group. Needs D&D Group evaluating B-Plant to work on this section

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

Not Applicable

COMMON NAME FOR EU

Waste Encapsulation and Storage Facility (WESF), Building 225-B, 200 East Area

KEY WORDS

Cesium, strontium, capsules, type-W overpack

REGULATORY STATUS

Present Configuration: WET STORAGE: WESF is a Hazard Category 2 nuclear facility based upon the quantity, form and location of radioactive material, as categorized by DOE-STD 1027-92[20]. It is also categorized as Dangerous Waste Storage and Treatment Facility by Washington State Department of Ecology.

Applicable regulatory documentation: In accordance with 10CFR830, *Nuclear Safety Management*, a documented safety analysis (HNF-8758) has been completed, with required safety controls implemented. The State of Washington has issued a RCRA permit (WA7890008967, Rev 8C, Part A)[21] for WESF operations. Waste at WESF is designated by waste designation "D" (WAC 173-303) and is also characterized with the requirements of 40CFR261 and 40CFR761[22] . Cs and Sr in the forms of cesium chloride and strontium fluoride are currently designated as mixed high-level waste[23]. The chemicals that qualify the capsules as mixed high-level waste are from the manufacturing process impurities (cadmium, chromium, lead, silver) and the decay products of Cs-137 (barium)[24]. WESF also operates under two

[20] [HNF-8758 (Rev9) pg. iv]
[21] [DOE/RL-2006-35 (Rev1) pg. 8-3] and [DOE/RL-2013-47 (Rev0), pg. 5.22]
[22] [DOE/RL-2006-35 (Rev1) pg. 3-2]
[23] [CHPRC-01371 (Rev0), pg. i]
[24] [HNF-8758 (Rev9), Pg. 9-4]

Type E permits under the EPA[25]: (1) WAC-246-247, Radiation Protection – Air Emissions (Permit No: AIR-02-1218) and (2) 40CFR61, Subpart H, NESHAPS (Permit No: EPA-1999-8-12)

Near-Future Configuration: BUILDING UPGRADES: WESF will remain a Hazard Category 2 when building upgrades are complete because the vast majority of the radiological source term is within the cesium and strontium capsules that have not been affected by the building upgrades[26]. A supplemental Hazards Analysis[27] was performed to understand any new or obsolete hazards that would be associated with these actions. There were new types of hazards identified[28] with the temporary operations to support building upgrades and will be discussed later (Part VI). The stabilization and ventilation project currently intends to tie into the existing facility K1/K3 stack placed on site, near WESF[29]. For the stabilization and ventilation project, a new set of Type E permits would be required from the EPA[30]. A list of the environmental strategy in regards to permitting is below[31]:

- Clean Air Act related permitting required for modifications to the ventilation system;
- Resource Conservation and Recovery Act (RCRA) permitting planned for stabilization of the contamination in the hot cells;
- Non-time critical removal action documentation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as a contingent measure, in the event RCRA permitting process cannot be completed in a timely manner to support the project schedule; and
- Cultural, historic, and biological resources reviews.

Longer-Term Future Configuration: Capsule Dry Storage, Limited D&D of 200E Area: The determination of the disposition path of the Cs and Sr capsules, required by the Tri-Party Agreement (M-092-05) by June 2017, requires an understanding of the options that exist for safe storage while meeting other requirements directly related to the decontamination, deactivation, decommissioning, and demolition (D4) of the adjacent B Plant.

Applicable regulatory documentation

DOE Safety and Design (*Present Configuration: WET STORAGE*):

- CHPRC-01352 (Rev2), WESF Hazards Analysis. (2013).
- HNF-8758 (Rev9), WESF Documented Safety Analysis. (2014).
- HNF-SD-WM-TI-733 (Rev3), WESF DSA Supporting Calculations and Assumptions. (2014).
- CHPRC-02047 (Rev0), WESF Beyond Design Basis Accident Conditions and Plans. (2013).
- DOE/RL-2006-35 (Rev1), Hanford Facility Dangerous Waste Permit Application, WESF. (2006).
- HNF-7100 (Rev1), Capsule System Design Description Document. (2013).
- HNF-2822 (Rev0), Capsule Integrity Program Plan for WESF Cs, Sr Capsule Storage. (1998).
- HNF-28601 (Rev3), WESF Capsule Inspection Plan. (2013)

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[25] [DOE/RL-2006-35 (Rev1) pg. 14 of the PDF report]
[26] [CHPRC-02203 (Rev0) pg. 10]
[27] [CHPRC-02203 (Rev0)]
[28] [CHPRC-02203 (Rev0) pg. 10]
[29] [CHPRC-02388 (Rev0), pg. 2]. Public release of CHPRC-02388 (Rev0) will occur near end of May 2015 (personal communication with RL and PNNL).
[30] Two Type E permits issued from the EPA are (1) WAC-246-247, Radiation Protection – Air Emissions (Permit No: AIR-02-1218) and (2) 40CFR61, Subpart H, NESHAPS (Permit No: EPA-1999-8-12) – as described in [DOE/RL-2006-35 (Rev1) pg. 14 of the PDF report].
[31] [CHPRC-02310 (Rev0) pg. 4]

DOE Safety and Design (*Near-Future Configuration: BUILDING UPGRADES*):

- CHPRC-02203 (Rev0), WESF Stabilization and Ventilation Project Hazards Analysis. (2014).
- CHPRC-02269 (Rev0), WESF Stabilization and Ventilation Project Conceptual Design Report. (2014).
- CHPRC-02310 (Rev0), Project Execution Plan for WESF Stabilization and Ventilation Project. (2014).
- CHPRC-02192 (Rev1), WESF Stabilization and Ventilation Project Functional Design Criteria. (2014).

DOE Safety and Design (*Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*):

- CHPRC-02248 (Rev0), Estimate of WESF Capsule Decay Heat Values on 01/01/2018. (2014).
- CHPRC-01371 (Rev0), Functions and Requirements for Cs and Sr Capsule Dry Storage. (2011).
- 6734-Cs-Sr-Storag-001 (Rev2), Cs and Sr Capsule Dry Storage Facility, Data Form 316. (2010).
- WMP-17265 (Rev0), Summary Report for Capsules Dry Storage Project (2003).
- WMP-16938 (Rev0), Capsules Characterization Report for Capsules Dry Storage Project (2003).
- WMP-16937 (Rev0), Corrosion Report for Capsules Dry Storage Project (2003).
- WMP-16940 (Rev0), Thermal Analysis of A Dry Storage Concept for Capsules Dry Storage Project (2003).
- HNF-7367 (Rev0), WESF Interim Status Closure Plan. (2000).
- DOE/RL-2010-102 (Rev0), Active MemorandumD4 Activities for 200 East Tier 2 Buildings/Structures. (2010).

Decision Documents for Final Disposition of Cs/Sr Capsules

- HNF-SD-WM-RPT-294 (Rev0), Decision Document for the Final Disposition of Cs and Sr Capsules. (1997).
- DOE, Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel. (October 2014).

NEPA FEIS and ROD:

- DOE/EIS-0391 (December 2012): Final Tank Closure and Waste Management EIS
- DOE/EIS-0391 ROD (December 2013): Federal Register Announcement

Applicable Consent Decree or TPA milestones

Tri-Party Agreement Milestones

- TPA Milestone M-092-05 (06/30/2017)[32]:
- *"Determine disposition path and establish interim Agreement Milestones for Hanford Site Cs/Sr capsules. DOE will assess the viability of direct disposal of the Hanford Cs/Sr capsules the national high-level waste repository and provide a schedule leading to its disposition. If DOE concludes that direct disposal is a viable and preferred alternative to vitrification, DOE will submit to Ecology specific documentation justifying its conclusion, with a proposed*

[32] [CHPRC-01371 (Rev0)]

Milestone change request establishing enforceable Agreement Milestones for disposition of Hanford Cs/Sr capsules."

- TPA Milestone M-092-03 (09/28/1998)[33]:
- *"Only mixed waste packaged in capsules as identified in the Hanford Federal Facility Agreement and Consent Order Milestone M-92-03 are stored at WSF. No waste has been received into WESF since the return of the capsules completing Tri-Party Agreement Milestone M-92-04 on September 28, 1998. There are no future plans to place additional waste into WESF."*

RISK REVIEW EVALUATION INFORMATION

Completed (Revised): February 9, 2015

Evaluated by: B. Burkhardt, S. Krahn, L. Fyffe

Reviewed by: A. Croff, H. Mayer

PART III. SUMMARY DESCRIPTION

CURRENT LAND USE

The current land use of area 200 East is the DOE Hanford Site.

DESIGNATED FUTURE LAND USE

The DOE preferred alternative is the Industrial Exclusive Use Category for the WESF area (and 200E area)[34]

PRIMARY EU SOURCE COMPONENTS

Legacy Source Sites

Not Applicable

High-Level Waste Tanks and Ancillary Equipment

Not Applicable

Groundwater Plumes

Not Applicable

D&D of Inactive Facilities

Not Applicable

Operating Facilities

There are only a few primary contaminants for WESF: Cesium-137 (Cs-137), strontium-90 (Sr-90), and ingrown decay products (e.g., barium 137 [Ba-137m, Ba-137] from Cs-137, yttrium-90 [Y-90] from Sr-90). These contaminants reside in 3 locations within WESF that present potential signification human impacts (see Part V. Waste and Contamination Inventory for detailed lists): (1) capsules within pool cells

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[33] [DOE-RL-2006-35 (Rev1), pg. 3-1]
[34] [DOE-EIS-0222 CLUP-EIS Summary document, Figure S-10 on page 45/131]

(vast majority with total radioactivity of ~98 MCi); (2) contamination within hot cells, hot cell-connected ventilation ductwork, and hot cell-connected HEPA filters (combined total activity of ~300 kCi); (3) pool water cleaning ion exchange module [WIXM] (varying radioactivity with maximum at 56 kCi).

LOCATION AND LAYOUT MAPS

WESF is located in the 200 East Area of the U. S. Department of Energy (DOE) Hanford Site, north of Richland, Washington. The Hanford Site is a 1517 km^2 (about 586 mi^2) area located in the southeast corner of Washington State (as seen in Figure H.5-1. The Hanford Site is bordered on the north by the Saddle Mountains, on the east by the Columbia River, on the south by the Yakima River, and on the west by the Rattlesnake Hills[35].

[35] [DOE/RL-2013-18 (Rev0), pg. 1.4]

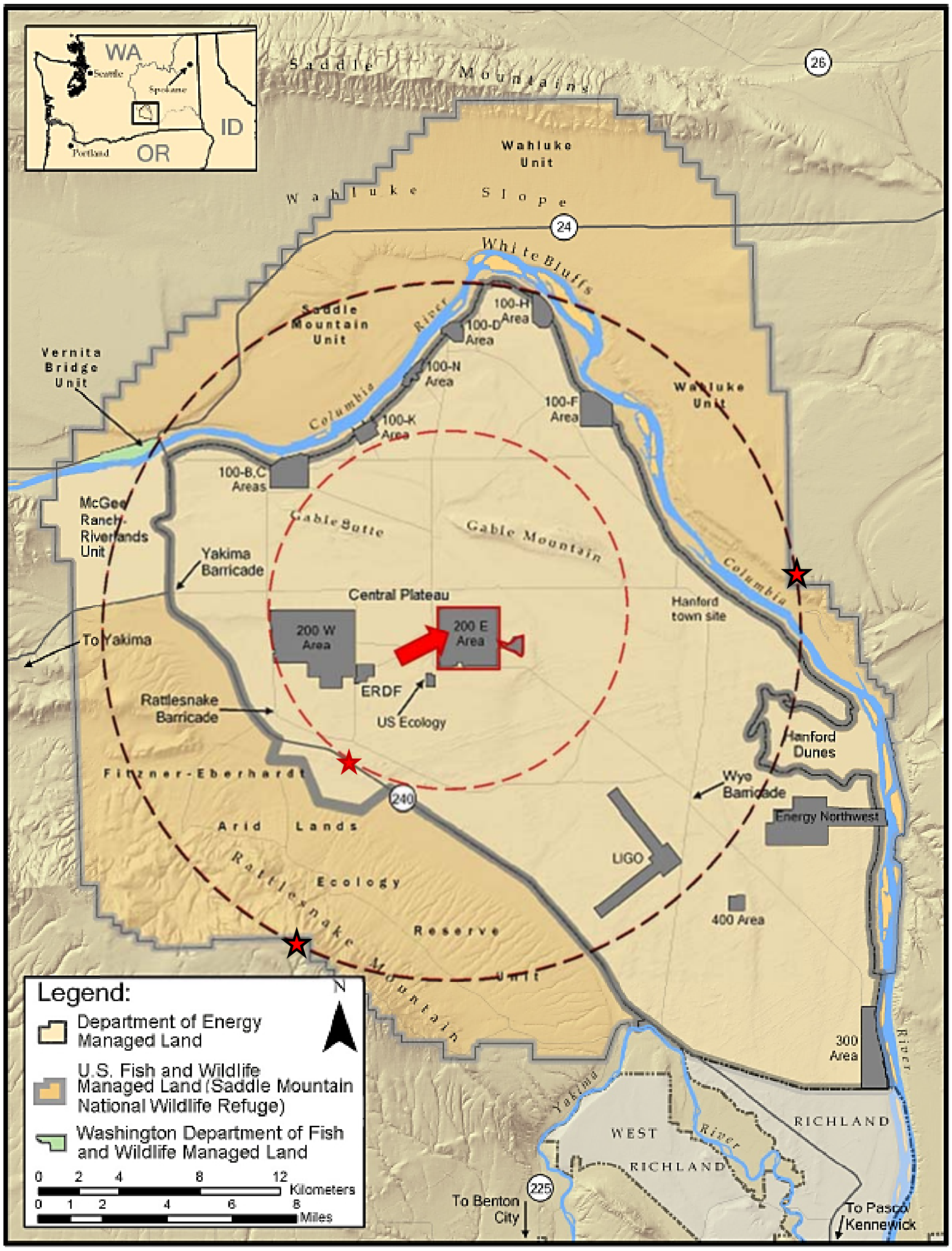

Figure H.5-1. Overall view of the Hanford Site with Highlighted Areas of Interest in Red[36]

Notes: The outline of the 200 East (200 E) Area is shown in red. The red arrow points to the approximate WESF Building location within the 200 E Area. The red star with the red outline marks the approximate location of the hypothetical Onsite Public Receptor on the State Highway 240[37] used for calculating estimated impacts to human health within the Hazards Analysis (HA)[38]

[36] This image from [DOE/RL-2013-18 (Rev0), pg. 1.4]

[37] [HNF-8758 (Rev9), pg. 3-52] states that, "the onsite public represents an alternate site boundary bounded by the near bank of the Columbia River to the north and east, the Wye barricade to the southwest, and Highway 240 to the west and south. The closest distance for the onsite public from Table 3-7 is 8,260 m, which is used in the RADIDOSE calculations (rounded to 8,300 m). The MOI or offsite receptor represents the current Hanford Site boundary (i.e., the fence line). The closest distance for the offsite receptor from Table 3-7 is 16,640 m, which is used in the RADIDOSE calculations (rounded to 17,000 m)."

[38] [CHPRC-01352 (Rev2)]

and the Documented Safety Analysis (DSA)[39] for the WESF facility. The distance from the WESF facility boundary to the approximate location of the Onsite Public receptor is 8,300 m (8.3 km)[40]. The dashed red circle marks the circumference of 17 km that the hypothetical Offsite Public receptor is located for estimating impacts to human health impacts[41]. The two red stars with black outline denotes the two eligible places that could be the location of the hypothetical Offsite Public receptor.

Figure H.5-2 illustrates the location of the 200 East (200E) Area in reference to the Hanford site and surrounding areas. The red arrow indicates the location of WESF inside of the 200 East area. The regional highway network traversing the Hanford Site (State Highways 24 and 240) has restricted access roadways. The nearest road to WESF is Atlanta Avenue located approximately 60 m (200 ft) west of 225-B[42].

The subsequent figure (Figure H.5-3) is an enlarged photo of the WESF complex and nearby facilities.

Figure H.5-2. Overall view of the 200E Area (outlined in yellow) and the WESF complex is highlighted in Red and a Red Arrow points to its location adjacent to the B-Plant[43]

[39] [HNF-8758 (Rev9)]
[40] [HNF-8758 (Rev9), pg. 3-52 and Appendix A, Pg. 336 of 371 of the PDF report].
[41] [HNF-8758 (Rev9), pg. 3-52 and Appendix A, Pg. 336 of 371 of the PDF report]
[42] [HNF-8758 (Rev9), pg. 1-10]
[43] From the online mapping tool, Phoenix, created by PNNL.

Figure H.5-3. Zoomed-in view of the 200E Area and the WESF complex is highlighted in Red[44]

[44] From the online mapping tool, Phoenix, created by PNNL.

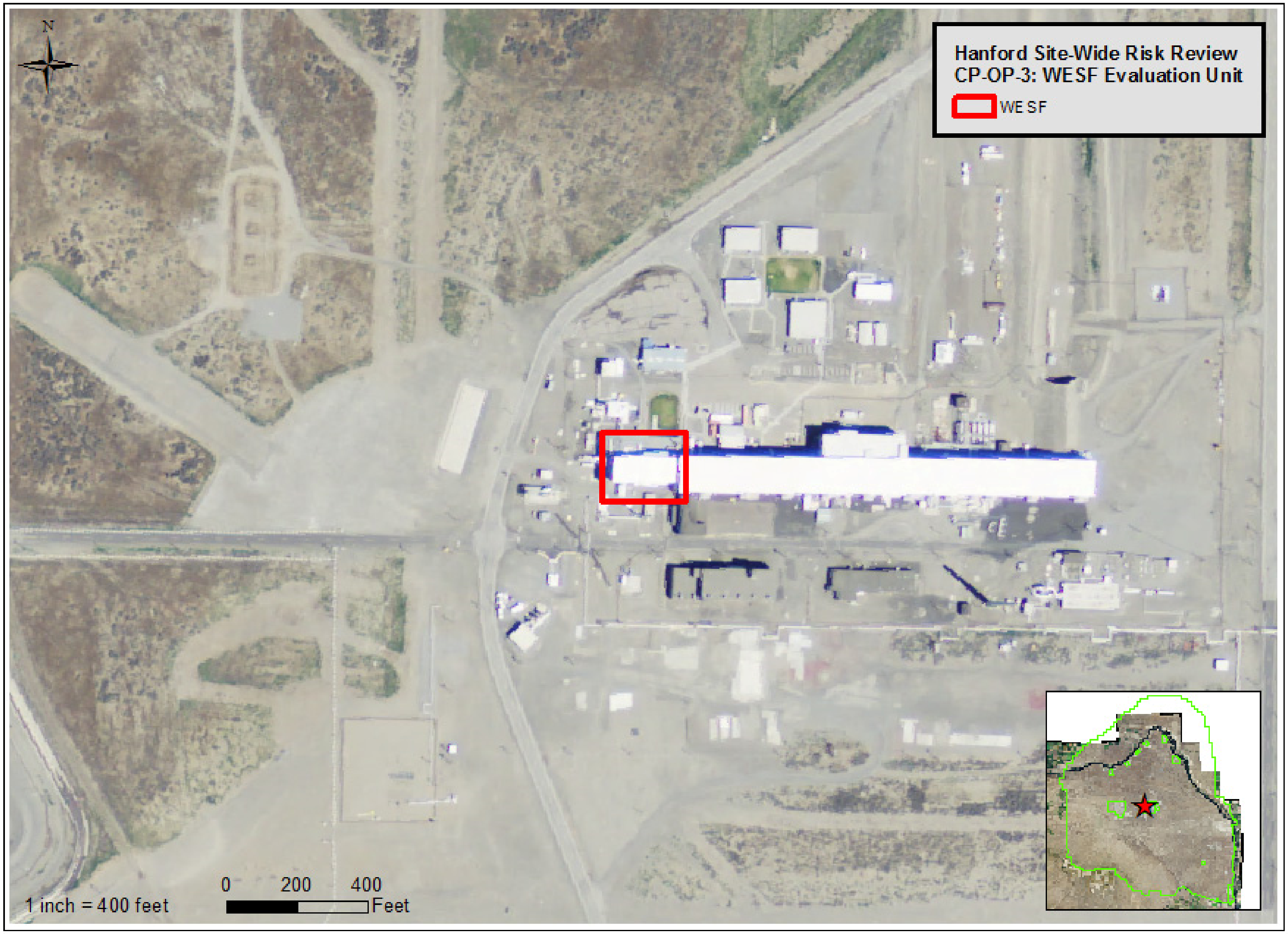

Figure H.5-4. EU Boundary Map

WESF is divided into three major functional unit areas. Area 1 is a one-story above grade reinforced masonry wall structure with a metal deck diaphragm roof supported on open-web steel joists and steel beams and includes the WESF support area, heating ventilation and air conditioning room, pool cell entry airlock, and pool cell monitoring area. Area 2 is a two-story above grade structure with reinforced concrete roof and floor slabs supported by reinforced concrete shear walls in the section of the 225-B Building enclosing the hot cells, canyon, hot and cold manipulator shops, manipulator repair shop, operating gallery, service gallery, and aqueous makeup area. Area 3 is a one-story structure that contains the truckport and pool cell area (pool cells are below grade)[45].

WESF consists of the 225-B Building and several support buildings and systems. The 225-B Building is a two-story structure 48 m (157 ft) long by 30 m (97 ft) wide by 12 m (40 ft) high at the outside dimensions. The first floor is 1300 m2 (14,000 ft^2) and the second floor is 560 m^2 (6,000 ft^2). The ground elevation at this facility is approximately 213 m (700 ft) above sea level and is approximately 61 m (200 ft) above the underground water table[46]. The plan views of the first and second floor are shown in Figure H.5-5 and Figure H.5-6. The following series of figures (Figure H.5-7 and Figure H.5-8) show the elevation views of the WESF complex according to various cardinal directions. It is not shown in Figure H.5-7, but it is important to note that the K3 ventilation ducts are subgrade and are located under the hot cells and will be grouted in place as part of the near-term phase for WESF.

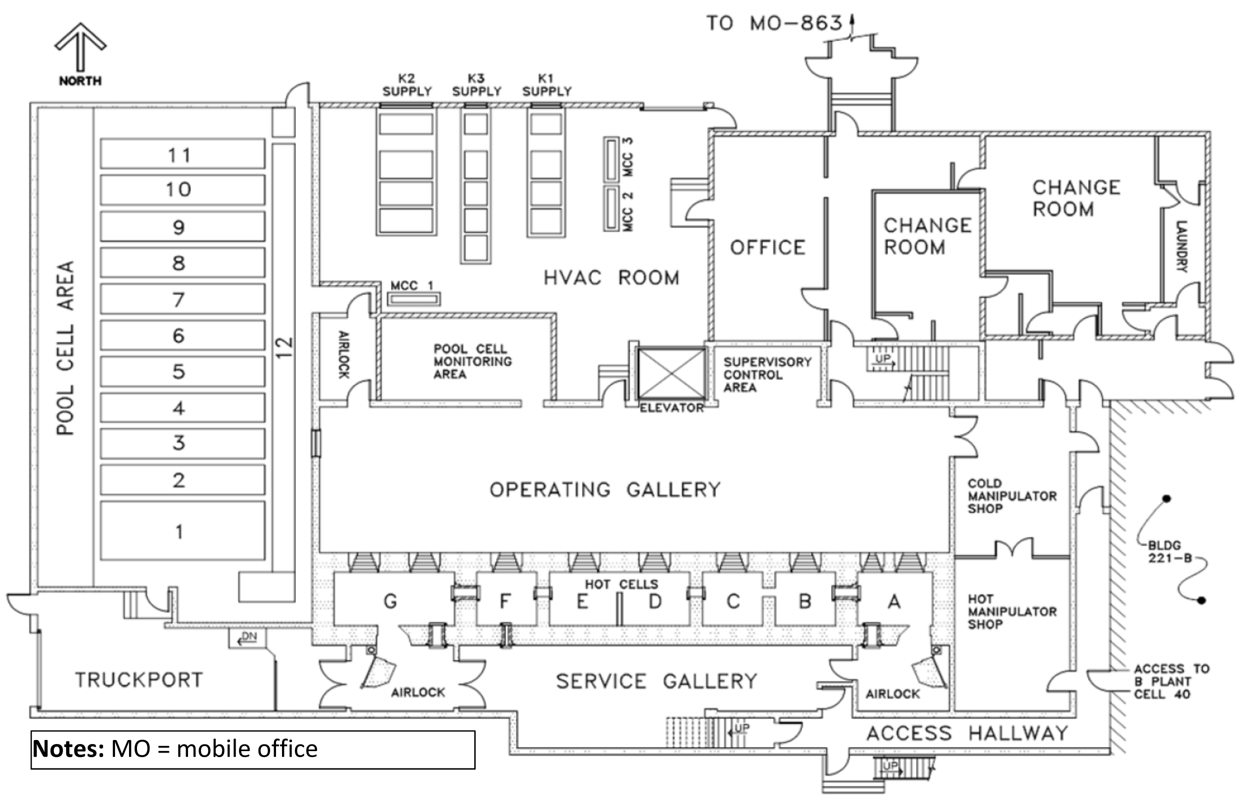

Figure H.5-5. WESF Pool and Process Cells Building Layout (1st Floor)[47]

45 [HNF-8758 (Rev9) pg. iii] [HNF-8758 (Rev9), Figure 2-4
46 [DOE/RL-2013-18 (Rev0), pg. 1.4]
47 [HNF-8758 (Rev9), Figure 2-5]

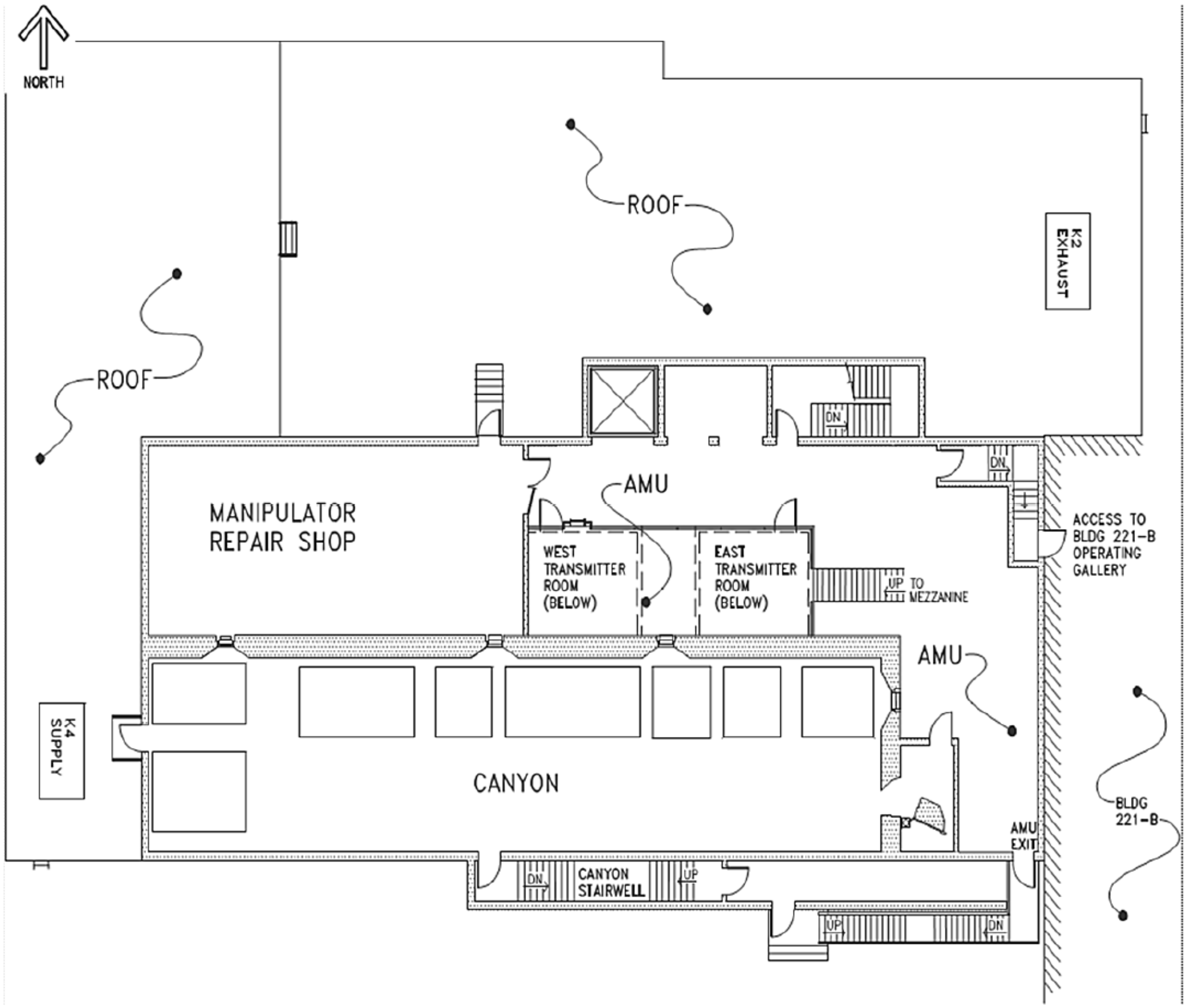

Figure H.5-6. WESF Pool and Process Cells Building Layout (2nd Floor)[48]

[48] [HNF-8758 (Rev9), Figure 2-6]

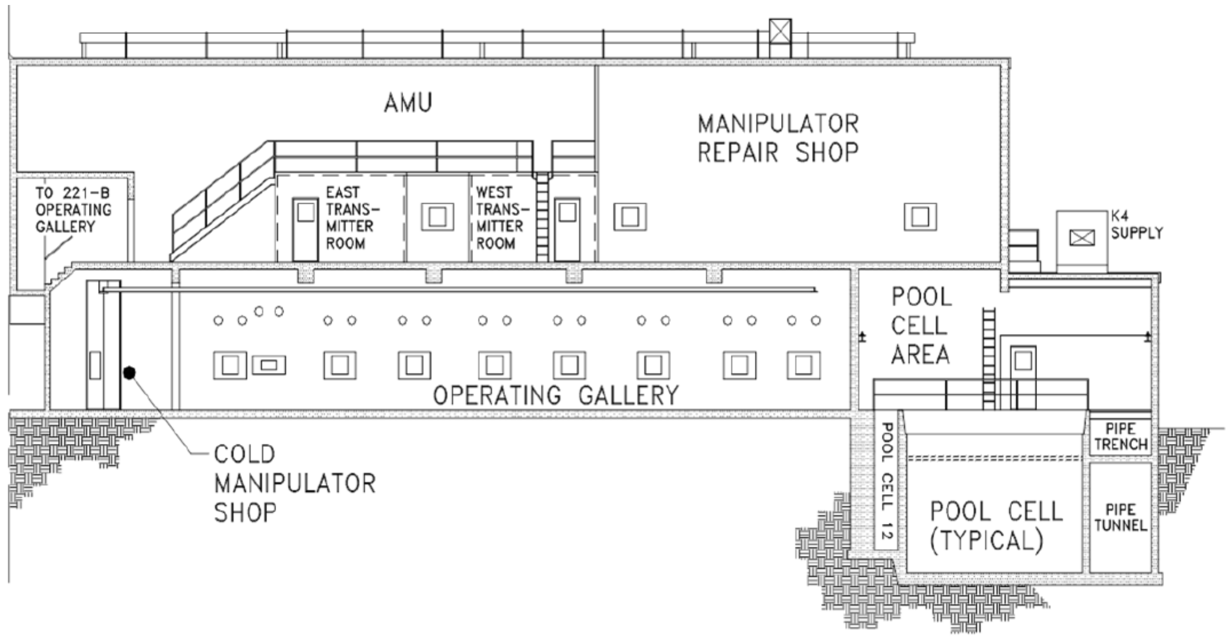

Figure H.5-7. WESF East-West Sectional View[49]

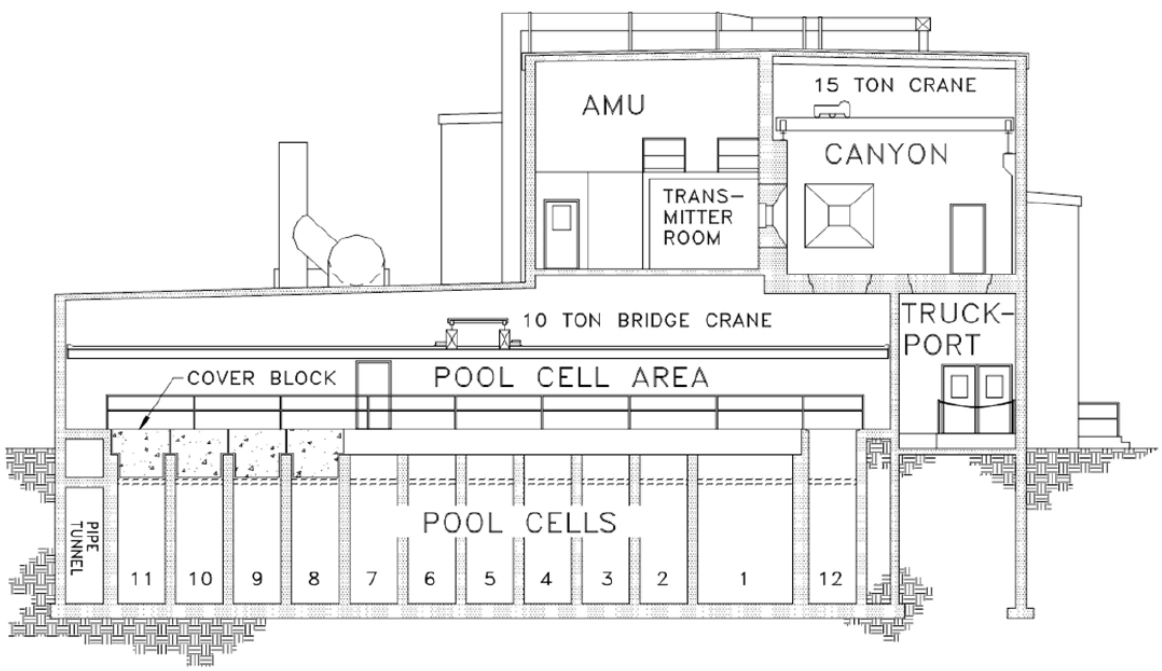

Figure H.5-8. WESF North-South Sectional View[50]

The general area of the K3 replacement ventilation and exhaust system is shown in the highlighted area in Figure H.5-9. The current configuration for the K3 ventilation system is shown in Figure H.5-11.

49 [HNF-8758 (Rev9), Figure 2-7]
50 [HNF-8758 (Rev9), Figure 2-8]

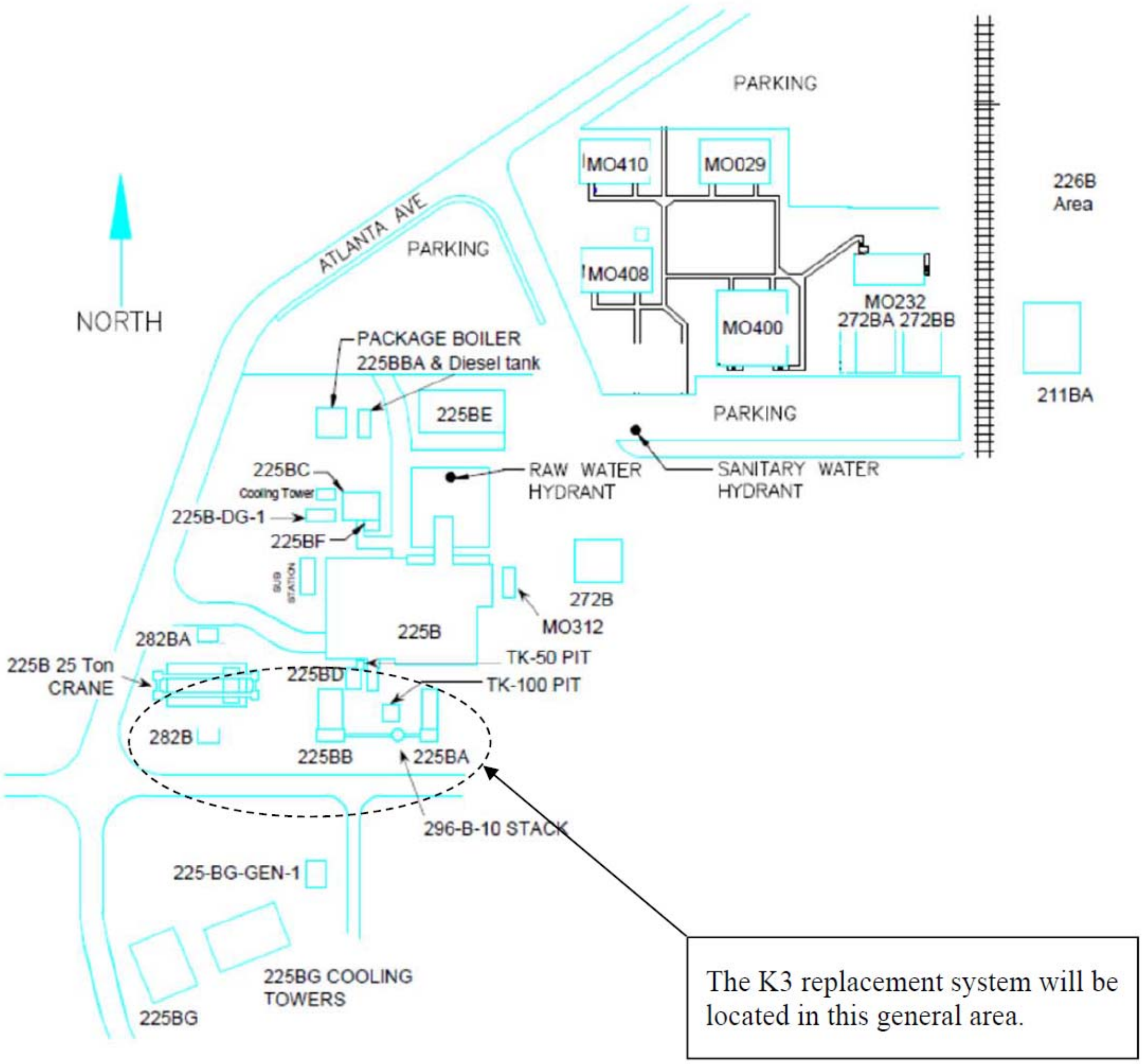

Figure H.5-9. WESF Site Plan and Anticipated K3 Replacement System General Location[51]

[51] [CHPRC-02203 (Rev0), Pg. 4, Figure 2]

PART IV. UNIT DESCRIPTION AND HISTORY

FORMER USES AND HISTORY

The Waste Encapsulation and Storage Facility (WESF) was designed and constructed to process, encapsulate, and store Sr-90 and Cs-137 separated from wastes generated during the chemical processing of used fuel on the Hanford Site. Hanford produced 1577 cesium capsules and 640 strontium capsules for a total of 2217 capsules. However, during the years since their production some capsules have been removed from WESF and sent elsewhere for a range of purposes under a range of conditions. The capsules that have been returned are in storage currently (1959 total capsules). The capsules that were not returned to WESF were deconstructed and placed into glass logs (Germany, 187 of the capsules) and the remaining 71 capsules were destructively examined by various entities.

The construction of WESF started in 1971 and was completed in 1973. Cesium processing was shut down in October 1983 and strontium processing was shut down in January 1985. Final overall process shutdown was accomplished in September 1985. Shutdown for the cesium and strontium processes involved equipment cleanout, equipment isolation or removal, jumper removal, nozzle blanking, window refurbishment, and instrumentation deactivation for the hot cells. Only equipment and instruments that were required for cell maintenance and surveillance remained operational in the hot cells. The water sources to A through F Cells have been isolated and the manipulators were removed from A through E Cells. Capsules can still be stored in F and G Cells if necessary (in addition, Cell G has very little contamination and only has a significant radiation source when capsules are present[52]). WESF continues to store the Hanford Site's inventory of cesium and strontium capsules in the pool cells. The current WESF mission is currently limited to facility maintenance activities; inspection, decontamination, and movement of capsules; and storage and surveillance of capsules[53].

WESF Risk Drivers

Present Configuration: WET STORAGE: WESF risk drivers are radioactive material (Cs, Sr, and decay products) contained in the capsules currently stored in the pool cell areas 1 through 11, the contamination from the production of these capsules remaining in the hot cells of Cs, Sr (and decay products), and contamination within the K3 ventilation system used as the dedicated exhaust and air-filtering system from the hot cells. There is also a bounded, but varying level of contamination from the pool water cleaning ion exchange module that is also considered as a potential source of radioactive material.

The radioactive Cs and Sr, and their decay products, poses a considerable hazard. To place the radioactivity of this radiological hazard source into context, the volume of the material in all of the Cs and Sr capsules combined is approximately 2 cubic meters (m^3) (70 ft^3), which is very small in comparison to the 2.1 E+5 m^3 (7.5 E+06 ft^3) in the waste storage tanks. Although the amount of material in the capsules is small, the amount of radioactivity contained in the capsules is approximately 35 percent of the total activity of the waste storage tanks and the capsules combined[54].

The chemical hazard evaluation estimated inhalation intakes for identified chemical emissions and evaluated potential Incremental Lifetime Cancer Risk (ILCR) and noncarcinogenic health hazards using chemical-specific cancer slope factors and reference doses, respectively. Although the cesium and

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[52] [HNF-8758 (Rev9), pg. 2-23]
[53] [HNF-8758 (Rev9)]
[54] [DOE-EIS-0189 (1996), pg. 352/1780 of the PDF]

strontium capsules contain chloride, fluoride, and the decay products barium-137 and zirconium-90, no emissions of these chemicals would be associated with any of the capsule alternatives.[55,56]

In regards to chemicals, except for the K-5 cooling system glycol, the trisodium phosphate crystals (Na3PO4), WIXM Amberlite or Purolite resin beads, and the chemicals used for the closed loop cooling system the quantities of chemical materials used in WESF are extremely low. Most of the materials are in use for general housekeeping purposes and are in quantities used for the typical household but not in greater quantities than found in institutions (e.g., schools, hospitals, hotels/motels). None of the chemicals at WESF pose a credible onsite, 100 m (328 ft), offsite (Hanford boundary), or environmental risk based on the quantity of material and the dispersion properties due to the physical characteristics of the materials. The materials discussed are not considered as having any significant exposure potential outside the immediate spill or work area[57].

Near-Future Configuration: BUILDING UPGRADES**:** Risk drivers during the ventilation upgrades are limited to the release of radioactive material that presently contaminates the K3 filter. Risk drivers for the building stabilization portion of work include release of contaminated material and radioactive constituents during the grouting of the hot cells. Building stabilization performed will include grouting in place hot cells A through F (while leaving hot cell G for potential future use as a location for a dry transfer of capsules into dry storage containers).

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area**:** Risk drivers associated with longer-term future configuration are radioactive material contained in the capsules during movement into dry storage containers. Any D&D activities are tentative for WESF until plans for dry storage of capsules can be finalized.

WESF Radioactive Material Storage

Present Configuration: WET STORAGE: The majority of radioactive material (cesium chloride and strontium fluoride) at WESF is confined in doubly encapsulated stainless steel capsules. WESF currently stores 1,335 cesium capsules, 23 of which are single-contained Type W overpack capsules[58], and 601 strontium capsules in pool cells located in the 225-B building. The dimensions of the capsules are listed in Table H.5-2 and shown in Figure H.5-10. The 23 W type overpack capsules consist of 16 capsules were placed inside Type W overpacks. In addition to the 16 WESF capsules placed in Type W overpacks, there were seven additional Type W overpack capsules produced that contain material from previously cut-up cesium capsules. A Type W is a single overpack capsule tested to the requirements of original WESF inner and outer capsules. Type W overpack capsules contain failed/suspect WESF capsules, powder and pellets from former WESF capsules, Nordian Capsules, or Oak Ridge Type 4 containers. The reports containing engineering design details and regarding the inspection and integrity testing plan are the following:

- HNF-7100 (Rev1), Capsule System Design Description Document
- HNF-2822 (Rev0), Capsule Integrity Program Plan for WESF Cs, Sr Capsule Storage
- HNF-28601 (Rev3), WESF Capsule Inspection Plan

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[55] [DOE-EIS-0189 (1996), pg. 213/1780 of the PDF]
[56] [CHPRC-02047 (Rev0), pg. 91/172 of the PDF]
[57] [HNF-8758 (Rev9), Pg. 3-23]
[58] [HNF-8758 (Rev9), Pg. 2-38]

Table H.5-2. Capsule Properties[59]

Item	Initial activity	Containment boundary	Material	Wall thickness[a] (in.)	Outside diameter (in.)	Total length (in.)	Cap thickness (in.)
CsCl capsule	70 kCi Cs-137	Inner	316L	0.095, 0.103, or 0.136	2.25	19.75	0.4
		Outer	316L	0.109, 0.119, or 0.136	2.625	20.775	0.4
SrF_2 capsule	90 kCi Sr-90	Inner	Hastelloy[b]	0.12	2.25	19.75	0.4
		Outer	316L	0.12	2.625	20.1	0.4
Type W overpack	70 kCi Cs-137	Single	316L	0.125	3.25	21.825	Not applicable

Note:

a. The specified wall thickness of the CsCl capsules was increased twice during production.

b. Hastelloy is a registered trademark of Haynes International, Inc.

CsCl = cesium chloride.
SrF_2 = strontium fluoride.

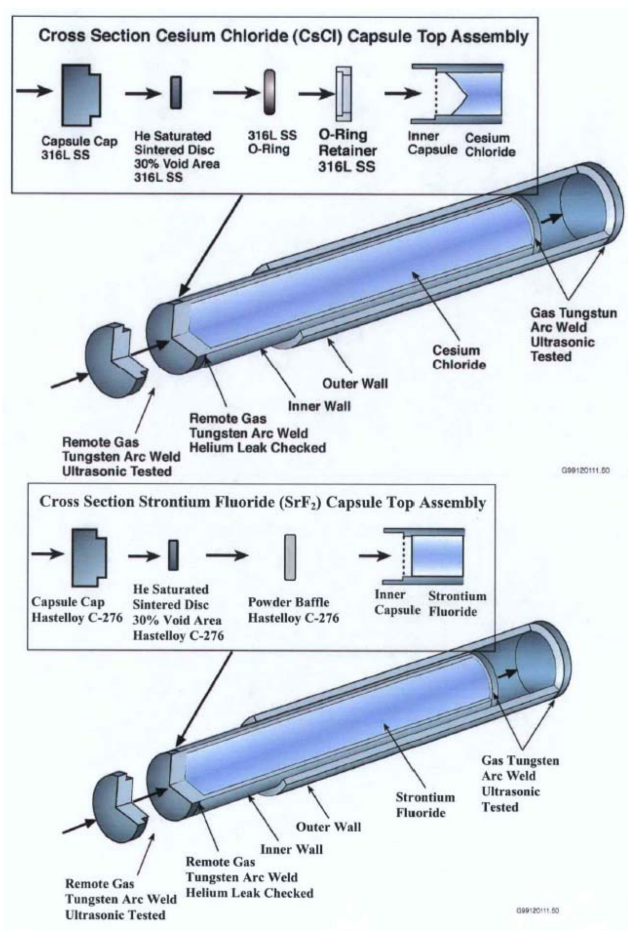

Figure H.5-10. Schematic of Cesium and Strontium Capsules[60]

[59] [CHPRC-01371(Rev0), pg. 6, Table 3-1]
[60] [CHPRC-01371(Rev0), pg. 7, Figure 3-1]

***Near-Future Configuration: BUILDING UPGRADES*:** Radioactive materials at WESF will remain stored in the cooling pool cells while building upgrades occur. Radioactive material that contaminates the hot cells A through F will be physically removed by scraping the face of the vertical walls of the hot cells (the scrapings will fall to the hot cell floor and remain[61]) and then the material will be grouted in place. The contaminated radioactive material within the K3 ventilation system will be grouted in place for the section of the ductwork that is not connected to the new ventilation/filtration system.

The WESF hot cells and the canyon are contaminated areas and are supplied and exhausted by the K3 ventilation system. The supply air is filtered, heated or cooled appropriately, and distributed through a duct network (as shown in Figure H.5-11). The K3 HVAC system supplies 100 percent outside air and all of the K3 air supply flows into the canyon. Some of the air is drawn into the hot cells through two parallel inlet HEPA filters for each cell located in the canyon. The canyon is also directly exhausted to the K3 HEPA filters. The exhaust from the K3 filter is discharged to a stack common to the K1 and K3 exhaust systems at WESF[62].

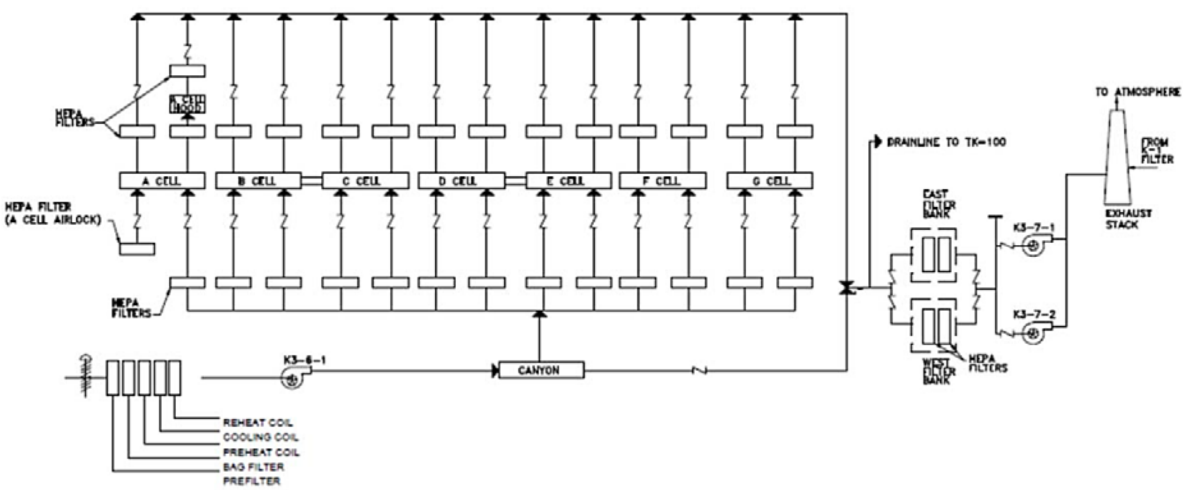

Figure H.5-11. K3 Ventilation Diagram[63]

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** Radioactive material inside of the doubly-housed capsules will be placed into an additional overpack designed to sit within a basket of a dry cask storage container—similar to those presently used for spent nuclear fuel. The dry cask container will be placed on a concrete pad in the 200 East area near the current location of the WESF building and B Plant. The design of the dry cask container is in the initial stages of requesting proposals, initial conceptual ideas include placing around 16 capsules into a single dry cask[64]; it is estimated that 2 casks can be loaded each week and placed on a concrete pad outside of WESF.

[61] Personal Communication with WESF Facility Managers during the CRESP visit in October 2014
[62] [HNF-8758 (Rev9), Pg. 2-40]
[63] [HNF-8758 (Rev9), Pg. 2-42, Figure 2-12]
[64] [CHPRC-01371 (Rev0), Pg. 12, Section 3.3]

WESF Radioactive Material Classifications

The waste at WESF, specifically the impurities and decay products within the Cs and Sr capsules, is designated by waste designation "D" (WAC 173-303) and is also characterized with the requirements of 40CFR261 and 40CFR761[65].

WESF Annual Average and Maximum Individual Worker Collective Doses

Present Configuration: WET STORAGE: The average and maximum annual individual dose for workers at the WESF facility was not available. The only value available described an assumed dose of 200 mrem/year for personnel operating evaporators, retrieval facilities, separation and treatment facilities (both in situ and ex situ), and for processing the capsules[66]. The data that were available and published related to the general 200 East area and assumed to be representative of the WESF facility. The average annual individual dose (averaged from 2011 to 2013) [67,68] was 102 mrem. The average of the maximum annual dose from 2011 to 2013 for an individual worker at WESF was 264 mrem (average of 100 mrem (2011); 176 mrem (2012); and 230 mrem (2013)).

Near-Future Configuration: BUILDING UPGRADES**:** The estimated average annual individual dose for workers at the WESF facility for during facility upgrades has not been quantified yet due to an absence of a documented safety analysis for this phase of work.

Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area**:** The estimated average annual individual dose for workers has not been estimated but preliminary information was provided at a conceptual and high level[69]. The Capsule Dry Storage (CDS) Project shall be designed to limit occupational radiation exposures in accordance with the requirements in 10 CFR 835 and CHPRC-00073[70]. The CDS Project shall use WESF HVAC systems with high-efficiency particulate air (HEPA)-filtered exhaust to minimize potential releases from the building as a result of capsule retrieval and overpacking operations. Limiting radiation exposure to facility personnel is a key driver for operations at WESF, during transport, and at the Capsule Dry Storage Area (CDSA). Due to the high dose rates associated with the capsules, all capsule handling and overpacking activities will be conducted in the WESF G Cell with remote-operated equipment or with sufficient shielding to protect facility workers. After overpacking, all handling operations will be performed within the transfer cask and/or storage cask. The design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupational occupancy (2,000 hours/year) shall be to maintain exposure levels below an average of *0.5* mrem *(5* mSv) per hour and as far below this average as is reasonably achievable. The design objectives for exposure rates for a potential exposure to a radiological worker where occupancy differs from the above shall be ALARA and shall not exceed 20 percent of the applicable standards in 10 CFR 835.202 of 5 rem (20% * 5 rem = 1 rem).

WESF Processes and Operations

Present Configuration: WET STORAGE: WESF is operated as a miscellaneous storage unit in accordance with the provision of WAC 173-303-680. Safe storage of the Cs and Sr capsules includes active monitoring, inspection, testing, and cooling of capsules in pool cells. Ancillary activities such as building maintenance are also conducted within the facility. Waste and drum load-out can be performed in Hot Cell A. Hot Cells B through E are on cold standby status. Hot cells F and G remain active for cesium and

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[65] [DOE/RL-2006-35 (Rev1) pg. 3-2]
[66] [DOE-EIS-0190 (1996), pg. 212/1780 of the PDF]
[67] [DOE/RL-2013-18 (Rev0), pg. 4.2)
[68] [DOE/RL-2013-47 (Rev0) pg. 4.3]
[69] [CHPRC-01371 (Rev0), Pg. 23]
[70] CH2MHill Plateau Remediation Company (CHPRC). (2013). CH2M HILL Plateau Remediation Company Radiological Control Manual. CHPRC-00073, Revision 10

strontium capsule storage[71]. F Cell is still an active hot cell with installed manipulators. G Cell is an active cell currently used for capsule inspections, capsule polishing and scribing, and providing dry storage of nonconforming capsules[72].

Monitoring and maintenance activities for the capsules involve calculating the annual inventory, physically verifying that the inner capsule can still move independently of the outer capsule (discussed below), and using online radiation monitors to detect pool cell water contamination. The annual inventory provides the exact storage location and accountability for all of the Cs and Sr capsules stored at WESF. The Cs and Sr capsules undergo the "Inner Capsule Movement (ICM)" test[73]. The ICM test involves physically grasping one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making it possible to be easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged. The frequency that the ICM test is performed has evolved over time; presently is to perform the ICM test on 20% of the inventory every other year with all capsules being inspected every 10 years irrespective of statistical considerations[74].

Near-Future Configuration: Building Upgrades**:** No process operations to the radioactive material will be performed[75]. Stabilization by grouting of the majority of the hot cells will be performed by grouting in place all waste and remaining equipment. The ventilation ductwork of K3 will have sealed off air pathways to prevent airborne spreading of radioactive materials. Major assumptions of the operations required to perform the stabilization of the residual (legacy) contamination in hot cells A through F and the below grade K3 ventilation system ductwork[76]:

- The stabilization method used will be grout
- The grouting will not affect the seismic design of the facility
- No equipment/material will be removed from the hot cells before grouting (e.g., tanks, conduit, filters, etc.) and the hot cells will not be decontaminated (other facility areas may require minor decontamination efforts to support work activities)
- Sealing of windows and manipulator ports will be performed
- Heavy equipment will be located near the 225B Building and crane work will be required over Area 2 (hot cells/canyon)
- No heavy loads will be lifted over Area 3 (pool cells)

Major assumptions of the required activities to complete the construction and then operate the replacement ventilation system include the following actions[77]:

- The replacement ventilation system will consist of fan(s), stack and aboveground HEPA filter unit
- The existing K3 duct will be isolated from existing stack (296-B-10)
- The replacement exhaust ventilation system will be located southwest of the 225B
- Heavy equipment will be located near the 225B Building and crane work will be required southwest of the 225B Building
- No heavy loads will be lifted over Area 3 (pool cells)

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[71] [DOE/RL-2013-47 (Rev0), pg. 5.22]
[72] [HNF-8758 (Rev9), pg. 2-23]
[73] The ICM test was formerly called the "clunk test". The name originated due to the "clunk" noise when the inner capsule slid within the outer capsule would make a "clunk" sound that is easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged. Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014.
[74] Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014 and fully documented in [HNF-8758 (Rev9), pg. 2-31 and [HNF-28601 (Rev3), Pg. 7]
[75] [CHPRC-02203 (Rev0) pg. 10]
[76] [CHPRC-02203 (Rev0) pg. 5]
[77] [CHPRC-02202 (Rev0), pg. 6]

- There will be no change to the function of the ventilation supply systems (flow rates may need to be adjusted)
- Hands-on filters change outs will be performed regularly
- The stack will have a monitoring system
- The filters will have a fire suppression system
- The replacement system will ventilate all hot cells until grouting is done and then will only vent G Cell and the canyon

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The unit operations required for longer-term configuration include transferring capsules within an additional storage overpack and then placement into dry storage casks. The dry storage casks will be then transferred to a concrete pad on the Hanford site in the 200 East Area near WESF and B Plant. Limited D&D efforts are ongoing and to be determined.

WESF Complexity of Processes and Operations

Present Configuration: WET STORAGE: Under the current mission of safe storage and maintenance of the Cs and Sr capsules, there are a limited number of processes that occur. The treatment of pool cell water and capsule integrity testing are performed on a regular basis. The ancillary activities required for generic building maintenance are performed. The complexity of these listed activities is low.

***Near-Future Configuration: BUILDING UPGRADES*:** Ventilation upgrades and stabilization actions of grouting hot cells do not anticipate complex operations. Normal construction safety considerations will be observed. The additional prudent actions that must be taken to prevent release of contamination within the hot cells, K3 duct and ventilation system include avoiding dropping heavy loads to avoid opening a pathway to radiological exposure of facility workers. The level of complexity for this near-term operational phase is elevated from the present status, but remains low.

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The unit operations required for longer-term configuration of Cs and Sr capsules within dry storage casks includes the transferal of capsules into the casks, placement of casks to and onto the designated CDSA (Capsules Dry Storage Area), and then dry storage of casks. All three types of operations have been performed extensively within the commercial nuclear power industry and are done so safely and efficiently. WESF facility managers know of this experience and have chosen to place a RFP from cask vendors that have such experience. The anticipated level of complexity required for this phase of work is comparable to operations in spent nuclear fuel storage pads at commercial nuclear power plants.

WESF Material Flows (Ingress and Egress)

Present Configuration: WET STORAGE: All of the waste in storage at WESF originated at WESF. WESF does not receive waste from other facilities at this time. Any additional waste accepted into WESF would require a revision to the Hanford Facility Dangerous Waste Permit Application[78] and a modification of the sitewide permit. Only mixed waste packaged in capsules as identified in the Tri-Party Agreement Milestone M-092-03 are stored at WESF. There are no plants to place additional waste into WESF[79].

During the site tour by the assigned CRESP team in mid-October 2014 – personal communication with the WESF managers and operators noted that the stainless steel liner of the pool for Pool Cells 5 and 10 are known to have small liner leaks. Pool cell water leakage was collected in a sump at a rate of

[78] [DOE/RL-2006-35, pg. 3-2]
[79] [DOE/RL-2006-35 (Rev1) pg. 3-2]

approximately 12-15 liters every few months[80]. Collected water was then tested through the facility's testing equipment for beta-counts and resulting with no radioactive material within the collected water.

***Near-Future Configuration: BUILDING UPGRADES*:** Ventilation upgrades and stabilization actions of grouting hot cells do not intend to move radioactive material or any hazard sources out of WESF.

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The unit operations required for longer-term configuration includes transferring capsules out of the facility. Doubly-contained capsules and W-type capsules will be placed into a dry cask. Initial conceptual ideas include placing around 16 capsules into a single dry cask, where it is estimated that 2 casks can be loaded each week and placed into a concrete storage module that will be located at a concrete pad outside of WESF. It was estimated that 8 dry casks will fit into a single concrete module. The total length of this process is estimated to take 16 months, as follows:

a. 1335 Cs capsules + 601 Sr capsules + 23 W-type capsules = 1959 total capsules
b. Total # of dry casks required = (1959 capsules) / (16 capsules/dry cask) ≈ 123 dry casks
c. Total # of concrete modules required = (123 casks) / (8 casks/module) ≈ 16 modules
d. Time to load all capsules (weeks) = (123 casks) / (2 casks/week) ≈ 62 weeks
e. Time to load all capsules (months) = (62 weeks) / (4 weeks/month) ≈ 16 months

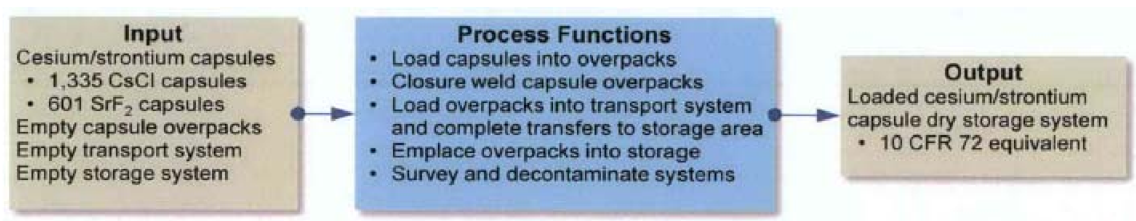

Figure H.5-12. Top-Level Process Function of Outloading Capsules from Pool Cells to a Dry Storage System[81]

WESF Impact of Delays

Present Configuration: WET STORAGE: Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules.

***Near-Future Configuration: BUILDING UPGRADES*:** Impacts of delays to ventilation upgrades and stabilization actions are described in Section VI, "Additional Risks and Potential Impacts if Cleanup is Delayed"

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** Continued need to perform surveillance and maintenance on WESF systems and Cs and Sr capsules. The timeliness of moving capsules out of WESF *does* impact the progress of the D&D timeline of B plant and milestone TPA M-092-05.

WESF Infrastructure

Present Configuration: WET STORAGE: Infrastructure that is considered part of the WESF facility includes the pool cells, hot cells, and the superstructure (building)[82]. For additional details, see Part VI

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[80] [HNF-8758 (Rev9), Pg. 2-27] The quoted volumetric flow rate of the leak is 0.8 L/week.
[81] [CHPRC-01371 (Rev0), pg. 8, Figure 3-3]
[82] [HNF-8758 (Rev9) pg. iii]

(answers to questions 2 through 4). The infrastructure is shown in the previous section (Part III: Summary Description) within Figure H.5-5, Figure H.5-6, Figure H.5-7, and Figure H.5-8).

***Near-Future Configuration: BUILDING UPGRADES*:** The infrastructure will remain the same with the exception that there will be a new exhaust ventilation system installed for the K3 system. The ductwork connecting the hot cell and canyon will be grouted to the point right before the K3 ventilation system crosses through the building wall. This disconnect point this will be the location of the new connection where the K3 system will be repurposed by joining to other exhaust air ventilation systems and filter air from just the Hot Cell G and the canyon[83]. The ventilation activities will replace the existing K3 exhaust ventilation system with new equipment that is tailored to the needs of the facility during stabilization operations and after stabilization activities are complete. The replacement exhaust ventilation system will include exhaust fans, stack monitoring equipment, and ventilation controls. The currently existing K1/K3 stack on the WESF site will be used as part of the ventilation upgrade[84].

***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The Capsule Dry Storage (CDS) Project has been identified for removal of cesium and strontium capsules from WESF and placement of the capsules into a compliant dry storage configuration pending final disposition. The initial planning for this activity has begun and documented[85]. There were several identified functions and requirements that establish the bases for initiating CDS Project scoping activities (e.g., preliminary conceptual design, preliminary cost estimate, design and construction schedule, and other related activities). The scope of the CDS Project will include (1) acquiring a new capsule dry storage area (CDSA) and storage systems for dry storage of the capsules; (2) implementing systems to remove the capsules from WESF and place the capsules into dry storage at the CDSA; (3) completing WESF modifications needed to support capsule retrieval, packaging, and transfer to the CDSA for dry storage; and (4) performing regulatory activities and operational preparations necessary for capsule removal from WESF and implementation of dry storage.

The Capsule Dry Storage (CDS) project shall use existing systems at WESF and canister storage building (CSB) to the maximum extent possible to distribute utilities (e.g., water, electricity, sanitation) required for facility operations, and to support a workforce of the size required to operate the facility at the required throughput rate. The CDS project shall interface with existing Hanford Site utilities and infrastructure to support design, construction, and operation. Interface requirements for utilities and infrastructure are undefined, pending facility siting and development of the facility concept. Assessment of utilities and infrastructure interfaces shall occur following preliminary facility definition and interface definition.[86]

Access roads, aprons, and walkways for the CDSA will be integrated into the existing infrastructure at the CSB. The CDS Project will provide a new absorption field and septic collection system separate from the current systems at existing facilities, if required due to insufficient capacity of the current system. It is anticipated that existing systems will be sufficient for these activities.[86]

ECOLOGICAL RESOURCE SETTING

Landscape Evaluation and Resource Classification

The amount and proximity of the biological resources to the EU were examined within the adjacent landscape buffer area radiating approximately 64 m from the geometric center of the EU (equivalent to

[83] [CHPRC-02203 (Rev0), pg. 6]
[84] [CHPRC-02388 (Rev0), pg. 2]. Public release of CHPRC-02388 (Rev0) will occur near end of May 2015 (personal communication with RL and PNNL).
[85] [CHPRC-01371 (Rev0), pg. i]
[86] [CHPRC-01371 (Rev0), pg. 16]

3.2 acres). The WESF EU and surrounding adjacent landscape buffer area consist entirely of level 0 resources; that is, paved, graveled surfaces and buildings with some landscaping around them.

Field Survey

A visual survey of the EU for WESF confirmed that the EU consists entirely of built structures and paved, graveled, or landscaped surfaces. No wildlife was observed. No field data sheets were generated. PNNL ECAP surveys conducted in 2009 for the WESF area indicated the following wildlife around the buildings: American robin (*Turdus migratorius*), lark sparrow (*Chondestes grammacus*), killdeer (*Charadrius vociferous*), barn swallow (*Hirundo rustica*), and mourning dove (*Zenaida macroura*).

Cultural Resource Setting

Cultural resources that are located in the WESF EU are limited to the National Register-eligible 225 B Waste Encapsulation and Storage Facility, a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required. All documentation has been addressed as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56). None of the WESF EU has been inventoried for archaeological resources and none are known to be located there.

The 212 B Fission Products Load out Station (documentation required) is located within 500 meters of the WESF Evaluation Unit, also a contributing property within the Manhattan Project and Cold War Era Historic District. It has also been documented as described in the *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan* (DOE.RL-97-56).

Historic maps indicate that there is no evidence of historic settlement in or near the WESF EU. Geomorphology and extensive ground disturbance further indicates a low potential for the presence of intact archaeological resources associated with all three landscapes to be present subsurface within the WESF EU. Consultation with Hanford Tribes (Confederated Bands of the Yakama Nation, Wanapum, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce) and other groups associated with these landscapes (e.g. East Benton Historical Society, the Franklin County Historical Society, the Prosser Cemetery Association, the Reach and B-Reactor Museum Association) may need to occur. Indirect effects are always possible when are known to be located in the general vicinity. Consultation with Hanford Tribes may also be necessary to provide input on indirect effects to both recorded and potential unrecorded TCPs in the area and other cultural resource issues of concern.

PART V. WASTE AND CONTAMINATION INVENTORY

Contamination within Primary EU Source Components

Legacy Source Sites

Not Applicable

High Level Waste Tanks and Ancillary Equipment

Not Applicable

Vadose Zone Contamination

Not Applicable

Groundwater Plumes

Not Applicable

Facilities for D&D

Not Applicable

Operating Facilities

There are only a few primary contaminants for WESF: Cesium-137 (Cs-137), strontium-90 (Sr-90), and ingrown decay products (e.g., barium 137 [Ba-137m, Ba-137] from Cs-137, yttrium-90 [Y-90] from Sr-90). These contaminants reside in 3 locations within WESF and present potential signification human impacts: (1) capsules within pool cells; (2) contamination within hot cells, hot cell-connected ventilation ductwork, and hot cell-connected HEPA filters; (3) non-constant level of contamination from the pool water cleaning ion exchange module. Because there are multiple phases that relate to the WESF complex, the inventories have been described within the context of these temporal designations (1) current operations under the safe storage of Cs/Sr capsules mission; (2) near-term operations with concurrent safe storage of capsules and stabilization of hot cell contamination and building upgrades specific to the K3; (3) transfer of capsules to dry storage; (4) final disposition of Cs and Sr radiological material. The relevant combinations of source terms described within the temporal designations are listed below. These combinations will be discussed in this section.

1. Cs/Sr Capsules (Current Operations)
2. Ion exchange Module (Current Operations)
3. Hot Cells, Ventilation Ductwork, HEPA Filter (Current Operations)
4. Hot Cells, Ventilation Ductwork, HEPA Filter (Building Stabilization, Near-term Operations)
5. Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage)
6. Cs/Sr Capsules (Final Disposition Pathway)

1. Cs/Sr Capsules (Current Operations):

Radioactivity:

- o Cs-137[87]: 34 MCi (as of February 2014)
  - a. Ba-137m: ~34 MCi (same as Cs-137 due to secular equilibrium)
- o Sr-90: 15 MCi (as of February 2014)
  - a. Y-90: ~15 MCi (same as Sr-90 due to secular equilibrium)
- o Tc-99: 0 Ci;
- o Pu (total): 0 Ci
- o U (total): 0 Ci
- o Total Activity[88]: ~98 MCi

Mass[89]:

- o U (total): 0 kg
- o Cr: 0 kg

Physical Form:

- o 1335 Cs capsules and 601 Sr capsules that also contain decay products of Cs and Sr (1936 total capsules)
  - a. Capsules contain 5-15% other elements (Impurities from processing and makes these capsules RCRA waste
- o Waste form as solidified CsCl and SrF_2
- o Double containment for Cs and Sr capsules in corrosion resistant metal canisters

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[87] Ionizing radiation types emitted from each radionuclide of interest: Beta (Cs-137, Sr-90, Y-90); Gamma (Ba-137m)

[88] [CHPRC-02248 (Rev0), Pg. 1]

[89] The mass of cesium chloride is around 3,600 kg and the mass of strontium fluoride is around 1,500 kg. This can be found if the masses of each salt type are summed from the Appendices A and B within [CHPRC-02248 (Rev. 0)].

- o 23 W-type capsules containing failed Cs/Sr Capsules, remnants from original production of capsules originating from hot cells, remnants from other programs

Values used for inventory plots:

EU	Cs-137	Sr-90	Sum of other radionuclides	Names of other radionuclides
WESF (Cs/Sr capsules)	34,000,000	15,000,000	=34,000,000+15,000,000 =49,000,000	Ba-137m, Y-90

2. Ion exchange Module (Current Operations):

Radioactivity:
- o Cs-137: Maximum at any given time: 31,000 Ci
- o Sr-90: Maximum at any given time: 25,000 Ci
- o Tc-99: 0 Ci
- o Pu (total): 0 Ci
- o U (total): 0 Ci
- o Total Activity: Cs-137+Sr-90: 25,000 – 56,000 Ci range
  - a. Minimum at any given time: 25,000 Ci (with no less than 150 kg resin)
  - b. Maximum is the sum of Cs-137 and Sr-90 given in points above

Mass:
- o U (total): 0 kg
- o Cr: 0 kg

Physical Form:
- o Cs and Sr adsorbed onto ion exchange resin

Values used for inventory plots: *The level of radioactivity within the ion exchange module during normal operations is kept well below the maximum allowable radioactivity and thereby is small relative to capsules and hot cell/connecting ventilation, therefore not included in the inventory plots for comparison purposes.

3. Hot Cells, Ventilation Ductwork, HEPA Filter (Current Operations):

Radioactivity:
- o Hot cells, ventilation ductwork, and HEPA filters, containing a combined[90] ~300 kCi
  - a. K3 Filter: Maximum of 100 Ci Cs-137 and 4,500 Ci Sr-90 on each train (2 trains)[91]
  - b. K3 Below-grade Ventilation Ductwork: 2,700 Ci Cs-137 and 103,000 Ci Sr-90
  - c. Hot Cells (A → F [G is clean]): ~55,000 Ci Cs-137 and ~43,000 Ci Sr-90
- o WESF Hot Cell and K3 Duct Inventory decayed to 2013 in Appendix O[92] was omitted from the report and the best estimates are from [HNF-8758 (Rev9), pg. 3-18]

Mass:
- o Unknown

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[90] Although, all the numbers that were provided in the report and listed in these sub-bullets equals ~212,400 Ci (as stated in the HNF-8758 (Rev9), pgs 3-16 through 3-17)
[91] [HNF-8758 (Rev9), pg. 3-18]
[92] [HNF-SD-WM-TI-733 (Rev6), Pg. O-1]

Physical Form:

- Small particulates and solids adsorbed onto interior surfaces of hot cells and ventilation ductwork, and absorbed within the interior of the HEPA filters

Values used for inventory plots:

EU	Cs-137	Sr-90	Sum of other radionuclides	Names of other radionuclides
WESF (Hot Cells, Ducts)	=100+2,700+54,537 =57,337	=4,500+4,500+103,000+42,937 =154,937	0	Not applicable

4. Hot Cells, Ventilation Ductwork, HEPA Filter (Building Stabilization, Near-term Operations):

WESF ventilation upgrades are to be completed by the end of Fiscal Year (FY) 2016[93] and it can be estimated that operations will begin for building upgrades will begin in the year 2015. Thus the inventory provided within the current operations can be assumed as the inventory for the near-term building upgrades and stabilization operations.

Radioactivity:

- Hot cells, ventilation ductwork, and HEPA filters, containing a combined[94] ~300 kCi
  - d. K3 Filter: Maximum of 100 Ci Cs-137 and 4,500 Ci Sr-90 on each train (2 trains)[95]
  - e. K3 Below-grade Ventilation Ductwork: 2,700 Ci Cs-137 and 103,000 Ci Sr-90
  - f. Hot Cells (A → F [G is clean]): 55,000 Ci Cs-137 and 43,000 Ci Sr-90

Mass:

- Unknown

Physical Form:

- Small particulates and solids adsorbed onto interior surfaces of hot cells and ventilation ductwork, and absorbed within the interior of the HEPA filters

5. Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage):

Radioactivity[96]:

- Cs-137: 32 MCi (dated to January 1, 2018)
  - a. Ba-137m: ~32 MCi (same as Cs-137 due to secular equilibrium)
- Sr-90: 13.5 MCi (dated to January 1, 2018)
  - b. Y-90: ~13.5 MCi (same as Sr-90 due to secular equilibrium)
- Tc-99: 0 Ci
- Pu (all isotopes): 0 Ci

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[93] The WESF K1/K3 Exhaust System Upgrade Project was initiated in 2009, then delayed in 2011 due to funding constraints The approach identified in CHPRC-01259 was later restructured to eliminate upgrades to the K1 system and focus on the K3 portion of the ventilation upgrades The revised approach includes stabilizing legacy contamination in WESF, isolating the K1 exhaust system from the K3 exhaust system, and replacing the existing K3 exhaust system. [CHPRC-02310 (Rev0), Pg. 2]

[94] Although, all the numbers that were provided in the report and listed in these sub-bullets equals ~212,400 Ci (as stated in the HNF-8758 (Rev9), pgs 3-16 through 3-17)

[95] [HNF-8758 (Rev9), pg. 3-18]

[96] The Capsule Extended Storage Project (W-135) is currently in the planning phase. This project will move the capsules from their current location inside WESF to a new storage location where the capsules will be stored under dry conditions. The earliest that this project is projected to be ready to move the capsules is January 1, 2018. To support design of the capsule storage system components, the decay heat of the capsules on this date needs to be known. Capsule data used to support reliable management of the capsules is contained within the Encapsulation Database System. Information within this database was used to project the WESF capsule decay heat on January 1, 2018. [CHPRC-02248 (Rev0), Pg. 1]. The radioactivity content was summed from each individual capsule from the Appendices A and B within [CHPRC-02248 (Rev. 0)].

    - Total Activity: ~91 MCi

Mass:

    - Total U: 0 kg
    - Cr: 0 kg

Physical Form:

    - 1335 Cs capsules and 601 Sr capsules that also contain decay products of Cs and Sr
        a. Capsules may contain 10-20% other elements (Impurities from processing and makes these capsules RCRA waste
    - 23 W-type capsules containing failed Cs/Sr Capsules, remnants from original production of capsules originating from hot cells
    - Waste form as solidified CsCl and SrF_2
    - Double containment for Cs and Sr capsules in corrosion resistant metal canisters
  - The unit operations required for longer-term configuration includes transferring capsules out of the facility. Doubly-contained capsules and W-type capsules will be placed into a dry cask.

6. Cs/Sr Capsules (Final Disposition Pathway):

No cleanup decisions have been made for final disposition of the cesium/strontium capsules. Decisions have been deferred to future decision-making processes.

a. Detailed inventories are provided in Table H.5-3, Table H.5-4, and Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

a. Table H.5-5. All values are to 2 significant figures. The source document should be consulted for greater precision data. The sum for each primary contaminant is shown in the first row. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.5-6 provides a summary of the evaluation of threats to groundwater as a protected resource from saturated zone and remaining vadose zone contamination associated with the evaluation unit.

Table H.5-3. Inventory of Primary Contaminants[a]

WIDS	Description	Decay Date	Ref[b]	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			NP	NP	NP	NP	34000000	NP	NP	NP	NP
	Anc Eq[b]	2013	HNF-8758 (Rev9)	NP	NP	NP	NP	55000	NP	NP	NP	NP
WESF	Process Building	2014	CHPRC-02248 (Rev0)	NP	NP	NP	NP	34000000	NP	NP	NP	NP

a. NP = Not present at significant quantities for indicated EU
b. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.5-4. Inventory of Primary Contaminants (cont)[a]

WIDS	Description	Decay Date	Ref	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NP	NP	NP	15000000	NP	NP
	Anc Eq	2013	HNF-8758 (Rev9)	NP	NP	NP	100000	NP	NP
WESF	Process Building	2014	CHPRC-02248 (Rev0)	NP	NP	NP	15000000	NP	NP

b. NP = Not present at significant quantities for indicated EU
c. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.5-5. Inventory of Primary Contaminants (cont)[a]

WIDS	Descrip-tion	Ref	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
	Anc Eq	HNF-8758 (Rev9)	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
WESF	Process Building	CHPRC-02248 (Rev0)	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP

b. NP = Not present at significant quantities for indicated EU
c. Anc Eq = Hot Cells, Ventilation Ductwork, HEPA Filter

Table H.5-6. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.25	0	1.82	---	---	---	---	---	ND
I-129	A	1 pCi/L	0.25	0.2	1.82	---	---	---	---	---	ND
Sr-90	B	8 pCi/L	0.25	22	1.82	---	---	---	---	---	ND
Tc-99	A	900 pCi/L	0.25	0	1.82	---	---	---	---	---	ND
CCl4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr	B	100 µg/L	0.25	0	1.82	---	---	---	---	---	ND
Cr-VI	A	48 µg/L[b]	0.25	0	1.82	---	---	---	---	---	ND
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	ND
U(tot)	B	30 µg/L	0.25	0.8	1.82	---	---	---	---	---	ND

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report (CRESP 2015).
b. “Model Toxics Control Act—Cleanup” (WAC 173-340) Method B groundwater cleanup level for hexavalent chromium.
c. Treatment amounts from the 2015 Hanford Annual Groundwater Report (DOE/RL-2016-09, Rev. 0).
d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report (CRESP 2015).

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Narrative description of pathways and barriers to receptors and conditions/events that can lead to completed pathways

Pathways and Barriers: (1. description of institutional, natural and engineered barriers (including material characteristics) that currently mitigate or prevent risk or impacts, 2. Time scale from loss of each barrier to realization of risk or impacts)

Briefly describe the current institutional, engineered and natural barriers that prevent release or dispersion of contamination, risk to human health and impacts to resources:

1. What nuclear and non-nuclear safety accident scenarios dominate risk at the facility?

The accident scenarios that dominate the risk to human health at the WESF complex are all nuclear related safety accident scenarios. The following accident scenarios dominate the risk at the facility for current operations are listed below. The beyond design basis accident of an earthquake greater than 0.25g magnitude and its impacts on human health are also described. Also discussed is the evolution of how this event was selected as part of the evaluated set of events.

1. Cs/Sr Capsules (Current Operations):
   a. Loss of Cooling and Shielding Water from All Pool Cells
   b. Beyond Design Basis Earthquake Leads to Loss of Cooling and Shielding Water from All Pool Cells and Release of Cs/Sr from Overheating
2. Ion exchange Module (Current Operations):
   a. Hydrogen explosion in Ion exchange Module [WIXM]
3. Hot Cells, Ventilation Ductwork, HEPA Filter (Current Operations):
   a. Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter
   b. Hydrogen explosion in Hot Cell G and K3 Duct

The accident scenarios that dominate the potential dose to human receptors at the WESF complex for the near-future phase of the building stabilization and ventilation upgrades have been analyzed within the Hazards Analysis[97]. The quantitative analysis within a Documented Safety Analysis for this phase of work has not been performed. The qualitative aspects of the dominating risks are described as available quantitative data allows and are considered the following:

4. Hot Cells, Ventilation Ductwork, HEPA Filter (Building Stabilization, Near-term Operations)[98]:
   a. Design basis earthquake with Ventilation Stack Collapse causes Damage Pool Cells and Capsules
   b. Crane drop through roof and impacts canyon and limited number of capsules in Hot Cell G failure
   c. Hydrogen explosion K3 Filter Housing

[97] [CHPRC-02203 (Rev0)]

[98] The impacts were evaluated by considering the impacts of potential new scenarios particular to the building stabilization operations and in tandem with the current mission of safe storage of the Cs/Sr capsules. The impacts (both qualitative and quantitative when available) include the levels of hazard and risk from the DSA and Hazards Analysis for current operations [HNF-8758 (Rev9); CHPRC-01352 (Rev2)] and the impacts evaluated in the Hazards Analysis for the near-term operations (building stabilization and ventilation upgrades) [CHPRC-02203 (Rev0)]

The accident scenarios that dominate the risk to human health at the WESF complex for future phases past the building stabilization and ventilation upgrades have yet to be analyzed quantitatively and qualitatively (i.e., Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage) and Cs/Sr Capsules (Final Disposition Pathway)). Therefore, there is currently insufficient information to evaluate the hazard and risk rating and the specific initiating events that would cause risks to human health and other potential receptors.

The complete list of design-basis accidents analyzed for current operations under the Capsules safe storage mission includes[99]:

a) Natural Phenomena
    a. Design Basis Earthquake (0.25g force) (Result[100]: An extensive structural evaluation of the integrity (Non-Destructive Examination) of the pool cell walls was performed and the pool cell wall strength was sufficient to maintain structural integrity during the design basis earthquake. No capsules would be damaged and lead to a release of capsule material. The radioactive source released would be from the hot cells, ventilation ductwork, and filter housings.)
b) External Events
    a. Aircraft Impact (Result[101]: Probability too low to require a structural response evaluation)
    b. Ground Vehicle Accident
    c. Accidents at adjacent facilities (see discussion below)
c) Facility Fires[102]
    a. Hot Cell Fire
    b. Truckport Fire
d) Facility Explosions[103]
    a. Hydrogen Explosion in Hot Cells
    b. Hydrogen Explosion in K3 Filter
    c. Hydrogen Explosion in the Pool Cell Area
    d. Flammable Gas Explosions
    e. Hydrogen Explosion in the WIXM (WESF Ion Exchange Module)
e) Loss of Confinement[104]
    a. K3 HEPA Filter Failure
    b. EMIX Spray Leak (WESF Emergency Ion Exchange system for Cs, Sr, and decay products)
    c. Hot Cell Cover Block Drop
f) Loss of Containment[105]
    a. Underwater Capsule Failure
    b. Loss of Pool Cell Water

It should also be noted that the closest facility to WESF is B Plant, which is directly adjacent to the WESF 225-B Building. Accidents at B Plant are significant to WESF because a release at B Plant could initiate a subsequent accident at WESF or hamper recovery actions should WESF operating personnel be in the process of responding to a common cause event (e.g., an earthquake or loss of

[99] [HNF-8758 (Rev9), pg. iv, pg. 1-4]
[100] [HNF-8758 (Rev9), pg. iv, pg. 1-4]
[101] [HNF-8758 (Rev9), pg. iv, pg. 1-10]
[102] [HNF-8758 (Rev9), pg. iv, pg. 3-66, pg. 3-78]
[103] [HNF-8758 (Rev9), pg. iv, pg. 3-84 through pg. 3-116]
[104] [HNF-8758 (Rev9), pg. iv, pg. 3-117 through pg. 3-124]
[105] [HNF-8758 (Rev9), pg. iv, pg. 3-125 through pg. 3-156]

offsite power). Several accidents were postulated and analyzed in the B Plant safety basis (HNF-14804, B Plant Documented Safety Analysis). The highest unmitigated dose of approximately 22 rem is possible to the co-located person (CP) (i.e., 100 m) due to the B Plant DBE. It should be noted that the B Plant DBE of 0.12 g is less severe than the WESF DBE of 0.25 g and the B Plant roof would likely collapse during a WESF DBE. The dose for the B Plant roof collapse is 8 rem to the CP. The radiological releases from B Plant could cause the evacuation of WESF; however, this plume would be very brief and would not prevent entry of essential personnel back into WESF with the proper protective gear for long-term post-DBE actions, including maintaining water level in the pool cells.

Loss of Cooling and Shielding Water[106] from All Pool Cells (Current Operations):

ACTIVE SAFETY CONTROLS: Yes

1. Credited SSC[107]: Pool Cell Drainage Prevention System[108]
2. Credited SSC: Pool Cell Water Transfer Ports[109]
3. Credited SSC: Defense-in-Depth Area Radiation Monitor Warning System[110]

PASSIVE SAFETY CONTROLS: Yes

4. Credited SSC: Outer capsules of the Cs/Sr doubly-contained capsules[111]
5. Credited SSC: Pool Cell Structure, Circulation Lines, Drain Pipe Lines, Sump Lines[112]
6. Pool Cell Air Dilution Ports[113]

OPERATIONAL and INSTITUTIONAL CONTROLS: Yes

7. Credited TSR: LCO - Maintaining Pool Cell Water Levels at least 130 inches
8. Credited TSR: SAC - A single WESF pool cell capsule inventory shall be less than 100 kW to remain within the analyzed condition
9. Credited TSR: LCO - Maintain the transfer ports for Pool Cells 1 and 3 through 7 open unless required to be closed for emergency response
10. Credited TSR: Defense-in-Depth AC: Capsules Configuration Management
11. Credited TSR: Worker Safety AC: Maintaining Radiation Monitoring Systems

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION:

12. Loss of pool water can be caused by any of the initiating events: Seismic Failure, Liner Leak, Transfer of water from a filled pool cell to an empty pool cell that had been previously blocked and emptied, pool cell vacuum system drains pools, drain line or any circulation line failure, duration of time passes and water evaporates without active measures to refill[114]
13. A fault tree of initiating events and subsequent events was developed[115] (see Figure H.5-13, below)

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[106] Loss of pool water can be caused by any of the initiating events: Seismic Failure, Liner Leak, Transfer of water from a filled pool cell to an empty pool cell that had been previously blocked and emptied, pool cell vacuum system drains pools, drain line or any circulation line failure, duration of time passes and water evaporates without active measures to refill
[107] SSC = System, Structure, and Component [HNF-8758 (Rev 9), Pg. 3-156]
[108] Safety Significant - Pool cell cleaning system has a suction break and the cleaning suction leg is partially hard-piped to prevent placement of suction hose into neighboring pool cell [HNF-8758 (Rev 9), Pg. 3-43]
[109] Fill pipe into Pool Cell 12 to allow for water addition to the pool cells from outside the facility [HNF-8758 (Rev 9), Pg. 3-43]
[110] [HNF-8758 (Rev 9), Pg. 3-43]
[111] Cs and Sr capsules are welded and constructed of stainless steel material [HNF-8758 (Rev 9), Pg. 3-43]
[112] Pool cell area structure, circulation lines, drain lines, and sump lines are qualified for a 0.25 g seismic event [HNF-8758 (Rev 9), Pg. 3-43]
[113] Not a credited SSC. Pool cell air dilution ports shall remain open for active pool cells with closed transfer ports to allow for overflow of water if Pool Cell 12 fill pipe is used [HNF-8758 (Rev9), Pg.3-43]
[114] [HNF-8758 (Rev9), Pgs. 3-134 through 3-139]
[115] [HNF-8758 (Rev9), Pgs. 3-141, Figure 3-4]

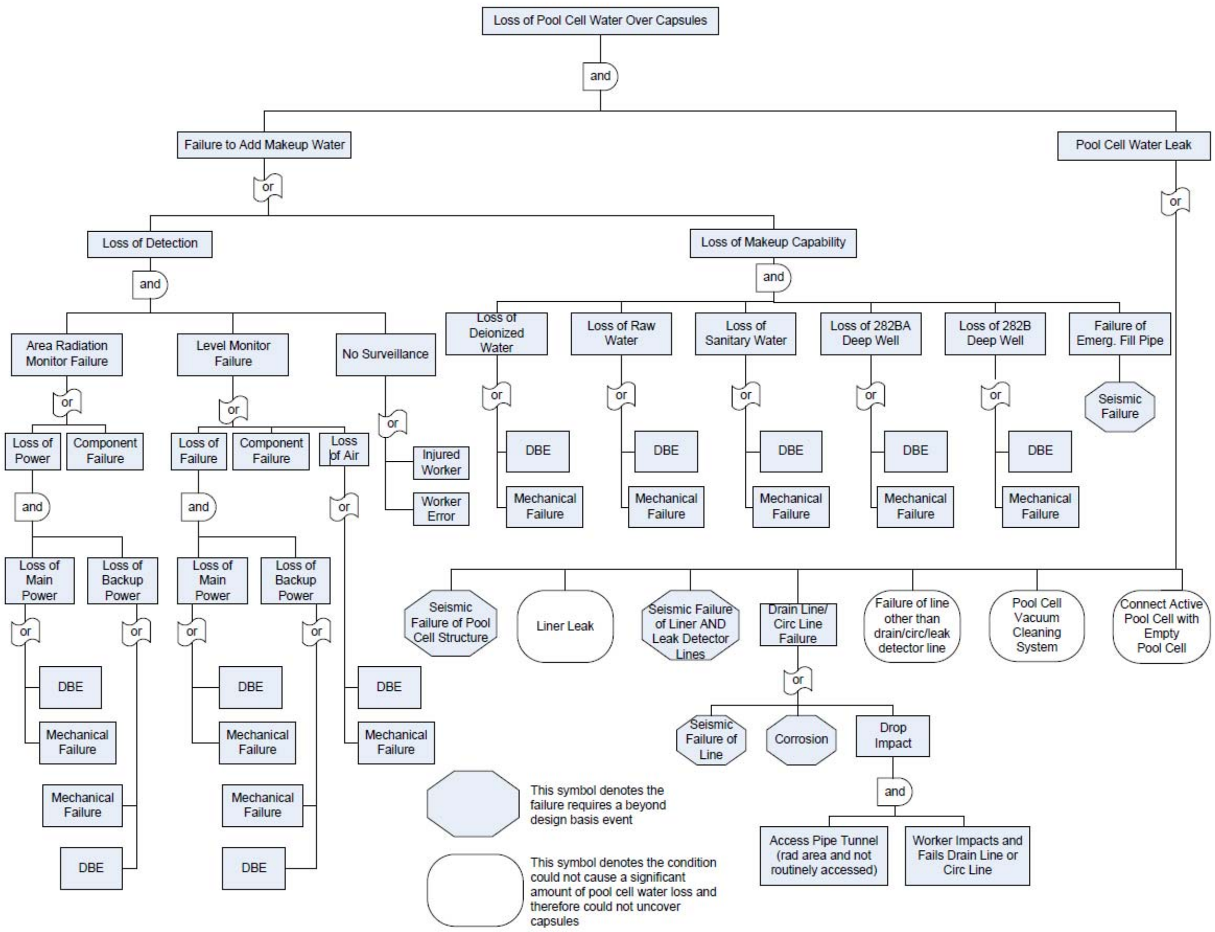

Figure H.5-13. Loss of Pool Cell Water Fault Tree Analysis (Design-Basis Accident, Earthquake, Loss of Water)[116]

There are several applicable barriers. Discussions of the integrity of those applicable barriers include:

Capsules (doubly-contained and W-type), Pool Cells (concrete and stainless steel liner), and WESF building superstructure

INTEGRITY OF APPLICABLE BARRIERS: Double-Walled Capsules (non Type-W Overpack capsules)

14. Routine testing of the integrity of the capsules is performed (as described before). The capsules are tested with the Inner Capsule Movement (ICM) test[117]. The ICM involves physically grasping one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making an audible

[116] [HNF 8758 (Rev9), Pg. 3-141, Figure 3-4]

[117] [HNF-8758 (Rev9), pgs. 2-30]; The ICM test was formerly called the "Clunk test" in former documentation because during the "clunk test" one would physically grasp one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making a "clunk" sound that is easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged.

sound that is easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged. The frequency that ICM test is performed has evolved over time. Presently it is to inspect (clunk test) 20% of the inventory every other year with all capsules being inspected every 10 years irrespective of statistics[118]. Listed below are criteria used by the facility to store capsules in the pool cells[119].

a. The capsule is designed for long-term storage in water.
b. A helium leak test was performed during production to verify containment integrity.
c. Thermally cycled capsules have been inspected to determine if there was capsule swelling.
d. The outer capsule is stainless steel and welded.
e. The capsule fits through the transfer chute on the transfer cart between G Cell and Pool Cell 12.
f. The capsule fits through the transfer ports into Pool Cell 12.
g. The capsule fits in the pool cell storage racks.
h. The capsule must be decontaminated to current Hanford Site radiological release limits.
i. The capsule is marked with a unique identification number.

15. These data support the conclusion that a capsule with a nominal amount of impurity will not see a significant amount of corrosion during the 50-year life in dry storage. In addition, an assessment of radiolytic production of chlorine or fluorine indicates that these gasses will not significantly contribute to corrosion during the 50-year storage life. Because capsules would not see significant corrosion during a 50-year dry storage condition, it is expected there would be very little if any corrosion under the cooler pool cell conditions[120].

INTEGRITY OF APPLICABLE BARRIERS: Type W Overpack Capsules

16. The Type W overpacks had both a helium leak check and ultrasonic weld inspection on the outer capsule to verify weld integrity. Because there has been essentially no stress placed on these capsules (i.e., no thermal cycling), there is no reason to suspect inner capsule swelling or weld failure of these capsules. It is the stress from thermal cycling that caused inner capsule swelling and likely caused the leak path to form in the outer capsule weld. Therefore, ICM testing of the Type W overpack capsules, whether in the pool cell or hot cell, will not be performed. However, it is prudent to ensure nothing unexpected is happening to the Type W capsules while they are stored at WESF. Therefore, a visual inspection of at least five of these capsules every ten years will be performed in a hot cell to ensure there is nothing obviously unusual about the capsule (e.g., visible corrosion or cracking, unexplained discoloration, etc.)[121].

INTEGRITY OF APPLICABLE BARRIERS: POOL CELLS (CONCRETE)

17. All pool cells have liners constructed of 16-gauge type 304L stainless steel at the sides and 14-gauge type 304L stainless steel flooring. Although all pool cells, except Pool Cell 12, are designed for cover block installation, cover blocks are not normally installed on pool cells that store capsules to prevent potential damage to the capsules due to a cover block drop. Cover blocks

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[118] Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014 and fully documented in [HNF-8758 (Rev9), pg. 2-31 and [HNF-28601 (Rev3), Pg. 7]
[119] [HNF-8758 (Rev9), Pg. 2-33]
[120] [HNF-28601 (Rev3), Pg. 2]. Corrosion nucleation points would be caused by impurities encapsulated into the capsule salt during original manufacturing process (cadmium, chromium, lead, and silver) or by the decay product of Cs-137 (barium) [HNF-8758 (Rev9), Pg. 9-4].
[121] [HNF-8758 (Rev9), pg. 2-32]

may be installed on a pool cell containing capsules in response to an emergency (e.g., loss of capsule integrity).

18. Several engineering reports for inspections and repairs to the reinforced concrete 225-B Building and the hot cell floor liners were obtained and reviewed. The lateral force resisting systems for the WESF structures were determined. The configuration, anchorages, and lateral supports for the systems and equipment items were determined and evaluations were made on the probability of survival for WESF structures and systems, based on engineering judgments about whether the responses of the items could be expected to be within acceptable limits[122].**This structural evaluation determined that the shear capacity of the pool cell divider walls significantly exceeds the maximum shear demand of the concrete walls during a WESF DBE and that the structural integrity of the WESF pool cells is not compromised under the levels of concrete degradation described in HNF-SD-WM-TI-733. This evaluation also concluded there would be no damage to the pool cell liner during a DBE[123].**

19. Appendix L – "Gamma Radiation Degradation of WESF Concrete Structure"[124], [125]

    Pool Cells 1, 3 through 7 store Cs/Sr capsules. The pool cell concrete has been exposed to significant gamma radiation due to the storage of cesium capsules. The conservatively estimated exposure (assuming maximum capsule loading) to the surface of the concrete divider walls is 3.3×10^{11} Rad. The continued storage of cesium capsules in the WESF pool cells for another 10 years would result in surface radiation exposures approaching 4×10^{11} Rad. The exposure in the center of the pool cell divider walls is 2×10^{10} Rad. Only the bottom three feet of the 18 foot pool cell divider walls has this exposure level. Floor exposures are lower by over a factor of 10 because the racks are mounted approximately eight inches above the floor, and the capsules have end caps with a combined stainless steel thickness of 0.8 inches. The top one inch of the 21-inch thick floor may have been exposed to the radiation level of concern (1×10^{10} Rad). Pool cell end walls have also seen greatly reduced exposures by over a factor of 100 compared to the pool cell divider walls due to; 1) routine practice of storing strontium capsules (primarily a beta emitter) in Rack 1 toward Pool Cell 12 end wall, and 2) not using the last four columns of Rack 3 under heat exchangers toward the pipe trench end wall. It is noted that after cesium capsules were returned from the offsite irradiators, Rack 1 in Pool Cell 7 contained cesium capsules, along with four strontium capsules. The cesium capsules were stored five columns away from the end wall until 2012 (which is similar to the other end wall where capsules are stored four columns away). In the summer of 2012, cesium capsules were spaced out with an empty rack location between each of the capsules. In this configuration, Pool Cells 2 through 6 still store only strontium capsules in Rack 1, but Rack 1 in Pool Cell 7 stored cesium capsules in all the

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122 [HNF-8758 (Rev9), pg. 1-4]
123 [HNF-8758 (Rev9), Pg.3-60]
124 [HNF-SD-WM-TI-733 (Rev 6), Pg. L-1]
125 Appendix L References – (1.) CHPRC-01858, Rev 0, Structural Evaluation of WESF Concrete Degradation Due to Radiation, dated August 2012.; (2.) HNF-8758, Revision 7, Waste Encapsulation and Storage Facility Documented Safety Analysis, dated April 6, 2012. (3.) HNF-8759, Revision 7, Waste Encapsulation and Storage Facility Technical Safety Requirements, dated April 6, 2012. (4.) INEEL/EXT-04-02319, Literature Review of the Effects of Radiation and Temperature on the Aging of Concrete, D. L. Fillmore, Ph.D., September 2004 (5.) Lowinska-Klugea, A., and Piszora, P., Effect of Gamma Irradiation on Cement Composites Observed with XRD and SEM Methods in the Range of Radiation Dose 0–1409 MGy, ACTA PHYSICA POLONICA A, vol. 114 (2008). (6.) Occurrence Report EM-RL--CPRC-WESF-2012-0002, Potential Inadequacy in the Safety Analysis (PISA) Related to Potential Radiation Degradation of Concrete in Pool Cells. (7.) SP-55-10, The Effects of Nuclear Radiation on the Mechanical Properties Concrete, American Concrete Institute report, 1978. (8.) SRNL-STI-2010-00004, Determining the Effects of Radiation on Aging Concrete Structures of Nuclear Reactors – 10243, by Cristian E. Acevedo, of Florida International University, and Michael G. Serrato, of Savannah River National Laboratory, 2010 Waste Management Conference. (9.) Unreviewed Safety Question Potential Inadequacy in the Safety Analysis Determination, WESF-12-145, Radiation Degradation of WESF Pool Cell Concrete. (10.) Unreviewed Safety Question Determination WESF-12-151, Radiation Degradation of WESF Pool Cell Concrete.

columns. If the conservative values are assumed for radiation exposure from the maximum capsules into the side wall, approximately $1x10^{10}$ Rad would be added to the total Pool Cell 7 end wall exposure every two years (this also decreases over time). With every other space filled and the distance to the wall being much greater than two inches, approximately $1x10^{10}$ Rad would be anticipated to the Pool Cell 7 end wall exposure over the next 10 years. Operational restrictions have been imposed to prevent storage of cesium capsules in the first four columns of Rack 1 and the last four columns of Rack 3 to minimize the long term gamma radiation to the pool cell end walls.

A figure from H Hilsdorf, J. Kropp, H. Kock, *The Effects of Nuclear Radiation on the Mechanical Properties Concrete,* American Concrete Institute report SP-55-10, 1978. This document provides a graph of compressive and tensile strength of concrete exposed to gamma radiation from various data. Conservative estimates are made as to the potential reduced strength of the pool cell concrete using this graph (shown in Figure H.5-14, below).

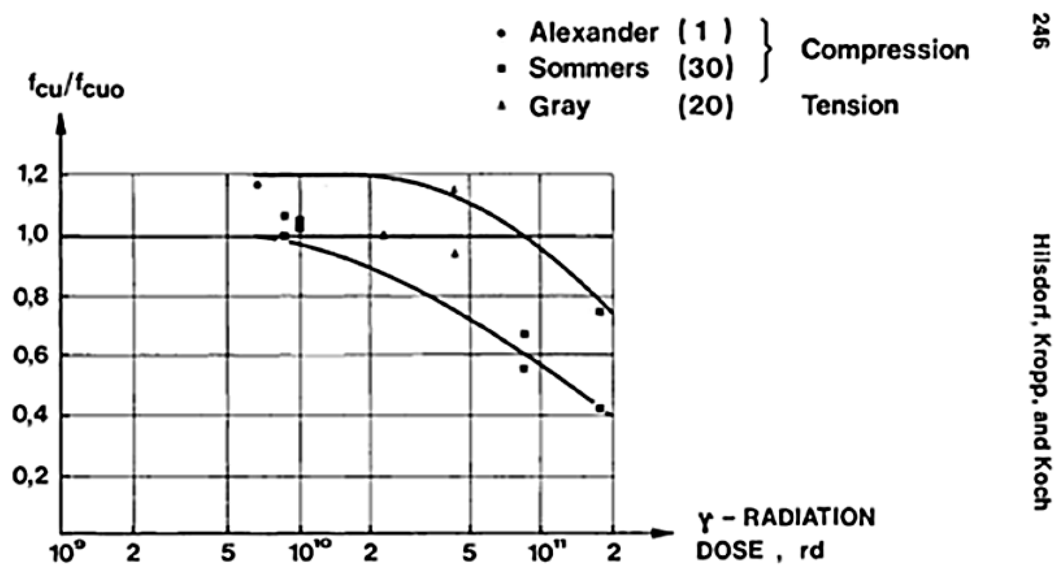

Fig. 7:
Compressive and Tensile Strength of Concrete Exposed to γ – Radiation f_{cu}, Related to Strength of Untreated Concrete f_{cuo}

Figure H.5-14. Concrete Strength vs. Gamma Radiation Dose[126]

A second study was also used to determine the possible gamma radiation degradation of concrete. Samples exposed to different doses of gamma radiation were tested using scanning electron microscopy and x-ray diffraction and the results are documented in Lowinska-Klugea, A., and Piszora, P., *Effect of Gamma Irradiation on Cement Composites Observed with XRD and SEM Methods in the Range of Radiation Dose 0–1409 MGy*, ACTA PHYSICA POLONICA A, vol. 114. There was significant visual change in the samples receiving >8.36E10 Rad indicating degradation but this degradation was not quantified in a loss of concrete strength. It will be conservatively assumed that any pool cell concrete receiving $>8.36x10^{10}$ Rad will have no

[126] [HNF-SD-WM-TI-733 (Rev6), Appendix L, Pg. L-5, Figure 1]

strength even though SP-55-10 indicates that that concrete at this radiation level would still have 50% strength.

The top one inch of the 21-inch thick floor may have been exposed to the radiation level of concern and will be assumed to have a 20% loss of concrete strength. The remaining 20 inches of floor has no loss of concrete strength. It will be assumed that outer one inch on each side of the bottom 3 feet of the pool cell divider wall has 100% loss of concrete strength and that the middle 10 inches of the wall has 50% reduction of concrete strength. The remaining top 15 feet of divider wall has no loss of concrete strength. A Schematic Diagram that summarizes the assumed concrete degradation was provided[127] and shown in Figure H.5-15, below.

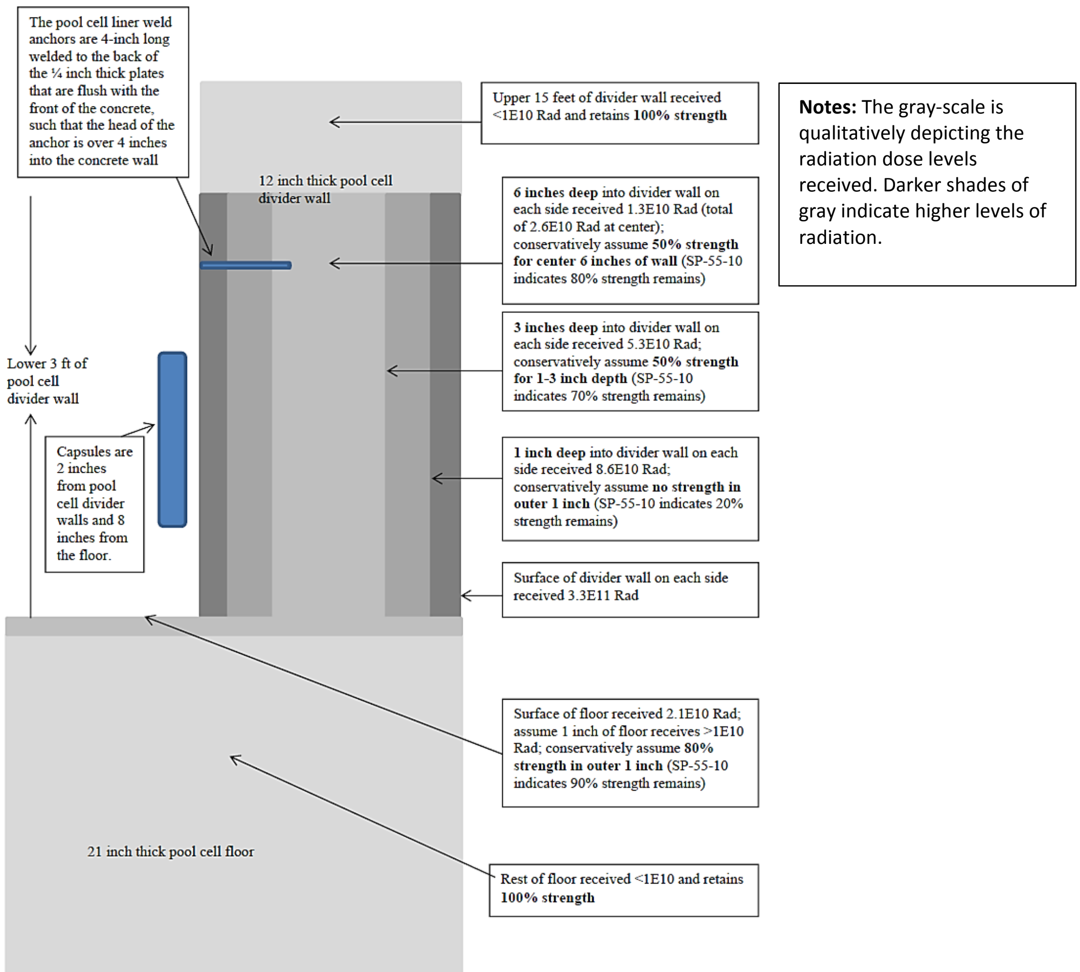

Figure 2. Summary of Damage to Pool Cell Concrete

Figure H.5-15. Summary of Assumed/Calculated Damage to Pool Cell Concrete[128]

[127] [HNF-SD-WM-TI-733 (Rev6), Appendix H, Pg. H-36]
[128] [HNF-SD-WM-TI-733 (Rev6), Appendix L, Pg. L-6, Figure 2]

INTEGRITY OF APPLICABLE BARRIERS: POOL CELLS (STEEL LINER)[129]:

20. During the site tour by the assigned CRESP team in mid-October 2014 – personal communication with the WESF managers and operators noted that the stainless steel liner of the pool for Pool Cells 5 and 10 are known to have small liner leaks. Pool cell water leakage was collected in a sump at a rate of approximately 12-15 liters every few months130. Collected water was then tested through the facility's testing equipment for beta-counts and resulting with no radioactive material within the collected water.

    Calculations were performed to estimate the volume of the leak detection sump boundary beneath the liner of the pool cells. For pool cells 2 through 11, this volume was calculated to be 68 gallons (258 liters) (assuming leak detector filled to 156 inch level) or equivalent to a 1.1 inch drop in pool cell water level. For pool cell 1 the volume was found to be 73 gallons (277 liters) or equivalent to 0.61 inches of pool cell water level.

INTEGRITY OF APPLICABLE BARRIERS: WESF BUILDING CONCRETE BARRIER STRUCTURE

21. Facility exterior walls that support the above grade structures have not seen any significant exposures as they are shielded by the primary storage pool cell physical structural arrangement so there is no assumed loss of concrete strength[131].

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

22. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[132]. The dose fields that would result from a loss of water from all pool cells are shown below in Table H.5-7.

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[129] [HNF-SD-WM-TI-733 (Rev6), Appendix H, Pg. H-36]
[130] [HNF-8758 (Rev9), Pg. 2-27] The quoted volumetric flow rate of the leak is 0.8 L/week.
[131] [HNF-SD-WM-TI-733 (Rev 6), Pg. L-5]
[132] [HNF-8758 (Rev9)]

Table H.5-7. Dose Fields within and near WESF for a Loss of Water from All Pool Cells[133]

Condition	Location	Dose rate rem/h (55 MCi ^{137}Cs)	Dose rate rem/h (38 MCi ^{137}Cs – capsule inventory decayed to February 2011)	Reference
Dry pools	Just outside north door	600[(b)]	400[(b)]	HNF-SD-WM-TI-733, App. G, KEH-8D150-94-001[(a)]
	5 m (16 ft) from pool cell area external wall	40	30	
	100 m (328 ft) from pool cell area external wall	4	3	

[(a)] This calculation did not account for the self-shielding provided by capsule array and appears conservative by a factor of 5 to 10.
[(b)] Dose rates represent capsules stored in center pool cells as calculated in KEH-8D150-94-001 because the all pool cell configuration assumes capsules are stored in Pool Cells 8 through 11.

TIME FRAMES (Response Times, Time for Impacts to be Realized)

23. Estimated Response Times[134]: minimum 25 seconds[135] for backup generators to respond and provide electricity to emergency coolant pumps; maximum several days (5-12 days) before remaining water would start to boil[136] and responders could add water by this time.
24. Time for impacts to be realized: Capsule failure would occur at the soonest at the second day after the loss of coolant and the remaining water would take nearly 5-12 days to boil to a point where loss of water would produce conditions in which potential damage to human health could be present[137].

Beyond Design Basis Earthquake Leads to Loss of Cooling and Shielding Water from All Pool Cells and Release of Cs/Sr from Overheating; Cs and Sr Capsules (Current Operations)

BACKGROUND:

1. As part of its response to the events that occurred at Fukushima, DOE had sites and operating contractors evaluate facility and site responses to beyond design basis events (BDBEs); specifically, they directed that for Category 1 and 2 facilities: a review of how BDBEs had been considered or analyzed be conducted; the facilities ability to safely manage a total loss of power event, including lass of backup capabilities; confirmation of safety system maintenance and operability; and a confirmation of emergency planning effectiveness, especially as regarded the potential loss of normal regional support infrastructure (e.g., off-site power, firefighting

[133] [CHPRC-02047 (Rev0), Pg. 21]
[134] With understanding that accidents at B Plant are significant to WESF because the release at B Plant could initiate a subsequent accident at WESF or a release at B Plant could hamper recovery actions should WESF operating personnel be in the process of responding to a common cause event, (e.g., an earthquake or loss of offsite power) It should be noted that the B Plant DBE of 0.12 g is less severe than the WESF DBE of 0.25 g and the B Plant roof would likely collapse during a WESF DBE. The dose for the B Plant roof collapse is 8 rem to the onsite receptor. The radiological releases from B Plant could cause the evacuation of WESF; however, this plume would be very brief and would not prevent entry of essential personnel back into WESF with the proper protective gear. [HNF-8758 (Rev9), Pg. 3-65].
[135] [HNF-8758 (Rev9), Pg. 2-48]
[136] Assumed that the same response time from the beyond design basis accident of an earthquake would also result with a loss of water (coolant and shielding) to the capsules [CHPRC-02047 (Rev0), Pg. 21]
[137] Assumed that the same response time from the beyond design basis accident of an earthquake would also result with a loss of water (coolant and shielding) to the capsules [CHPRC-02047 (Rev0), Pg. 21]

capability, etc.)[138]. One of the facilities that garnered particular attention was WESF, due to its similarity to a commercial reactor spent nuclear fuel pool. In the CHPRC response[139] to this DOE tasking a plan of action involved nine (9) actions to address issues at WESF. The major concern evaluated was a loss of water, and thus cooling, to the pool which presently provides both cooling to the capsules and shielding for personnel in the facility and surrounding area. WESF-specific actions included: revision of emergency planning/management procedures to better document actions to be taken to keep adequate water level in the pools; re-arrangement of capsules in the pools to reduce the net heat generation rate; and conduct of drills to demonstrate the ability of emergency response personnel to locate, identify and use emergency fill connections.

Further, the analysis of the seismic BDBE identified that about half of the calculated radiation exposure was due to the release of contamination from ventilation piping in areas of WESF no longer required for the present safe storage mission, of for potential future work, such as capsule movement for packing and dry storage. Thus a project was initiated[140] to retire those portions of the ventilation system that are no longer required for present and anticipated missions, and stabilize the contamination (via grouting in-place); this work will be conducted in parallel with already planned ventilation modifications to be consistent with DOE commitments responding to DNFSB Recommendation 2004-2, *Confinement Ventilation*.

ACTIVE CONTROLS, PASSIVE SAFETY CONTROLS, OPERATIONAL AND INSTITUTIONAL CONTROLS:

2. For a BDBA, the unmitigated frequency of occurrence for NPH events cannot be reduced. As this was a BDBA, the contractor was to determine the unmitigated consequences only and not pursue control selection or mitigated consequence evaluation; therefore, no controls were identified to prevent/mitigate the BDBA. The evaluation does recognize that there are current credited design features, exhaust ventilation, and area radiation monitors that are operable and capable of performing their safety functions and that TSR surveillance are current[141].

   There were "Existing Facility Controls That Might Help Prevent/Mitigate Event" listed. This included a "Source Inventory Control" that limits heat load in a pool cell Pool Cell Fill Pipe (design feature) and allows for water addition to pool cells from outside facility if radiation levels in pool cell area are high.

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION

3. In the scenario that was used for the basis of the DSA calculations, it was assumed that 1,162 capsules would fail[142] that would release 38 MCi (of the 98 MCi estimated radioactivity of February 2014 within the Cs/Sr capsules). During a BDBA, the building structure is assumed to fail. Hot cell contamination is released due to impact from debris or vibration. The below grade pool cell structure is assumed to fail and releases pool cell water (water may be contaminated if capsules were damaged by debris). Once the water is gone, the capsules fail over time due to stress cracking or corrosion and material is released from pool cells via evaporation. Pool cell above grade structure is assumed to survive because this results in the largest consequence.

[138] DOE-HS Safety Bulletin 2011-01, Events Beyond Design Safety Basis Analysis, March 23, 2011
[139] CHPRC letter 1104737A-R1, Evaluation of Events Beyond the Design Safety Basis, October 21, 2011; as supplemented by CHPRC letter 11047337A-R2 (same title), January 16, 2012
[140] The project execution plan for this effort is documented in CHPRC-02310 (Rev. 0), "Project Execution Plan for WESF Stabilization and Ventilation Project," September 2014
[141] [CHPRC-020407 (Rev0) Pg. 2A-7]
[142] [CHPRC-020407 (Rev0) Pg. 23]

Failure of the above ground pool cell area structure provides cooling for the capsules upon a loss of pool cell water and significantly reduces the release of capsule material due to evaporation.

INTEGRITY OF APPLICABLE BARRIERS:

4. See "Loss of Cooling and Shielding Water from All Pool Cells (Current Operations)" section

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

5. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[143].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

6. The 2-hr dose consequences are less than for a complete loss of pool cell water without failure of the aboveground structure so the loss of pool cell water dose consequences are used in the BDBE. However, it is noted that the failed capsule consequences and boiling of contaminated water could occur sooner than the loss of pool cell water consequences (**boiling of the water could occur in approximately 9 days).** Capsule failures due to corrosion from a loss of pool cell water with no failure of the structure would not start until approximately **50 days after a loss of all pool cell water assuming a packed rack configuration and approximately 300 days after a loss of all pool cell water for a spaced rack configuration**[144].
7. In the event of total loss of power (primary and backup power), no additional impact of this BDBE would be expected because the building structure and equipment are assumed to fail. It was assumed that the facility could continue to safely manage inventory. Water can be added to pool cells via tanker trucks and there are **several days (~12) to respond before capsules become uncovered**. Opening a door in the pool cell area will provide passive ventilation to prevent hydrogen accumulation above the flammability limit. There may be minor contamination spread due to loss of ventilation.
8. WESF Hanford Fire Department Pre-incident Plan was revised to include alternate water sources available to respond to a BDBE involving a WESF Loss of Pool Water event. The assumption is that the BDBE would cause severe damage to hydrant water supply and facility make-up water system capabilities. HFD may need to shuttle water from alternate water sources. Also, there are special considerations for adding water. The revised plan references facility procedures to assist in decision making.
9. The DSA also discusses post loss of water concerns. The question of whether or not to add water to a pool after capsules have been uncovered for a period of time was also addressed in the thermal analysis report (WHC-SD-WM-TI-770). The particular concerns addressed were: (1) the potential for thermal stresses causing new capsule failures, (2) molten salt-water interactions potentially damaging capsules or the pool, or increasing the source term by mechanical aerosol generation, (3) water reacting with cesium chloride to create new trace species that exacerbate the source term, (4) contaminated water leakage through failed confinement boundaries, and

[143] [CHPRC-020407 (Rev0)]
[144] [CHPRC-02047 (Rev0), Pg. 21]

(5) boiling of contaminated water. Items 2, 3, 4 and 5 are relevant only if capsule failures have occurred, but Item 1 is relevant anytime a pool cell is drained[145].

Hydrogen explosion in Ion exchange Module [WIXM] (Current Operations)

ACTIVE SAFETY CONTROLS[146]: Yes

1. Credited SSC: Fill of Void Space in WIXM (WESF Ion Exchange Module)

PASSIVE SAFETY CONTROLS: No

OPERATIONAL and INSTITUTIONAL CONTROLS: Yes

2. Credited TSR[147]: Limited Maximum Radionuclide Content (by Radioactivity and Mass)[148]
3. Credited TSR: Maintaining Pool Cell Water Levels at least 130 inches

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[149]:

4. As the resin in a WIXM becomes loaded with radioactive material, the ionizing radiation results in radiolysis of the resin/water and produces hydrogen. If hydrogen were to accumulate inside the WIXM vessel to quantities of 4 percent volume or more, the hydrogen can become flammable and eventually detonable if it continues to increase. Such a combustion event could result in the release of contaminated resin and water. For such accident conditions to exist, the excess water in the WIXM vessel would have to be drained (allowing a void volume for the hydrogen to accumulate) and would likely be undergoing preparation for transport. The resin material would be water-soaked with the hydrogen originating from the water trapped within the resin bed. Hydrogen would then accumulate in the head space of the vessel above the resin bed. In order for the hydrogen to ignite, an energy source would have to be present in the WIXM. This could potentially be provided by a static charge inside the vessel or possibly by a spark introduced into the hydrogen-containing vent or inlet pipe from some outside activity (e.g., a worker's tool). The worst case would be ignition of the hydrogen at the end of the inlet pipe because the flame front could propagate down the inlet pipe, transition into a detonation, enter the WIXM and impact the resin bed with the maximum force. The detonation pressure pulse would impact the resin/water surface and rebound upward, possibly rupturing the WIXM assembly and ejecting some resin, radioactive material, and water into the truckport.

INTEGRITY OF APPLICABLE BARRIERS:

5. Condition of the credited void space in the WIXM is unknown.

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

6. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[150].

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[145] [CHPRC-02047 (Rev0), Pg. 22]
[146] [HNF-8758 (Rev 9), Pg. 3-109]
[147] TSR = Technical Safety Requirement [HNF-8758, (Rev9), Pg. viii]
[148] Radionuclide limited to 25,000 Ci Sr-90 or 31,000 Ci Cs-137 with no less than 150 kg resin material. For combinations of Cs-137 and Sr-90, a maximum of 35,000 Ci Sr-90 and Cs-137 with no less than 150 kg resin material. [HNF-8758 (Rev 9), Pg. 3-117]
[149] [HNF-8758 (Rev 9), Pg. 3-109]
[150] [HNF-8758 (Rev9)]

TIME FRAMES (Response Times, Time for Impacts to be Realized)

7. No response times or durations of times were provided of when impacts could be first realized. The amount of hydrogen to reach the lower flammability limit (LFL) is 4%. The time for the G cell to accumulate hydrogen to the LFL is weeks to months. It could be postulated that since the ion exchange column volume is smaller than the Hot Cell G volume that the time would be less.

Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter (Current Operations)

ACTIVE SAFETY CONTROLS: No

PASSIVE SAFETY CONTROLS[151]: Yes

1. Credited SSC: 225-B Area 3 (pool cells); pool cell bridge crane, catwalk, and associated support structures; pool cell drain line, circulation piping, and sump lines
2. Credited SSC: 225-B Area 2 (hot cells, canyon, hot and cold manipulator shops, manipulator repair shop, operating gallery, service gallery, and AMU)

OPERATIONAL and INSTITUTIONAL CONTROLS[152]: Yes

3. Specific Administrative Control (SAC): F Cell and G Cell each contain a maximum capsule inventory of 150,000 Ci Cs-137 and 150,000 Ci Sr-90 (this keeps the total stored capsule wattage in F Cell or G Cell at less than 1.8 kW), and capsules are located a minimum of 20 cm (7.9 in.) from any hot cell structural surface to protect against degradation of the concrete structure.
4. Defense-in-Depth Administrative Control: A program is established and maintained to address configuration management of the TSR design features to ensure the continued integrity of the SSCs relied upon in the analysis.

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[153]

5. Two design basis seismic events were considered in WESF design and construction. The first event, called the operating basis earthquake, has a peak ground acceleration of 0.12 g and was applied to the office and support areas of the 225-B Building (i.e., Area 1). The second event, called the safe shutdown earthquake, has a peak ground acceleration of 0.25 g and was applied to those portions of the 225-B Building having a radiological confinement function, such as the hot cells and pool cell area (i.e., Areas 2 and 3, respectively). The seismic event analyzed in this section is the more severe safe shutdown earthquake and will be referred to hereafter as the DBE.
6. The DBE would result in the immediate release of hazardous material from the hot cells and the K3 exhaust ducting. Some of the contamination in the hot cells and K3 duct is postulated to become suspended as a result of the shock of the DBE which may involve structural failure of the stack or A Cell due to failure of the 221-B Building end wall which is not qualified to survive the 0.25 g DBE associated with WESF. The same isotopes are present in the K3 exhaust ducting downstream of the hot cells and would also be subject to shock-vibration release in a DBE. The radioactive material in the truckport and in capsules located in the pool cells, F Cell, or G Cell would not be impacted by the immediate effects of the DBE. The hot cells (excluding A Cell which is assumed to fail from the collapse of the B Plant end wall), canyon, and truckport would

151 [HNF-8758 (Rev 9) Pg. 3-64]
152 AC = Administrative Control [HNF-8758 (Rev 9) Pg. 3-64]
153 [HNF-8758 (Rev 9) Pgs. 3-28, 3-60 through 3-]

survive the DBE. The structures confining the capsules, including the hot cells and the pool cells, are also designed to survive the DBE. Thus, the capsules are not impacted by falling objects and, in the absence of such an impact, the capsules are adequately protected from the DBE. The packaging associated with any LLW located throughout the facility would likely be sufficient to prevent the suspension of contamination; however, the DSA assumes the containers fail due to potential impact from any surrounding unqualified structures.

INTEGRITY OF APPLICABLE BARRIERS: HOT CELL CONCRETE BARRIER STRUCTURE

7. The north and south walls of all the hot cells and both east and west walls of A and G Cell are 89 cm (35 in.) thick, high-density (3.8 g/cm^3 [235 lb/ft^3]) reinforced concrete for personnel shielding (HNF-SD-WM-DB-034). The A and G Cells also have an 89 cm (35 in.) high-density concrete shielding door for personnel entry from the service gallery[154].

8. The floor and walls of the Hot Cells A, B, C, F are lined with 14-gauge 304L stainless steel. The floor and lower portion of the walls of Hot Cells D and E are lined with 14-gauge Inconel™-600 alloy. Hot Cell G does not have an additional metal liner, only the walls and floor are coated with white, radiation-resistant and corrosion-resistant paint[155].

9. Calculations were performed to estimate the gamma radiation exposure to the pool cells and hot cells as well as the assumptions made regarding pool cell concrete degradation due to radiation exposure. Gamma exposure is from the cesium capsules. The estimated accumulated exposure in the hot cells was estimated in the $1x10^8$ to $1x10^9$ Rad range.[156] The accumulated gamma radiation exposure in the hot cells does not approach levels of concerns for beginning signs of concrete degradation ($1x10^{10}$ Rad) so there is no assumed loss of concrete strength.[157]

INTEGRITY OF APPLICABLE BARRIERS: HOT CELL VENTILATION SYSTEMS

10. K1 and K2 ventilation and exhaust systems are functional and capable. The K3 supply and exhaust system will be upgraded (as explained further in

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[154] [HNF-8758 (Rev9), pgs. 2-21 through 2-23]
[155] [HNF-8758 (Rev9), pgs. 2-21 through 2-23]
[156] [HNF-SD-WM-TI-733 (Rev 6), Pg. L-1] Appendix L – "Gamma Radiation Degradation of WESF Concrete Structure"
[157] [HNF-SD-WM-TI-733 (Rev 6), Pg. L-5]

11. Part IV. Unit Description and History)

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

12. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[158].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

13. Water sources outside the facility (i.e., sanitary and raw water) are also vulnerable to failure in the DBE. Therefore, the DBE could result in failure of makeup water sources to the pool cells. Elapsed time to uncover the capsules due to evaporative losses from the highest heat load single pool cell would require at **least 7 days (without cooling). If the transfer ports were opened to all active pool cells, it would take 19 days (without cooling) to uncover the capsules. Because the loss of water would occur slowly, it is reasonable to assume that a source of water could be provided to the pool cells (e.g., tanker truck) within the 7 to 19 days required to uncover the capsules**. The fill pipe into Pool Cell 12 allows for water addition outside the facility and will be identified as a design feature.

14. For a loss of pool cell water analysis due to evaporation. It must be assumed that an explosion that resulted in falling debris also caused a loss of pool cell cooling. The contaminated water **could reach boiling temperatures in 17 hours as conservatively calculated**[159].

Hydrogen explosion in Hot Cell G and K3 Duct (Current Operations)

ACTIVE SAFETY CONTROLS: Yes

1. Backup power for ventilation system[160]

2. Hot cell ventilation[161]

PASSIVE SAFETY CONTROLS: Yes

3. Credited SSC: Safety Significant - G Cell capsule transfer chute is a design feature to prevent overflow of water into the other hot cells

4. G Cell is the only cell with water sources and it takes several weeks to months to generate 4% hydrogen[162]

OPERATIONAL and INSTITUTIONAL CONTROLS: Yes

5. Credited TSR: SAC - Maximum cesium capsule inventory of 150 kCi and maximum strontium capsule inventory of 150 kCi in a single hot cell

6. Credited TSR: Defense-in-Depth AC - Configuration control of design features

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[163]:

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[158] [HNF-8758 (Rev9)]
[159] [HNF-8758 (Rev9), Pg. 3-101]
[160] [HNF-8758 (Rev9), Table B-3, Page B-65, Row 56]
[161] [HNF-8758 (Rev9), Table B-3, Page B-65, Row 56]
[162] [HNF-8758 (Rev9), Table B-3, Page B-65, Row 56]
[163] [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]

7. Loss of ventilation to hot cells with radiolytic hydrogen from water use in cell in combination with inadvertent accumulation of water in the K3 ventilation system. Potential consequences are a buildup of hydrogen gas and blockage of the K3 airflow resulting in a loss of facility ventilation. An explosion in a hot cell could also cause shock/vibration through the ventilation system such that contamination could be released from the other hot cells or the K3 duct. Capsules could also be located in F Cell but the material in the capsules would not be released due to the shock/vibration.

INTEGRITY OF APPLICABLE BARRIERS: HOT CELL CONCRETE BARRIER STRUCTURE

8. See " Design Basis Earthquake Releases from Hot Cells, Ventilation Ductwork, HEPA filter (Current Operations)" Section

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

9. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF DSA[164].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

10. Even with a seismic event causing a loss of power and damaging the K3 ventilation system, it would be reasonable to assume that hot cell ventilation could be restored, water could be removed from G Cell or capsules could be removed from G Cell **within six months**[165]**.**

Design Basis Earthquake + Stack Collapse Cause Releases (Building Stabilization, Near-term Operations)

ACTIVE SAFETY CONTROLS: Potentially, but no specific technology listed in the Hazards Analysis

PASSIVE SAFETY CONTROLS[166]: Yes

1. Design of 225B building
2. Design of Stack
3. Design of capsules

OPERATIONAL and INSTITUTIONAL CONTROLS[167]: Yes

4. When capsules are in the hot cells, radiation protection measures used
5. Initial testing, in-service surveillance and maintenance
6. Operational safety measures
7. Procedures and training
8. Emergency preparedness

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION

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[164] [HNF-8758 (Rev9)]
[165] [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]
[166] [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]
[167] [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]

9. If the stack falls over the pool cells, debris could damage capsules and there could be a loss of pool cell cooling or a loss of water. The WESF DSA[168] analyzes significant failure of roof/walls caused by hydrogen explosion in the pool cell area which causes failure of capsules. The unmitigated doses of this accident scenario were added to the unmitigated design basis earthquake impacts in the DSA for current operations[169].

INTEGRITY OF APPLICABLE BARRIERS:

10. See "Loss of Cooling and Shielding Water from All Pool Cells (Current Operations):"

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

11. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[170].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

12. To be determined in the revised Documented Safety Analysis
13. It can be postulated that the response time would be similar to the response time for a seismic event causing a loss of power and damaging the K3 ventilation system, it would be reasonable to assume that hot cell ventilation could be restored, water could be removed from G Cell or capsules could be removed from G Cell **within six months**[171]**.**

Crane/Heavy Load Drop Damages Canyon, Hot Cells, and Limited Number of Capsules Stored in Hot Cell G (Building Stabilization, Near-term Operations)

ACTIVE SAFETY CONTROLS: Potentially, but no specific technology listed in the Hazards Analysis

PASSIVE SAFETY CONTROLS[172]: Yes

1. Design of 225B building
2. Design of capsules

OPERATIONAL and INSTITUTIONAL CONTROLS[173]: Yes

3. Prohibited movement of heavy loads over pool cell area
4. When capsules are in the hot cells, radiation protection measures used
5. Initial testing, in-service surveillance and maintenance
6. Operational safety measures
7. Procedures and training
8. Emergency preparedness

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[168] [HNF-8758 (Rev9)]
[169] [CHPRC-02203 (Rev0), Pg. B-24, Table B-1]. The specific [HNF-8758 (Rev9)] section that describes the hydrogen explosion in the pool cell is within Section 3.4.2.4.3.
[170] [CHPRC-02203 (Rev0)]
[171] [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]
[172] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]
[173] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION

9. Human error or equipment failure could cause a moving mobile crane or the load to be dropped over Area 2 and could impact the canyon and aqueous makeup unit to the pool cells. Roof failure could cause debris and crane load to fall to canyon floor. The crane load would lose much of its energy breaking through the roof and it would be very unlikely for the debris and crane load to break the 30-inch high density concrete hot cell cover blocks. If the hot cell cover blocks do fail, it is assumed that there are a limited number of capsules located in Hot Cell G. The limited number of stored capsules within Hot Cell G would completely fail. The impacts would be a combination release of contamination from the Hot Cell G and limited capsule release[174].

INTEGRITY OF APPLICABLE BARRIERS:

10. See "Hydrogen explosion in Hot Cell G and K3 Duct (Current Operations):"

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

11. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[175].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

12. To be determined in the revised Documented Safety Analysis
13. It can be postulated that the response time would be similar to the response time for a seismic event causing a loss of power and damaging the K3 ventilation system, it would be reasonable to assume that hot cell ventilation could be restored, water could be removed from G Cell or capsules could be removed from G Cell **within six months**[176]**.**

Hydrogen explosion in K3 Filter Housing (Building Stabilization, Near-term Operations)

ACTIVE SAFETY CONTROLS[177]: Yes

1. Ventilation

PASSIVE SAFETY CONTROLS[178]:

2. Design of filter system

OPERATIONAL and INSTITUTIONAL CONTROLS[179]:

3. Remove ignition sources

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION[180]:

4. The WESF DSA[181] analyzes a K3 filter hydrogen explosion and unmitigated consequences are moderate for the co-located person (CP; 58 rem) and low for the maximally-exposed offsite

[174] [CHPRC-02203 (Rev0), Pg. B-8, Table B-1]
[175] [CHPRC-02203 (Rev0)]
[176] [HNF-8758 (Rev 9), Pg. 3-39, Pg. 3-91]
[177] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[178] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[179] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[180] [CHPRC-02203 (Rev0), Pg. B-66, Table B-1]
[181] [HNF-8758 (Rev9)]

individual (MOI; 0.018 rem). The inventory assumed in this analysis is significantly higher than expected for the new system because the new system will ventilate the canyon and G cell only and there would be an insignificant inventory available in the facility to accumulate on the filters. However, the new system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the MOI.

INTEGRITY OF APPLICABLE BARRIERS:

5. The replacement ventilation system will be new and not have any foreseeable issues with the level of integrity and ability to retain radioactive contamination

PRIMARY PATHWAYS AND POPULATIONS AT RISK:

6. The primary pathway is the air pathway/ radiological contaminants become airborne and present a radiological hazard because of the committed effective dose equivalent (CEDE) incurred from inhalation and the external effective dose equivalent that would be incurred from gamma radiation (and maybe some high energy beta radiation). The populations at risk are facility workers and potentially co-located persons as analyzed in the WESF documentation[182].

TIME FRAMES (Response Times, Time for Impacts to be Realized)

7. To be determined in the revised Documented Safety Analysis

Cs/Sr Capsules (Longer-term Operations Transfer to On-site Dry Storage)

Barriers to be utilized for the dry storage of capsules are the capsules and dry storage casks. A draft request for proposal (RFP) has been drafted but the project is not funded at the current time. The use of technology similar to/from the commercial nuclear power industry with storing used nuclear fuel in dry storage concrete casks is planned[183]. Many of the data points for understanding the potential risk of on-site dry storage of the Cs and Sr capsules are unknown; however, it can be noted that potential impacts could be estimated by the use of the dry storage operations of commercial used nuclear fuel currently ongoing in the nuclear power industry. There are a number of environmental impact statements that have been published as part of the licensure requirements by the Nuclear Regulatory Commission (NRC).

ACTIVE SAFETY CONTROLS: Unknown

PASSIVE SAFETY CONTROLS: Unknown to the full extent

10. There would be no credited controls for capsule integrity as part of the performance assessment of the dry storage casks[183].

OPERATIONAL and INSTITUTIONAL CONTROLS: Unknown

ACCIDENT SCENARIO DEVELOPMENT DESCRIPTION: Unknown

INTEGRITY OF APPLICABLE BARRIERS:

11. The integrity of the capsules is described in previous sections. The integrity of the dry storage canister is unknown at this time; however, the requirements that were included as part of the draft RFP were that the dry casks metal-canisters must have a 300-year life and if concrete casks

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[182] [CHPRC-02203 (Rev0)]
[183] Personal Communication with L. I. Covey and other WESF facility operators/managers during the CRESP visit to Hanford in October 2014.

are used, then a 100-year life is required. The dry storage casks, regardless of material, would not be licensed by the Nuclear Regulatory Commission (NRC).

A guideline for maximum temperatures for the interface between the salt and capsule during capsule movement and storage are provided in Table H.5-8. It was noted that heat rejection may be designed based on the blending of high and low hear capsules within an array. However, if blending is required, 10% must be added to the estimated decay heat in any specific array to allow for operating margin, and a complete loading sequence of all capsules must be addressed within the thermal analysis. Alternatively, the design may be developed that will accept the bounding array of capsules.

Table H.5-8. Maximum Temperatures for Salt/Capsule Interface during Capsule Movement and Storage[184]

	Strontium capsules	Cesium capsules
Accident conditions	800°C	600°C
Processing, including process upset	540°C	450°C
Interim storage configuration, summer storage conditions as described below per PNL-4622, *Climatological Summary for the Hanford Area*	540°C	317°C

Primary Pathways And Populations At Risk: Unknown

Time Frames (Response Times, Time for Impacts to be Realized): Unknown

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Waste generated at WESF includes radioactive and non-radioactive solids, liquids, and gases from decontamination activities, maintenance, and miscellaneous operations[185]. The DSA does not report the volume or mass of the wastes produced. The DSA does not report the spent resin volume or mass that is used during a specific operational time frame. The types of waste produced are Liquid Low-Level Waste[186] (LLLW), solid and compacted LLW in drums and metal crates, solid and uncompacted LLW in bags, and mixed LLW[187]. A bounding and extremely conservative assumption of 1,000 Ci of 90Sr was used as an inventory material at risk value for the LLW that could be accumulated throughout WESF. LLW at WESF would contain significantly less radioactive material than this assumption (typically fractions of a curie)[188].

LLW is collected from areas throughout the facility and is typically placed into a waste container or moved to a conex box and stored until shipped from the facility for final disposal. Most of the material consists of gloves, paper, swipes, plastic, broken tools, etc. LLW originating from the hot cells typically consists of manipulator sleeves, swipes, failed equipment, etc. Hazardous and mixed waste produced at WESF consists primarily of maintenance waste (e.g., oily waste), batteries, fluorescent lamps, and miscellaneous waste from the use of chemical cleaning agents and will be recycled or disposed of as appropriate. The hazardous and mixed solid waste identified for disposal is packaged and shipped to the appropriate regulated waste storage or disposal facility. Nonregulated waste from activities such as

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[184] [CHPRC-01371 (Rev0), Pg. 13]
[185] [HNF-8758 (Rev9), Pg. 9-3]
[186] [HNF-8758 (Rev9), Pg. 2-44]
[187] [CHPRC-02203 (Rev0), Pg. B-21]
[188] [HNF-8758 (Rev9), Pg. 3-80]

housekeeping will be recycled or disposed of as appropriate and consists of materials such as office waste, nonregulated aerosols, vegetation growth, and sewage from facilities.

Two liquid effluent streams evolve from WESF operations, the WESF liquid effluent stream and the WESF cooling water stream. The WESF liquid effluent stream is routed to the TEDF via "F" Line and consists of sanitary water, raw water from the compressed air heat exchanger, 282-B deep well testing, and storm water. The primary contributor to the waste stream is the raw water discharges from the compressed air heat exchanger in the 225-BC Building. Other sources contributing to the stream are batch discharges from Pool Cells 9 and 10, floor drains, filter backwash, and street drains. Pool Cells 9 and 10 collect sanitary and raw water discharges from the pool cell area. The WESF cooling water effluent stream is routed to TEDF via "E" Line and consists of water from the pool cell CLCS, the WESF deep well pumps during testing, and raw water used for single pass cooling in the pool cell heat exchangers. Discharge of the single pass cooling water from the pool cell heat exchangers will only occur if the CLCS fails.

During the site tour by the assigned CRESP team in mid-October 2014 – personal communication with the WESF managers and operators noted that the stainless steel liner of the pool for Pool Cells 5 and 10 are known to have small liner leaks. Pool cell water leakage was collected in a sump at a rate of approximately 12-15 liters every few months[189]. Collected water was then tested through the facility's testing equipment for beta-counts and resulting with no radioactive material within the collected water.

Facility Workers

The Cs and Sr capsules and contamination within the facility do not pose potential impacts during normal operating conditions to the facility workers directly involved with carrying out duties under the current authorized mission of safe storage. The initiating events that could cause the highest impact to the facility workers within the Hazards Analysis[190] are the following[191]:

- Loss of cooling/shielding water from the all pool cells (High Unmitigated Dose Consequence Category)
- Hydrogen explosion in Hot Cell G and the K3 duct (High Unmitigated Dose Consequence Category)
- Hydrogen explosion in the WESF Ion Exchange Modules (WIXM) (Medium Unmitigated Dose Consequence Category)

Co-located Person

The Cs and Sr capsules and contamination within the facility do not pose potential impacts during normal operating conditions to the persons co-located to the WESF complex under the current authorized mission of safe storage. The initiating events that could cause the highest impact to the co-located person within the WESF Documented Safety Analysis[192] and the Hazards Analysis[193] are the following:

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[189] [HNF-8758 (Rev9), Pg. 2-27] The quoted volumetric flow rate of the leak is 0.8 L/week.
[190] [CHPRC-01352 (Rev2)]
[191] The Beyond Design Basis Accident where contaminants from both the pool-stored capsules and the hot cell/connecting ducts combined produce the largest impact. The doses are listed in two places within [CHPRC-02047 (Rev0)] on pages [CHPRC-02407 (Rev0) Pg. 21] and [CHPRC-02407 (Rev0) Pg. 2A-7]. Within [CHPRC-02407 (Rev0) Pg. 21]: The doses listed are FW: 380 rem; CP: 0.53 rem; MOI: 0.24 rem. On page [CHPRC-02407 (Rev0) Pg. 2A-7], the doses are given as FW: 780 rem; CP: 1.0 rem; MOI: 0.42 rem. The higher values were used within this report. The Dose rates for the higher values are 4 rem/h 100 m from 225B Building and 40 rem/hr 5 m from external wall.
[192] [HNF-8758 (Rev9)]
[193] [CHPRC-01352 (Rev2)]

- Loss of cooling/shielding water from the all pool cells (277 rem)
- Hydrogen explosion in Hot Cell G and the K3 duct (102 rem)
- Hydrogen explosion in the WESF Ion Exchange Modules (WIXM) (71 rem)

Public

The Cs and Sr capsules and contamination within the facility do not pose potential impacts during normal operating conditions to the local populace outside of the Hanford site under the current authorized mission of safe storage. The initiating events that could cause the highest impact to the maximally-exposed offsite individual (MOI) within the WESF Documented Safety Analysis[194] and the Hazards Analysis[195] are the following:

- Loss of cooling/shielding water from the all pool cells (0.21 rem)
- Hydrogen explosion in Hot Cell G and the K3 duct (0.031 rem)
- Hydrogen explosion in the WESF Ion Exchange Modules (WIXM) (0.022 rem)

Groundwater

WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by WESF due to the distance between the facility and the river. This leads a ND rating.

Ecological Resources

- No species of concern were observed either within the EU or in the immediate vicinity.
- The EU for WESF and adjacent landscape buffer consist of 0 level resources; that is, paved and graveled surfaces, buildings, infrastructure, and minor amounts of landscaping.
- Remediation of the WESF EU would not have any negative impacts on habitat connectivity.

Cultural Resources Setting

- There are no known recorded archaeological sites or TCPs located within the WESF EU.
- The WESF EU is located inside the 225 B Waste Encapsulation and Storage Facility, a contributing property within the Manhattan Project and Cold War Era Historic District with documentation required.

Archaeological sites and TCPs located within 500 meters of the EU:

- The 212 B Fission Products Load out Station (documentation required) is located nearby the WESF Evaluation Unit, also a contributing property within the Manhattan Project and Cold War Era Historic District. In accordance with the 1998 *Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan (*DOE/RL-97-56), all documentation requirements have been completed for this property.
- There are no known archaeological sites or TCPs located within 500 meters of the WESF EU.

194 [HNF-8758 (Rev9)]
195 [CHPRC-01352 (Rev2)]

Recorded TCPs Visible from the EU

- There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the WESF EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

1. What is the range of potential remedial actions?

No cleanup decisions have been made for final disposition of the cesium/strontium capsules. Decisions have been deferred to future decision-making processes. The plausible alternatives are:

- Package and transport capsules from WESF to dry storage; store capsules pending final disposition; direct dispose of capsules at a geologic repository.
- Incorporate capsules into immobilized high-level waste glass at WTP.
- Store capsules at Hanford for 300 years (approximately 10 half-lives); after natural decay, direct dispose of capsules as mixed low-level radioactive waste.

It is unknown what the potential degree of disturbance of an area due to the uncertainty of the final disposition pathway for the Cs and Sr capsules.

2. What is the sequence of activities and duration of each phase?
   See Part IV (Unit Description and History) under "WESF Processes and Operations"

3. What is the magnitude of each activity (i.e., cubic yards of excavation, etc.)?

   Present Configuration: WET STORAGE: Waste generated at WESF includes radioactive and non-radioactive solids, liquids, and gases from decontamination activities, maintenance, and miscellaneous operations[196]. The DSA does not report the volume or mass of the wastes produced. The DSA does not report the spent resin volume or mass that is used during a specific operational time frame. The types of waste produced are Liquid Low-Level Waste[197] (LLLW), solid and compacted LLW in drums and metal crates, solid and uncompacted LLW in bags, and mixed LLW[198]. A bounding and extremely conservative assumption of 1,000 Ci of 90Sr was used as an inventory material at risk value for the LLW that could be accumulated throughout WESF. LLW at WESF would contain significantly less radioactive material than this assumption (typically fractions of a curie)[199].

   ***Near-Future Configuration: BUILDING UPGRADES*:** The types of waste estimated to be produced during this phase is the same as the current operations under the safe storage of Cs/Sr capsules mission. It is postulated that the amount of waste will increase relative to the current operational status due to increased activity.

   ***Longer-Term Future Configuration: CAPSULE DRY STORAGE, Limited D&D of 200E Area*:** The estimated waste quantity (reported as tons of material) was reported [200]:

   - 225BA: K1 Filter Pit Encapsulation Facility: 386 tons

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[196] [HNF-8758 (Rev9), Pg. 9-3]
[197] [HNF-8758 (Rev9), Pg. 2-44]
[198] [CHPRC-02203 (Rev0), Pg. B-21]
[199] [HNF-8758 (Rev9), Pg. 3-80]
[200] [DOE/RL-2010-102 (Rev0), Appendix A, pg. A1]

- 225BB: K3 Filter Pit Encapsulation Facility: 39 tons
- 225BF: WESF Tanker Loadout Station: 331 tons

The D4 activities are not described in detail for these individual facilities. There is information provided on the two filter pit encapsulation facilities which indicates some to some level the resultant tonnage from D4 operations[201]:

- 225BA and 225BB are considered "Typical Reinforced Structures". These structures are typically cast-in-place concrete beams or columns, and could include below-grade construction or basements. These buildings/structures normally have exterior walls that exceed 0.3048 mn (12 in.) in thickness, and are heavily reinforced on minimal centerline spacing. Interior walls will vary depending on bearing and nonbearing requirements. Floor and roof framing system consists of cast-in-place concrete slabs with concrete beams, one-way joists, two-way waffle joists, or flat slabs. Buildings that fall into this generic category include the following:
- 225BA K1 Filter Pit Encapsulation Facility. The 225BA Kl Filter Pit Encapsulation Facility is associated with the WESF ventilation system and is approximately 59 M2 (638 ft^2).
- 225BB K3 Filter Pit Encapsulation Facility. The 225BB K3 Filter Pit Encapsulation Facility is associated with the WESF ventilation system and is approximately 121 M2 (1,302 ft^2).

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

It is unknown what the potential contaminant inventory within or nearby WESF due to the uncertainty of the final disposition pathway for the Cs and Sr capsules.

Risks and Potential Impacts Associated with Cleanup

During the near-future phase of contamination stabilization and ventilation upgrades, there were identified risks of current operations to co-located persons that could be augmented due to the additional heavy equipment on site (e.g., cranes). The contaminant inventory would stay the same but the number of possible initiating events (e.g., crane load drops) would increase the risk during initial construction. After grouting and stabilization of contaminants in the hot cells and ventilation system occur, the likelihood of the grouted contaminant being released from the cemented matrix will be lowered greatly.

Populations and Resources at Risk or Potentially Impacted During or as a Consequence of Cleanup Actions

Facility Worker

The Hazards Analysis did not provide quantitative dose impact information for the facility workers directly involved with the WESF complex near-future operations. The qualitative risk ratings and potential consequence categories were provided and listed below:

- K3 filter housing hydrogen explosion
  - Potential Consequence Categories: (FW: high; CP: moderate/medium; MOI: low)
  - Qualitative Risk Ratings: (FW: I; CP: II; MOI: III)
- Design basis earthquake causes the ventilation stack to collapse and releases from the canyon, hot cells, and a limited number of capsules assumed to be stored in Hot Cell G
  - Potential Consequence Categories: (FW: high; CP: moderate/medium; MOI: low)

[201] [DOE/RL-2010-102 (Rev0), Appendix A, pg. A9]

  - Qualitative Risk Ratings: (FW: I; CP: II; MOI: III)
- A crane fall/heavy load drop causes releases from the canyon, hot cells, and a limited number of capsules assumed to be stored in Hot Cell G
  - Potential Consequence Categories: (FW: high; CP: moderate/medium; MOI: low)
  - Qualitative Risk Ratings: (FW: I; CP: II; MOI: III)

Co-located Person

The WESF Stabilization and Ventilation Project Hazards Analysis[202] evaluates a K3 filter housing hydrogen explosion resulting with the highest unmitigated dose consequences to the co-located person 100 meters from the WESF boundary. The impacts to a co-located person are considered moderate (58 rem) and low for the MOI (0.018 rem). The inventory assumed in the Hazards Analysis is significantly higher than expected for the new system because the new system will ventilate the canyon and G cell only and there would be an insignificant inventory available in the facility to accumulate on the filters. However, the new system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the maximally-exposed offsite individual.

Public

The WESF Stabilization and Ventilation Project Hazards Analysis[203] evaluates a design-basis earthquake resulting with a collapse of the ventilation stack onto the WESF building resulting the highest impact to the MOI. Due to the stack collapse, damage to the hot cells, canyon, and limited number of capsules potentially stored in Hot Cell G is postulated to release radioactive contaminants causing concern to human health. The unmitigated dose consequence to the MOI is estimated to be 0.036 rem. The impacts to the maximally-exposed offsite individual are considered low and moderate for the co-located persons (46 rem). The new ventilation system will likely be used while the grouting operation is being performed and there may be some disturbances of the contamination in the hot cells. Therefore, the same moderate level consequence will be assumed for the co-located person and the same low level consequence will be assumed for the MOI.

Groundwater

WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 50 years. This leads to a ND rating.

Columbia River

The Columbia River will not be impacted by WESF due to the distance between the facility and the river. This leads a ND rating.

Ecological Resources

Personnel, car, pick-up truck, truck traffic and heavy equipment through non-target and remediated areas will likely lead to permanent effects in areas of heavy equipment use. Effects on the ecological resources are likely to include exotic/alien species, differences in native species structure, and soil invertebrate changes in areas of high activity (compaction).

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[202] [CHPRC-02203 (Rev0)]
[203] [CHPRC-02203 (Rev0)]

Cultural Resources

Personnel, car, and truck traffic on paved roads as well as use of heavy equipment will not have any direct impact on archaeological resources because there is no disturbance to soil/ground or alteration to the landscape. Assuming heavy equipment locations and staging areas have been cleared for cultural resources, then it is assumed adverse effects would have been resolved and/or mitigated. If heavy equipment locations and staging areas have not been cleared, this could result in artifact breakage and scattering, compaction and disturbance to the soil surface and immediate subsurface, thereby compromising stratigraphic integrity of an archaeological site. TCPs may be directly affected if personnel are on roads located on TCP and if personnel are unaware of cultural resource sensitivity, appropriate behaviors and protocols. For traffic on paved roads located on TCP, direct effects include visual, auditory and vibrational alterations to landscape/setting. Heavy equipment may cause direct effects to TCPs including destruction of culturally important plants, physical attributes of the TCP and introduction of noise and vibrations also altering the setting. These actions may interfere with traditional uses of TCP. Contamination remaining in situ may have direct effects including permanent physical alteration of TCP, and lead to permanent intrusion in long-term use and access to TCP.

Indirect effects from personnel, car, and truck traffic on paved roads as well as use of heavy equipment may lead to the introduction of invasive plant species or removal of culturally important plants that alters the landscape/setting for roads located within the viewshed and noise-scape of TCP. Existing road causes no alteration to viewshed or noise-scape. Presence of vehicles may result in visual, auditory and vibrational alterations to landscape/setting. Remediation actions may lead to visual alteration of landscape/setting. Introduction of noise alters landscape/setting. Introduction of equipment and buildings may interfere with traditional uses of TCP. Remaining contamination could lead to indirect effects from permanent intrusion, which could limit the use and access to TCP.

Additional Risks and Potential Impacts if Cleanup is Delayed

This is a multi-phase project and delay would have different impacts, depending on when it occurred. These will be addressed in chronological order.

1. Delay in completion of the Stabilization and Ventilation Modification Project – will results in a longer time period in which: (a) a substantial (~300,000 Ci) source term is available for potential dispersion during a beyond design basis event, and (b) the ventilation system at WESF is not compliance with requirement for confinement ventilation systems, thus increasing the potential for an inadequately filtered release from WESF.
2. The Waste Management EIS mentions two potential options for addressing the HLW present in the capsules at WESF: (a) designing and building a facility which would be an adjunct to the Waste Treatment and Immobilization Plant (WTP), which would allow the capsules to be opened, prepared and fed to the HLW vitrification melter; and (b) more recently, due to the age of WESF and schedule challenges at WTP, the retrieval of the capsules from the storage pool in WESF and placement in dry cask storage, similar to commercial spent nuclear fuel, to await disposition in a geologic repository. Both of these options require the design and construction of new facilities. Delay in either option results in extended storage of the capsules in the 40-year-old WESF.

NEAR-TERM, POST-CLEANUP STATUS, RISKS AND POTENTIAL IMPACTS

Populations and Resources at Risk or Potentially Impacted After Cleanup Actions (from residual contaminant inventory or long-term activities)

Table H.5-5. Population or Resource Risk/ Impact Rating

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Insufficient Information (IS)	
	Co-located Person	IS	
	Public	IS	
Environmental	Groundwater	Not Discernible (ND)	WESF contamination is confined and there are no vadose zone sources or current groundwater contamination associated with this EU and none are expected over the next 150 years.
	Columbia River	ND	The Columbia River will not be impacted by WESF due to the distance between the facility and the river.
	Ecological Resources[a]	ND	Few ecological resources now, and likely none in the future. If there is re-vegetation, then continued activity and monitoring could result in minor disturbance in EU.
Social	Cultural Resources[a]	**Native American:** Direct: Unknown Indirect: Unknown **Historic Pre-Hanford:** Direct: Unknown Indirect: Unknown **Manhattan/Cold War**: Direct: None Indirect: None	No expectations for impacts to known cultural resources.

a. For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report. The abbreviation "IS" denotes insufficient information available to rate.

The determination of the disposition path of the Cs and Sr capsules, required by the Tri-Party Agreement (M-092-05) by June 2017, requires an understanding of the options that exist for safe storage while meeting other requirements directly related to the decontamination, deactivation, decommissioning, and demolition (D4) of the adjacent B Plant. The unit operations required for longer-term configuration include transferring capsules within an additional storage overpack and then placement into dry storage casks. The dry storage casks will be then transferred to a concrete pad on the Hanford site in the 200 East Area near WESF and B Plant. Limited D&D efforts are ongoing and to be determined. Risk drivers associated with longer-term future configuration are radioactive material contained in the capsules during movement into dry storage containers. Any D&D activities are tentative for WESF until plans for dry storage of capsules can be finalized.

LONG-TERM, POST-CLEANUP STATUS – INVENTORIES AND RISKS AND POTENTIAL IMPACT PATHWAYS

Same as Near Term above.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

No supplemental information applicable.

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