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Removal Action Report for the 190-KE and 190-KW Pump Houses, 100-K Area

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Signature page for the *Removal Action Report for the 190-KE and 190-KW Main Pump Houses, 100-K Area* at the U.S. Department of Energy's Hanford Site.

Thomas K. Teynor
Federal Project Director for the River Corridor
U.S. Department of Energy, Richland Operations Office

Sept. 25, 2012
Date

Executive Summary

This Removal Action Report summarizes the completion of deactivation, decommissioning, decontamination, and demolition (D4) activities associated with the 190-K East (KE) and the 190-K West (KW) Main Pump Houses. The D4 activities were conducted by the U.S. Department of Energy under a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) response action in accordance with the *Action Memorandum for the Non-Time-Critical Removal Action for the 105-KE and 105-KW Reactor Facilities and Ancillary Facilities* ([Action Memorandum 1] EPA, 2007) for the 190-KE Pump House and the *Action Memorandum for the Non-Time-Critical Removal Action of the 100-K Area Ancillary Facilities* ([Action Memorandum 2] EPA, 2005) for the 190-KW Pump House, and the *Removal Action Work Plan for 105-KE/105-KW Reactor Facilities and Ancillary Facilities* (DOE/RL-2005-26) for both facilities.

The 190-KE Pump House and 190-KW Pump House were located in the 100-K Area of the Hanford Site, and were single-story buildings with basements that were used to house large water pumping units, which included service and backwash pumps. The 190-KE and 190-KW Pump Houses developed the pressure necessary to pump treated water from the 183.4-KE and 183.4-KW Clearwells to the 105-KE and 105-KW Reactors for cooling.

The physical demolition and load out activities for the 190-KE Pump House occurred between July 2011 and September 2012 and for the 190-KW Pump House occurred between July 2011 and March 2012. The above-grade structures were removed, and the below-grade structures were removed to a minimum of 3 ft below grade level. Soil samples were collected from the soils below pump well reservoirs to verify that no remedial action will be required for the underlying soils.

The completion of these removal actions mitigate the potential threat of release of contaminants to the environment and are consistent with the remedial actions for the 100-KR-1 and 100-KR-2 Operable Units, identified in Action Memorandum 1 (EPA, 2007) and Action Memorandum 2 (EPA, 2005). The D4 activities for the 190-KE and 190-KW Pump Houses were funded by the *American Recovery and Reinvestment Act of 2009*.

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Terms

ACM	asbestos-containing material
ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminants of concern
D4	deactivation, decommissioning, decontamination, and demolition
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HEIS	Hanford Environmental Information System
K_d	distribution coefficient
KE	K East
KW	K West
NPL	National Priorities List
OU	operable unit
PCB	polychlorinated biphenyl
RAO	removal action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RAWP	Removal Action Work Plan
ROD	Record of Decision
SAP	sampling and analysis plan
TPH	total petroleum hydrocarbons
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UHCM	unquantified hazardous construction materials

1 Introduction

This report documents completion of removal actions conducted by the U.S. Department of Energy (DOE) for the 190-K East (KE) Main Pump House and the 190-K West (KW) Main Pump House. The deactivation, decommissioning, decontamination, and demolition (D4) of the 190-KE Pump House was conducted in accordance with the *Action Memorandum for the Non-Time-Critical Removal Action for the 105-KE and 105-KW Reactor Facilities and Ancillary Facilities* ([Action Memorandum 1] EPA, 2007) and the *Removal Action Work Plan for 105-KE/105-KW Reactor Facilities and Ancillary Facilities* ([RAWP] DOE/RL-2005-26) for both facilities. The D4 of the 190-KW Pump House was done in accordance with the *Action Memorandum for the Non-Time-Critical Removal Action of the 100-K Area Ancillary Facilities* ([Action Memorandum 2] EPA, 2005), and the *Removal Action Work Plan for 105-KE/105-KW Reactor Facilities and Ancillary Facilities* ([RAWP] DOE/RL-2005-26).

1.1 Site Description

The Hanford Site, located in southeastern Washington State and situated along the Columbia River, is approximately 1,518 km^2 (586 mi^2) in size. The Hanford Site mission from the early 1940s to approximately 1989 included defense-related nuclear research, development, and weapons material production activities. These activities created chemical and radioactive wastes. The Hanford Site mission now is focused on the cleanup of those wastes and ultimate closure of the site.

The 100 Area, which encompasses approximately 68 km^2 (26 mi^2) bordering the southern shore of the Columbia River, included six reactor areas (i.e., 100-B/C, 100-D/DR, 100-F, 100-H, 100-K, and 100-N) that contained nine reactors. The identified structures 190-KE and 190-KW are shown in Figure 1-1 and included in the 100-K Area.

1.2 Regulatory and Enforcement History

The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) was enacted to enable the Federal government to conduct cleanup of hazardous substances released into the environment. In 1986, CERCLA was amended by the *Superfund Amendments and Reauthorization Act of 1986*, which included Section 120 (42 USC 9620, "Federal Facilities"), developed specifically for federal facility cleanup. Presidential Executive Order 12580 delegated to DOE the primary authority to conduct removal and remedial actions under authority of CERCLA Section 104, "Response Authorities."

In 1987, the Federal government determined that wastes which included a mixture of radioactive and hazardous chemical components were subject to regulation under the *Resource Conservation and Recovery Act of 1976* (RCRA) and its Washington State counterpart. In 1989, DOE, the U.S. Environmental Protection Agency (EPA) and Washington Department of Ecology (Ecology) signed the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989, also known as the Tri-Party Agreement or TPA). The TPA implemented DOE's exercise of CERCLA remedial action authority under EPA oversight, in accordance with CERCLA Section 120, and also included an Ecology Consent Order containing a schedule for bringing all current Hanford hazardous waste operations into compliance with RCRA under the new mixed waste requirements. DOE's authority to conduct removal actions under CERCLA Section 104 is independent of the TPA, but is exercised cooperatively with the respective oversight authorities of EPA and Ecology.

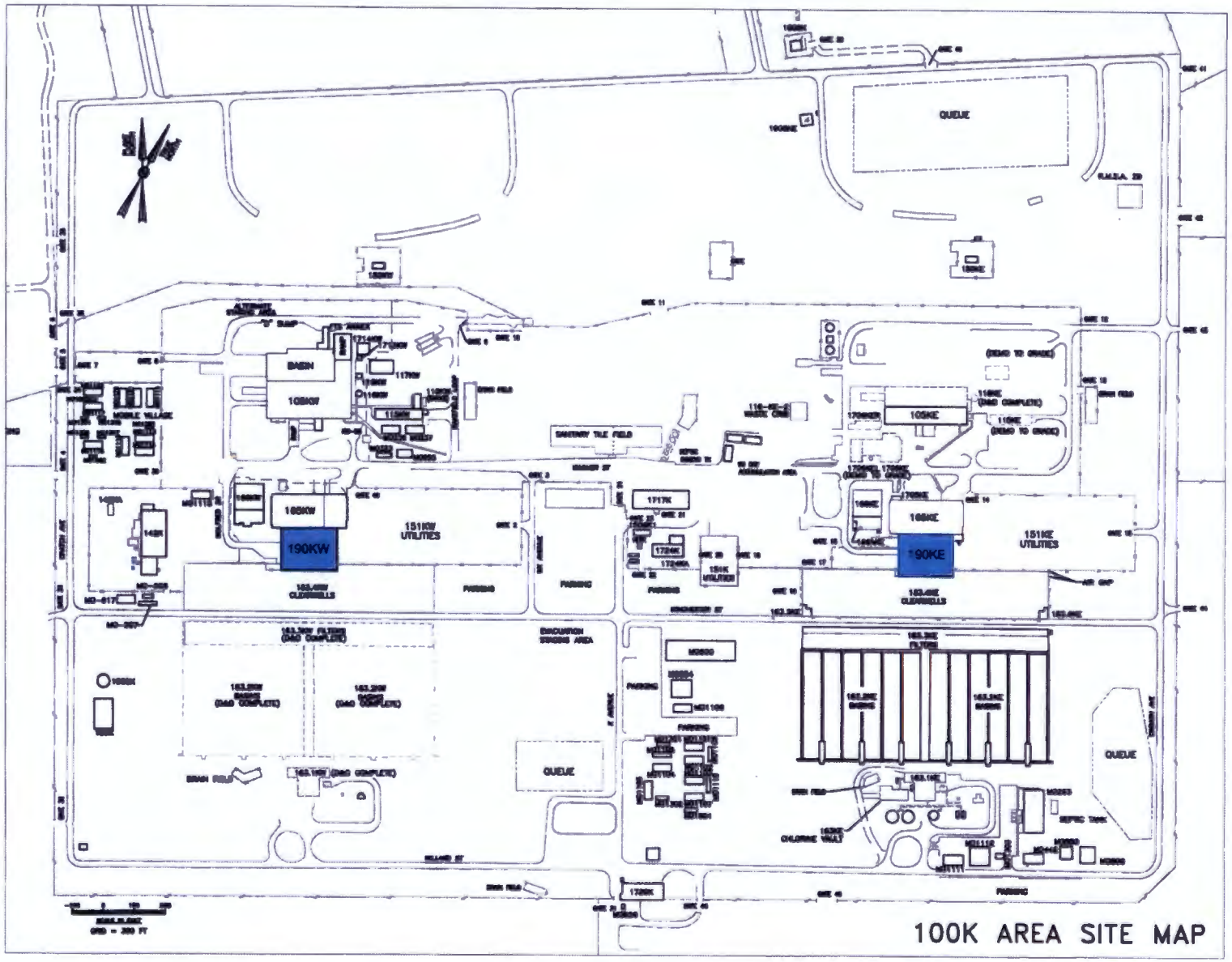

Figure 1-1. Location of the 190-KE and 190-KW Pump Houses within the 100-K Area

During this timeframe, the Hanford Site was proposed for inclusion on the Superfund National Priorities List (NPL, 53 FR 23988, "National Priorities List for Uncontrolled Hazardous Waste Sites – Update 7"). EPA placed the Hanford Site's 100, 200, 300, and 1100 Areas on the NPL on November 3, 1989 (54 FR 41015, "National Priorities List for Uncontrolled Hazardous Waste Sites – Final Rule 10/04/89"). These areas were then further divided into CERCLA operable units (OUs).

1.3 Environmental Setting

The 100-K Area is located in the Columbia River corridor of the Hanford Site. Most of the area within the 100-K boundary is highly disturbed, with substrate consisting primarily of compacted gravel. Vegetation consists primarily of widely scattered weedy species, with most of the areas having essentially no vegetation. The 190-KE and 190-KW Pump Houses were located approximately 1,219 m (4,000 ft) from the Columbia River, and groundwater at these locations is at a depth of approximately 23 m (76 ft) below ground surface.

2 190-KE and 190-KW Pump House Descriptions and Background

The 190-K Main Pump Houses contained the large pumping units used by the 100-K process water system to provide a continuous supply of cold purified process water for cooling of the two 100-K reactors. Water from the Columbia River was pumped by the 181-KW and 181-KE River Pump Houses to the 183.1-KW and 183.1-KE Headhouses, where the water was treated and filtered. The water entered the flocculation basins and then the sedimentation basins (183.2-KW and 183.2-KE), where coagulated particles and other solids were allowed to settle out. The water was further filtered at the 183.3-KW and 183.3-KE Filter Basins and then sent to the 183.4-KW or 183.4-KE Clearwells for storage. The main pump houses were located between the 165-KW and 165-KE Control Buildings and the respective north walls of the clearwells.

The main pump houses, designated 190-KE and 190-KW, were identical in function and construction. Construction of the 190-KW main pump house was started on December 15, 1952, with construction of the 190-KE pump house starting on January 13, 1953. Each main pump house was approximately 55.5 m (182 ft) wide by 42.8 m (140 ft-3 in.) long, and sat 9.2 m (30 ft-2 in.) above grade. Each building was constructed of reinforced concrete with an above ground steel frame structure that supported two overhead cranes along with transite siding and a corrugated asbestos cement panel roof, with a basement below. The operating floor of the pump house was built at ground level with the basement floor at approximately 4.6 m (15 ft) below grade. Under the operating floor at the south end of the building, adjacent to the clearwells, were two large concrete pump wells. Water entered the pump wells from the clearwells through three sluice gates located on each side of a pipe trench tunnel that ran below the basement floor in a north to south orientation. The pipe trench tunnel was open to the basement and extended from the south end of the process water system (183.1-K Headhouses) all the way to the Cross-Tie Vault. A concrete flue located below the pipe trench tunnel connected the pump wells (Figure 2-1). The concrete flue was approximately 8.5 m (28 ft) below grade. The pipe trench tunnel was designated as the 183.7-KW and 183.7-KE Pipe Tunnel.

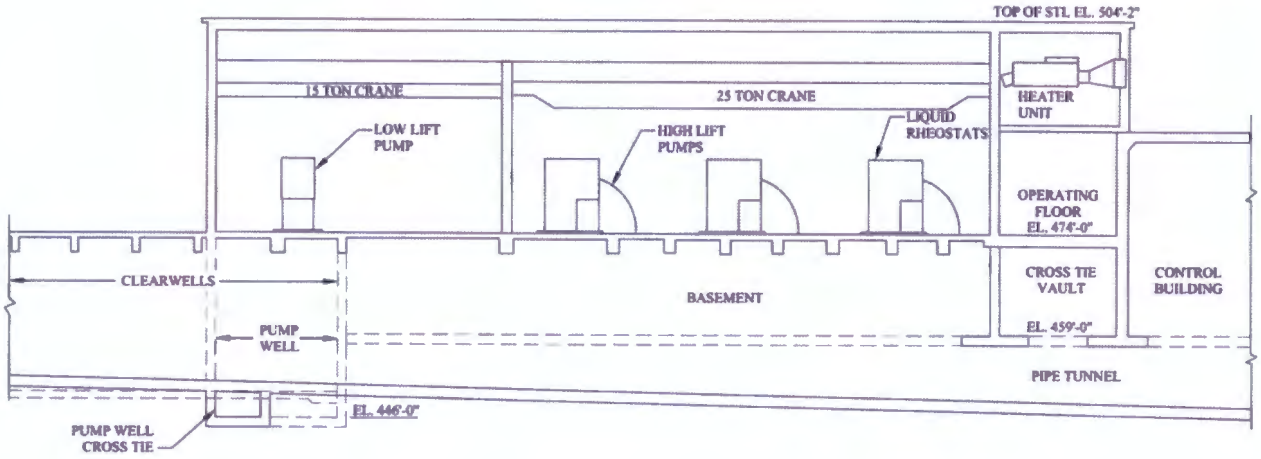

Figure 2-1. 190-KW Main Pump House Elevation (Looking West, Mirror Image of 190-KE Elevation)

Six single stage centrifugal high lift pumps and their 10,000 hp variable speed wound rotor induction motors were arranged in two rows in the central area of the operating floor of each main pump house, though their foundation pedestals extended to the basement. The operating speed of each motor was regulated by means of a liquid rheostat. On the south end of the operating floor, twelve vertical turbine or mixed flow low lift pumps were mounted that extended into the pump wells. Six of these pumps were two stage 900 hp, low lift pumps that supplied the net positive suction head required by the high lift pumps. These six low lift pumps were required for operation of the high lift pumps and could pump directly to the reactors. Four of the pumps were three stage 300 hp service water pumps that provided cooling water for the high lift drive assemblies, and two were single stage 300 hp backwash pumps. A small control panel was located near each pump containing annunciator lights, various gauges, and emergency stop controls. All operating control of the pumps was handled from the 165-K Control buildings, except for the backwash pumps which were controlled from the 183.1-K Headhouses or filter gallery within the 183.3-K Filter Basins.

All the large piping in the main pump houses was located in the basement or pipe trench tunnel with the exception of the actual pump connections. This piping consisted of

- 0.76 m (30 in.) diameter high lift pump suction lines
- 0.6 m (24 in.) diameter discharge lines
- 0.6 m (24 in.) diameter service water loop and distribution line
- two 0.76 m (30 in.) diameter back wash lines
- four 0.6 m (24 in.) diameter condenser cooling water supply and return lines
- 1.22 m (48 in.) diameter sewer (located in the pipe trench tunnel)
- two 1.5 m (60 in.) diameter raw water lines (located in the pipe trench tunnel)

The liquid rheostat for each drive unit was located opposite of its corresponding motor. As large amounts of energy were absorbed by the liquid rheostat at reduced speed operation, a heat exchanger and an electrolyte circulating pump were provided to cool the electrolyte. At the north end of the operating floor seven heating, cooling and ventilating units were suspended from the roof steel to provide heat to the facility.

Immediately north of and adjacent to the basement is another tunnel, designated the Cross-Tie Tunnel, that ran between the two 100-K reactors. The pipe trench tunnel ran into the Cross-Tie Vault housed within the Cross-Tie Tunnel. The operating floor above had a footprint that was greater than the basement floor footprint. The operating floor extended approximately 6.1 m (20 ft) over the Cross-Tie Tunnel.

Process water for cooling the 105-KW reactor flowed from the Clearwells (183.4-KW) into collection sumps located on each side of the Pipe Tunnel (183.7-KW). Lift pumps in the sumps transferred the water within the Pump House (190-KW) to a second set of pumps, which provided cooling water for the reactor. Sodium dichromate was added to the water as it exited the lift pumps and was transferred to the second set of pumps. This addition point was located above the operating floor, as the piping exited the lift pump and before it turned and passed through the operating floor into the basement.

2.1 Contaminants of Concern

A summary of the contaminants of concern (COCs) for the 190-KE and 190-KW Pump Houses is presented in Table 2-1. The processes found at 190-KE/KW were identical, as are the contaminants of concern.

The contaminants of concern identified in the Action Memorandums (EPA, 2007 and EPA, 2005) include unquantified hazardous construction materials (UHCM) and chemical contamination. Before demolition activities began, all UHCM items such as mercury containing gauges, ballasts, and asbestos-containing material (ACM) were removed.

The 190-KE/KW facilities were the final step in the water treatment process in order to provide cooling water to the reactors. Within these facilities a concentrated sodium dichromate solution was metered into the cooling water as a corrosion inhibitor, adding hexavalent chromium as a COC. The water processed through these facilities was treated prior at 183.1KE/KW and 183.2KE/KW with chlorine, bauxite, sulfuric acid and sodium silicate. After the water was treated it was stored in the 183.4KE/KW clearwells and flowed directly into the 190-KE/KW pump well reservoir. Extensive sampling of the underlying soils at 183.4KE/KW and 183.2KE/KW was completed prior to the sampling at 190-KE/KW. Given the sample results from the soils underneath the upstream water treatment facilities (183.4KE/KW and 183.2KE/KW) the following COCs are included for the 190-KE/KW facilities: barium, cadmium, chromium, copper, lead, mercury, vanadium, zinc, chloride, and sulfate.

Additionally, various lubrication oils for the pumps were also used within these facilities adding polychlorinated biphenyls (PCBs) and total petroleum hydrocarbons (TPH) to the COC list. The 190-KE/KW facilities stored and transported treated water prior to use as cooling water for the 105-KE/KW Reactors; therefore, radiological constituents are not considered COCs.

Table 2-1. Contaminants of Concern for the 190-KE and 190-KW Pump Houses

Metals		
Barium	Cadmium	Chromium (VI)
Chromium (total)	Copper	Lead
Mercury	Vanadium	Zinc
Anions		
Chloride	Sulfate	
Organics		
Polychlorinated Biphenyls	Total Petroleum Hydrocarbons	

2.2 Description of the Removal Action

The purpose of these removal actions was to mitigate the threat of release of contaminants from the 100-K Area ancillary facilities to the environment, and to be consistent with remedial actions for the 100-KR-2 OU. These removal actions were performed in accordance with the Action Memorandum 1 (EPA, 2007) and the Action Memorandum 2 (EPA, 2005), and the approved RAWP (DOE/RL-2005-26).

2.2.1 Removal Action Objectives

The following removal action objectives (RAOs) were established in the approved RAWP (DOE/RL-2005-26):

- Protect human receptors from exposure to contaminants above acceptable exposure levels within facility structures
- Control the migration of contaminants from the facilities into the environment
- Facilitate and, to the extent practicable, be consistent with anticipated remedial actions within the 100-K Area OUs
- Prevent adverse impacts to cultural resources and nesting migratory birds
- Achieve applicable or relevant and appropriate requirements (ARARs) to the fullest extent practicable
- Safely treat, as appropriate, and dispose of waste streams generated by the removal action
- Take no action that will preclude the eventual final disposition of the 105-KE and 105-KW Reactor blocks

The completion criteria by which the RAOs were achieved for these removal actions are documented in Section 5.

2.2.2 Exposure and Land Use Assumptions

Cleanup activities at the 100-K Area are conducted to achieve compliance with a rural-residential exposure scenario, as stipulated in the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2,*

100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites Record of Decision [ROD], EPA/ROD/R10-99/039).

2.2.3 Design Summary

The removal actions were planned through research of the process history and review of historical drawings of the buildings. Additionally, prior to the start of the removal actions, field investigations and walkdowns of the facilities were conducted by project personnel (engineers, planners, field work supervisors, waste specialists and management), DOE-RL and EPA. From this information, a demolition plan was developed and documented in a site-specific work package, which included the following:

- Pre-demolition location of all utility interfaces (i.e., electrical, water, etc.) within the building footprint were identified
- Pre-demolition characterization activities to identify UHCM requiring disposition
- Estimated depth to support structure removal
- The placement of access roads into and out of the basement of the structure
- Disposal pathways identified for all materials found within the structure
- Characterization of the structure and identification of any potential waste sites

2.3 ROD Amendments, Significant Differences, or Waivers

No ROD amendments, significant differences, or waivers apply to these removal actions.

3 Removal Activity Summary

This section describes actions taken to complete the removal of the 190-KE and 190-KW Pump Houses.

3.1 Summary of Activities

Work to demolish the 190-KE and 190-KW structures followed a detailed site-specific work package as described in section 2.2.3. The demolition and work activities for 190-KE and 190-KW were nearly identical. Pre-demolition planning activities included field investigations to identify any utility interfaces (i.e., electrical, water, etc.) and characterization activities to identify UHCM requiring disposition prior to or during demolition of each building.

The removal action for 190-KE began in July 2011 and completed in August 2012. The 190-KW removal action began in July 2011 and was completed in March 2012. The facilities were deactivated through equipment and component demolition and removal. The service utility pipelines were isolated by cutting, plugging, or air gapping the water lines and sanitary sewer lines.

The 190-KE/KW pump well reservoirs each contained approximately 100,000 gallons of residual treated water. The water was sampled in June 2011 and determined to be suitable for use as dust suppression water or release into the adjacent 183.4-KE/KW Clearwells (CHPRC-0900289 R24, *Meeting Minutes Transmittal/Approval 100K Project Managers Meeting September 8, 2011*). The water was pumped from the pump well reservoirs into the 183.4-KE/KW Clearwells and allowed to drain through potholes in the concrete floor.

The basement level in 190-KE/KW was accessed by ramping in from the west side, followed by removal of the equipment and structural features including pumps, motors, piping, walls, and walking platforms. The portion of the 183.7-KE/KW Pipe Tunnels that traversed the 190-KE/KW Pump Houses was also removed. The perimeter and interior walls of each Pump House were removed to at least 3 ft below grade. The main level and components located in the basement of the Pump Houses were completely removed. Basement walls were rubblized in place and used for backfill in the tunnel and basement. Portions of the basement floor remained exposed and were visually inspected for cracks and stains from operations. The 190-KW basement floor showed no indication of any chemical impacts except for one area of staining. Iinside 190-KE on the east side of the 183.7KE Pipe Tunnel, green stained concrete was observed. One sample of the stained concrete was collected (HEIS # B2KD38) and showed elevated levels of chromium, chromium (VI), copper, zinc and lead. The concrete in this area ranges in thickness of approximately 8 to 15 ft. Staining in the concrete was observed to penetrate approximately 0.5inch. Approximately 3 to 5 ft of concrete was removed from a 50 ft area and treated for chromium before disposal at the environmental restoration and disposal facility (ERDF). No staining is present on the remaining concrete floor within the 190-KE building. A sample from the remaining concrete was collected (HEIS # B2LRC8); results from this sample are discussed in Section 3.

Waste characterization and demolition waste load-out activities were conducted in accordance with the waste management ARARs identified in the Action Memorandums (EPA, 2007 and EPA, 2005), the RAWP (DOE/RL-2005-26), and the ERDF waste acceptance criteria. Approximately 4,740 tons (472 containers) from 190-KE and 7,500 tons (690 containers) from 190-KW of demolition debris waste were disposed at the ERDF. Figures 3-1 and 3-2 are post-demolition photographs of the 190-KE and 190-KW Pump Houses, respectively, post demolition.

Figure 3-1. The 190-KE Pump House at Completion of Demolition and Prior to Backfill

Figure 3-2. The 190-KW Pump House at Completion of Demolition and Prior to Backfill

3.2 Verification Activities

The RAWP (DOE/RL-2005-26) requires verification sampling of subsurface soils if it is believed that impacts may have occurred from prior facility operations or from the D4 activities. On a walkdown August 2, 2011 EPA identified two locations for soil samples from below each Pump House; one from each side of the 183.7KE/KW Pipe Tunnel below the pump well reservoirs. The soil samples were collected and analyzed in accordance with requirements of the *100 Area Remedial Action Sampling and Analysis Plan* (DOE/RL-96-22). The analytical results were evaluated to verify that no remedial action is required for the underlying soils. Several considerations affected the development of the sampling approach for the 190-KE and 190-KW facilities:

- The water processed through the 190-KE and 190-KW Pump Houses was the same water stored in the183.4KW/KE Clearwells. Therefore, it would be expected that contamination of the concrete at 183.4KE/KW is analogous to the concrete at the Pump Houses. The analysis for the 183.4KE/KW facilities indicated the concrete could remain in place. Therefore, the basement of the 190-KE and 190-KW facilities could potentially remain in place without significant additional concrete analysis.

- During a walkdown at 190-KE in February 2012 with project management, DOE-RL and EPA green staining was observed on the concrete floor; a concrete sample was collected and analyzed.It was agreed between DOE-RL and EPA that sampling of the soil below the pump well reservoirs, where the water first entered the Pump House, should be representative of the nature of any contamination below the 190-KE and 190-KW Pump Houses.Radiological Surveys

The 190-KE/KW facilities presented no risk of radiological contamination as both facilities stored and transported treated water before use in the 105-KE/KW Reactor and were not exposed to a radiological source.

3.2.1 Sampling and Analysis

Two focused soil samples were collected from both 190-KE/KW to evaluate the underlying soil. The samples were collected under the concrete floor of the pump well reservoirs on either side of the 183.7KE/KW Pipe Tunnel. An excavator was used to pothole the concrete floor to access soil below the structure (Figure 3-3). Soil Samples from 190-KE were collected in October 2011. 190-KW was sampled in February 2012. The Hanford Environmental Information System (HEIS) numbers are:

- 190-KE: B2J4T8, B2J4T9, B2J4V1 and B2J4V2
- 190-KW: B2KCP4 and B2KCP5.

These samples were biased, based on the assumption that potential contamination associated with 190-KE/KW would likely be found in the area below the pump well reservoirs. The soil samples were collected in accordance with requirements of the 100 Area Remedial Action Sampling and Analysis Plan (DOE/RL-96-22) and analyzed for the COCs identified in Section 2.1.

Additionally, one concrete sample was collected within the 190-KE facility. The location of this concrete sample correlates with the location of the green stained concrete that was removed. The concrete sample was collected in accordance with the requirements of the 100 Area SAP (DOE/RL-96-22) and analyzed for the COCs listed in Section 2.1.

The sampling for the 190-KE and 190-KW Facilities met the requirements of DOE/RL-2005-26 to evaluate potential impacts from these facilities. Complete sample results are included in Appendix A. Section 5.1.2 presents an analysis of these results.

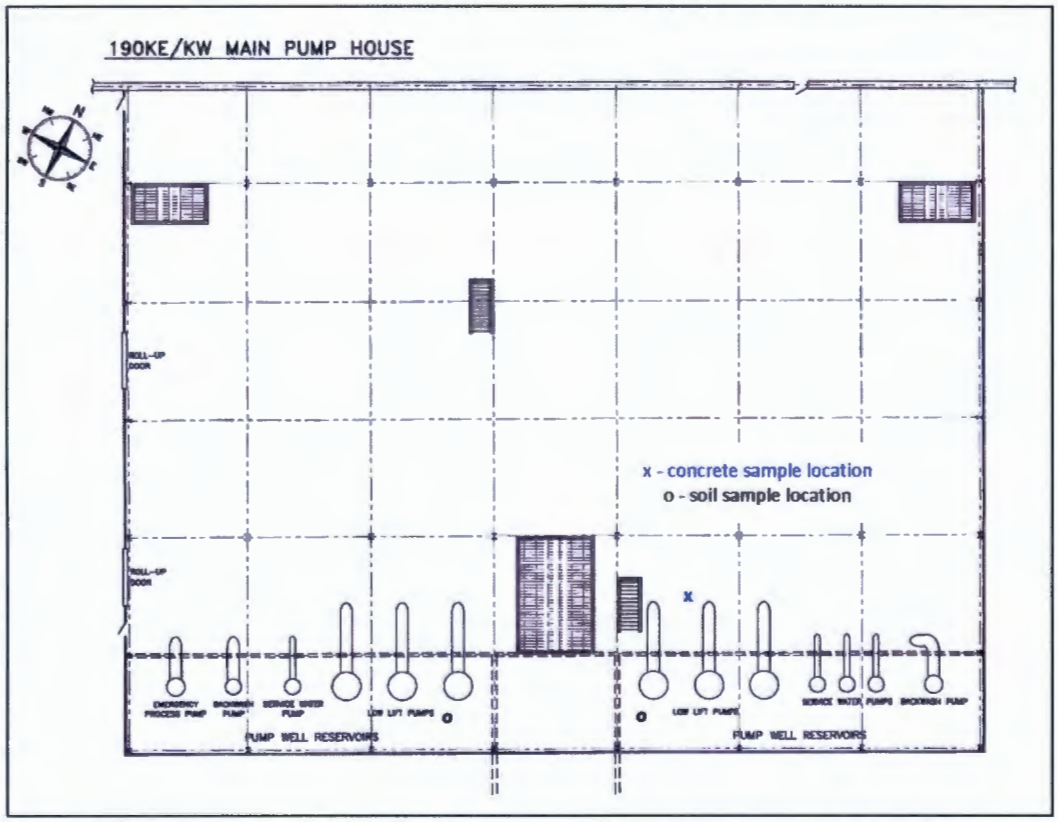

Figure 3-3. Concrete and Soil Sample Locations within the 190-KE and 190-KW Facilities

4 Chronology of Events

This section provides the significant events and activities pertinent to the removal of the 190-KE and 190-KW Pump Houses. Table 4-1 lists those events chronologically.

Table 4-1. Chronology of D4 Activities for the 190-KE and 190-KW Pump Houses

Date	Event
1955	Operation of the 190-KE and 190-KW Pump Houses began.
1970	Operation of the 190-KW Pump House in support of the 105-KW Reactor ended.
1971	Operation of the 190-KE Pump House in support of the 105-KE Reactor ended.
July 2011	The deactivation of the 190-KW and 190-KE Pump Houses begins with completion of hazardous energy and electrical isolation activities.
July 2011	Demolition of the 190-KE Pump House began
October 2011	Collected soil samples from below 190-KE
October 2011	Demolition of the 190-KW Pump House began
February 2012	Collected soil samples from below 190-KW
March 2012	Demolition and loadout of the 190-KW Pump House complete

Table 4-1. Chronology of D4 Activities for the 190-KE and 190-KW Pump Houses

Date	Event
June 2012	Collected concrete sample from 190-KE
August 2012	Demolition and loadout of the 190-KE Pump House complete

5 Performance Standards and Construction Quality Control

This section documents:

- The evaluation process for demonstrating achievement of performance standards
- The results of that evaluation
- The quality control requirements implemented during remedial activities, including a data quality assessment

5.1 Attainment of Performance Standards

The overall performance of the removal action and evaluation of attainment of protectiveness for human health and the environment are addressed in the following sections.

5.1.1 Performance Completion Criteria

Table 5-1 presents the completion criteria developed from the approved RAWP (DOE/RL-2005-26) and a summary of the actions taken.

Table 5-1. Completion Criteria for the 190-KE and 190-KW Pump Houses

Phase of the Demolition Activities	Completion Criteria*	Criteria Complete?	Description of How the Completion Criteria Were Addressed
Above-Grade Structures	Remove interior portions of the building, including ACM, lead bricks, sheeting, PCBs (primarily in motor oils and light ballasts), mercury (primarily in light components and switches), and other hazardous materials for treatment, recycle, or disposal.	Yes	Interior portions of the 190-KE and 190-KW Pump Houses, including UHCM (e.g., mercury, ballasts, ACM, lubricants) were removed and/or absorbed and disposed prior to or during demolition. All substances removed were characterized and disposed in accordance with waste management ARARs and waste disposal facility criteria. The debris with asbestos containing material was staged within the building footprint area adjacent to the facility prior to disposal. The footprint of the staged material is currently being evaluated for future action to address residual asbestos in the soil.
	Above-grade portions of the facility will be removed or demolished to grade using standard demolition techniques (e.g., excavator with a hoe-ram, hydraulic shear with steel shear jaws, concrete pulverizer jaws or breaker jaws, crane with wrecking ball, and/or controlled explosives).	Yes	The above-grade portions of the 190-KE and 190-KW Pump Houses were demolished using standard demolition techniques.
Below-Grade Structures	Below-grade structures, if present, will be removed to a minimum of 3 ft below surrounding grade, and the remaining portion will either be removed or left in place, depending on whether cleanup standards can be achieved.	Yes	The concrete floor level and below-grade structures (i.e., side walls and columns) for 190-KE/KW Pump Houses (and portions of the 183.7-KE/KW Tunnels that traverse the 190-KE/KW Pump Houses) were removed to a minimum of 3 ft below grade. Additionally, a stained area of concrete on the floor of 190-KE was removed. The remaining below-grade portions of 190-KE/KW were left in place.
			Also, the concrete floor level and below-grade structures (i.e., side walls and columns) for the 190-KW Pump House (and portions of the 183.7-KW Tunnel that traverse the 190-KW Pump House) were removed to a minimum of 3 ft below grade. The remaining below-grade structures were left in place.

Table 5-1. Completion Criteria for the 190-KE and 190-KW Pump Houses

Phase of the Demolition Activities	Completion Criteria*	Criteria Complete?	Description of How the Completion Criteria Were Addressed
	Remediate contaminated soils within the footprint of the facilities or defer to a later remedial action (with approval from EPA).	N/A	Sample results from the underlying soils show no levels above remedial action goals, no remediation was required.
	Upon completion of demolition activities, a minimum of 3 ft of clean fill/soil cover will be placed over any remaining below-grade structure and inert material, and the fill will be graded to match the surrounding terrain.	No	The demolition areas for the 190-KE and 190-KW Pump Houses have not yet been graded to match surrounding terrain. The backfilling and grading of both areas will be coordinated with ongoing post-D4 site grading and restoration activities and area-wide 100-KR-2 OU remedial action.
Waste Management	Conduct waste characterization prior to and during D4 activities in accordance with the data quality objectives process identified in the applicable SAP. Characterization is conducted to support waste disposal activities, define contaminants present before or after the completion of the removal action, and, in some cases, support site closure documentation.	Yes	Waste characterization for the 190-KE and 190-KW Pump Houses was performed in accordance with the *100-K Area Interim Safe Storage and D4 Project Waste Sampling and Analysis Plan* (DOE/RL-2005-33) to guide waste removal and disposal. Based on pre-demolition planning activities, UHCM (i.e., ballasts, ACM, and lubricants) was identified, characterized, and disposed prior to and during demolition, as required.
	Manage and dispose of all waste (including general demolition debris, and any ACM, lead bricks, sheeting, PCBs, mercury, and other hazardous materials) generated during the removal action. Waste generated will be characterized in accordance with the contractor's procedures, the requirements of the receiving facility, and the waste characterization SAP.	Yes	All wastes generated during D4 activities were characterized, shipped, and disposed in accordance with waste management ARARs and the ERDF waste acceptance criteria. The D4 waste (consisting primarily of pump and piping debris) from the 190-KE and 190-KW Pump Houses was sent to the ERDF for disposal.
Verification	After the removal activities are completed, the site will be characterized to document the condition following the removal of the facility and/or structure.	Yes	Field sampling and laboratory analysis were conducted of soils below the subsurface pump well reservoirs. The results were reviewed and verify that no remedial action will be required for the underlying soils.
Documentation	DOE-Richland Operations Office will provide documentation describing the environmental conditions at the end of the D4 activity.	Yes	The post-D4 environmental conditions for the 190-KE and 190-KW Pump Houses are presented in this report.

* Completion criteria were developed from the removal action requirements of DOE/RL-2005-26, *Removal Action Work Plan for 105-KE/105-KW Reactor Facilities and Ancillary Facilities.*

5.1.2 Removal Action Objectives Verification

Removal of the 190-KE and 190-KW Pump Houses achieved the following RAOs identified in Section 2.3.1:

- *Protect human receptors from exposure to contaminants above acceptable exposure levels within facility structures*

  The physical removal and appropriate disposal of the 190-KE and 190-KW Pump Houses eliminated the potential for exposure to hazardous substances above acceptable levels within each facility structure.

- *Control the migration of contaminants from the facilities into the environment*

  During D4 activities, the physical removal and appropriate management and disposal of the 190-KE and 190-KW Pump Houses eliminated the potential for release of contaminants from each facility into the environment.

- *Facilitate and, to the extent practicable, be consistent with anticipated remedial actions within the 100-K Area OUs*

  The physical removal and appropriate management and disposal of the 190-KE and 190-KW Pump Houses are consistent with the selected remedy of Remove/Treat/Dispose from the 100 Area Remaining Sites ROD (EPA/ROD/R10-99/039).

- *Prevent adverse impacts to cultural resources and nesting migratory birds*

  A cultural resources review was conducted for various D4 activities within an 183-acre area inside the fence line of the 100-K Area (encompassing the footprints of the 190-KE and 190-KW Pump Houses), which found no known archaeological sites located on the ground surface within this area. The 190-KE and 190-KW Pump Houses were determined to be contributing components of the historical district, but did not require individual documentation or a walkthrough. However, the history of the 190-KE and 190-KW Pump Houses were documented in the *History of the Plutonium Production Facilities at the Hanford Site Historic District, 1943-1990* (DOE/RL-97-1047), as required. Therefore, the removal action activities at the 190KE and 190-KW Pump Houses are not anticipated to have had an adverse impact to cultural resources.

  A blanket biological review was completed in November 2010 and addressed the demolition and removal of several facilities, including the 190-KE and 190-KW Pump Houses (ECR #2010-100-116, "Biological Review of the Accelerated D&D of the 100-K Area"). No migratory birds or nests were noted at the time of the survey or prior to D4 activities. Therefore, this removal action did not have an adverse impact to nesting migratory birds.

- *Achieve ARARs to the fullest extent practicable*

  The ARARs presented in the Action Memorandum 1 (EPA, 2007), Action Memorandum 2 (EPA, 2005), and RAWP (DOE/RL-2005-26) included waste management standards, air emission control standards, protection of cultural and natural resources, and safety and health standards. These removal actions were completed in accordance with these ARARs.

- *Safely treat, as appropriate, and dispose of waste streams generated by the removal action*

  Waste streams generated by these removal actions were managed in accordance with the ARARs and treated, as appropriate, to meet the ERDF waste acceptance criteria for disposal. These removal

actions included the safe physical removal and disposal of D4 waste from the 190-KE and 190-KW Pump Houses into the ERDF.

- *Take no action that will preclude the eventual final disposition of the 105-KE and 105-KW Reactor blocks*

  Completion of these removal actions does not preclude the eventual disposition of the 105-KE or 105-KW Reactor blocks.

5.1.2.1 190 KE Pump House Data Evaluation

This section provides an evaluation of the 190-KE Pump House sampling data for the COCs identified in Table 2-1. The underlying soils and concrete were sampled to determine if they could be left in place and be protective of human health and the environment. Biased soil samples were collected from directly under the pump well reservoirs from either side of the 183.7KE tunnel as described in Section 3.2. Additionally, a biased concrete sample was collected from below the stained concrete described in Section 3.2. The results were evaluated based on the maximum concentration detected as listed in Tables 5-2 and 5-3.

The Analogous Sites RESRAD Model from the RDR/RAWP for the 100 Area (DOE/RL-96-17, Appendix C), predicts whether or not contaminants in 100 Area soils will migrate to groundwater within a 1,000-year time frame based on the K_d value and the vertical distance to groundwater.

Soil

For the underlying soils the maximum concentration for each COC was below the direct exposure RAG. In the underlying soils aroclor-1254 was above the RAGs for protection of groundwater and the Columbia River and vanadium was above the RAG for the protection of groundwater.

The soil samples were collected from an elevation of 137 m (449.5 ft), and the depth to groundwater is 17 m (56 ft). In order to use the RESRAD model 3 m (9.8 ft) is subtracted from the depth to groundwater. Given a clean vadose zone of 14 m (46 ft), the RESRAD model predicts constituents present in the soil with a K_d value of 5.3 mL/g or greater will not reach groundwater within 1,000 years. Since the K_d value for aroclor 1254 is 75.6 mL/g, and the K_d value for vanadium is 1,000 mL/g neither of these contaminants is predicted to reach groundwater within 1,000 years. The residual concentrations of aroclor 1254 and vanadium are protective of groundwater and the Columbia River. The residual concentration of all COCs in the soils are protective of all exposure scenarios and can remain in place.

Table 5-2. 190-KE Pump House Soil Sample Results

Contaminant of Concern	Back-ground (mg/kg)	Soil Kd value (mL/g)	Soil Cleanup Levels (mg/kg)[a]			Maximum Sample Result (mg/kg)	Exceeds Soil RAGs?
			Direct Exposure	Ground-water Protection	River Protection		
PCBs							
Aroclor - 1016	NA	107	0.5	0.017	0.017	U 0.0093	No
Aroclor – 1221	NA	10.3	0.5	0.017	0.017	U 0.0093	No
Aroclor – 1232	NA	10.3	0.5	0.017	0.017	U 0.0093	No
Aroclor – 1242	NA	44.8	0.5	0.017	0.017	U 0.0093	No
Aroclor – 1248	NA	43.9	0.5	0.017	0.017	U 0.0093	No
Aroclor – 1254	NA	75.6	0.5	**0.017**	**0.017**	**J 0.02**	**Yes**
Aroclor – 1260	NA	822	0.5	0.017	0.017	U 0.0059	No
TPH							
TPH-Diesel	--	50	200	200	200	U 0.35	No
TPH-Kerosene	--	50	200	200	200	U 0.35	No
Metals							
Barium	132	25	5,600	200	400	67	No
Cadmium	0.81[d]	30	13.9[e]	0.81[c]	0.81[c]	0.093	No
Chloride	100	0	--	25,000	--	4.3	No
Chromium, Total	18.5	200	80,000	18.5[c]	18.5[c]	4.6	No
Copper	22.0	22	2,960	59.2	22.0[c]	19	No
Hexavalent Chromium	--[b]	0	2.1[c]	4.8	2	U 0.155	No
Lead	10.2	30	353	10.2[c]	10.2[c]	3.8	No
Mercury	0.33	30	24	0.33[c]	0.33[c]	B 0.019	No
Sulfate	237	0	--	25,000	--	25.9	No
Vanadium	85.1	1000	560	**85.1[c]**	--	**91**	Yes
Zinc	67.8	30	24,000	480	67.8[c]	62.2	No

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. Maximum soil concentration was used where there was not sufficient data to calculate a 95%UCL.

Concrete Floor

The 190-KE concrete floor sample concentration for hexavalent chromium exceeded the direct exposure and river protection RAG; copper and zinc exceeded the river protection RAG; and lead exceeded the groundwater protection and river protection RAG. The 190-KE basement floor will be below 15' after final backfill and contouring, therefore the data was not evaluated for compliance with direct exposure RAGs.

The remaining concrete floor at 190-KE is at an elevation of 139.4 m (457.5ft) and the depth to groundwater is 19.4 m (63.6 ft). The RESRAD model predicts constituents present in the soil with a K_d value of 3.6 mL/g or greater will not reach groundwater within 1,000 years. Since the K_d values for copper, lead and zinc are all above 3.6 mL/g (22 mL/g, 30 mL/g and 30 mL/g respectively), the model predicts that if these contaminants were in the soil they would reach groundwater within 1,000 years. The contaminants, however, are not in soil, but in the concrete floor where the K_d values are at least an order of magnitude greater for each of these constituents. Therefore, residual concentrations of copper, lead, and zinc in the concrete are protective of groundwater and the Columbia River.

Hexavalent chromium has a K_d value of 0 mL/g in 100 Area soils. However, hexavalent chromium in concrete behaves differently due to interaction with concrete constituents. Appendix C, Section C.3.1.3, of DOE/RL-2005-93, Rev.0, Remedial Design Report/Remedial Action Work Plan for the 100-N Area provides a list of K_d values for materials in a concrete matrix. The K_d value for hexavalent chromium in concrete 870 mL/g, rendering the contaminant immobile in the concrete matrix. The hexavalent chromium in the surface of the concrete floor will not migrate through the concrete matrix, will not leach into the underlying soil, and therefore does not pose a risk to groundwater or the Columbia River. Therefore, residual concentrations of hexavalent chromium in the concrete are protective of groundwater and the Columbia River.

Table 5-3. 190-KE Pump House Concrete Sample Results

Contaminant of Concern	Back-ground (mg/kg)	Soil Kd value (mL/g)	Concrete Kd value (mL/g)	Soil Cleanup Levels (mg/kg)[a]			Sample Result (mg/kg)	Exceeds Soil RAGs?
				Direct Exposure	Ground-water Protection	River Protection		
Metals								
Barium	132	25	25[f]	5,600	200	400	158	No
Cadmium	0.81[d]	30	30[f]	13.9[e]	0.81[c]	0.81[c]	B 0.0895	No
Chromium, Total	18.5	200	200[f]	80,000	18.5[c]	18.5[c]	18.5	No
Copper	22.0	22	100	2,960	59.2	**22.0[c]**	**30.2**	Yes
Hexavalent Chromium	--[b]	0	870	**2.1[c]**	4.8	**2**	**2.83**	Yes
Lead	10.2	30	500	353	**10.2[c]**	**10.2[c]**	**16.8**	Yes
Mercury	0.33	30	30[f]	24	0.33[c]	0.33[c]	U 0.026	No
Vanadium	85.1	1000	100	560	85.1[c]	--	51.2	No
Zinc	67.8	30	30[f]	24,000	480	**67.8[c]**	**91.3**	Yes

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. Maximum soil concentration was used where there was not sufficient data to calculate a 95%UCL.

f. No concrete Kd value known; soil Kd value should be used and discussed.

5.1.2.2 190-KW Pump House Data Evaluation

This section provides an evaluation of the 190-KW Pump House sampling data for the COCs identified in Table 2-1. The underlying soils were sampled to determine if they could be left in place and be protective of human health and the environment. Biased soil samples were collected from directly under the pump well reservoirs on either side of the 183.7KW tunnel as described in Section 3.2. The results were evaluated based on the maximum concentration detected as listed in Tables 5-4.

For the underlying soils at 190-KW, the maximum concentration for each COC was below the direct exposure, protection of groundwater and the Columbia River RAGs and for all COCs, Table 5-2. Therefore, the residual concentration of all COCs in the soils are protective of all exposure scenarios and can remain in place.

Table 5-4. 190-KW Pump House Soil Sample Results

Contaminant of Concern	Back-ground (mg/kg)	Soil Kd value (mL/g)	Soil Cleanup Levels (mg/kg)[a]			Maximum Sample Result (mg/kg)	Exceeds Soil RAGs?
			Direct Exposure	Ground-water Protection	River Protection		
PCBs							
Aroclor - 1016	NA	107	0.5	0.017	0.017	U 0.005	No
Aroclor – 1221	NA	10.3	0.5	0.017	0.017	U 0.009	No
Aroclor – 1232	NA	10.3	0.5	0.017	0.017	U 0.005	No
Aroclor – 1242	NA	44.8	0.5	0.017	0.017	U 0.005	No
Aroclor – 1248	NA	43.9	0.5	0.017	0.017	U 0.005	No
Aroclor – 1254	NA	75.6	0.5	0.017	0.017	U 0.005	No
Aroclor – 1260	NA	822	0.5	0.017	0.017	U 0.005	No
TPH							
TPH-Diesel	--	50	200	200	200	U 5	No
TPH-Kerosene	--	50	200	200	200	U 5	No
Metals							
Barium	132	25	5,600	200	400	79.9	No
Cadmium	0.81[d]	30	13.9[e]	0.81[c]	0.81[c]	B 0.105	No
Chloride	100	0	--	25,000	--	U 3.4	No
Chromium, Total	18.5	200	80,000	18.5[c]	18.5[c]	7.74	No
Copper	22.0	22	2,960	59.2	22.0[c]	18.4	No
Hexavalent Chromium	--[b]	0	2.1[c]	4.8	2	B 0.367	No
Lead	10.2	30	353	10.2[c]	10.2[c]	6.25	No
Mercury	0.33	30	24	0.33[c]	0.33[c]	UN 0.063	No
Sulfate	237	0	--	25,000	--	BN 20.5	No
Vanadium	85.1	1000	560	85.1[c]	--	40.9	No
Zinc	67.8	30	24,000	480	67.8[c]	42.6	No

a. RAGs obtained from the RDR/RAWP for the 100 Area (DOE/RL-96-17).

b. No Hanford Site specific or Washington State background value available.

c. Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996).

d. Hanford Site-specific background not available. Value is from Ecology (1994).

e. Maximum soil concentration was used where there was not sufficient data to calculate a 95%UCL.

5.1.3 Statement of Protectiveness

This removal action mitigates the threat of release of contaminants to the environment and is consistent with interim remedial actions for the 100 Area of the Hanford site. Protection of human health and the environment has been demonstrated by the removal of most of the 190-KE/KW Facilities, and follow-up sampling and analysis confirms that the remaining structure and underlying soil does not pose a threat to human health or the environment.

Appendix C of DOE/RL-96-17 (Rev.6) provides an approach to determine the potential for contaminants to leach through the soil column to groundwater and the Columbia River. The approach uses an analogous site contaminant depth/distribution coefficient (K_d) model to predict whether the levels of contaminants in soil are protective of groundwater and the river. The model relies on knowledge of the groundwater elevation and sample elevation to determine the depth of the vadose zone (i.e., distance to groundwater). The K_d value necessary to be protective of groundwater varies based on vadose zone thickness and the mobility of the contaminant. A detailed evaluation of the data presented in Section 5.1.2 demonstrates that the residual concentration of COCs in the structure floors and underlying soils is protective of groundwater and the Columbia River.

5.2 Construction Quality Assurance/Quality Control

Not applicable. No construction related aspects were implemented as part of the removal action for the 190-KE and the 190-KW Pump Houses.

5.3 Cleanup Verification Quality Assurance/Quality Control

Two soil samples from below each 190-KE and 190-KW were collected as part of this removal action for the 190-KE and 190-KW Pump Houses. No equipment blank and no duplicate samples were collected as a part of this sampling.

One concrete sample from 190-KE was collected as a part of the removal action. One equipment blank and no duplicate samples were collected.

The laboratories have a quality control (QC) regarding the analytical process including:

- Laboratory method blanks provide a measure of the cleanliness of the analytical process. The appearance of measurable analytes in the method blank may indicate contamination of customer samples during sample preparation and analysis.
- Laboratory control samples, matrix spike samples, and surrogates provide a measure of the accuracy of the analytical process. Percent recovery is the metric used to determine analytical accuracy. Percent recoveries consistently less than or greater than 100 percent may indicate a bias in the analytical process.
- Laboratory control sample duplicates, matrix spike duplicates, sample duplicates, and surrogate duplicates provide a measure of the reproducibility of the analytical process. RPD is the metric used to determine reproducibility.

5.3.1 Data Quality Assessment

Field sampling and laboratory analysis were conducted for soil samples from the soil below the pump well reservoirs located within the 190-KE and 190-KW Pump Houses. The analytical results from soils collected were evaluated to demonstrate protectiveness for the footprint of the 190-KE and 190-KW Pump Houses as part of this removal action. In accordance with the SAP (DOE/RL-96-22), minimally 5 percent of all data packages are validated for the 100-K Area D4 and soil remediation activities to

ensure the laboratory results are of appropriate quality for the intended use. Although the data package for this specific D4 activity was not third party validated, the data were reviewed by qualified technical reviewers and the data presented in this report as determined to be of the appropriate quantity and quality to support the decision.

5.3.2 Environmental Quality Assurance

Although this was not a radiologically contaminated facility, radiological surveys were routinely performed during waste load out. Field instrumentation, calibration, and quality assurance checks were performed in accordance with the following procedures:

- Calibration of radiological field instruments on the Hanford Site is performed under contract by Pacific Northwest National Laboratory.
- Daily calibration checks are performed and documented for each radiological instrument used for conducting surveys. The calibration checks are made using direct comparison to standard materials that are sufficiently similar to the matrix under consideration and/or certified radioactive sealed sources.

The approval of field data by the radiological control organization provides the data validation and usability review for handheld field radiological measurements.

5.4 Regulatory Oversight

EPA is the lead regulatory agency for this removal action, and provided oversight.

6 Final Inspection and Certifications

No final inspections or certifications are applicable to or required by the removal actions for the 190-KE and the 190-KW Pump Houses.

7 Operation and Maintenance Activities

There are no operations and maintenance activities resulting from these removal actions.

8 Summary of Project Costs

The total cost for D&D activities associated with the 190-KE Facility is estimated at $2,533,000 through completion of demolition activities. The total cost for D&D activities associated with the 190-KW Facility is estimated at $3,068,000. Backfill and revegetation will be conducted as part of the area-wide activities; therefore, facility-specific costs are not included in these estimates.

9 Observations and Lessons Learned

No observations or lessons learned were identified for the removal actions.

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Appendix A

190-KE and 190-KW Pump House Soil and Concrete Results

190-KE & 190-KW Soil and Concrete Sample Results

Contaminants of Concern	190-KE Soil Sample #1 HEIS # B2J4T8, B2J4T9 (mg/kg)	190-KE Soil Sample #2 HEIS # B2J4V1, B2J4V2 (mg/kg)	190-KW Soil Sample #1 HEIS # B2KCP4 (mg/kg)	190-KW Soil Sample #2 HEIS # B2KCP5 (mg/kg)	190-KE Concrete Sample #1 HEIS # B2KD38 (mg/kg)
Aroclor-1016	U 0.0093	U 0.0091	U 0.005	U 0.005	--
Aroclor-1221	U 0.0093	U 0.0091	U 0.009	U 0.009	--
Aroclor-1232	U 0.0093	U 0.0091	U 0.005	U 0.005	--
Aroclor-1242	U 0.0093	U 0.0091	U 0.005	U 0.005	--
Aroclor-1248	U 0.0093	U 0.0091	U 0.005	U 0.005	--
Aroclor-1254	J 0.02	U 0.0057	U 0.005	UN 0.005	--
Aroclor-1260	U 0.0059	U 0.0057	U 0.005	U 0.005	--
Aroclor-1262	U 0.0059	U 0.0057	U 0.005	U 0.005	--
Aroclor-1268	U 0.0059	U 0.0057	U 0.005	U 0.005	--
Barium	54.1	67	79.9	63.1	158
Cadmium	0.093	0.076	B 0.105	B 0.0819	B 0.0895
Chloride	4.3	BC 1.9	U 3.4	U 3.3	--
Chromium	4.6	4.4	7.74	5.61	18.5
Copper	19	18.9	18.4	16.2	30.2
Hexavalent Chromium	U 0.155	U 0.155	U 0.11	B 0.367	2.83
Lead	3.8	2.5	6.25	3.99	16.8
Mercury	B 0.019	B 0.017	UN 0.063	UN 0.052	U <0.026
Sulfate	25.9	13.9	UN 6.5	BN 20.5	--
TPH - diesel range	U 0.35	U 0.35	U 5	U 5	--
TPH - kerosene range	U 0.35	U 0.35	U 5	U 5	--
Vanadium	88.6	91	40.9	30.8	51.2
Zinc	62.2	60.9	42.6	31.4	91.3

U – Analyzed for but not detected above limiting criteria
B – Analyte < the PQL (or Estimated Quantitation Limit) but >= the IDL/MDL (inorganic)
J – Sample estimated and less than the reporting limit

HEIS = Hanford Environmental Information System
-- = Analyte not analyzed