Remedial Investigation of Hanford Site Releases to the Columbia River – 13603

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ABSTRACT

In south-central Washington State, the Columbia River flows through the U.S. Department of Energy Hanford Site. A primary objective of the Hanford Site cleanup mission is protection of the Columbia River, through remediation of contaminated soil and groundwater that resulted from its weapons production mission. Within the Columbia River system, surface water, sediment, and biota samples related to potential Hanford Site hazardous substance releases have been collected since the start of Hanford operations. The impacts from release of Hanford Site radioactive substances to the Columbia River in areas upstream, within, and downstream of the Hanford Site boundary have been previously investigated as mandated by the U.S. Department of Energy requirements under the Atomic Energy Act.

The *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River* [1] was issued in 2008 to initiate assessment of the impacts under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* [2]. The work plan established a phased approach to characterize contaminants, assess current risks, and determine whether or not there is a need for any cleanup actions. Field investigation activities over a 120-mile stretch of the Columbia River began in October 2008 and were completed in 2010. Sampled media included surface water, pore water, surface and core sediment, island soil, and fish (carp, walleye, whitefish, sucker, smallmouth bass, and sturgeon).

Information and sample results from the field investigation were used to characterize current conditions within the Columbia River and assess whether current conditions posed a risk to ecological or human receptors that would merit additional study or response actions under CERCLA. The human health and ecological risk assessments are documented in reports that were published in 2012 [3, 4].

Conclusions from the risk assessment reports are being summarized and integrated with remedial investigation/feasibility study (RI/FS) reports developed for upland areas, riparian areas, and groundwater in the Hanford Site River Corridor. The RI/FS reports will evaluate the impacts to soil, groundwater, and river sediments and lead to proposed cleanup actions and records of decision to address releases from the Hanford Site reactor operations.

INTRODUCTION

A primary objective of the Hanford Site cleanup mission is protection of the Columbia River, through remediation of contaminated soil and groundwater that resulted from its weapons production mission. These remedial actions were initiated under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) [2] in 1994 and continue today, with an emphasis on activities in the "River Corridor" because of its proximity to the river and presence of the former production reactors in the 100 Area and fuel fabrication and development facilities in the 300 Area (Fig. 1).

Large amounts of surface water, sediment, and biota data potentially related to Hanford Site contaminant releases have been collected within the Columbia River system since the start of operations through various sampling and monitoring programs. Areas upstream, within, and downstream of the Hanford Site have also been investigated per U.S. Department of Energy (DOE) orders. The *Remedial Investigation Work Plan for Hanford Site Releases to the Columbia River* [1] established the approach to assess impacts of Hanford Site releases to the Columbia River under CERCLA.

Purpose and Scope

The remedial investigation was performed in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* [5]. The purpose of the remedial investigation was to:

- Characterize the nature and extent of Hanford Site-related contaminants that have come to be located within the Columbia River

- Assess risk to ecological and human receptors posed by Hanford Site-related contaminants.

- Support decisions of whether or not any cleanup actions are needed to lower the risk to ecological or humans receptors from being exposed to Hanford Site-related contaminants.

The remedial investigation focused on the impacts of Hanford Site releases to the Columbia River and its users. In order to evaluate the impacts from Hanford Site releases, it was equally important to understand the contributions of non-Hanford Site influences to the Columbia River upstream, within, and downstream of the Hanford Site.

Physical Setting

The Columbia River stretches 2,000 km (1,243 mi) from the Canadian province of British Columbia through the U.S. State of Washington, forming much of the border between Washington and Oregon, before emptying into the Pacific Ocean. Measured by the volume of its flow, the Columbia River is the largest river flowing into the Pacific from North America and is the fourth-largest river in the United States. In south-central Washington State, the river flows through the DOE Hanford Site (Fig. 1). The Columbia River is the dominant aquatic ecosystem on the Hanford Site and supports a large and diverse population of plant and animal communities, as well as providing many recreational opportunities.

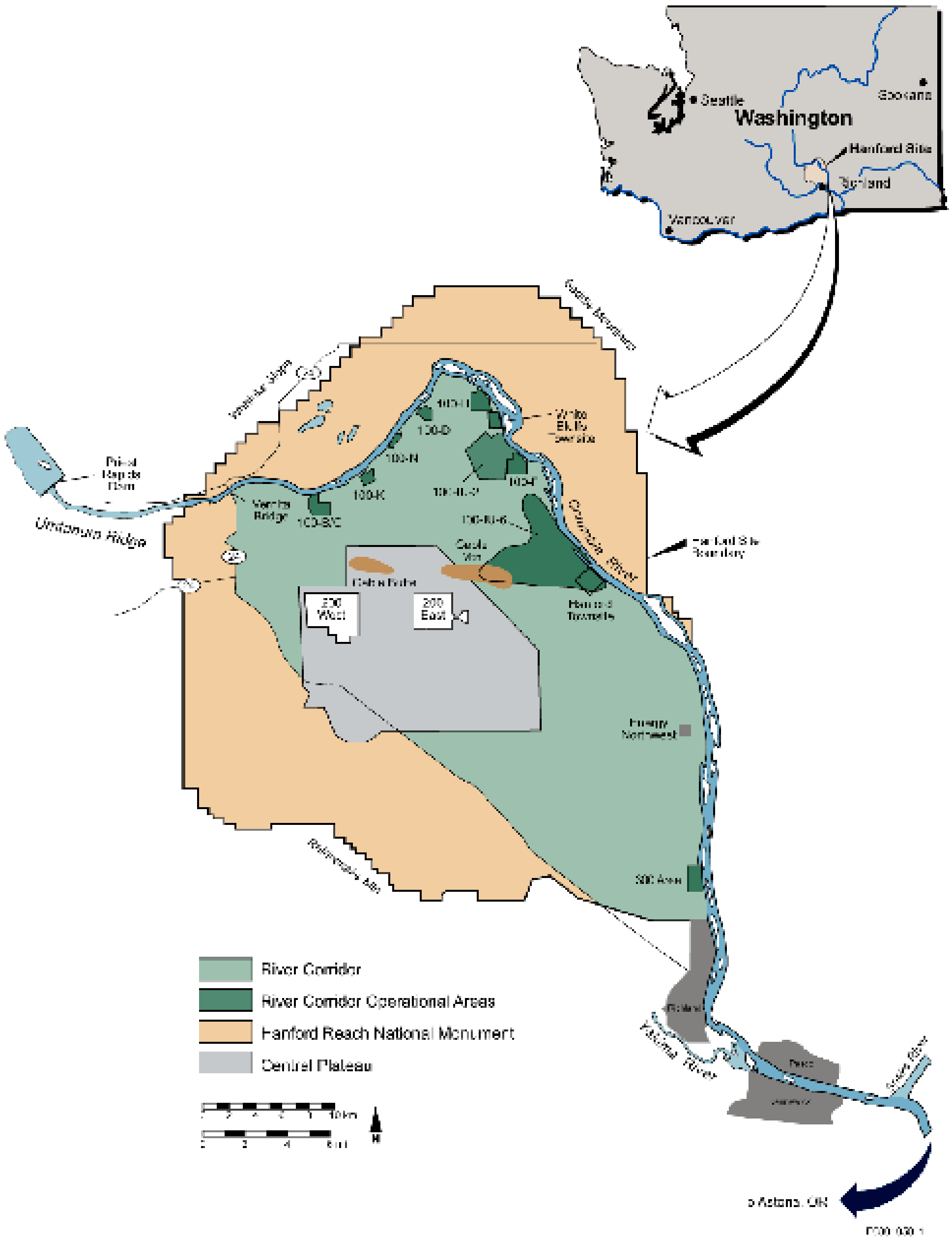

Fig. 1. Columbia River and Hanford Site River Corridor.

Most of the Columbia River within the U.S. is impounded by 11 dams. Seven of these dams are located upstream and four are downstream of the Hanford Site. An area known as the Hanford Reach is a 51-mile stretch of the Columbia River that flows unimpeded between the Priest Rapids Dam to the head of Lake Wallula upstream of McNary Dam. The Hanford Reach is the only free-flowing portion of the river above Bonneville Dam in the U.S. Three tributaries enter the Columbia River between the Hanford Site and the McNary Dam. Beginning with the furthest upstream, these tributaries are the Yakima, Snake, and Walla Walla Rivers.

Hanford Site History

The Hanford Site became a federal facility in 1943 when the U.S. Government took possession of the land to produce weapons-grade plutonium during World War II. During five decades of Hanford Site operations and nuclear material production, large quantities of by-products were discharged to the environment. Liquid effluents from plutonium production reactors were discharged directly to the Columbia River and unplanned overland flows from retention ponds and basins occasionally occurred. In addition, plumes of contaminated groundwater developed in portions of the Hanford Site as a result of waste disposal practices and subsequent migration through the soil. Some of these contaminated groundwater plumes have reached the Columbia River, discharging as springs along the shoreline and upwelling through the river bottom.

Hanford Site production activities continued until the late 1980s, when the mission focus changed to cleaning up the radioactive and hazardous wastes that had been generated during the previous decades. In 1989, areas of the Hanford Site were placed on the National Priorities List under CERCLA authority, leading to the cleanup actions that are under way today.

INITIAL EVALUATION AND SCOPING

The federal government has extensively monitored the environment within, adjacent to, and "downwind" of the Hanford Site from the beginning of operations in the 1940s through the present. Radioactivity from the Hanford Site has been measured at detectable levels in various media (soil, sediment, biota, groundwater) over a large regional area. Most of this detectable radioactivity has largely decayed away over the years due to the short half-lives associated with many of the isotopes that were released.

An extensive data compilation effort was performed between 2004 and 2006 to identify and organize the results from previous investigations and programs, as documented in the *Columbia River Component Data Evaluation Summary Report* [6]. The compiled data included results from more than 5,900 surface water samples, 1,400 sediment samples, and 7,000 biota (fish, shellfish, waterfowl) samples. Further evaluations of the compiled data were conducted with the purpose of identifying potential data gaps to be addressed, with results summarized in the *Columbia River Component Data Gap Analysis* report [7].

Concurrent with scoping activities for the river, baseline risk assessments of upland, riparian, and near-shore areas of the River Corridor were conducted. The River Corridor baseline risk assessment (RCBRA) began in 2004 and included evaluation of potential impacts to ecological and human receptors. In the near-shore area, the assessment was supported by results from more than 100 surface water samples, 190 pore water samples, 190 sediment samples, and 160 biota samples. The associated assessment reports were issued in 2011 and 2012 [8, 9].

Conceptual Site Model

The conceptual site model (CSM) identifies the sources of contamination, migration and exposure pathways, and applicable receptors. Elements of the CSM for Hanford Site releases to the Columbia River are summarized in Table I.

Table I. Conceptual Site Model Elements.

CSM Element	Model Inputs
Contaminant sources	**Hanford Site**: Past reactor cooling water discharges, limited overland flow, contaminated groundwater seepage to the Columbia River, and sediment deposition/redeposition. **Non-Hanford Site** (upriver and within study area): Mining operations, smelting, pulp and paper production, runoff from cities and agricultural areas, treatment plants, atmospheric nuclear testing, commercial or recreational vessel operation.
Release mechanisms and migration	Infiltration, percolation, and leaching from upland soils; direct discharge of reactor effluents; unplanned surface runoff; dust generation through wind and during facility operation; and biota uptake.
Exposure pathways	Dermal contact, incidental ingestion, external radiation, biota/fish consumption, vapor and dust inhalation (human health only).
Potential receptors	**Ecological:** Wide array of flora and fauna, with fish and benthic invertebrates being likely to have the greatest potential exposure to site contaminants in surface water and sediment. **Human:** Native Americans, recreational users (e.g., swimming, boating, beach going, fishing).

Data Quality Objectives

A data quality objectives (DQO) process began in 2007 with a comprehensive review of previous investigations and existing data. A series of interviews were then conducted with representatives from the Tri-Parties, Tribal Nations, Natural Resource Trustee Council, and Hanford Advisory Board. The input from these interviews was tabulated in a matrix and used to refine development of the DQOs. In addition, two public workshops were held in 2008 to provide updates and receive feedback on the DQO and remedial investigation scoping process. The DQOs developed to support this remedial investigation are presented in the *DQO Summary Report for the Remedial Investigation of Hanford Site Releases to the Columbia River* [10].

Site characterization and data needs were identified based on process and operational knowledge, review of the existing data, an understanding of the contaminant transport mechanisms, and input received from the DQO interviews and workshops. These needs included collection of supplemental data to characterize Hanford Site releases to the river and to support evaluation of exposure pathways, media-specific exposures, and risk calculations.

Study Area Boundaries

Study area boundaries were developed based on the review of existing data along the entire Columbia River below the upstream boundary of the Hanford Site, river hydrodynamics and bathymetry, Hanford Site operational history, and dam construction timelines. The geographical study area included a 120-mile stretch of the Columbia River and islands from above the Wanapum Dam to McNary Dam (the first downriver dam from the Hanford Site), plus a limited investigation of the area immediately upstream of Bonneville Dam to address potential deposits that may have occurred prior to the construction of McNary Dam. The study area was divided into five sub-areas to organize the work based on proximity to the Hanford Site and the relation of associated production operations. These five sub-areas include the Upriver, 100 Area, 300 Area, Lake Wallula (downriver), and Bonneville Dam Pool segments (Fig. 2).

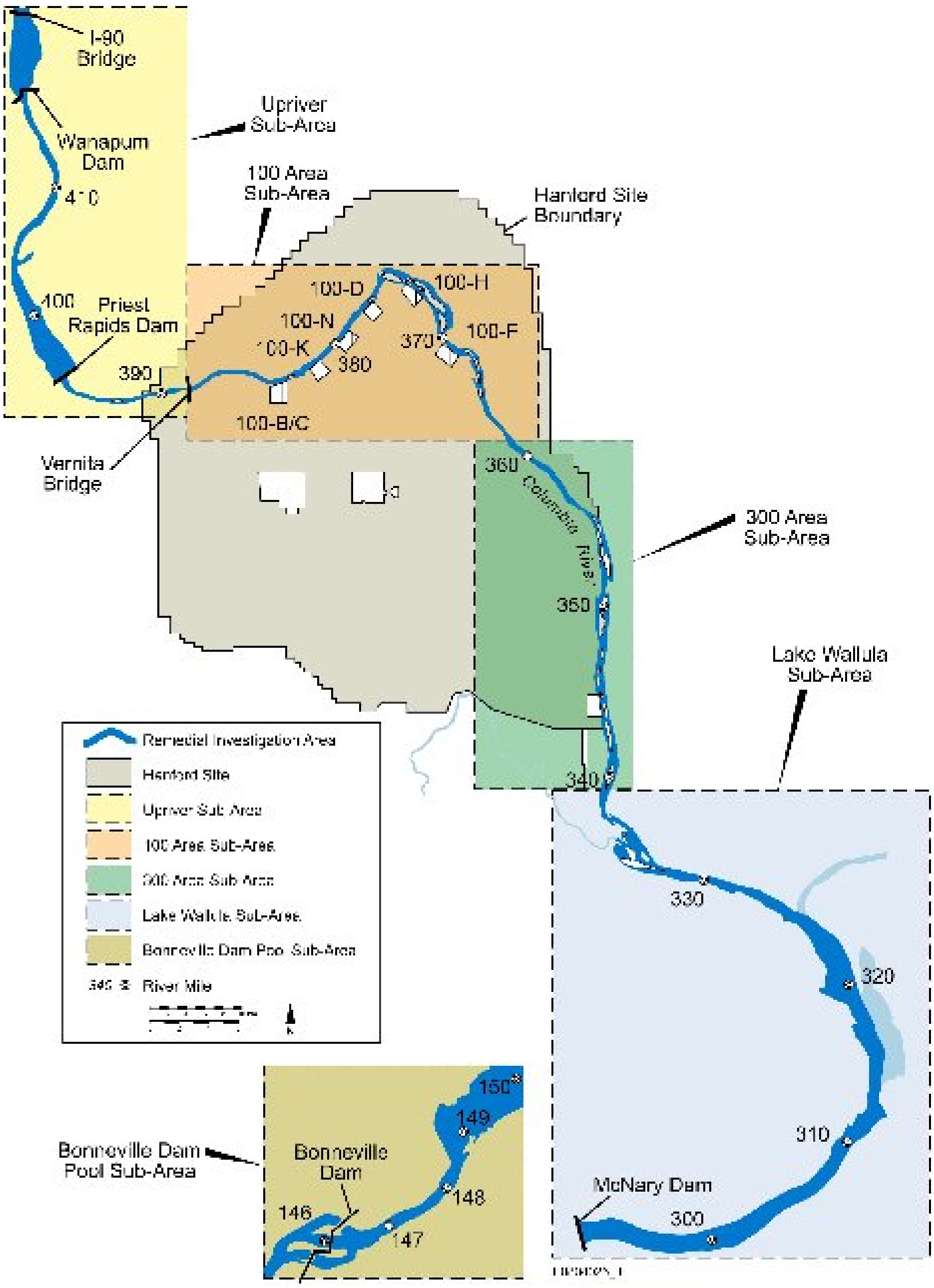

Fig. 2. Remedial Investigation Area and Sub-Areas.

The lateral study area of the Columbia River extends shore to shore (ordinary high water mark to ordinary high water mark[1]), except for the "near shore" areas within the Hanford Reach that have been previously characterized and assessed by RCBRA. In these areas of the Hanford Reach, the study area begins where the RCBRA investigation left off at the near shore.

[1] "The ordinary high water mark on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland…" [11]

FIELD INVESTIGATION

Field investigation activities to fill the data gaps and characterization needs were initiated in October 2008 and were completed in 2010. Elements contributing to the field investigation design included information compiled from previous investigations, the CSM assumptions, and outcomes of the DQO process. The field investigation emphasized information gathering for sediment areas not addressed by previous environmental monitoring, augmenting previous core data behind downstream dams that did not show contamination, and sampling of fish species commonly consumed by humans. Because of the large volume of existing data that was available and due to the large size of the study area, the field investigation design was stratified to address locations where:

- Hanford Site contaminants were most likely to be present (e.g., sediment deposition locations downstream of reactor outfall structures, areas where contaminated groundwater plumes are upwelling in the river bottom, and behind the first downstream dam).

- Human recreational use is prevalent (parks and beaches, boat launches, and other public access points).

- Non-Hanford Site contaminants were most likely to be present or introduced into the study area (upstream sources, irrigation returns, and tributary river confluences), because it was important to help understand background conditions.

Primary media sampled during the field investigation included surface water, pore water, sediment, soil, and fish. Sediment includes shallow, deep, shallow core, and deep core samples. Sample collection activities were completed in 2010 and are summarized in Tables II, III, and IV. An additional emphasis of the field investigation was further delineation and characterization of areas where contaminated groundwater is upwelling in the river bottom throughout the Hanford Reach. The groundwater upwelling investigation was a multi-phased design, with each completed phase informing the specific activities for the subsequent phase, as summarized in Table III.

Fish collection activities were completed using a combination of electrofishing, rod and reel, and long-line techniques in accordance with state and Federal collection permits. Fish were sampled primarily to evaluate the potential human exposure via consumption. Species were selected because they were identified by Native Americans as being part of their diet and/or because they are popular sport fish in the investigation area. Salmon were not selected because their migratory nature provides little opportunity for exposure to Hanford Site contaminants. Additional information on the fish sample collection activities is presented in Table IV.

Table II. Field Investigation Summary.

Medium	Sample Quantity	Sample Type	Description
Surface water	60	Surface water	Reactor areas, 300 Area, recreational locations (parks, boat launches), Lake Wallula, McNary Dam, irrigation returns, tributary deltas (Yakima, Snake, and Walla Walla). Samples collected at two-thirds the depth of the water column.
	3	Deep surface water	Samples collected from directly above the riverbed.
Sediment	168	Shallow sediment samples (i.e., submerged)	Irrigation returns, downriver islands, shoreline, tributary deltas (Yakima, Snake, and Walla Walla), depositional areas between reactors and McNary Dam. Samples collected from the upper 10 cm of the sediment.
	183	Shoreline sediment	Collected from the upper 10 cm of the lower riparian zone, typically the area devoid of terrestrial vegetation.
	4	Deep sediment	Potential deep areas of sediment deposits (e.g., 100 B/C Hole) where fish may be affected or areas of sediment accumulation upriver of the Yakima River confluence and downriver of the Walla Walla River confluence. Collected from the upper 10 cm of the sediment, in greater than 1.8 m of water.
Sediment cores	64	Shallow sediment cores	Potential areas containing sediments dating back to reactor operations including 100-B/C, 100-K, 100-N, and 100-D Reactor inlet structures, head of Lake Wallula pool (near the 300 Area), Yakima and Snake River deltas. Cores completed in sediment sequences generally thinner than 3 m thick.
	45	Deep sediment cores	Areas of thick sediment deposits dating back to reactor operations including Lake Wallula (Port Kelly, Hat Rock, just upriver from McNary Dam) and upriver of Bonneville Dam. Cores completed at water depths of up to 27 m with anticipated thick sediments (greater than 3 m thick).
Island soils	79	Island soils (e.g., generally above the high water line)	Island soil that may have been transported during high river levels including Island 3, Locke Island, Homestead Island, Wooded Island, and Johnson Island. Collected from the upper 15 cm of the riparian and upland zones of the islands.

Table III. Groundwater Upwelling Investigation Summary.

Activity	Quantity	Sample Type	Description
Phase IIa	675	Surface water	In-situ conductivity/temperature mapping of surface water.
	675	Pore water	In-situ conductivity/temperature mapping of pore water.
Phase IIb	240	Pore Water	In-situ conductivity/temperature and collection of pore water for indicator contaminant screening at upwelling locations selected from Phase IIa results.
	240	Surface water	In-situ conductivity and temperature of surface water at pore water sample locations.
Phase III	49	Pore water	Collection of pore water at sediment sampling locations.
	49	Sediment	Collection of sediment adjacent to groundwater plume upwellings.
	49	Surface Water	Surface water samples collected at sediment sampling locations.

Table IV. Fish Sampling Summary.

Target Fish Species	Collection Technique	Collection Summary	Tissues for Separate Analyses
Sturgeon	Long-line	30 fish; 30 samples for each tissue	Fillets (muscle) with fatty tissue but without skin; kidney; liver; carcass; eggs (if available); sediment or mussels in stomach (if present); blood (archived)
Carp	Electrofish	100 fish; 20 samples for each tissue (composite of 5 fish per sample)	Fillets (muscle) with skin; kidney; liver; carcass
Suckers	Electrofish	100 fish; 20 samples for each tissue (composite of 5 fish per sample)	Fillets (muscle) with skin; kidney and liver (combined); carcass
Walleye	Rod and reel, electrofish	100 fish; 20 samples for each tissue (composite of 5 fish per sample)	Fillets (muscle) with skin; kidney and liver (combined); carcass
Whitefish	Electrofish	100 fish; 20 samples for each tissue (composite of 5 fish per sample)	Fillets (muscle) with skin; kidney and liver (combined); carcass
Smallmouth bass	Rod and reel	100 fish; 20 samples for each tissue (composite of 5 fish per sample)	Fillets (muscle) with skin; kidney and liver (combined); carcass

RISK ASSESSMENTS

The field investigation data were described in detail in the *Data Summary Report for the Remedial Investigation of Hanford Site Releases to the Columbia River* [12]. Results were combined with existing data to conduct baseline human health and screening level ecological risk assessments. The risk assessments results are being used to help inform decision makers on whether or not there is a need for additional investigation or response actions under CERCLA.

Screening Level Ecological Risk Assessment

A screening level ecological risk assessment (SLERA) was conducted to evaluate whether Hanford Site-related contaminants currently exist at concentrations that may warrant further investigation due to potential adverse effects to ecological receptors either within the Columbia River or on the numerous islands that exist within the river channel. A parallel objective was to identify constituents and media that are not expected to have adverse ecological impacts. The risk assessment methodology and results are presented in the *Columbia River Component Risk Assessment, Volume I: Screening-Level Ecological Risk Assessment* [3].

The SLERA was based on application of the first two steps of an eight-step process outlined in EPA guidance [13], where generic benchmarks are used to evaluate site data. The assessment also included a refinement analysis of the constituents identified by the SLERA, part of Step 3 (Problem Formulation) and a fish evaluation of body characteristics and tissue samples characteristic of a baseline assessment.

Information from the conceptual site model was used to establish the assessment endpoints of the study. An assessment endpoint is the explicit expression of the ecological value to be protected and includes both the ecological entity (such as wading birds) and a characteristic of that entity (e.g., survival and reproduction). Assessment endpoints are linked by the measures of effects to the risk characterization process for the Hanford Site. In accordance with the conservative nature of a screening assessment, receptors with the highest potential exposures to contaminated media in the Columbia River were selected (Table V).

Table V. Assessment Endpoints and Measures of Effect.

Habitat Type	Assessment Endpoint	Measure of Effect
Aquatic habitat	Survival, growth, and reproduction of fish	Aquatic life water quality criteria and benchmarks. Tissue residue effects concentrations
	Survival, growth, and reproduction of aquatic plants	Plant-based soil benchmarks
	Survival, growth, and reproduction of algae and zooplankton	Aquatic life water quality criteria
	Survival, growth, and reproduction of amphibians	Amphibian-specific benchmarks and toxicity values; aquatic life water quality criteria
	Survival, growth, and reproduction of benthic organisms	Sediment benchmarks
Terrestrial habitat	Survival, growth, and reproduction of soil invertebrates	Invertebrate-based benchmarks
	Survival, growth, and reproduction of terrestrial plants	Plant-based soil benchmarks
	Survival, growth, and reproduction of mammals and birds	Wildlife-based soil benchmarks

The methodology for selection of contaminants of potential ecological concern (COPECs) was described in detail in the work plan [1] and risk assessment report [3]. Detected constituents in each media (surface water, sediment, porewater, island soils, and fish tissue) and sub-area were designated as COPECs where present at concentrations higher than reference samples or known to be a key Hanford Site contaminant. Because of the numerous non-Hanford Site contributions to the river within the study area (e.g., tributaries, wasteways, irrigation returns) the specific reference areas for surface water and sediment varied for each sub-area, resulting in separate COPEC lists for each media and sub-area.

Potential effects on receptors were evaluated by the use of screening benchmarks below which the potential for risk is expected to be negligible (no observed effect concentration). The benchmarks were media- and often receptor-specific. Exceedance of the values does not necessarily indicate risk but rather that further evaluation is necessary. To reflect “worst-case” exposures, the maximum detected concentration of each COPEC was compared to the applicable benchmark. The COPECs with maximum concentrations less than the screening benchmarks were considered to present negligible risk and were eliminated from further consideration. Contaminants of potential ecological concern with maximum concentrations equal to or greater than the benchmarks were retained for further evaluation.

Additional factors were reviewed to evaluate the potential risk represented by the COPECs that exceeded screening benchmarks. Factors reviewed included the number and magnitude of exceedances, date and location of the samples, field and laboratory notes, and the magnitude of the concentration relative to lowest observed effect concentrations. The ratio of COPEC concentration to the lowest observed effect concentration (hazard quotient or HQ) was calculated for all samples with a screening benchmark exceedance. The HQ calculations were less than 1.0 for many COPECs which were consequently eliminated from further consideration in this step including constituents that had multiple anthropogenic sources and no clear tie to the Hanford Site. Lowest observed effect concentration HQs equal to or higher than 1.0 were considered "exceedances" and recommended for further evaluation (Table VI).

Table VI. Contaminants of Potential Ecological Concern Recommended for Further Evaluation.

Media	100 Area Sub-Area	300 Area Sub-Area	Lake Wallula Sub-Area
Surface water	None	None	None
Sediment	Chromium Hexavalent chromium	Hexavalent chromium	None
Soil	None	None	--
Shoreline sediments	None	None	None
Porewater:			
100-BC Area	Aluminum Hexavalent chromium Lead		
100-K Area	Hexavalent chromium Manganese		
100-N Area	Hexavalent chromium Nitrate		
100-D/H Areas	Aluminum Chromium Hexavalent chromium Lead Nickel Nitrate		
100-F Area	Hexavalent chromium Manganese		
200 Area		Hexavalent chromium Lead	
300 Area		Aluminum Lead Nitrate Selenium Uranium	

NOTE: Shoreline sediment is an exposure media for terrestrial birds, as well as aquatic biota; sediment is an exposure media for aquatic biota only.

-- = no COPECs in this sub-area

Further evaluations of COPECs in sediment or porewater are being conducted as part of the RI/FS development process for groundwater and the upland reactor areas. The RI/FS for the relevant reactor area will evaluate the nature and extent, conceptual site model, and fate and transport of COPECs identified above to determine if detected concentrations in the river are potentially from current or historical operations. Based on this assessment, the need for further study or remedial action will be determined.

Baseline Human Health Risk Assessment

The methodology and results from a baseline human health risk assessment are presented in the *Columbia River Component Risk Assessment, Volume II: Baseline Human Health Risk Assessment* [4]. The baseline human health risk assessment (HHRA) focused on estimating health risks for receptor groups likely to have potential exposures to river media (sediment, surface water, pore water, island soils, and/or fish). In accordance with EPA guidance [14], risks were evaluated over a range of exposure levels or intensities. Exposure scenarios evaluated in the HHRA are depicted in Fig. 3.

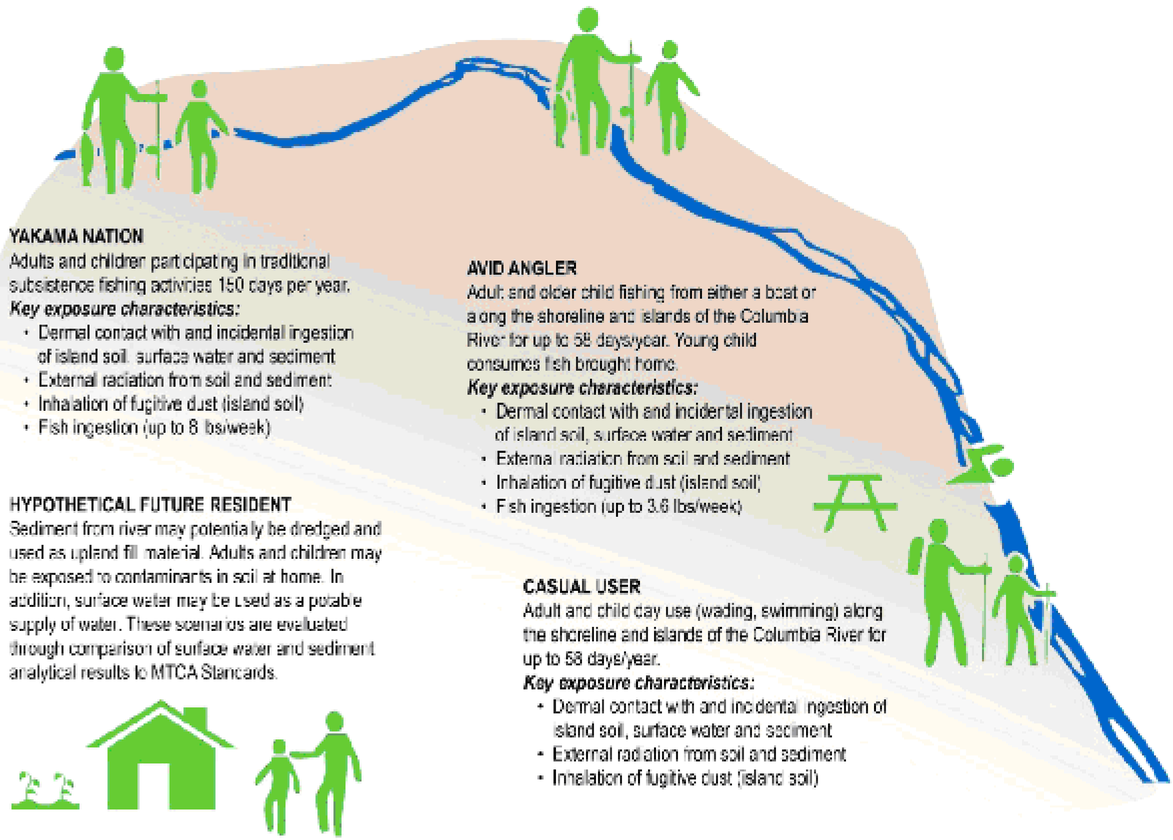

Fig. 3. Human Health Exposure Scenarios.

Contaminants of potential concern (COPCs) were selected for quantitative assessment in the HHRA based on a methodology presented in the work plan [1] and risk assessment report [4]. Considerations included detection frequency, concentration relative to risk-based benchmarks, essential nutrient status, and known Hanford Site-related contaminants in soil or groundwater. The selection methodology also included a statistical comparison to data from reference locations to identify COPCs present in the Hanford Site study area (i.e., 100 Area, 300 Area, and Lake Wallula Sub-Areas) at concentrations inconsistent with or statistically higher than those in reference locations.

Estimates of the incidence and severity of adverse effects that may potentially occur from exposures to chemicals or radionuclides in fish, water, or other media were calculated as either a numerical index or as a "probability." Cumulative cancer risk and noncancer hazard estimates were calculated for each receptor and compared to EPA and State of Washington (Ecology) risk management criteria. Incremental lifetime cancer risks (ILCR) were calculated for carcinogenic chemicals and radionuclides and then compared to the CERCLA target cancer risk range of 10^{-6} to 10^{-4} and the Ecology *Washington Administrative Code* 173-340, "Model Toxics Control Act - Cleanup" (MTCA) [15] risk limit of 1×10^{-5}. Hazard indexes (HIs) were calculated to estimate potential noncancer effects related to developmental, reproductive, neurobehavioral, and other physiological functions. EPA and MTCA noncancer risk management criterion assume that a HI less than or equal to 1.0 does not pose a human health.

Tables VII and VIII present a summary of the range of cumulative noncancer hazard and cancer risk, respectively, for all reasonable maximum exposure (RME) scenarios and across all COPCs. Also presented are cumulative hazard and risk estimates for Study Area COPCs. Cumulative noncancer hazards and cancer risk for the Casual User RME scenario did not exceed EPA or MTCA risk management criteria. However, cumulative hazard and risk for the Avid Angler and Yakama Nation scenarios did exceed risk management criteria, primarily due to the fish ingestion pathway.

Table VII. Noncancer Hazard Indices for Reasonable Maximum Exposure Scenarios.

		Hazard index [a]		
Endpoint	**Exposure Media**	**Casual User**	**Avid Angler**	**Yakama Nation**
Noncancer Hazard	Abiotic - All COPCs [b]	0.2 to 0.7	0.06 to 0.2	1 to 3
	Fish – All COPCs	Not applicable	97 to 146	675 to 1066
	Cumulative hazard index - all COPCs	0.2 to 0.8	97 to 146	676 to 1069
	Cumulative hazard index - Study Area COPCs	0.001 to 0.04	0.6 to 8	6 to 57
EPA and MTCA Target Hazard Index		1	1	1

[a] Ranges for cumulative hazard index reflect risks across the three sub-areas (100 Area, 300 Area, and Lake Wallula).
[b] Includes sediment, island soil, and surface water.
Shading = exceedance of target hazard index

Table VIII. Cumulative Cancer Risks for Reasonable Maximum Exposure Scenarios.

		Incremental lifetime cancer risk [a]		
Endpoint	**Exposure Media**	**Casual User**	**Avid Angler**	**Yakama Nation**
Cancer Risk	Abiotic - All COPCs [b]	7 x 10^{-6} to 1 x 10^{-5}	6 x 10^{-6} to 1 x 10^{-5}	5 x 10^{-5} to 1 x 10^{-4}
	Fish – All COPCs	Not applicable	5 x 10^{-3} to 6 x 10^{-3}	2 x 10^{-2} to 3 x 10^{-2}
	Cumulative ILCR - all COPCs	7 x 10^{-6} to 1 x 10^{-5}	5 x 10^{-3} to 6 x 10^{-3}	2 x 10^{-2} to 3 x 10^{-2}
	Cumulative ILCR - Study Area COPCs	3 x 10^{-6} to 4 x 10^{-6}	3 x 10^{-6} to 4 x 10^{-5}	1 x 10^{-4} to 2 x 10^{-4}
EPA Target ILCR Range		10^{-6} to 10^{-4}	10^{-6} to 10^{-4}	10^{-6} to 10^{-4}
MTCA Target ILCR		1 x 10^{-5}	1 x 10^{-5}	1 x 10^{-5}

[a] Ranges for ILCR reflect cumulative cancer risk across the three sub-areas (100 Area, 300 Area, and Lake Wallula), for both chemical and radionuclide COPCs.
[b] Includes sediment, island soil, and surface water.
Shading = exceedance target ILCR

The fish ingestion pathway comprised more than 99% of the cumulative risk for the Avid Angler and Yakama Nation scenarios. Primary risk drivers included PCBs, chlorinated pesticides, mercury and other metals. These contaminants are prevalent in fish tissue in many water bodies due to widespread historical use, atmospheric deposition, and resulting high prevalence in abiotic media. Consequently, it is unclear what contribution, if any, Hanford Site releases have had to fish in the Columbia River for these types of constituents.

Inherent in all risk assessments are uncertainties associated with key parameters used to estimate risk including the environmental concentrations, toxicity values, and exposure assumptions used to estimate magnitude of exposure and to quantify health risks. In general, the assumptions used in the HHRA were intended to be protective of human health. By design, this HHRA was developed to provide conservative estimates of risk to those who visit or use the Columbia River within the Hanford Site study area.

The RI/FS development process for groundwater and the upland reactor areas includes further evaluation of the nature and extent, conceptual site model, and fate and transport of the HHRA COPCs. An objective of the evaluation will be to determine if concentrations (current detected or future predicted) in the river are potentially from current or historical operations associated with the operable unit being evaluated. Based on that assessment, the need for further study or remedial action will be determined.

ROLE IN THE INTEGRATED CLEANUP STRATEGY FOR THE RIVER CORRIDOR

The results of this investigation are important to other Hanford Site cleanup activities in areas that border the Columbia River, also known as the “River Corridor.” In 1991, the Tri-Parties agreed to a “bias-for-action” approach to the CERCLA process for the Hanford Site. The agreement, known as the *Hanford Past-Practice Strategy* [16], streamlined the RI/FS process to begin remediation of contaminated waste sites earlier than typically performed under the traditional CERCLA process in place at that time. Source and groundwater cleanup actions at the 100 Area and 300 Area National Priorities List sites, a geographical area broadly referred to as the "River Corridor" began in 1994 and continue today. These cleanup actions were authorized via interim action Records of Decision (RODs) that were supported by qualitative risk assessments to establish a need for action.

The Tri-Parties are now implementing a plan to transition from interim remedial actions to final remedial actions for the River Corridor source and groundwater operable units. The RODs that are produced from this effort will establish the final remedial goals and objectives and any associated actions required to complete CERCLA cleanup for the River Corridor. The process to pursue final cleanup decisions has been organized into smaller pieces of work that are more manageable and aligned with Hanford Site operational functions. Six final remedy RODs will be developed for areas associated with the following:

- 100-B/C Reactors
- 100-K Reactors
- 100-N Reactor
- 100-D and 100-H Reactors
- 100-F Reactor and Hanford townsite
- 300 Area fuel fabrication and development facilities.

Each of the six final remedy RODs will be integrated to address both source and groundwater remedial actions for the decision area. The impacts of Hanford Site releases to the Columbia River are an integral piece of these final decisions. Results from the human health and ecological risk assessments will be used to support decisions of whether or not any cleanup actions are needed. If any cleanup actions are needed to address Hanford Site contamination in the river they will be included with the final decisions for one or more of the six areas (e.g., future contaminant release from upwelling porewater will be addressed by cleanup actions for upland soil and groundwater). It is anticipated that final action RODs for the six areas will be issued between 2013 and 2016.

REFERENCES

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