4.0 Environmental Surveillance Information

R. W. Hanf and L. E. Bisping

Results of the Hanford Site Surface Environmental Surveillance and Drinking Water Surveillance Projects for 2003 are described in the following sections and include, where applicable, information on both radiological and non-radiological constituents. The objectives, criteria, design, and description of these projects are summarized below and provided in detail in the Hanford Site Environmental Monitoring Plan (DOE/RL-91-50). Radiological doses associated with the surveillance results are discussed in Chapter 5. Quality assurance and quality control programs developed to assure the value of surveillance data are described in Chapter 8.

Many samples are collected and analyzed for the Hanford Site environmental surveillance and drinking water surveillance projects, and the resulting data are compiled in a large database (Hanford Environmental Information System [HEIS 1994]). Only summary information is reported here emphasizing those radionuclides and chemicals of Hanford Site origin that may be important to the environment or human health and safety. Supplemental data for some sections can be found in Appendix C. More detailed results for specific surface environmental surveillance sampling locations are contained in *Hanford Site Environmental Surveillance Data Report for Calendar Year 2003* (PNNL-14687, APP. 1). The intent of these sections (4.1 through 4.6) is to provide current surveillance data, to compare 2003 data to past data and appropriate standards, and to present a general overview of Hanford Site surveillance activities.

In addition to Hanford Site environmental surveillance, environmental monitoring is conducted at or near facilities on the site. These near-facility monitoring efforts are discussed in Section 3.2 of this report.

4.0.1 Surface Environmental Surveillance

The Pacific Northwest National Laboratory's Surface Environmental Surveillance Project measures the concentrations of radionuclides and chemicals in environmental media and assesses the potential effects (Chapter 5) of these materials on the environment and the public. Samples of agricultural products, air, fish, sediment, soil, surface water, vegetation, and wildlife are collected routinely or periodically. The samples are then analyzed for radionuclides, at very low environmental levels, and chemicals, including metals and anions. In addition, ambient external radiation is measured at selected locations.

The environmental surveillance project focuses on routine releases from U.S. Department of Energy (DOE) facilities on the Hanford Site; however, the project also responds to unplanned releases and releases from non-DOE operations on and near the site. Surveillance results are provided to the DOE and the public annually through this report series. Unusually high results are reported to the DOE Richland Operations Office and the appropriate facility managers when they occur. Whereas effluent and near-facility environmental monitoring are conducted by the facility operating contractor or designated subcontractor, environmental surveillance is conducted under an independent program that reports directly to the DOE Richland Operations Office, Closure Division.

4.0.1.1 Surveillance Objectives

The general requirements and objectives for environmental surveillance are to monitor routine and non-routine contaminant releases to the environment from DOE facilities and operations, to assess doses to members of the

public, and to monitor potential impacts of contaminants on other biota, and to alert the DOE to the possible need for corrective action (DOE Orders 450.1 and 5400.5; DOE/EH-0173T).

The surveillance objectives include

- Determine compliance with applicable environmental quality standards, public exposure limits, and applicable laws and regulations; the requirements of DOE Orders; and the environmental commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents. Additional objectives include conducting pre-operational assessments, assessing radiological doses to the public and environment, assessing doses from other local sources, reporting alarm levels, and potential doses exceeding reporting limits.
- Determine background levels and site contributions of contaminants in the environment.
- Determine long-term accumulations of site-related contaminants in the environment and predict trends.
- Characterize and define trends in the physical, chemical, and biological conditions of environmental media.
- Determine the effectiveness of treatments and controls in reducing effluents and emissions.
- Determine the validity and effectiveness of models to predict concentrations of pollutants in the environment.
- Detect and quantify unplanned releases.
- Identify and quantify new environmental quality problems.
- Maintain the capability to assess the consequence of accidents.
- Provide public assurance; address issues of concern to the public, stakeholders, regulators, and business community.
- Enhance public understanding of site environmental issues, primarily through public involvement and by providing environmental information to the public.
- Provide environmental data and assessments to assist the DOE and its contractors in environmental management of the site.

4.0.1.2 Surveillance Design

The DOE Orders require that the content of surveillance programs be determined on a site-specific basis by the DOE site offices. The surveillance programs must reflect facility characteristics; applicable regulations; hazard potential; quantities and concentrations of materials stored or released; extent and use of affected air, land, and water; and specific local public interests and concerns. Environmental surveillance at the Hanford Site is designed to meet the listed objectives while considering the environmental characteristics of the site and potential and actual releases from site operations, surface contamination areas, former waste disposal sites, current waste disposal and storage facilities, and ongoing remediation efforts. Knowledge gained from nearly 60 years of environmental surveillance and studies at the Hanford Site provides valuable technical background information for planning surveillance activities and managing the site.

The Hanford Site environmental surveillance project historically has focused on radionuclides in various media and non-radiological water quality parameters. However, surveillance for non-radiological constituents, including metals and hazardous chemicals, in selected media is also conducted. A detailed chemical pathway and exposure analysis for the Hanford Site was completed during 1995 (PNL-10714). The analysis helped guide the selection of chemical surveillance media, sampling locations, and chemical constituents.

Each year, a radiological pathway analysis and exposure assessment is performed. The 2003 pathway analysis was based on 2003 source-term data and on the comprehensive pathway and dose assessment methods included in the Generation II (GENII) computer code (PNL-6584) used to estimate radiation doses to the public from Hanford Site operations. The Radiological-Biota Concentration Guide (RAD-BCG) Calculator, a spreadsheet program developed by the DOE, was used to screen doses to biota (DOE-STD-1153-2002). The results of the pathway analysis and exposure assessment (discussed in Chapter 5) serve as a basis for future years' surveillance program design.

Exposure can be defined as the interaction of an organism with a physical or chemical agent of interest, the absorption of radiation, or the ingestion of a radionuclide (Shleien and Terpilak 1984). Thus, exposure can be quantified

as the amount of chemical or physical agent available in the proper form for absorption, intake, or uptake at the organism's exchange boundaries (i.e., skin, mouth, lungs, gastrointestinal tract). An exposure pathway is identified based on (1) examination of the types, location, and sources (e.g., contaminated air, water, vegetation, food, soil) of contaminants; (2) principal release mechanisms; (3) probable environmental fate and transport (including persistence, partitioning, and intermediate transfer) of contaminants of interest; and, most importantly, (4) location and activities of the potentially exposed populations of people or animals. Several mechanisms influence the fate and transport of radionuclides and chemicals through the environment. Thus, once a radionuclide or chemical enters the environment, it may be

- Transported (e.g., migrate downstream in solution or on suspended sediment, travel through the atmosphere, or be carried off the site by wildlife).
- Physically or chemically transformed (e.g., deposition, precipitation, volatilization, photolysis, oxidation, reduction, hydrolysis, or radioactive decay).
- Biologically transformed (e.g., biodegradation).
- Accumulated in the receiving media (e.g., sorbed strongly in the soil column, stored in organism tissues [bio-accumulation]).

The principal pathways for movement of radioactive materials and chemicals from the Hanford Site to the public are the atmosphere and surface water (Figure 4.0.1).

The significance of each pathway was determined from measurements and calculations that estimated the amount of radioactive material or chemical transported along each pathway and by comparing the concentrations or potential radiological doses to environmental and public health protection standards or guides. Pathways were also evaluated based on prior studies and observations of radionuclide and chemical movement through the environment and food chains. Calculations based on effluent data showed the expected concentrations off the Hanford Site, for all Hanford-produced radionuclides and chemicals, to be frequently below contractual detection limits established for the analytical laboratory (DOE/RL-91-50). To assure that radiological and chemical analyses of samples were sufficiently sensitive, minimum detectable concentrations of key radionuclides and chemicals were established at levels well below applicable health standards.

Environmental pathways were monitored near site facilities, locations, or operations with the potential to release contaminants. Food chain pathways were monitored at potential offsite receptor locations where people reside. Concentrations of radionuclides and chemicals were measured in the following three general surveillance zones that extended from onsite facilities and operations to the offsite environs:

- **Onsite Zone** – Sampling locations were situated between the Near-Facility Environmental Monitoring Program samplers (located near active and inactive facilities) and the Hanford Site perimeter. Samples were collected at these locations to monitor potential fugitive emissions such as windblown contaminated soil and unplanned contaminant releases from facilities, and to verify the effectiveness of effluent and emissions controls.
- **Perimeter Zone** – Sampling locations were located along or near the Hanford Site boundary, along State Highway 240, and along the Hanford Reach of the Columbia River.
- **Nearby Community Zone** – Sampling locations were located in and between communities within an 80-kilometer (50-mile) radius of the industrial areas on the site. Surveillance was conducted in communities to obtain measurements at locations where a large number of people potentially could be exposed to Hanford Site releases and to document that contaminant levels were well below standards established to protect public health.

Table 4.0.1 lists the sample types and measurement locations in all three zones for 2003. A summary of the number and types of samples collected during 2003, and the number of analytical results obtained from those samples is provided in Table 4.0.2. Except for special studies, soil and vegetation samples are only collected every 3 to 5 years. Routine soil and vegetation samples were last collected in 2001 and are scheduled for collection again in 2004. A number of samples are collected and analyzed by or for other agencies and organizations each year either for their own use or to evaluate the precision and accuracy of the analytical laboratories that are analyzing samples for the DOE. Other samples are collected and archived in a storage facility in the event that additional material is needed for further or repeat analyses (Table 4.0.2).

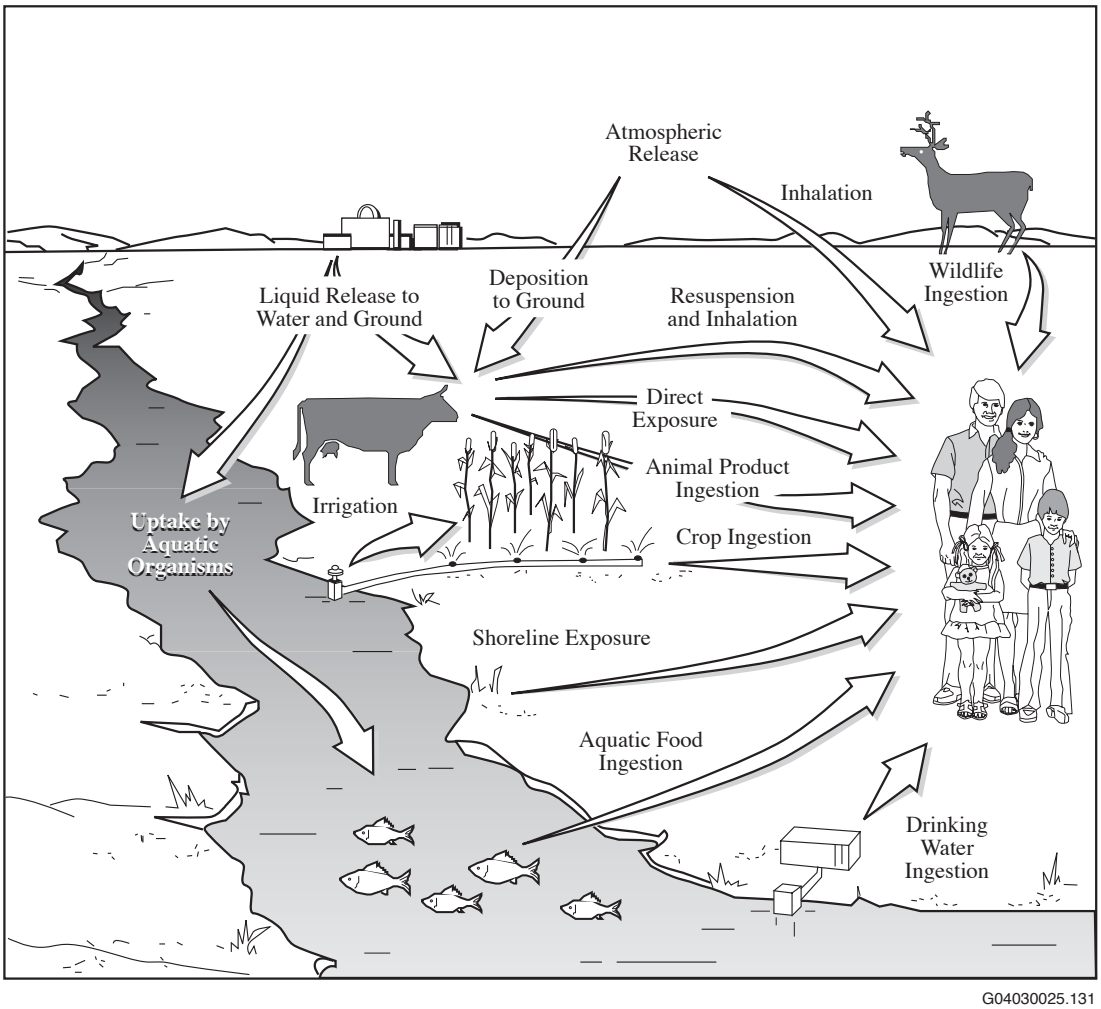

Figure 4.0.1. Potential Pathways for Human and Biota Exposure to Effluent and Emissions from the DOE's Hanford Site

Background concentrations of contaminants were measured at distant locations and compared with concentrations measured on the site and at perimeter and community locations. Background locations are assumed to be unaffected by Hanford Site operations (i.e., these locations could be used to measure ambient environmental levels of chemicals and radionuclides). Comparing concentrations at these background locations to contaminant concentrations measured on or near the site indicated the impact, if any, of Hanford Site operations.

The environmental surveillance design is reviewed annually and documented in the environmental surveillance master sampling schedule (e.g., PNNL-14184).

Table 4.0.1. Routine Environmental Surveillance Sample Types and Measurement Locations On and Around the Hanford Site in Washington State, 2003

		Sample Locations						
						Columbia River		
Type	Total Number	Onsite[a]	Site Perimeter[b]	Nearby[c]	Distant[c]	Upstream[c]	Hanford Reach[b]	Downstream[c]
Air	44	23	11	8[d]	2[d]			
Spring water	8						8	
Spring sediment	6						6	
Columbia River water	7					2	4	1
Irrigation water	2		2					
Drinking water	4	4						
River sediment	6					1	3	2
Ponds	2	2						
Pond sediment	1	1						
Foodstuffs	8			6	2			
Alfalfa	4			3	1			
Wildlife	6	4			2			
Aquatic biota	2					1	1	
External dose[e]	80	33	12	6	2	1	23	3
External shoreline radiation[f]	14					1	13	
Exposure rate (PIC)[g]	4			3	1			

(a) Surveillance Zone 1 (between the Near-Facility Environmental Monitoring Program sampling locations and the site perimeter).
(b) Surveillance Zone 2 (near or just inside the site boundary).
(c) Surveillance Zone 3 (in and between communities within an 80-kilometer [50-mile] radius of the site's industrial areas).
(d) Includes community-operated environmental surveillance stations.
(e) Thermoluminescent dosimeters.
(f) Handheld survey instruments.
(g) Pressurized ionization chambers.

Table 4.0.2. Samples Collected by the Hanford Site Surface Environmental Surveillance Project, 2003

Media	Number of Samples Collected and Submitted for Analyses	Number of Analytical Results Obtained	Number of Samples Collected and Archived or Submitted to Other Agencies and Organizations[a]
Air	1,556	4,101	
Biota	384	3,827	141
Soil and sediment	141	1,286	82
Surface water	709	7,192	95
Groundwater	12	156	4
Drinking water	38	101	
External radiation	310	310	
Miscellaneous materials	3	58	2
Totals	3,153	17,031	324

(a) Selected samples were collected and archived, not submitted for analyses. Some samples were relinquished to Bechtel Hanford, Inc., Washington State Department of Health, Washington State Department of Ecology, U.S. Food and Drug Administration, or Oregon Department of Energy.