

THE HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT: OVERVIEW

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ABSTRACT

In 1988, researchers began a multiyear effort to estimate radiation doses that people could have received since 1944 at the U.S. Department of Energy's Hanford Site. The study was prompted by increasing concern about potential health effects to the public from more than 40 yr of nuclear activities. We will provide an overview of the Hanford Environmental Dose Reconstruction Project and its technical approach. The work has required development of new methods and tools for dealing with unique technical and communication challenges. Scientists are using a probabilistic, rather than the more typical deterministic, approach to generate dose distributions rather than single-point estimates. Uncertainties in input parameters are reflected in dose results. Sensitivity analyses are used to optimize project resources and define the project's scope. An independent technical steering panel directs and approves the work in a public forum.

Dose estimates are based on review and analysis of historical data related to operations, effluents, and monitoring; determination of important radionuclides; and reconstruction of source terms, environmental conditions that affected transport, concentrations in environmental media, and human elements, such as population distribution, agricultural practices, food consumption patterns, and lifestyles. A companion paper in this volume, The Hanford Environmental Dose Reconstruction Project: Technical Approach, describes the computational framework for the work.

INTRODUCTION

The objective of the Hanford Environmental Dose Reconstruction (HEDR) Project is to estimate radiation doses that the public could have received from nuclear operations at the U.S. Department of Energy's (DOE's) Hanford Site since 1944. HEDR dose estimates will be used by the U.S. Public Health Service's Centers for Disease Control in a thyroid morbidity study being conducted in counties adjacent to the Hanford Site. HEDR Project staff are currently evaluating past monitoring and assessment efforts, deciding when we have enough

monitoring data, and identifying ways to make monitoring and assessment more cost-effective.

Our experiences confirm those of scientists working in the hazardous waste area; that is, addressing dose-assessment issues requires a technical and sociopolitical framework. We must move from deterministic to probabilistic radiological assessments and involve the interested public in the process. A dose assessment that is accepted by the scientific community but is not understood or accepted as credible by the public is strictly a scientific exercise. A successful dose assessment must also provide potentially affected people with information to independently evaluate impacts.

HISTORICAL BACKGROUND

HEDR was prompted by mounting concern about potential public health effects from more than 40 yr of operations at Hanford. Of particular interest was the period from startup until environmental monitoring reports were made publicly available in the late 1950s. In 1986, the Hanford Health Effects Review Panel, convened by the Centers for Disease Control at the request of the Washington State Nuclear Waste Board and the Indian Health Service, recommended that potential doses from radioactive releases at Hanford be reconstructed. The states of Oregon and Washington, representatives of three regional Indian tribes, and DOE agreed that an independent technical steering panel (TSP) should direct the HEDR Project, which is managed and conducted by the Pacific Northwest Laboratory. A TSP was subsequently selected by representatives from four Northwest universities, and the project was formally initiated in 1988.

The TSP reviews, evaluates, and approves all technical decisions and reports. Panel members include experts in various technical fields and individuals representing the states of Washington and Oregon, the Indian tribes, and the public. The TSP conducts periodic public meetings (about every 2 mo) and provides public access to the data used in reconstructing doses.

TECHNICAL APPROACH

HEDR uses an approach similar to a typical deterministic radiological dose assessment. However, HEDR uses distributions rather than point estimates as input and produces distributions rather than point estimates as results (dose estimates). Our work also differs from typical dose assessments in that it involves many years of operations and must reconstruct past conditions.

Figure 1 shows the flow of information required to estimate radiological doses; these are based on: (1) identification, review, and analysis of historical data on nuclear operations; (2) determination of radionuclides that could have contributed to dose; (3) reconstruction of the types and quantities of radiological materials released to the atmosphere, the Columbia River, and soils; (4) reconstruction of atmospheric, river, and ground-water conditions that affected the transport of radiological materials from operating facilities to offsite populations; (5) delineation of study areas; (6) review of historical measurements of radionuclides that originated at Hanford in environmental media; (7) reconstruction of agricultural practices; (8) reconstruction of general and specific population distributions; and (9) reconstruction of food consumption patterns and lifestyles.

A phased approach is being used; for example, identifying the most significant radionuclides, selecting appropriate computer models, identifying key parameters for model input, and developing preliminary dose estimates and their uncertainties for people who lived closest to the Hanford Site. Results from our initial work will support cost/benefit decisions concerning modification of the study (area and time period covered), identification of methods for improving models, and identification of additional data sources.

All major technical decisions concerning work scope and approach, including selection of radionuclides, exposure pathways, study areas and populations, time periods, computer models, methods for assessing uncertainties in dose estimates, key input parameters, and dose threshold levels, are reviewed and approved by the TSP in a public forum. Thus, the public is an integral part of the decision-making process.

Initially, the project is focussing on air emissions from 1944 through 1947 and liquid emissions from 1964 through 1966 for 10 counties surrounding the Hanford Site (about a 150-km radius; Figure 2). Preliminary doses are being estimated for the general public and for Native American populations in the study area, primarily the Yakima and Umatilla tribes.

The major surface-water pathway includes that portion of the Columbia River (about 100 river miles) between Priest Rapids Dam, immediately upstream of the site, and McNary, the first downstream dam. Radiological dose estimates for the water pathway will be compared with historical dose estimates from 1964 through 1966.

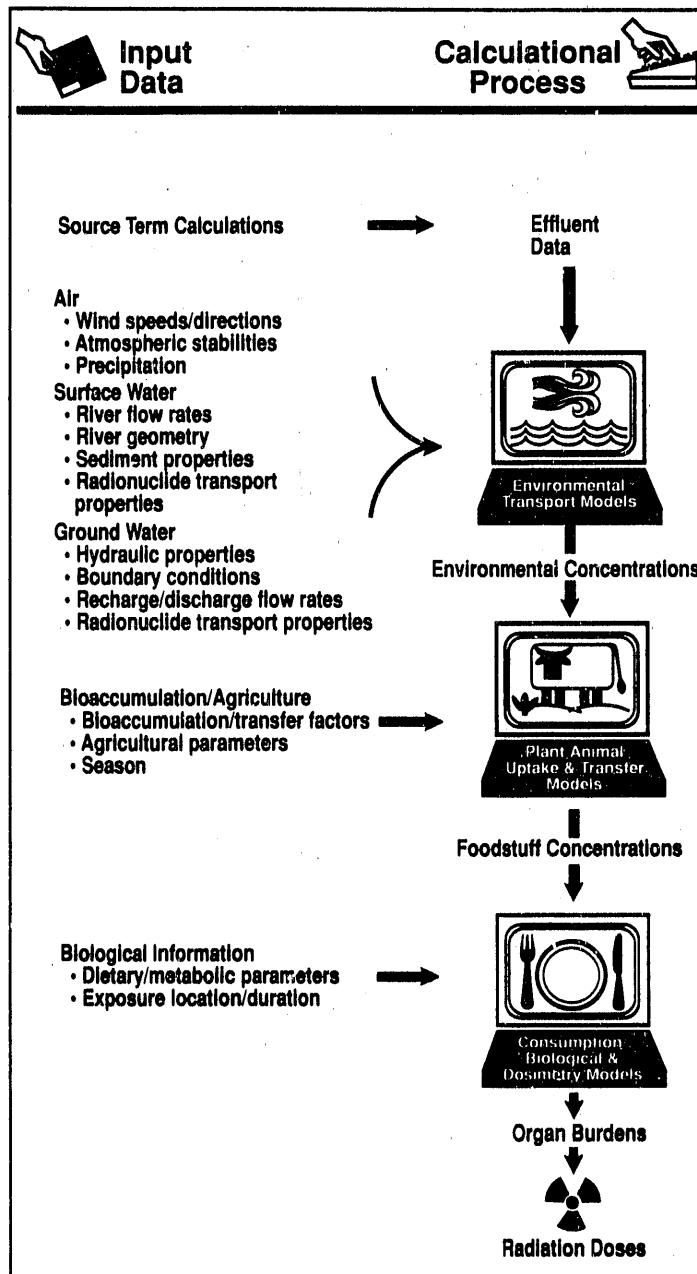


Figure 1. Data-gathering process for Hanford Environmental Dose Reconstruction.

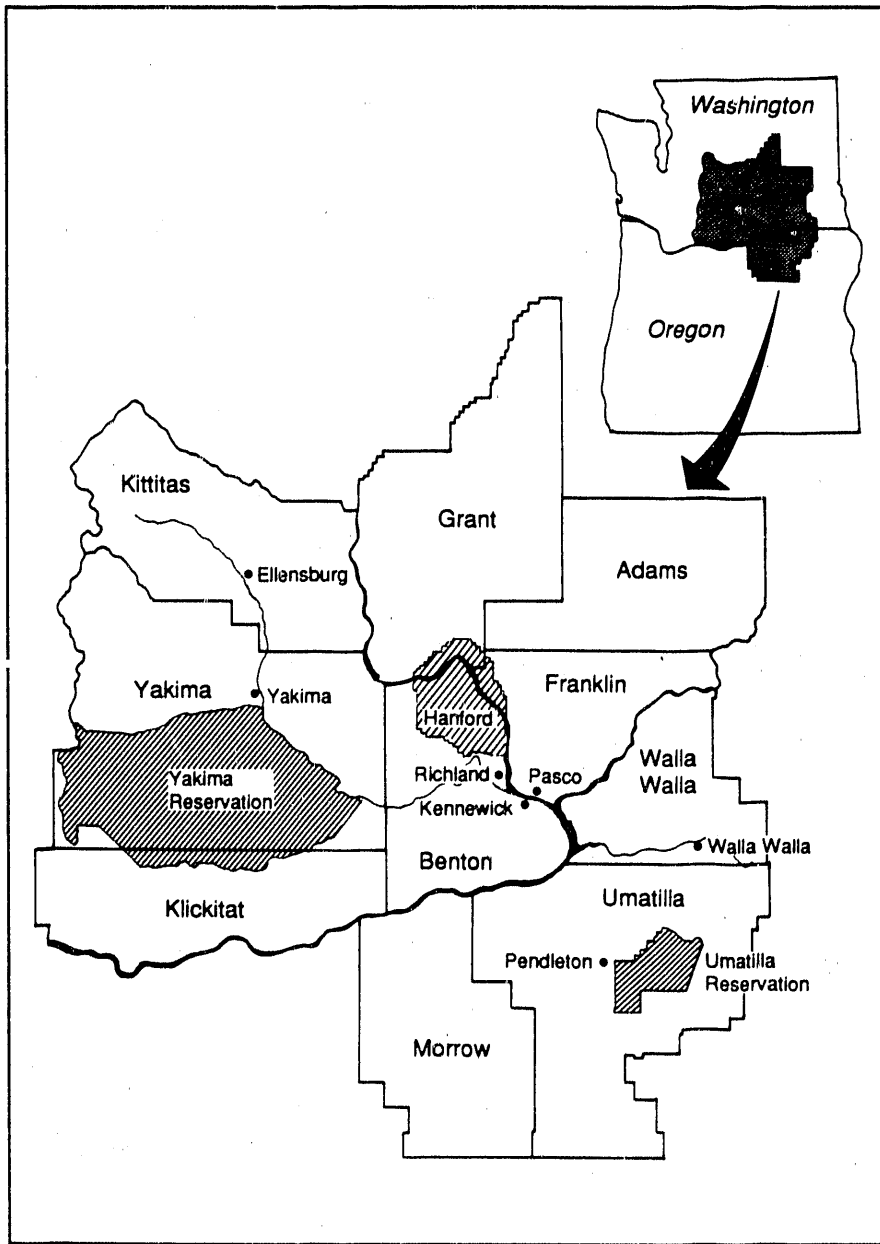


Figure 2. Map of 10 counties closest to Hanford Site, initial study area for dose reconstruction.

Figure 3 shows the relationship between our study and historical radionuclide releases to the atmosphere and radionuclides in the river. The years 1944 through 1947 were selected to study airborne emissions because more than 90% of the ^{131}I released from 1944 through 1988 occurred during that time. We are focusing on ^{131}I because it had the greatest potential contribution to radiation doses. All other important radionuclides are also being investigated in the first phase of study.

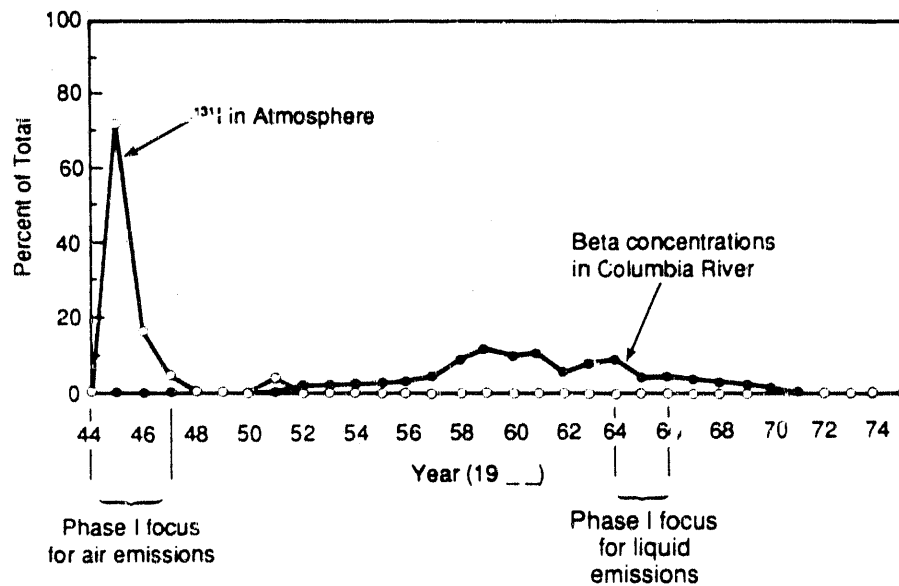


Figure 3. ^{131}I Releases from separations plants and total beta concentrations in the Columbia River, expressed as percents of totals from 1944-1975. Values from Anderson (1974), Essig (1970), and Hanford Site environmental monitoring reports, such as Wilson (1964), which are the basis for time periods selected for initial phase of dose reconstruction.

The years 1964 through 1966 were selected to study releases to the Columbia River primarily because extensive monitoring data were available during that period. In addition, releases to the Columbia River from 1944 through 1947 were relatively low, because only one to three reactors were operating (of the nine production reactors that operated on site in 1964), and because they operated at lower power levels than in later years. Thus, higher releases of water-transported radionuclides occurred during the late 1950s through mid-1960s. Moreover, all reactors were shut down for about 50 days in 1966, then

restarted. This event provided an unusual opportunity to assess changes in radionuclide concentrations in fish, water, and sediments as related to changes in reactor emissions.

We will summarize the first phase of study for the TSP, including preliminary dose estimates and associated uncertainties, in 1990. The summary report will document the rationale for selecting radionuclides, models, parameters, study areas, and time periods for the first phase, including a comparison and evaluation of methods for analyzing sensitivity and uncertainty of preliminary dose estimates. The project is scheduled for completion in 1993.

CONCLUSIONS

HEDR uses a probabilistic approach to dose assessment that incorporates explicit evaluations of uncertainties in input parameters and dose estimates. The project assesses relative importance of input parameters using sensitivity analyses and thereby optimizes project resources in selecting radionuclides, pathways, geographic areas, time periods, and critical subpopulations. HEDR is conducted under the direction of a TSP and in full view of the public who will ultimately judge the success of the work.

ACKNOWLEDGMENT

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REFERENCES

- Anderson, J. D. 1974. Emitted and Decay Values of Radionuclides in Gaseous Wastes Discharged to the Atmosphere from the Separations Facilities through Calendar Year 1972, ARH-3026. Atlantic Richfield Hanford Company, Richland, WA.
- Essig, T. H. 1970. Age-Dependent Radiation Dose Estimates for Residents of the Hanford Environs, 1945-1968, A special problem report submitted to the Faculty of Civil Engineering, Washington State University, for partial fulfillment of the requirements for the degree of Master of Science in Sanitary Engineering. Washington State University, Pullman, WA.
- Wilson, R. H. (ed.). 1964. Evaluation of Radiological Conditions in the Vicinity of Hanford for 1963, HW-80991. General Electric Company, Richland, WA.