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Work Plan for the Hanford Environmental Dose Reconstruction Project

Revision 1

December 1989

Prepared for the Technical Steering Panel of the
Hanford Environmental Dose Reconstruction Project

DISCLAIMER

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WORK PLAN FOR THE
HANFORD ENVIRONMENTAL DOSE
RECONSTRUCTION PROJECT

Revision 1

December 1989

Pacific Northwest Laboratory
Richland, Washington 99352

Work Plan for the
Hanford Environmental Dose Reconstruction Project

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This document has been reviewed by the Technical Steering Panel and is approved for public release.

J. E. Till, Chair
Technical Steering Panel

December 1, 1989
Date

WORK PLAN
FOR THE
HANFORD ENVIRONMENTAL DOSE
RECONSTRUCTION PROJECT

Project No. 12578
Revision 1
December 1989

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SUMMARY

The primary objective of the Hanford Environmental Dose Reconstruction (HEDR) Project is to estimate the radiation doses that populations could have received from nuclear operations at the Hanford Site since 1944, with descriptions of uncertainties inherent in such estimates. The secondary objective is to make project records--information that HEDR staff members used to estimate radiation doses--available to the public.

The project is managed and conducted by the Pacific Northwest Laboratory (PNL) under the direction of an independent Technical Steering Panel (TSP) (Figure S.1). The TSP consists of experts in environmental pathways, epidemiology, surface-water transport, ground-water transport, statistics, demography, agriculture, meteorology, nuclear engineering, radiation dosimetry, and cultural anthropology. Included among the members are appointees representing the states of Oregon and Washington, cultural and technical experts nominated by the Indian tribes in the region, and an individual representing the public. The TSP reviews, evaluates, and approves all major project technical decisions and reports. The U.S. Department of Energy (DOE) funds the project, but provides no technical direction or oversight.

Preliminary dose estimates for a limited geographic area and time period, certain radionuclides, and certain populations are planned to be available in 1990; complete results are planned to be reported in 1993. Project reports, which have been approved by the TSP, and references used in the reports are available to the public in the DOE Public Reading Room in Richland, Washington. Project progress is documented in monthly reports, which are also available to the public in the DOE Public Reading Room.

THE PROJECT'S BEGINNINGS

The study was prompted by mounting concern about potential health effects to the public from more than 40 years of operations at the Hanford Site. In 1986, the Hanford Health Effects Review Panel--convened by the Centers for Disease Control (CDC) at the request of the Washington State Nuclear Waste Board and the Indian Health Service--recommended that potential doses from radioactive releases at

FIGURE S.1. Project Organization

Hanford be reconstructed. Representatives from four Northwest universities selected the technical members of the independent TSP to direct the dose reconstruction effort.

WORK APPROACH

Dose estimates will be based on

- identification, review, and analysis of historical data
- determination of radionuclides that could have contributed significantly to dose
- reconstruction of the types and quantities of radioactive materials released to the atmosphere, Columbia River, and soils, and potentially transported via soil to ground water
- reconstruction of atmospheric, river, and ground-water conditions that affected the transport of radioactive materials from operating facilities to offsite populations
- estimation of radionuclide concentrations in environmental pathways to offsite populations
- delineation of study areas

- review of historical measurements of radionuclides of Hanford origin in environmental media
- reconstruction of agricultural practices
- reconstruction of general and specific population distributions
- reconstruction of food consumption habits and lifestyles.

At the direction of the TSP, a "phased approach" is being used to reconstruct doses. The geographical area and time period under study will be successively expanded in four progressive phases that culminate in 1993. The results of each phase will be used to assist in defining the scope of work--the study area, time periods, and technical approach--in the following phase. In Phase I, which will be completed in 1990, HEDR staff are estimating doses to populations within a 10-county area surrounding the Hanford Site, using information from 1944 through 1947 for radionuclides that were released to the air and from 1964 through 1966 for those that were released to the Columbia River. These limited time periods, which represent periods of relatively high releases of radionuclides to the air and water, were selected to achieve the objective of Phase I: to develop working conceptual and mathematical models that can be used to estimate doses to people. Data from periods of relatively high releases are needed to obtain model results that can be compared to actual environmental monitoring data to verify that the models work as intended. In later phases of the project, the time periods of study may be expanded as warranted by project results in conjunction with TSP direction.

SCOPE

The period of study begins in September 1944 when the first Hanford reactor began operating. Potential radiation doses prior to 1957--when historical dose estimates were first reported in annual environmental monitoring reports--are being estimated. Doses reported after 1957 will be compared with dose estimates made using current dose assessment technology. The results of this comparison will be used to determine whether the previous dose estimates can be improved sufficiently to warrant further refinement.

The study area boundaries are determined primarily by where radionuclides traveled in the environment when they were emitted by past Hanford operations.

These boundaries are defined and limited by prevailing wind direction, weather patterns, topography, and the Columbia River and its estuary.

Radiation doses will be estimated for typical individuals--including infants, children, and pregnant women--specific individuals, and special populations. The special populations (i.e., Hanford nonbadged workers, U.S. Army personnel, Indian tribes, and migrant workers) have characteristics that could result in doses that are different than those of the general population. Construction workers and Army personnel stationed at Hanford were close to the sources of emissions. Some members of Indian tribes had dietary and lifestyle habits that differed from those of the general population. Migrant workers moved frequently and worked directly on and with the land.

Many of the radionuclides released from Hanford Site operations may not have significantly affected populations because of low levels of emissions, losses during transport, short half-lives, mode of exposure, or low biological uptake. Key radionuclides are being selected for the study on the basis of their potential contribution to doses to populations. In addition, other radionuclides of public interest will be investigated to determine how significantly they contribute to dose.

TASK DESCRIPTIONS

Activities to reconstruct radiation doses are divided among 12 tasks whose responsibilities are as follows:

- Project Management Task - controls and coordinates all project activities
- Internal Peer Review Task - periodically reviews all phases of the project
- Project Technical Coordination Task - provides technical guidance and coordinates the input generated by all technical tasks
- Source Terms Task - develops estimates of the amount and type of radioactive materials released to the environment from Hanford Site operations
- Environmental Transport Task - uses release estimates to reconstruct the movement of radioactive materials from the Hanford Site through the atmosphere, surface water, and ground water to locations where people could have been exposed

- **Environmental Monitoring Data Task** - assembles, evaluates, and summarizes historical measurements of radionuclides in the environment around the Hanford Site
- **Demographics, Agriculture, Food Habits Task** - develops population, food consumption, and food production information for the populations under study
- **Environmental Pathways and Dose Estimates Task** - calculates the range of dose levels that the study populations could have received based on radionuclide concentration information generated by other tasks
- **Statistics Task** - assesses the uncertainties inherent in the model parameters and estimated doses
- **Information Resources, Records Management, and Quality Assurance Tasks** - support the technical tasks to ensure that published and referenced information is publicly available, easily retrievable, properly recorded, and that technical work and documentation meet quality assurance requirements.

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1.0 INTRODUCTION

This work plan describes the plans, organization, and systems that will be used by the Pacific Northwest Laboratory (PNL) to conduct the Hanford Environmental Dose Reconstruction (HEDR) Project under the direction of the Technical Steering Panel (TSP). The project will result in estimates of radiation doses that people could have received since 1944 from nuclear operations on the Hanford Site (Figure 1.1).

FIGURE 1.1. Hanford Site Location and Key Operating Areas

The work plan represents an agreement between the TSP and PNL concerning the project objectives, scope, and work to be performed to complete the HEDR Project. Throughout the project, HEDR Project staff will submit proposed technical decisions, approaches, assumptions, methods, rationale, key radionuclides for study, models, and reports to the TSP for review, evaluation, and approval.

This work plan serves as a general guide in the conduct of the HEDR Project. The work plan describes the objectives, approach, and activities planned for the entire HEDR Project; however, emphasis is on Phase I of the work, which ends in 1990. The TSP will review, redirect if necessary, and approve the Phase I work. The work plan will be updated as needed, but at least annually, to reflect new technical knowledge or scope changes.

1.1 THE PROJECT'S BEGINNINGS

The HEDR Project was prompted by mounting concern about possible health effects to the public from more than 40 years of nuclear operations at the Hanford Site. In 1986, the Hanford Health Effects Review Panel--convened by the Centers for Disease Control (CDC) at the request of the Washington State Nuclear Waste Board and the Indian Health Service--recommended as a top priority that potential doses from radioactive releases at Hanford be reconstructed.

Representatives from four Northwest universities selected technical members of an independent TSP to direct PNL's dose reconstruction work. The TSP reviews, evaluates, and approves all project technical decisions and reports. Panel members include experts in various technical fields as well as individuals who represent the states of Washington and Oregon, Indian tribes, and the general public. The project is funded by the U.S. Department of Energy (DOE).

1.2 WORK PLAN ORGANIZATION

Chapter 2.0 of this document describes the project objectives and technical approach, and Chapter 3.0 describes the technical activities required to complete the work. Chapters 4.0 and 5.0 identify and depict project organization, schedule of milestone activities, and other systems and methods for controlling and reporting project progress. The appendices contain supporting information, including TSP directives addressed in the work plan (Appendix A), quality assurance procedures

(Appendix B), formats for reporting project progress (Appendix C), project schedule and budget (Appendices D and E), a glossary (Appendix F), and information about units of measure (Appendix G).

units of measure (Appendix G)
and budget (Appendices D and E); a glossary (Appendix F); and information about
(Appendix B); formulas for calculating project progress (Appendix C); project schedule

2.0 OBJECTIVES AND APPROACH

This chapter describes HEDR Project objectives and the basic approach for completing the work, including the organization of dose reconstruction into four successive phases.

2.1 OBJECTIVES

The primary objective of the HEDR Project is to develop estimates of radiation doses that the public could have received from radioactive materials released since 1944 from nuclear operations on the Hanford Site. A secondary objective is to make project records--project reports and referenced documents--available to the public. Copies of project records are maintained in the DOE Public Reading Room in the Federal Building, Richland, Washington.

2.2 APPROACH

Figure 2.1 shows the flow of information required to estimate doses. Dose estimates will be based on

- identification, review, and analysis of historical data relating to nuclear operations
- determination of radionuclides that could have contributed significantly to dose
- reconstruction of the types and quantities of radioactive materials released to the atmosphere, Columbia River, and soils
- reconstruction of atmospheric, river, and ground-water conditions that affected the transport of radioactive materials from operating facilities to offsite populations
- estimation of radionuclide concentrations in environmental pathways to offsite populations
- delineation of study areas

FIGURE 2.1. Process for Dose Calculation

- review of historical measurements of radionuclides of Hanford origin in environmental media
- reconstruction of agricultural practices
- reconstruction of general and specific population distributions
- reconstruction of food consumption patterns and lifestyles.

2.2.1 Phased Approach

The following discussion describes the phased approach that the TSP directed PNL to use in reconstructing radiation doses (see TSP Directives 88-1, 89-1, and 89-5 in Appendix A). In four progressive phases that culminate in 1993, the geographical area and time period under study will be successively expanded (Table 2.1 and Figure 2.2).

The phased approach will enable initial efforts to focus on developing "tools" for the rest of the study--such as 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 the initial work phase will be used to determine how far to expand the study area and time, to identify methods for improving models, and to identify additional data sources.

The TSP reviews, approves, and directs all major technical decisions concerning the scope and approach of the work, including selection of radionuclides, exposure pathways, study areas and populations, time periods of study, computer models, methods for assessing uncertainties in dose estimates, key input parameters, and dose threshold levels.

The scope of each of the four phases is described in the following sections.

2.2.1.1 Phase I

Work focuses on the 10 counties surrounding the Hanford Site (Figure 2.3; about a 150-km radius) for air emissions from 1944 through 1947 and for liquid emissions from 1964 through 1966. Preliminary doses will be estimated for the general population and Native American populations within the study area. Phase I

TABLE 2.1. Scope of Phased Approach

Study Element	Phase I	Phase II	Phase III	Phase IV
Geographic area, radius	150 km (10 counties)	240 km	TBD(a)	TBD
Time period for atmospheric pathway	1944-47	1944-TBD	1944-TBD	1944-TBD
Time period for river pathway	1964-66	TBD	TBD	1944-TBD

(a) TBD = to be decided based on results of previous phase.

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FIGURE 2.2. Proposed Timeline for Phased Approach

FIGURE 2.3. Phase I Study Area

results will be used as the basis for defining the scope of Phase II work. Because Phase I work focuses primarily on establishing and testing the calculation procedure for estimating doses, the preliminary doses developed in this phase will be refined in Phase II as models and procedures are refined.

The geographic study area for Phase I work comprises the 10 counties closest to the Hanford Site (Figure 2.3) and includes the Yakima and Umatilla Indian Reservations. In Phase I, limited activities will be conducted for areas outside these

counties to identify and collect information associated with monitoring data, Native American lifestyles, demographics, and agriculture.

Columbia River investigations focus on the portion of the river between Priest Rapids Dam and McNary Dam (see Figure 2.3). Key radionuclides transported through the water pathway will be investigated, as will major exposure pathways associated with the river (such as drinking treated river water or eating food irrigated with river water). Investigations will also account for specific lifestyles potentially associated with higher exposure from the river pathway, such as high consumption of fish. To estimate the upper bounds of potential doses to Native Americans who ate fish from downstream of McNary Dam during the Phase I time period, dose estimates will be based on the radionuclide concentrations in fish and water above McNary Dam. Average radionuclide concentrations in water were higher immediately downstream of the Hanford Site than downstream of McNary Dam because dilution of the Columbia River occurs where the Yakima and Snake Rivers join the Columbia River. The most extensive data on radionuclide concentrations in fish are from the portion of the Columbia River from Priest Rapids Dam to McNary Dam.

Figure 2.4 shows the Phase I study period as related to historical radionuclide releases to the atmosphere and radionuclide concentrations in the river. These limited time periods, which represent periods of relatively high releases of radionuclides to the air and water, were selected to achieve the objective of Phase I: to develop working conceptual and mathematical models that can be used to estimate doses to people. Data from periods of relatively high releases are needed to obtain model results that can be compared to actual environmental modeling data to verify that the models work as intended. In addition, studying the periods of relatively high releases in the initial phase of the study enables researchers to identify the time periods, geographical areas, populations, and exposure pathways of highest potential risk early in the study. This information, in turn, can be used to determine how and where to expand the study in later phases.

The time period of 1944 through 1947 was selected for study of airborne emissions as directed by the TSP in Research Directive 89-5, which states, "The pilot study approach using information, for I-131 assessment, from 1944 - 1947 should be used to obtain 'best' estimates of dose." More than 90% of the iodine-131 released between 1944 and 1988 was estimated to have been released during that time

FIGURE 2.4. Iodine-131 Releases from the Separations Plants and Total Beta Concentrations in the Columbia River Expressed as Percents of Totals from 1944-1975 (based on Anderson 1974 and annual Hanford Site environmental monitoring reports)

(Anderson 1974). Work focuses on iodine-131 because it had the greatest potential for contributing to radiation doses received by people; however, all other important radionuclides will be investigated as part of Phase I.

The 1944-1947 time period was also considered for reconstructing releases to the Columbia River for Phase I, but was overruled in favor of the 1964-1966 time period. The maximum number of operating reactors and power levels peaked in the late 1950s and in the 1960s, leading to the highest releases to the river during that time period. As in the case of emissions to air, data from a time period of relatively high releases are needed to obtain model results that can be compared with environmental monitoring data to verify that the models work as intended. With the goal of creating workable conceptual and computer models for reconstructing the water pathway, the 1964-1966 time period was selected for Phase I study of doses resulting from the Columbia River pathway for several reasons:

- Extensive water monitoring data were collected during that period. Continuous sampling at the Richland water intake was initiated in 1964. In addition, the U.S. Geological Survey conducted independent measurements of radionuclide concentrations in the river during 1964-1966.
- The city of Richland, whose population potentially sustained the highest exposure from the water pathway, did not withdraw drinking water from the Columbia River until 1964.
- All reactors were shut down for about 50 days in 1966 and then restarted. This event provided an unusual opportunity to assess the rate of change of radionuclide concentrations in fish, water, and sediments as related to changes in reactor emissions.

For the water pathway, the dose estimates developed in Phase I will be compared with historical dose estimates for 1964 through 1966.

PNL will submit a report summarizing Phase I work--including preliminary dose distributions and associated uncertainties for the general and Native American populations in the study area--to the TSP for review. The report will document the rationale for the radionuclides, models, parameters, study areas, and time periods selected for Phase I work, including a comparison and evaluation of methods for analyzing sensitivity and uncertainty of the preliminary dose results.

2.2.1.2 Phase II

Work will expand beyond the 10-county area and beyond the initial study times as warranted by Phase I study results. All important radionuclides and pathways will be investigated. Doses will be estimated for the general and special populations and for specific individuals at specific locations. Dose estimates will also be provided to the CDC to support their thyroid morbidity study. Though the CDC will have access to the Phase I dose estimates, the preliminary nature of these results will preclude their use for any but the most general epidemiology questions. Phase II results will be used to define the scope of Phase III work.

The geographical study area for Phase II work, which will be selected primarily on the basis of Phase I atmospheric pathway studies for iodine-131, may be extended 240 km or more downwind of the Hanford Site. Emissions to the Columbia River could be investigated downriver to the estuary and beyond. The study period for Phase II work could be extended forward to 1957 (when the first offsite doses were estimated and reported) or beyond for the air pathway and extended to include time periods

other than 1964 through 1966 for the water pathway. HEDR staff will carry out a significant effort to determine whether uncertainties associated with Phase I dose estimates can be reduced by selectively reducing uncertainties of key input parameters. Phase I dose estimates will be used to redefine the scope of the analysis for the river pathway.

A progress report summarizing Phase II work will be submitted to the TSP in 1990 for review and approval. The report will include revised dose estimates and their associated uncertainties for the Phase I study area and preliminary dose estimates for extended areas and time periods. The report will also document any changes to Phase I rationale regarding the identification of significant radionuclides, models, parameters, study areas, time periods, and methods of analyzing sensitivity and uncertainty for the dose results.

2.2.1.3 Phases III and IV

Study areas, time periods, and populations will be expanded as warranted by results from Phase II and III, respectively. Uncertainties in key input parameters will be reduced when feasible and when these reductions result in significant reductions in the uncertainties of the dose estimates. Summary reports for Phase III and Phase IV work will be transmitted to the TSP in 1991 and 1992, respectively. The Phase IV report will summarize the entire project.

other than 1964 through 1966 for the water pathway. HEDR staff will carry out a significant effort to determine whether uncertainties associated with Phase I dose estimates can be reduced by selectively reducing uncertainties of key input parameters. Phase I dose estimates will be used to reform the scope of the analysis for the river pathway.

A progress report summarizing Phase II work will be submitted to the TSP in 1990 for review and approval. The report will include revised dose estimates and their associated uncertainties for the Phase I study area and preliminary dose estimates for extended areas and time periods. The report will also document any changes to Phase I rationale regarding the identification of significant radionuclides, models, parameters, study areas, time periods, and methods of analyzing sensitivity and uncertainty for the dose results.

2.2.1.3 Phase III and IV

Study areas, time periods, and populations will be expanded as warranted by results from Phase II and III, respectively. Uncertainties in key input parameters will be reduced when tests are and when these reductions result in significant reductions in the uncertainties of the dose estimates. Summary reports for Phase III and Phase IV work will be transmitted to the TSP in 1991 and 1992, respectively. The Phase IV report will summarize the entire project.

3.0 TASK DESCRIPTIONS

This chapter identifies the tasks and associated activities required to conduct dose reconstruction. The work breakdown structure is shown in Figure 3.1. Each task description includes a summary (in italics), the task's purpose and approach, and activities required to complete the work, including milestones as appropriate.

Milestones are events or products that represent work "outputs" and are used to monitor and control project progress. Activities contribute to milestones. A complete list of milestones for FY 1989 is shown in Appendix D. All tasks contribute to the major milestone for FY 1989, which is the internal draft version of the Phase I report.

All technical tasks contain a "task management" component, which provides the overall technical, administrative, and quality assurance guidance for all other technical activities in the task. Task management activities, which are conducted by the task leader or designated alternate, include

- planning and organizing task work, including the use of labor and other resources
- representing the task in meetings with the project manager, other task members, the TSP, and other external organizations
- ensuring that reporting and records management requirements of the task are met
- ensuring that all work conducted within the task is in accordance with applicable quality assurance requirements.

3.1 PROJECT MANAGEMENT (WBS 01)

The Project Management Task manager controls and coordinates all project activities. Task members provide project control, communications support, and records control.

FIGURE 3.1. Work Breakdown Structure

The objective of the Project Management Task is to coordinate and manage the other tasks in accordance with this work plan and with directives received from the TSP. This task is responsible for producing, with input from all other tasks, the summary reports of dose reconstruction activities for each phase of the project, as well as progress reports and formal communication with the TSP.

Administrative procedures, which provide controls necessary to ensure compliance with PNL project management standards and quality assurance requirements, are presented in Chapter 4.0 and the appendices. Organizational structure and communications protocols are described in Chapter 4.0. The Project Management Task is supported by three key activities: project control, communications support, and records control.

Project Management staff and a specialist assigned to the HEDR Project provide project control support in the following areas:

- develop logic diagrams, networks, and schedules
- prepare cost account plans based on work package planning
- track project progress
- provide training in project management systems and disciplines.

A communications specialist is assigned to the project to plan, review, write, and advise HEDR team members on communication products that document project work.

The project records custodian is responsible for the maintenance and accuracy of project records and document control. All records generated by HEDR team members are forwarded to the project office for verification of completeness and legibility. Each record is assigned a sequential number and entered into a data base system and the project files. Records are transferred to the PNL Records Center at regular intervals in accordance with approved procedures.

3.2 INTERNAL PEER REVIEW GROUP (WBS 02)

An internal peer review group periodically reviews all phases of the HEDR Project to help ensure technical soundness, accuracy, and completeness of information generated by project staff.

The objective of the Internal Peer Review Group Task is to provide internal technical review of HEDR work.

The internal peer review group reviews all HEDR formal presentations and documents. The group includes technical experts representing senior PNL management, PNL senior technical staff, Hanford Site contractors, and external experts as necessary. The group provides technical guidance and support to the HEDR project manager, and expedites communication with senior PNL management and the managers of other Hanford Site contractors.

3.3 SOURCE TERMS (WBS 03)

Task members will develop estimates of the amounts and types of radioactive materials released to the environment (source terms) since 1944 from Hanford Site operations. This involves identifying the radionuclides that contribute most significantly to doses, based on the following factors: the quantity of a given radionuclide produced, its radiological half-life, fraction released to the environment (atmosphere, surface water, and ground water), behavior in the environment, and potential risk to populations.

Historical measurements and production information will be used to estimate the quantity of dominant radionuclides emitted from Hanford Site facilities. Values will be calculated for time periods for which actual measurements of radionuclide emissions do not exist. Task members will use historical information regarding operation of facilities, process operations, emission control technologies, waste management practices, and effluent monitoring to help develop estimates of radionuclide emissions. The proposed methods and results of this task will be reviewed, evaluated, and approved by the TSP. The estimates developed as a result of this task will be used by Environmental Transport Task members to reconstruct concentrations of radionuclides in the environment.

3.3.1 Background

The Hanford Site was established in 1943 to produce plutonium for nuclear weapons. As shown in Figure 1.1, four operating areas exist at the Hanford Site: the 100 Areas, which contain plutonium production reactors and ancillary operations; the 200 Areas (200 East and 200 West), which contain irradiated fuel processing facilities, material purification facilities, waste management activities, and ancillary operations; the 300 Area, which contains fuel fabrication and research and development operations; and the 400 Area, which contains the Fast Flux Test Facility and its associated support operations.

For the HEDR Project, a facility is defined as any building, engineered structure, or operating area from which radioactive emissions could have been released. Process operations are those activities that produce, separate, purify, modify, or dispose of specific materials. Facility operations include emission control technologies, waste treatment, storage, and disposal. Research and development activities are also included in the broad definition of facility and process operations.

Numerous radionuclides have been produced by Hanford Site operations. Most of these radionuclides have not had a significant impact on radiation doses to individuals because of the quantities emitted, behavior in the environment (chemical form and transport), radioactive half-lives, and biological half-lives.

3.3.2 Hanford Site Operations and Facilities (WBS 0302)

The objective of the Hanford Site Operations and Facilities Subtask is to identify Hanford Site facilities and their process and facility operations that were, or had the potential to be, sources of radioactive emissions since 1944.

3.3.2.1 Approach

A timeline will be developed that identifies, for each major Hanford facility, dates of operation, process operations, emission control, waste management technologies, and major effluent streams.

3.3.2.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- reviewed relevant documents addressing Hanford Site facilities and operations
- **Milestone 0302-A:** identified the locations of the major sources of radioactive emissions to the atmosphere at the Hanford Site. Identified the relevant parameters of discharge points, i.e., stack height, stack diameter, air flow and temperature. Provided this information to Atmospheric Transport Subtask of the Environmental Transport Task - April 1989
- **Milestone 0302-B:** drafted a report, *A History of Major Hanford Operations Involving Radioactive Material* - March 1989 and submitted it to the TSP for review - June 1989.

3.3.2.3 Activities and Milestones Required to Complete Phase I Work

None.

3.3.3 Hanford Site Radioactive Emissions (WBS 0303)

The objective of the Hanford Site Radioactive Emissions Subtask is to obtain and document estimates of the emissions of the dominant radionuclides resulting from Hanford Site operations as a function of location, time and pathway.

3.3.3.1 Approach

Members of this task and the Environmental Pathways and Dose Estimates Task will identify the dominant radionuclides to be considered as source terms from each Hanford Site area and its facilities. Dominant radionuclides will differ for emissions to the atmosphere, surface water, and ground water. These activities

will be coordinated with members of the Environmental Transport and Environmental Monitoring Data tasks to ensure a consistent list of dominant radionuclides for the project.

The following activities will be used to estimate releases of dominant radionuclides:

- compile actual measured release on radioactive emissions from Hanford facilities and processes as a function of time
- identify the fraction of dominant radionuclides released relative to the quantity available for a given facility and/or process operation
- compile information on accidental radioactive releases, including the facilities involved, the type and quantity of radionuclides released, and the release dates
- calculate estimated radioactive emissions for facilities and time periods for which either actual measured release data do not exist or are not radionuclide-specific.

3.3.3.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- prepared an abstract, *Estimated Quantity of ¹³¹I Contained In Irradiated Fuel At Time of Fuel Processing, CY 1944-1945*. The project manager presented information from the abstract to the TSP on November 11-12, 1988.
- prepared a draft format for the task's numerical data base
- calculated fission product yields and quantities of activation products to support efforts to help define dominant radionuclides
- added all documents identified and reviewed to the task bibliographic data base
- determined final format of task numerical data base and initiated its use
- compiled all available measured release data on iodine-131 to the atmosphere from the fuel processing plants for the period 1944 through 1947
- calculated, as needed, estimated radionuclide emission data from the fuel processing plants for the period 1944 through 1947

- **Milestone 0303-A:** compiled available measured release data from fuel processing plants, 1944-1947, for atmospheric releases of iodine-131 - May 1989
- **Milestone 0303-C:** developed a preliminary list of dominant radionuclides and their decay schemes for consideration - April 1989
- **Milestone 0303-D:** estimated the radionuclide release fractions to the atmosphere for the fuel processing plants (1944-1947) for iodine-131 - April 1989
- **Milestone 0303-E:** focused estimates of radionuclide release fractions on iodine-131 released to the atmosphere, 1944-1947 - May 1989
- **Milestone 0303-F:** provided a recommendation to the project regarding the development of libraries specific to Hanford Site production reactors for use in ORIGIN Code calculations (Croff 1980) - March 1989
- **Milestone 0303-G:** drafted a report describing the chemical form and atmospheric chemistry of iodine emissions - May 1989
- **Milestone 0303-H:** determined the quantity of iodine-131 in irradiated fuel at the time of its processing from 1944 through the portion of 1945 for which existing operational information permits a "best estimate" to be calculated - May 1989
- **Milestone 0303-B:** identified dates of irradiated fuel dissolution for the PUREX Plant, 1984-1986, and provided this information to the atmospheric transport subtask of the Environmental Transport Task - June 1989.

3.3.3.3 Activities and Milestones Required To Complete Phase I Work

None.

3.3.3.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- continue to determine radionuclide release fractions for all dominant radionuclides for emissions from major facilities as a function of time and pathway
- add all documents identified and reviewed to task bibliographic data base
- compile all available measured release data on dominant radionuclides for Hanford Site operations for each phase of the project

- calculate estimated radionuclide emission data as needed for each phase of the project
- enter all radionuclide emission data obtained or calculated into the task numerical data base project reports for each phase.

3.4 ENVIRONMENTAL TRANSPORT (WBS 04)

Environmental Transport Task members will reconstruct the movement of radioactive materials identified by Source Terms Task members from areas of release at the Hanford Site to locations where individuals and/or populations can be exposed to such materials. Radionuclide transport will be reconstructed in the atmosphere, surface water, and ground water.

To track the releases to the atmosphere from the Hanford Site, meteorological information will be compiled, including wind speed, wind direction, and other data on phenomena that affect the spreading of the material. Mathematical models will be applied with these meteorological data and the source term data to calculate the concentration of radionuclides in the air and on the ground.

Reconstruction of the transport of radionuclides in the Columbia River will be based primarily on historical studies of the Columbia River and its tributaries. For those time periods when data were limited or unavailable, computer models will be used to reconstruct radionuclide concentrations in the river.

The movement of radionuclides in the ground water will be determined initially by using monitoring data to estimate the contribution of radionuclides in ground water to the surface-water pathway. Computer modeling may be required where data are lacking. The TSP will review, evaluate, and provide direction concerning the models proposed for this task.

3.4.1 Background

Radionuclides have been released to the atmosphere from a variety of Hanford Site operations since late 1944, primarily from the reactor fuel reprocessing plants in the 200 Areas. Once released, the radionuclides were transported away from the Hanford Site by wind. Radionuclide concentrations decreased in a downwind direction during air transport as a result of diffusion; deposition on soil, water, and vegetation surfaces; and radioactive decay.

The routes of exposure following atmospheric transport are defined as part of the Environmental Pathways and Dose Estimates Task. Individuals were exposed to the material from the radioactive plumes through inhalation, surface contamination, and ingestion of contaminated food and water.

From 1944 to 1971, from one to nine production reactors operated along the banks of the Columbia River in the northern portion of the Hanford Site. During their operation, eight of these reactors were cooled by a "once-through" process whereby treated river water was passed through the reactor, held in retention basins, then released to the river as effluent. The effluent contained radionuclides that were transported downstream in the Columbia River, as far as the Pacific Ocean.

Key radionuclides contributed to dose through various exposure pathways associated with the Columbia River. These exposure pathways, which are defined as part of the Environmental Pathways and Dose Estimates Task, will be evaluated to determine their contribution to dose from the Columbia River from 1964 through 1966 in Phase I. The study may be extended to include other time periods in Phases II through IV.

Radionuclides from waste-management activities have been discharged to the ground at the Hanford Site since reactor operations began. In addition to the contaminants that have been discharged to the ground, large volumes of cooling water and process condensates were discharged, resulting in a significant volume of ground-water recharge to the unconfined aquifer. Waste-management operations that have had the greatest impact on the ground water are the chemical processing operations, most of which occur in the 200-West and 200-East Areas. Recharge in the 200 Areas has altered the flow paths of ground water and contaminants moving toward the Columbia River.

Ground water in the 100 Areas has been affected by reactor operations; ground water in the 300 Area has been affected by fuel fabrication and activities associated with research and development. Because the lengths of flow paths to the river from these locations are shorter than from the 200 Areas, the impacts on ground and surface water from the 100 and 300 Areas have occurred in a shorter time frame than have the impacts from the 200 Areas.

The movement of contaminants in ground water at the Hanford Site has been mapped by monitoring both the unconfined and the uppermost confined aquifers beneath the Site. The unconfined aquifer, which has been affected by Site operations much more significantly than have the confined aquifers, has been monitored more extensively.

Estimates of radionuclide concentrations in the environment will be compared with measured concentrations to assess the performance of the atmospheric models. Estimated radionuclide concentrations in the environment will be used to reconstruct doses resulting from Hanford Site operations.

3.4.2 Atmospheric Transport

The objective of the Atmospheric Transport Subtask is to reconstruct the transport, diffusion, deposition, and resuspension of radionuclides released to the atmosphere by Hanford operations. Radionuclide concentrations in air and surface contamination will be estimated as functions of time and location for use in dose calculations.

3.4.2.1 Selecting and Implementing a Modeling Approach

Existing approaches for modeling the processes responsible for transport, diffusion, deposition, and resuspension of radionuclides in the atmosphere will be evaluated; modeling approaches selected for use in the project will be reviewed and approved by the TSP and documented.

Once a modeling approach is selected, existing computer codes will be modified to implement the approach. Code modifications required for implementation may include customizing model input and output to meet project needs, representing the effects of topography on transport and diffusion, and optimizing the codes to reduce model execution time. Mathematical descriptions of atmospheric processes within the codes will be examined; alternative descriptions will be

developed if appropriate. Mathematical descriptions of wind fields and deposition/depletion mechanisms will be given special attention.

Model Evaluation. Atmospheric models developed for use in the HEDR Project will be evaluated by comparing model predictions of transport, diffusion, and deposition of radionuclides with actual monitoring data. For Phase I, the uncertainty inherent in model calculations will be estimated by using several years worth of recent data as the basis for selecting the distribution shape and extreme values. The models will be evaluated to determine their sensitivities to changes in the number and frequency of meteorological observations used as model input and to changes in the temporal and spatial distribution of the releases. Task members will also evaluate the models' sensitivities to changes in descriptions of atmospheric processes such as deposition and depletion.

Model Documentation. After atmospheric models are developed, they will be documented. This documentation will include descriptions of the model objectives, atmospheric process represented, code algorithms, code organization, as well as a complete listing of the code. All computer code modules implementing the models will be verified in accordance with quality assurance procedures for project software.

Availability of Meteorological Data. Though an extensive collection of meteorological records for the Pacific Northwest exists at PNL as a result of previous projects, the records do not cover the period prior to 1948. However, meteorological data are available from 21 locations on and immediately adjacent to the Hanford Site for 1983 through 1988. These data provide better resolution of the wind patterns in the vicinity of Hanford than is possible from the data available for earlier years. For the Phase I calculations, task members will use the average wind-field patterns defined by these data to as input to the computer model that estimates doses. After Phase I, pre-1948 data and supplementary data for all years will be obtained from the National Climatic Data Center and entered into the project data base.

3.4.2.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- evaluated alternative approaches to modeling atmospheric transport and diffusion and identified a preferred approach. This approach includes the

use of a straight-line model for estimating air concentrations and surface contamination near release points and the use of a Lagrangian puff model for estimating air concentrations and surface contamination at locations off the Hanford Site.

- conducted preliminary modeling studies using an existing Lagrangian puff model. The studies were designed to examine relative magnitudes of average air concentrations and deposition within several possible domains, sensitivity of the average air concentrations to time of day of release, and seasonal variations in atmospheric transport and diffusion.
- evaluated various methods of estimating wind fields from sparse wind observations. The accuracy of model estimates of concentrations at specific locations depends on the proper representation of wind fields.
- prepared a map showing the locations for which pertinent data are readily available and charts showing the periods of record for each location
- documented the recommended approach for modeling atmospheric transport and diffusion
- developed and adapted for the project a suite of atmospheric models consistent with the recommended modeling approach, and developed working versions of these models
- acquired meteorological data pertinent to the HEDR Project from the National Climatic Data Center and entered the data for the period from 1983 - 1987
- calculated atmospheric transport, diffusion, and deposition using the working models and the HEDR meteorological data base at the end of June 1989. Results of these predictions were provided to members of the Environmental Pathways and Dose Estimates Task for dose estimation.
- **Milestone 0402-A:** identified preferred MESOI/MESORAD (existing computer codes for atmospheric transport) grid sizes and center points - February 1989
- **Milestone 0402-B:** calculated the average air concentrations and surface contamination for the period from 1983-1987 by month and census district for each significant radionuclide - August 1989
- **Milestone 0402-C:** completed a working model for the Phase I atmospheric transport and diffusion calculations - June 1989
- **Milestone 0402-D:** completed status table on meteorological data base development - September 1989.

3.4.2.3 Activities and Milestones Required to Complete Phase I Work

None.

3.4.2.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- continue model development, including reviewing, modifying as appropriate, and testing the mathematical descriptions of important processes in the model; fully document the completed model and submit to the TSP for review, evaluation, and approval
- evaluate model sensitivity and uncertainty with available data
- continue preparing the meteorological data base as necessary to include data from 1944-1947. The order of entry of data will be determined as domains and time periods for subsequent phases are defined. Fully document the completed meteorological data base.
- calculate additional average air concentrations and surface contamination as required to meet project objectives.

3.4.3 Surface-Water Transport (WBS 0403)

The objective of the Surface-Water Subtask is to reconstruct the concentrations and distributions of radionuclides in the Columbia River system.

3.4.3.1 Approach

Reconstruction of the transport of radionuclides in the Columbia River is based primarily on historical studies of the Columbia River and its tributaries. Review of existing literature that summarizes the physics of transport processes and the known distribution of radioactivity will provide valuable information related to transport of radionuclides in the Columbia River system. This literature review forms the basis for a conceptual model of radionuclide transport in the river. Any computer models used to reconstruct radionuclide concentrations in the river will be based on this conceptual model.

Phase I work focuses on a time period when river monitoring data for a select set of radionuclides are generally available. In studies of the river beyond

Phase I, for locations and time periods where data are limited or unavailable, computer models will be used to reconstruct radionuclide concentrations in the river.

Task members will document the conceptual model of the Columbia River system. The conceptual model will provide the basis for predicting concentrations of radionuclides in Columbia River water and sediments at specified locations where exposure occurs and estimating concentrations at times or other locations where information on dominant radionuclides is missing (dominant radionuclides are those that contribute significantly to dose). The literature review and interpretation of existing data will identify physical processes governing the transport and distribution of key radionuclides in the Columbia River and adjacent coastal areas. The conceptual model description will identify various physical processes and summarize their relative importance in determining the distribution of radionuclides in the river.

For Phase I of the project, task members will investigate the Columbia River from Priest Rapids Dam upstream of the Hanford Site to McNary Dam downstream (see previous Figure 2.3). The time period of 1964 through 1966 was selected for study of the surface-water pathway because during that time, monitoring data for the river were extensive and releases of water-transported radionuclides were considerably higher, compared with other time periods (see previous Figure 2.3). In addition, all reactors were shut down for approximately 50 days in 1966 as the result of a worker strike, which enabled scientists to study the rate of change of radionuclide concentrations in water, sediments, and fish in the Columbia River system.

For Phase I, task members will focus on reviewing existing reports and data prepared by members of the Environmental Transport, Environmental Monitoring Data, and Source Terms Tasks. These monitoring and source term data will be reviewed to determine whether they are sufficient to estimate exposure. Radionuclide concentrations in water and sediments will be estimated for locations where monitoring data are not available. Data from all locations will be provided to staff in the Environmental Pathways and Dose Estimates Task for dose estimation.

3.4.3.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- evaluated approaches for simulating radionuclide transport in the Columbia River
- reviewed and summarized existing literature pertaining to the transport and distribution of radioactivity in the Columbia River. Published data on radionuclide distribution in the river were integrated with hydrologic and sedimentological data and knowledge of the river processes to summarize the conceptual model of radionuclide transport in the Columbia River for the Phase I area and time periods.
- evaluated the measured radionuclide concentrations of river water and sediment at locations for which monitoring data exist to estimate the concentrations for use by members of the Environmental Pathways and Dose Estimates Task. Estimated concentrations included averages as well as ranges of variability for the various radionuclides monitored. The ranges of variability in the concentrations will be used to help analyze uncertainties in the dose estimate process.
- used information from members of the Demographics, Agriculture, Food Habits Task and the Environmental Pathways and Dose Estimates Tasks to identify locations where exposure to radionuclides in the river occurred, and estimate radionuclide concentrations for those areas not covered by monitoring data
- **Milestone 0403-A:** developed conceptual model of radionuclide transport in the Columbia River for Phase I - August 1989
- **Milestone 0403-B:** provided river water and sediment radionuclide concentrations at specific locations to the Environmental Pathways and Dose Estimate Task - August 1989.

3.4.3.3 Activities and Milestones Required to Complete Phase I Work

None.

3.4.3.4 Work Beyond Phase I

Task members will conduct analyses similar to those in Phase I for other time periods and reaches of the Columbia River system beyond McNary Dam. The conceptual model work will also be completed. Phase I results will provide guidance for selecting other time periods and optimizing the technical approach, such as selecting the most economic computational methods for the river analysis.

Selection of the river reaches downstream of McNary Dam and time periods other than 1964-1966 will be based on significance to the exposure pathway.

3.4.4 Ground-Water Transport (WBS 0404)

The objective of the Ground-Water Transport Subtask is to determine the contribution of radionuclides from ground water beneath the Hanford Site to doses people may have received off the Hanford Site. Ground water beneath the Hanford Site exists in both unconfined and confined aquifers. However, the unconfined aquifer has been affected more significantly by Hanford Site operations than have the underlying confined aquifers. Work will therefore focus on investigation of radionuclide transport in the unconfined aquifer discharging to the Columbia River and radionuclide transport in the surface-water pathway as it contributes to dose.

3.4.4.1 Approach

Task members will determine the potential contribution of radionuclides from Hanford ground water to doses that people off the Hanford Site may have received by evaluating ground-water monitoring data from the unconfined aquifer. Ground-water monitoring data are summarized in annual environmental monitoring reports and other documents. Information from these documents will be compiled to describe the movement of radionuclides from ground water under the Hanford Site to the Columbia River, which may have subsequently contributed to exposure to people. For Phase I, the potential for contribution of radionuclides to the Columbia River from the ground-water pathway during the period from 1964 to 1966 will be evaluated and reported.

3.4.4.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- reviewed ground-water monitoring data
- **Milestone 0404:** responded to TSP Directive 88-4, *Ground-Water Contamination Data* - March 1989.

3.4.4.3 Activities and Milestones Required to Complete Phase I Work

None.

3.4.4.4 Work Beyond Phase I

Activities in Phases II, III and IV will include the following:

- conduct a sensitivity analysis on the contribution of ground water to the Columbia River to evaluate the importance of the ground-water pathway
- evaluate ground-water flow and contaminant transport--depending on results of the review of ground-water monitoring literature and the sensitivity study--to estimate the contribution of radionuclides in the ground water to the river.

3.5 ENVIRONMENTAL MONITORING DATA (WBS 05)

Since Hanford Site operations began, radionuclide concentrations have been periodically measured in air, water, vegetation, fish, and other environmental media. Task members will assemble, evaluate, and summarize key historical measurements of the concentrations of radionuclides in the environment around the Hanford Site. With the assistance of members of the Statistics Task, staff will estimate sources of bias and uncertainty associated with the measurements. Proposed methods for attaining these objectives will be reviewed, evaluated, and approved by the TSP. The measurements will be used by members of the Environmental Transport Task and the Environmental Pathways and Dose Estimates Task to evaluate and/or supplement results of transport models and dose estimates.

3.5.1 Background

Since the start of Hanford Site operations, radiation and radioactivity measurements in the environment have been used to assess the performance of facilities and controls and to measure radionuclide concentrations in the environment at points where people might be exposed. During the period from 1945 through 1947, the monitoring program was evolving. Vegetation monitoring was emphasized. From current knowledge, food products, including milk, were not

routinely monitored during the early years of Hanford operations. Convenient, direct radionuclide-specific measurements were not yet possible. Types and amounts of specific radionuclides had to be identified by chemically isolating the radioactive element and/or measuring the rate of decay of the gross (alpha, beta or gamma) activity in the sample.

By 1964, the predominant dose pathway was not through vegetation but from the consumption of fish and drinking water from the Columbia River, and published material indicates that the doses were dramatically lower than in the 1940s. By this time, the environmental monitoring programs were comprehensive, well established, and well documented, and used direct methods (gamma energy spectroscopy) for measuring many radionuclides.

3.5.2 Terrestrial Data (WBS 0502)

The Phase I objective of this subtask is to obtain historical measurement data for concentrations of iodine-131 on vegetation for 1945^(a) through 1947 that can be used to evaluate preliminary modeling results of radionuclide deposition and transport through the air pathway.

3.5.2.1 Approach

Task members will search historical documents and records for information describing the environmental measurement programs, methods, and data. The information will be used to reconstruct the nature of the measurement program(s), methods used, and preliminary selected data sets. The data sets will be those identified by members of other tasks as being essential to meet their Phase I objectives.

In addition to identifying, inventorying and evaluating information, a major effort will be undertaken to develop preliminary estimates of potential or actual sources of bias and uncertainty in the measurements. Some quantitative data are available and calculations can be made to quantify some sources of bias and uncertainty, but subjective estimates may be necessary for others. Task members will conduct these evaluations and analyses with assistance from Statistics Task members as well as former or current Hanford employees previously involved in the monitoring programs.

(a) The earliest time for which historical data have been found.

3.5.2.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- compiled a database of more than 600 titles of historical records containing vegetation data
- extracted preliminary raw data on iodine concentrations in vegetation and provided the data to project staff to assist in scoping technical approaches
- evaluated of vegetation data and monitoring methods for 1945 through 1947, and complete internal peer review of estimates of biases
- provided selected data and a preliminary assessment of associated biases in vegetation data from 1945-1957 to members of the Environmental Transport Task
- **Milestone 0502:** determined concentrations of iodine-131 in vegetation for 1945 through 1947 with correction factors - July 1989.

3.5.2.3 Activities and Milestones Required to Complete Phase I Work

None.

3.5.2.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- refine estimates of biases and uncertainty for vegetation data for 1945 through 1957
- obtain and evaluate data for selected emissions episodes
- seek and evaluate data for selected vegetation and crop types.

3.5.3 River Data (WBS 0503)

The objective of this subtask is to obtain measurements of key radionuclides in Columbia River water and sediments for 1964 through 1966 for the Phase I study area that can be used to estimate preliminary doses and river pathway transport models.

3.5.3.1 Approach

Task members will use the same approach as that described in Section 3.5.2, Terrestrial Data.

3.5.3.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- completed a database of more than 800 documents containing river and sediment data
- completed evaluation of monitoring data on river water and sediment for 1964 through 1966
- **Milestone 0503-A:** prepared and provided to project staff a preliminary inventory of available monitoring data on radionuclide concentrations in river water and sediment for 1964 through 1966 - April 1989
- **Milestone 0503-B:** provided final monitoring data on river water and sediment for 1964 through 1966 to Environmental Transport Task members, with a preliminary assessment of biases and uncertainty associated with the data - August 1989.

3.5.3.3 Activities and Milestones Required to Complete Phase I Work

None.

3.5.3.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- update and issue an inventory of monitoring data
- refine estimates of biases and uncertainty for monitoring data for river water and sediment
- extend data collection and evaluation for the river pathway downstream to the estuary.

3.5.4 Fish Data (WBS 0504)

The primary objective of this subtask is to obtain measurements of key radionuclides in Columbia River fish flesh for 1964 through 1966 in the Phase I study region that can be used to estimate preliminary doses. A secondary objective is to provide a means for estimating radionuclide concentrations in fish at locations where such measurements are lacking.

3.5.4.1 Approach

Task members will use the same approach as that described in Section 3.5.2, Terrestrial Data. At locations where data on radionuclide concentrations in fish are unavailable, the ratio of radionuclide concentrations in fish to concentrations in water will be obtained from areas when both sets of data are available. These concentration ratios will then be applied to radionuclide concentrations in the river in areas where fish concentration data are unavailable.

3.5.4.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- completed a preliminary inventory of monitoring data on radionuclide concentrations in fish and other aquatic foods for 1945 through 1972 for use by project staff
- **Milestone 0504-A:** estimated radionuclide concentration ratios for fish flesh for the mid-1960s and provide results to members of the Environmental Pathways and Dose Estimates Task - July 1989
- **Milestone 0504-B:** provided fish flesh concentration data for 1964 through 1966 for members of the Environmental Pathways and Dose Estimates Task - July 1989.

3.5.4.3 Activities and Milestones Required to Complete Phase I Work

None.

3.5.4.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- extend data collection and evaluation for the river pathway from the mid-1960s to other time periods, to the river estuary and to additional fish species
- refine estimates of biases and uncertainties.

3.5.5 Air Data (WBS 0505)

The objective of this subtask is to obtain measurements of radioiodine in air for 1945 through 1947 and selected radionuclide emissions episodes that can be used to estimate doses and evaluate modeling results for radionuclide transport through the air pathway.

3.5.5.1 Approach

Task members will use the same approach as that described in Section 3.5.2, Terrestrial Data.

3.5.5.2 Activities and Milestones Accomplished to Date

Accomplishments to date include the following:

- provided preliminary raw data for 1944 through 1947 to members of the Statistics Task
- **Milestone 0505:** completed a draft preliminary inventory of air monitoring concentration and external radiation data for the period from 1945 through 1957 for use by project staff - February 1989.

3.5.5.3 Activities and Milestones Required to Complete Phase I Work

- Work on this task was postponed to later phases because the information will not be used during Phase I work.

3.5.5.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- update and provide inventory of key air monitoring data
- evaluate and summarize air monitoring data and selected episodes useful for model evaluation.

3.6 DEMOGRAPHICS, AGRICULTURE, FOOD HABITS (WBS 06)

Task members will develop the demographic, food consumption, and food production information needed to calculate dose estimates. Demographic information will be developed both for the general population and for several

special population groups, including Native American tribes, Army personnel stationed at Hanford, Hanford construction workers, and migrant workers.

In addition to demographic data, sources and quantities of food and water consumed must be estimated, because food and water provide a pathway for radionuclide intake. For example, milk from cows represents a significant food pathway for iodine-131 if the cows were fed vegetation contaminated with radionuclides. Task members will study dairy farming practices and milk distribution systems to provide the information needed to estimate doses from this pathway. Other foods may have been pathways for exposure to radioactive materials. Task members will estimate the sources and amounts of potentially contaminated food consumed by residents in the study area.

Treated Columbia River water was used as a drinking water source by some of the communities downstream from the Hanford Site. To estimate the doses from this exposure pathway, task members will identify the communities that used the water, characterize the water treatment and distribution system, and estimate the amount of water consumed. Irrigation water usage downstream from the Hanford Site will also be studied, because the radioactive materials in the river water could have been deposited on crops consumed by people or animals.

Methods to collect data and to estimate population densities and food consumption will be submitted to the TSP for review, evaluation, and approval.

3.6.1 Background

Demographic information must be developed to describe the study population in enough detail to enable staff members to identify population groups that may have been exposed. Although not all the demographic needs of the HEDR Project can be identified at this time, existing dose models suggest that, at a minimum, information on the age, sex, and race composition of the study population will be needed, as well as information on population density, migration patterns, and residential location. Other demographic parameters, such as income level and occupation, may also be important because they are closely associated with lifestyle and food consumption. To provide such detailed demographic information requires accurate estimates of county populations and information on residential locations within counties.

Task members have determined that national survey data is the only relevant available information for estimating individual food intake for the Phase I study period. Other data sources will be used to adjust these estimates to better fit the population in the study area during the period of interest. In Phase II, a survey of local residents may be conducted to identify significant lifestyle patterns that have influenced individual food intake. A key activity is reconstructing the milk production and distribution system for the study area because consumption of milk from cows that have eaten contaminated vegetation is the dominant pathway by which radioactive iodine enters the human body.

Native Americans tribes are being studied as special population groups because some tribal members may have had very different diets and lifestyles from the general population, which may affect their dose estimates. In addition, accurate population estimates will require data available from the Bureau of Indian Affairs, the Indian Health Service, and the tribal governments because accurate U.S. Census data are unavailable for Native Americans.

Task members will focus work initially on the eight Native American reservations located in the Columbia Plateau region of Washington, Oregon, and Idaho: Coeur d'Alene, Colville, Kalispel, Nez Perce, Spokane, Umatilla, Warm Springs, and Yakima.

3.6.2 General Population Data (WBS 0602)

The objective of the General Population Data Subtask is to estimate total population counts for all counties and county subdivisions in the study area. Population estimates will be broken down by sex, race, and age and will be provided to staff in the Environmental Pathways and Dose Estimates Task for estimation of doses to various population groups. Population data will be analyzed to develop other demographic information needed for the dose estimates.

3.6.2.1 Approach

County populations will be estimated using the ratio-correlation, component II, and vital rates estimation techniques. Subcounty populations will be estimated by using a censal-ratio technique in which the ratio of subdivision population to county population is interpolated for the appropriate census year.

3.6.2.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- completed preliminary county population estimates using the component II and vital rates techniques
- obtained external review of population estimates
- collected birth, death, and symptomatic population indicator data for all counties in the Phase I study area
- developed age and sex detail for sub-county areas
- **Milestone 0602-A:** developed demographic information for 1944-1947 and 1964-1966 broken down by age, sex, and census subdivision - August 1989
- **Milestone 0602-B:** developed lifestyle information for each subpopulation by age, urbanization, time spent outdoors vs. indoors - September 1989
- **Milestone 0602-C:** census district boundaries plotted on map - May 1989.

3.6.2.3 Activities and Milestones Required to Complete Phase I Work

None.

3.6.2.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- develop population estimates for time periods and areas included in each phase
- collect demographic information on construction workers, military personnel, and migrant farm workers.

3.6.3 Food Consumption (WBS 0603)

The objective of the Food Consumption Subtask is to estimate the food intake by various population groups in the study area and time periods of study. This information will be provided to staff in the Environmental Pathways and Dose Estimates Task and the Statistic Tasks for estimation of doses to individuals and their associated uncertainties.

3.6.3.1 Approach

In Phase I, task members will use 1977-1978 food consumption survey data collected by the U.S. Department of Agriculture (USDA) to develop estimates of the mean and variance of the distributions of daily food intake in ten food groups for individuals based on their age, sex, and urban/rural status. Correlation coefficients with other foods within each group will also be determined. In addition, in cases where seasonal differences in food consumption appear to be significant, the mean food intake will also be estimated on a seasonal basis for selected foods, such as leafy vegetables and fruit. Time series data will then be used to adjust these intake estimates backwards in time to the period of interest. These parameter estimates will be provided to staff in the Environmental Pathways and Dose Estimates Task and the Statistics Task for estimation of doses to individuals and the uncertainties associated with those doses. In addition, existing Battelle studies on dietary habits of local residents surrounding the Hanford Site in the 1960s and 1970s are being assessed to determine their usefulness to the project. Other sources of data will be investigated for specific food types (e.g., infant milk consumption rates) if determined necessary.

3.6.3.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- identified and reviewed local and national data sources for estimating individual food intake
- conducted a preliminary food categorization process using the 1966-67 Food Consumption Surveys (FCSs) published by the USDA
- estimated individual food intake for selected aggregate food groups for a number of different age and sex groups using the 1966-67 FCS
- identified and reviewed alternative methods for estimating the parameters of individual food intake distributions
- proposed the methods identified above to the TSP and received feedback
- identified population groups into which the Phase I food intake estimates would be divided
- developed an approach for efficiently processing and calculating the means, variances, and correlations of the food intake estimates for the very large number of observations contained in the 1977-78 FCS

- processed the 1977-78 data on a high-speed mini-supercomputer
- recoded the 1977-78 FCS food codes into 10 aggregate food categories
- generated information about the food intake distributions for each food and population group
- selected the appropriate regional and seasonal delineation for the intake estimates
- estimated the mean daily food intake, the variance of daily food intake and the correlation coefficients between food intakes for each population group
- used historical time series data on aggregate food intake to adjust the estimates of mean daily intake back in time, as required
- distributed these adjusted estimates of mean food intake and associated information about the variability in daily food intake to members of the Environmental Pathways and Dose Estimates and Statistics Tasks
- **Milestone 0603-A:** developed food consumption parameters for the years 1944-1947 for each age, sex, and urbanization category - August 1989
- **Milestone 0603-B:** developed food consumption parameters for 1964-1966 for each age, sex, and urbanization category - August 1989.

3.6.3.3 Activities and Milestone Required to Complete Phase I Work

None.

3.6.3.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- work with the CDC to develop their recall survey to improve food consumption estimates
- use lifestyle information to modify estimates of individual food intake from Phase I.

3.6.4 Agricultural Research (WBS 0604)

The objective of the Agricultural Research Subtask is to identify and develop information on the production and distribution of agricultural products in the HEDR study area, especially for milk. Information will be gathered on the type and amount of feed consumed by milk cows, the geographical location and production

quantity of the various milk producers, the areas to which each producer supplied milk, and the time lags between deposition and human consumption.

3.6.4.1 Approach

Key contacts will be identified for each of the milk-processing plants operating in the study area. By interviewing processing plant operators, task members will identify the specific locations of the producers supplying each of the plants. Initial information on lag times and marketing will be gathered through focus groups, and will be refined through the use of surveys. Preliminary information on dairy cow feeding practices will be gathered by analyzing existing data from the Dairy Herd Improvement Association and by interviewing milk industry experts. Milk producer surveys will be used to refine the preliminary information.

For information on non-milk food production and distribution, secondary data sources will be used to produce preliminary estimates. These data will later be supplemented with information obtained in a workshop with local agricultural experts.

3.6.4.2 Activities and Milestone Completed to Date

Accomplishments to date include the following:

- began an ongoing search for milk processing plant operators in January 1988 to collect information on processing and milk distribution
- began an ongoing literature search in January 1988 to compile available data on location of dairy herds, and dairy feeding practices
- held a workshop on November 30, 1988, for milk industry experts to identify information sources and to verify preliminary information gathered through individual interviews
- entered information in the computer data base, collected through individual interviews, on the locations of dairy producers in the study area
- produced maps of dairy herd locations.
- estimated the market share for each of the processing plants in the study area, using expert judgement
- gathered specific information, using expert judgement, on dairy cow feed intake and management practices

- **Milestone 0604-A:** developed food production and distribution information for the years 1944-1947 for each census sub-division - August 1989
- **Milestone 0604-B:** developed milk production and distribution information for the years 1944-1947 for each census sub-division - August 1989
- **Milestone 0604-C:** developed demographic information for 1964-1966 for river recreation and drinking river water for subgroups - August 1989
- **Milestone 0604-D:** identified locations and quantity of irrigation water withdrawals - August 1989.

3.6.4.3 Activities and Milestones Required to Complete Phase I Work

None.

3.6.4.4 Work Beyond Phase I

Similar activities as those described for Phase I will be carried out for additional agricultural areas once the geographic boundaries for subsequent phases have been determined. Models of milk production and distribution will be refined by collecting information on feeding and production practices from dairy farmers. The milk production and distribution model will be expanded to cover the geographic areas and time periods included in other phases. A non-milk, food production and distribution workshop will be held with local agricultural experts to estimate where food consumed in the study area was produced and processed.

3.6.5 Native American Population, Food Consumption, and Lifestyles (WBS 0605)

Task members will identify and develop information on population, food consumption, and lifestyle of Indian tribes whose members may have been exposed to radioactive materials emitted from Hanford Site operations. This information will be provided to members of the Environmental Pathways and Dose Estimates Task for estimating doses to Native Americans.

3.6.5.1 Approach

Lifestyle, food consumption, and population information for tribal members will be developed through cooperative research agreements with each tribal

government. Contracts are being negotiated to reimburse tribal members for collecting the data needed for the Phase I estimates. Additional contracts will be negotiated as necessary for work in subsequent phases.

The results of these estimates will be provided to members of the Environmental Pathways and Dose Estimates Task for use in developing Phase I dose calculations. Dose estimates will be developed for Native Americans when the data developed by the tribes are made available.

3.6.5.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- completed literature search in FY 88 on Native American food consumption and lifestyles
- met informally with tribal council members and technical staff of the Yakima, Umatilla, and Nez Perce tribes to familiarize them with the project
- held formal meeting/workshop with tribal representatives and tribal technical staff to gather background data and make informal contacts with tribal members
- attended the Northwest Conference on Cultural Preservation at Silverdale, Washington to meet with cultural representatives of the Coeur d'Alene, Colville, and Warm Springs reservations
- initiated studies on Native Americans to better understand which traditional food items may be important pathways
- initiated negotiations with eight tribal governments to establish contracts that can be used to reimburse the tribes for data collection efforts in support of the project
- **Milestone 0605-A:** developed preliminary description of traditional diet for Native Americans, air pathway using published information- May 1989
- **Milestone 0605-B:** developed preliminary description of traditional diet for native Americans, river pathway using published information - June 1989.

3.6.5.3 Activities and Milestones Required to Complete Phase I Work

None.

3.6.5.4 Work Beyond Phase I

Contracts and statements of work will continue to be developed with tribal governments for data collection. Final diet estimates will be developed with tribal input. Data provided by the tribes will be used to estimate Native American migration into the area near Hanford, population estimates by lifestyle groups and food consumption by age and sex.

The results of Phase I research will determine the type of data that must be gathered for additional research. This may involve extending the work to include other reservations or collecting more detailed data on some of the tribes involved in Phase I work.

3.6.6 Methods for Presenting HEDR Results to the Public (WBS 0606)

The objective of this subtask is to review and evaluate methods that can be used to communicate the results of the HEDR project to the public, in response to TSP Directive 89.7.

3.6.6.1 Approach

The following activities will be performed to achieve the objectives of this subtask:

Describing Technical Results. An internal working meeting will be held to develop a description of the technical results of the HEDR Project. This meeting will be attended by staff from the Statistics and Dose Estimates Tasks as well as the staff working on this subtask. The types of results that will be developed in the project, the form of these results, and the interpretation of the results will be described in the working meeting.

Literature Review. A literature review will be conducted to identify alternative presentation methods applicable to HEDR. The types of literature that will be examined include risk communication; public involvement in decision making; risk perception; and previous surveys of public knowledge and attitudes about radiation, nuclear power and Hanford. Literature of potential use to the project will be categorized and summarized for use in the remainder of the work.

Defining Communications Objectives. The objectives of the HEDR communication process will be identified and documented. This activity will

characterize what the project needs/wants to accomplish through its communication program. This activity will require involvement/participation of the TSP.

Audience Analysis. An audience analysis will be performed. Groups that are potential users of the information being developed in the HEDR Project will be identified. These groups will be characterized by state of knowledge, concerns/interest in the results, preconceived notions about the results, and other characteristics related to communication of results. This will enable the project to understand the concerns/ needs of each group and develop communications materials and techniques tailored to the concerns and needs of each group.

Media Analysis. A media analysis will be conducted using the press clippings to date from the project. The analysis will be used to evaluate communications mechanisms that have been used in the past in HEDR project staff and to help identify public concerns, interested groups, existing attitudes and information needs. The results of this analysis will be used in the audience analysis and in developing mechanisms for effective interactions with the media.

Role of the Media. Recommendations will be developed for dealing with the media effectively. To assist in developing this recommendation, the special needs of the media will be defined and mechanisms that have been used successfully in the past to interact with the media will be described. As part of this effort, project staff may interact directly with members of the media likely to cover HEDR activities.

Evaluating Methods and Developing Recommendations Communication methods potentially applicable to the project will be evaluated. The evaluation will be based on the communications objectives, the audience analysis and the literature review. Techniques such as focus groups may be used to test the effectiveness of some of the more promising methods. The evaluation will form the basis for recommending communications strategies and methods to the TSP for use in the project. It is expected that the recommendation will include use of feedback mechanisms such as focus groups, interviews with people attending meetings, and surveys of users of information. These feedback mechanisms will be used to continuously evaluate the effectiveness of the communication program.

This will allow the TSP and project staff to make continuous adjustments in the communications activities so they continue to meet the needs of the project and public.

Implementing Approach. After communications recommendations have been reviewed by the TSP and revised as necessary to incorporate their input, they will be implemented.

3.6.6.2 Activities Completed to Date

Accomplishments to date include the following:

- developed description of technical results
- developed a preliminary audience analysis
- completed literature review
- presented preliminary information to the TSP
- provided TSP members with a speaker packet including basic guidelines, viewgraphs, audience analysis, sample questions audiences may ask, and an audience feedback form.

3.6.6.3 Activities Required to Complete Phase I Work

- complete media analysis
- analyze completed audience feedback forms to refine communication methods
- make recommendations to the TSP on methods of communicating Phase I work to the public.
- work with the TSP to communicate Phase I work to the public.

3.7 ENVIRONMENTAL PATHWAYS AND DOSE ESTIMATES (WBS 07)

Task members will use calculated and measured concentrations of radionuclides provided by members of the Environmental Transport and Environmental Monitoring Data Tasks to calculate doses to populations, typical individuals, and specific individuals. These calculations will account for direct transfer of radionuclides from air and water to people (via pathways such as breathing, drinking, and immersion) as well as indirect transfer from air and water through environmental pathways such as soil, plants, animals, and fish to people. All significant decisions on exposure models and input parameters will be presented to the TSP for review, evaluation, and approval.

3.7.1 Model Evaluation (WBS 0702)

The objective of this subtask is to select several computer models and couple them to calculate the transport of radionuclides through environmental pathways to humans, resulting in radiation dose estimates.

3.7.1.1 Approach

The model selection process and resulting recommendations will be documented and submitted to the TSP for review. The models for which members of this task are responsible are described in the following sections.

- **Soil model**, including atmospheric and irrigation deposition, leaching, harvest removal, and local resuspension
- **Drinking water model**, including water treatment plant cleanup factors
- **Aquatic foods model**, including river and marine fish, crustacea, mollusca, and plants, and anadromous fish. Task members are defining transfer factors from water to aquatic food, and will ultimately generate an extensive tabulation supported by the ranges of selected parameters and detailed explanations of the parameters.
- **Vegetation model**, including interception from air and irrigation, growing period, rooting depths, weathering, translocation, and splash-up

components. HEDR staff are reviewing the literature on soil-to-plant concentration ratios, and will ultimately generate an extensive tabulation supported by a detailed explanation of the selection of parameters and of the ranges of the parameters. Interception models are being evaluated concurrently.

- **Animal product model**, including milk, meat, and eggs from both domestic and wild animals. This model will account for the possibility that feed came from multiple sources. HEDR staff are currently defining feed-to-animal-product transfer factors, and will ultimately generate an extensive tabulation, supported by a detailed explanation of the selection and ranges of parameters.
- **External exposure model**, including air submersion, water immersion, and direct radiation from soils, sediments, and building surfaces. The potential for dose reduction by shielding from structures will be incorporated.
- **Inhalation dose model**, including considerations of radionuclide chemistry and particle size. Task members are currently using the model developed by the International Commission on Radiological Protection (ICRP) Task Group on Lung Dynamics and tracking the development of a new lung model by the ICRP. The new model will be adopted should it become available.
- **Ingestion dose model**, including considerations of radionuclide chemical form. The model will be selected from appropriate models in existing Hanford technology, the PATHWAY model, developed by the Offsite Radiation Exposure Review Project^(a), and additional sources.

Other models of individual and population exposure must be coordinated with members of the Demographics, Agriculture, Food Habits Task. Appropriate mathematical formulations for each of these models will be selected and proposed to the TSP review, evaluation, and approval.

3.7.1.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- **Milestone 0702-C:** provided a deposition-to-milk-concentration model - April 1989
- **Milestone 0702-A:** created an aquatic foods (fish) model - May 1989.

(a) The Offsite Radiation Exposure Review Project was established in 1980 to reconstruct radiation doses people may have received from nuclear testing at the Nevada Test Site.

- **Milestone 0702-B:** selected and prepared a soil-to-plant model - August 1989
- **Milestone 0702-D:** documented selection of models for environmental pathways - September 1989.

3.7.1.3 Activities and Milestones Required to Complete Phase I Work

None.

3.7.1.4 Work Beyond Phase I

Most task activities initiated in Phase I will be continued throughout subsequent phases of the project, being modified as needed to meet the objectives of each phase.

3.7.2 Geographic Information Systems Evaluation

The objective of the Geographic Information Systems Evaluation Subtask is to obtain or develop computer codes implementing the selected models. The codes must interface with outputs of the codes used in the Environmental Transport Task, as well as the data generated in the Environmental Monitoring Data Task. Output from these models must be displayed in a way that allows the results to be easily interpreted by the analysts, the TSP, and the public. Design and implementation of the selected models will require coordination of all of the data-generating tasks, including the Statistics Task.

3.7.2.1 Approach

All models will be designed to use available measured data directly. The models will extrapolate to extend the measurements in space and time, which will maximize the use of measured data and not totally replace measured data with calculated results. All computer code modules implementing the models will be verified in accordance with quality assurance procedures for project software.

3.7.2.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- coordinated integration of models and data base structure
- coordinated integration of models and sensitivity analysis techniques

- **Milestone 0703-A:** recommended computer system requirements - March 1989
- **Milestone 0703-B:** recommended Geographic Information System/data base system - September 1989.

3.7.2.3 Activities and Milestones Required to Complete Phase I Work

None.

3.7.2.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- incorporate Phase I recommendations into complete computer system for use by all tasks.

3.7.3 Bioassay Data Investigation (WBS 0704)

The objective of the Bioassay Data Investigation Subtask is to review dose measurements of Hanford workers and residents for possible application to the project.

3.7.3.1 Approach

Certain historical measurements of dose to Hanford workers and residents of the Hanford surroundings will be compiled and investigated to determine whether they can be used in the project. Examples of historical measurements include the thyroids of selected Hanford workers that were monitored for iodine-131 content during the early years of Hanford operation, and whole-body-counts of Richland schoolchildren in the early 1960s. Historical measurements could provide a means to bound results of certain dose estimates. For example, if milk consumption information can be developed for at least some of the workers whose thyroids were measured for iodine-131, and if the origin of the milk (grocery store vs. backyard cow) can be traced, the thyroid measurements could be an important indicator of doses received by at least a subset of the Tri-Cities population.

3.7.3.2 Activities and Milestones Completed to Date

- **Milestone 0704-A:** initially recover and tabulate applicable measurements - August 1989.

3.7.3.3 Activities and Milestones Required to Complete Phase I

None.

3.7.3.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- investigate potential uses of bioassay data.

3.7.4 Transfer Factor Development (WBS 0705)

The objective of this subtask is to develop factors to account for the transfer of radionuclides from one portion of the environment to the other.

3.7.4.1 Approach

The models to be used are generally accepted in the environmental assessment community. The most important parts of many of the models are the factors used to account for the transfer of radionuclides from one portion of the environment to another, for example soil-to-plant uptake factors. A literature review is being conducted to identify reported factors and a system is being developed for the selection of preferred values. All factors chosen for use in the project will be traceable and documented.

3.7.4.2 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- reviewed literature to identify sources of data and ranges of reported values
- established a data base of all identified reported values
- developed a system for the selection of preferred values
- **Milestone 0705-A:** identified fish types and fish uptake factors to develop Columbia-River-specific concentration ratio - March 1989
- **Milestone 0705-B:** developed soil-to-plant transfer factors for agricultural products - May 1989
- **Milestone 0705-C:** developed milk transfer factors as a function of important variables - April 1989.

3.7.4.3 Activities and Milestones Required to Complete Phase I Work

Task members will document distributions for the transfer factors and the rationale for their selection.

3.7.4.4 Work Beyond Phase I

Activities in Phases II, III, and IV will be defined based on the results of the previous phase.

3.7.5 Preliminary Dose Estimates (WBS 0706)

The objective of the Preliminary Dose Estimates Subtask is to calculate the dose estimates to populations. The types of doses calculated include doses to individual organs, in terms of both dose in grays (rad) and dose equivalent in sieverts (rem).^(a) Annual dose rates as well as committed doses will be calculated as will effective dose equivalent (organ doses weighted and summed by the technique of the ICRP).

3.7.5.1 Approach

Age-dependent lifestyle, intake, and dose conversion parameters will be used in calculating doses. All final calculations will be done stochastically (i.e., probabilistically). All final dose results will be reported either in terms of a range of potential doses--with an assessment of the probability that specific doses within the range could have occurred--or as a geometric mean and a geometric standard deviation or in a similar statistical format, depending on the audience and the nature of the result. Several options for presenting the results, and a recommended option, will be submitted to the TSP as a preliminary response to Directive 89-7 in Appendix A. Implementation of the techniques necessary to do this will be developed in conjunction with members of the Statistics Task.

3.7.5.2 Activities and Milestones Completed to Date

None yet.

(a) 1 gray = 100 rad; 1 sievert = 100 rem.

3.7.5.3 Activities and Milestones Required to Complete Phase I Work

The following activities will be completed as part of Phase I:

- **Milestone 0706-A:** calculate inhalation doses, vegetation concentrations, fallout dose rates.
- **Milestone 0706-B:** calculate 1944 - 1947 inhalation doses
- **Milestone 0706-C:** calculate 1944 - 1947 food product (non-milk) consumption doses
- **Milestone 0706-D:** calculate 1944 - 1947 milk ingestion doses
- **Milestone 0706-E:** calculate 1944 - 1947 external doses
- **Milestone 0706-F:** calculate 1964 - 1966 doses from Columbia River pathways.

3.7.5.4 Work Beyond Phase I

Task members will develop dose calculations as required for areas and times defined in later project phases.

3.8 INFORMATION RESOURCES (WBS 08)

Information Resources Task Members work with other task members to meet information needs, including ensuring that all data referenced in project reports are publicly available and establishing a microcomputer-based system for ready retrieval of historical information.

3.8.1 Background

Historical documents about the Hanford Site that are pertinent to dose reconstruction will be identified, collected, reviewed, and made available to appropriate task leaders. Arrangements will be made for review for declassification of pertinent information on a case-by-case basis.

A microcomputer text-based tracking system contains a core collection of documents related to Hanford Site environmental issues. These documents are now publicly available or have been in the public domain since their original issuance. As additional documents of potential interest or use are identified, they are directed to appropriate task members and incorporated in the tracking system.

3.8.2 Task Objective and Approach

The objective of the Information Resources Task is to identify, collect, and organize document literature necessary to meet project information needs. Title listings and/or copies of Hanford-Site originated documents of potential interest or use will be available in the DOE Public Reading Room in the Federal Building in Richland, Washington. All references in project reports will be publicly available.

Documents of potential interest or use will be identified using available subject indices. To the extent possible, Hanford Site documents identified by task members' data bases will be verified to ensure their inclusion in the tracking system. Throughout the study, Information Resources Task members will be available to assist other task members in collection of specific information not previously identified.

3.8.3 Activities Completed to Date

Accomplishments to date include the following:

- placed several listings of Hanford-Site originated document titles of potential interest or use in the DOE Public Reading Room
- declassified approximately 200 Hanford Site documents of potential interest or use since January 1988
- analyzed the 39,000 pages of "core documents" in the tracking system to identify their makeup in terms of availability, their classification at origination, their classification prior to 1984, and their public availability.
- made available, in the DOE Public Reading Room in Richland, Washington, copies of all Hanford-Site originated, unclassified documents identified as of potential interest or use to the project (ongoing activity)
- identified and collected documents addressing iodine-131 emissions and their impact on the environment from 1944 through 1947 (ongoing)
- identified and collected documents addressing radioactive effluents released to the Columbia River from 1964 through 1966.

3.8.4 Activities Required to Complete Phase I Work

None.

3.8.5 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- expand information needs as warranted by specific task requirements
- continue declassifications on a case-by-case basis
- continue to ensure that all references in project records are publicly available.
- continue to make publicly available documents of potential interest or use to the HEDR Project.

3.9 RECORDS MANAGEMENT (WBS 09)

Records Management Task members provide storage and control for completed project records and maintain an automated inventory of project documentation.

Through the records management task, project records are organized and managed in accordance with approved PNL procedures, including ensuring that the records meet legal, regulatory, and QA requirements. Records Management Task members provide technical assistance, training, personnel, facilities, and services to ensure that these objectives are met.

3.9.1 Background

A project record is defined as any document such as paper, microfilm, computer tape or disk, audio or video tape, photograph or map created during or referenced by the project. A record is considered complete if it will receive no more

entries, requires a reissue for revision, and is signed and dated by the originator or other authorized person.

3.9.2 Task Objectives and Approach

Objectives. The objectives of the Records Management Task are to review project records for accuracy and compliance to approved records management procedures, provide storage for completed project records, and transmit approved records to the DOE Public Reading Room. Records Management Task members also provide training and technical assistance to project staff, and review records management procedures for revisions.

Approach. Records are accumulated at the project management level and are organized under a uniform file index system. The indexing system conforms to the Battelle Standard Filing System for research records. In addition, records management practices conform to special QA requirements for QA Level II research projects as interpreted by PNL's quality assurance program.

Project records are transferred to a central records repository in the PNL Records Center, where they are inspected to verify that they meet QA requirements for a completed record. Data from each document and its accompanying cover sheet are entered into a personal computer system network. The data base consists of at least the following items for each record:

- document title
- document date
- name of author(s)
- number of pages
- file classification/index number
- project and task number
- location code
- HEDR project document number.

As each transmittal of records is processed at the PNL Records Center, it is entered into a data base file for all project records and a computer listing of the records is produced. The computer list is verified against the transmittal to assure that all

documents are accounted for. A copy of the computer listing and the signed transmittal are returned to the project office as a receipt. The project records are then organized for storage by project/task number and in file classification order.

Copies of project technical reports that have been approved by the TSP and documents referenced in these technical reports are transmitted to the Public Reading Room located in the Richland Federal Building. All transmittals to the Public Reading Room are accompanied by a detailed file inventory describing each document on the transmittal. In addition, the Public Reading Room is provided with a cumulative history of all project documents transmitted to date.

3.9.3 Activities Completed to Date

Accomplishments to date include the following:

- completed records management procedures
- presented records management workshop to task leaders
- completed a feasibility study for the purchase of an optical disk system
- received and processed project documents
- transmitted documents to the DOE Public Reading Room in Richland, Washington.

3.9.4 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- continue to process incoming project records
- continue to transfer documents to the DOE Public Reading Room.

3.10 QUALITY ASSURANCE (WBS 10)

Quality Assurance (QA) Task members assist project staff to ensure that the project meets all QA requirements established by PNL.

3.10.1 Background

PNL's QA Program is based on ANSI/ASME NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*, as it is applicable to the research and development services performed by PNL. This QA program provides for conducting activities in a planned and controlled manner and verifying the quality of end results. The QA requirements applicable to Phase I have been identified in a QA plan, OHE-3, which is included as Appendix B.

Quality assurance is recognized at PNL as an interdisciplinary function involving all the organizational components. The project manager has the overall responsibility for implementation of the QA requirements identified in the QA plan. Project staff are responsible for meeting the requirements applicable to their individual contributions to the project. A quality engineer, who reports to the Quality Assurance Department, is assigned to support the HEDR Project in assisting project staff in implementing the QA program requirements.

3.10.2 Task Objectives and Approach

The objectives of the Quality Assurance Task are to ensure continuous QA support and coordination with all project tasks. The quality engineer assigned to the project will provide QA program implementation support.

Activities include

- participating in the development of project QA planning
- providing quality engineering assistance to project staff in areas of procedure implementation guidance/interpretation, resolving QA problems, QA training, document reviews, and processing deficiencies
- performing quality verification activities (surveillance) to assure control of activities and compliance with QA program requirements throughout the duration of the project.

3.10.3 Activities Completed to Date

Accomplishments to date include the following:

- identified software control requirements needed to verify correct entry of data into applicable data bases

- assisted in developing the following HEDR-specific procedures:

HEDR-TP-1, *Documentation of Primary Data Collection* - methods for documenting field contacts, key informant interviews, and field surveys

HEDR-TP-2, *HEDR Indoctrination and Training* - methods for planning, performing and documenting training

HEDR-TP-3, *HEDR Documentation of Critical Decisions* - methods for documenting critical decisions of key project activities

HEDR-TP-4, *HEDR Data Quality Objectives* - methods for determining what and how data quality objectives are to be described in planning documents

HEDR-TP-5, *HEDR Peer Review* - methods for performing and documenting peer reviews

- assisted in determining required training for all HEDR staff and in updating the training documentation.
- performed surveillance in the following areas:
 - computer model verification and application of data
 - verification of data entered into computer data base
 - hand calculations used to support computer model applications
 - project records control requirements

3.10.4 Activities Required to Complete Phase I Work

The following activities will be completed as part of Phase I:

- conduct an internal audit of Phase I work
- review results in the Phase I summary report results to ensure that results are traceable to the raw data and that the work was performed in accordance with applicable QA requirements.

3.10.5 Work Beyond Phase I

Similar QA activities as those described for Phase I will be performed for Phases II, III, and IV. Any additional QA activities beyond those described here will be based on the nature of the work performed by members of other tasks.

3.11 STATISTICS (WBS 11)

Statistics Task members work with members of other tasks to assess the uncertainty of estimated doses to populations, reference individuals, and specific individuals that may have resulted from radionuclide emissions from Hanford operations. Methods for attaining this objective will be submitted to the TSP for review, evaluation, and approval.

3.11.1 Background

Estimated doses will be obtained using a mathematical model that is being developed by members of the Environmental Pathways and Dose Estimates Task to describe the transport of Hanford Site radionuclide emissions to the environment and humans. Dose estimates will be calculated as distributions to reflect uncertainties in input parameters, transfer factors, and dose conversion factors.

3.11.2 Task Objectives and Approach

The goal of the Statistics Task is to assess the magnitude of the uncertainties associated with dose estimates and to help develop methods for effectively communicating that information to various audiences. During Phase I, the primary objectives of the statistics task are to

- estimate uncertainties of dose estimates for a selected set of lifestyles and radionuclides for the period of 1945 through 1947 (air pathway) and for 1964 through 1966 (water pathway)
- evaluate the "art of the possible" for estimating uncertainties in dose estimates for the several thousand lifestyle/location/ time/radionuclide scenarios for which doses will be estimated
- help develop methods for effectively communicating dose estimates and their uncertainties to scientists and the public.

Statistics Task members will work closely with other HEDR scientists to develop a strategy for conducting sensitivity/uncertainty analyses, and then to

apply this strategy to the Phase I dose model for several selected scenarios that apply to the Phase I study area. The selected scenarios will cover the range from expected relatively low doses to relatively high ones. This approach will generate two key outputs: 1) initial estimates of uncertainties in estimated doses for important (higher-dose) cases, and 2) additional information for identifying methods for assessing uncertainties for the thousands of lifestyle/location/time/radionuclide scenarios for which doses are expected to be low and for which complete sensitivity/uncertainty analyses are neither essential nor practical.

3.11.3 Activities Completed to Date

Accomplishments to date include the following:

- developed and documented the strategy for assessing the uncertainty in Phase I dose estimates
- organized and held a sensitivity/uncertainty analysis workshop in Pasco, Washington, January 16-18, 1989, and prepared a summary report of the workshop
- evaluated the potential for using Monte Carlo Latin hypercube sampling to assess uncertainties. This method will be used to assess the uncertainty in two types of estimated doses: 1) iodine-131 doses to the thyroid of infants living in Pasco in 1946 and 2) phosphorus-32 doses to fishermen eating whitefish from the Columbia River in 1965.
- reviewed published methods for conducting sensitivity/uncertainty analyses
- prepared responses to TSP Directive 89-5, Items 1, 2, 4, and 5 to address the following issues:
 - determining the "art of the possible" concerning the quality of dose estimates that can be achieved
 - describing the uncertainty of model parameters
 - evaluating alternative approaches to sensitivity/uncertainty analysis
 - evaluating, ranking, and minimizing the set of models and parameters that can be supported by available knowledge and data
- attended meetings of the National Cancer Institute Task Group on Exposure of American People to Iodine-131 from Nevada Test Site Fallout to obtain information on uncertainty methods applicable to the HEDR Project

- worked with members of the Environmental Pathways and Dose Estimates Task to begin developing a strategy for conducting sensitivity/uncertainty analyses for Phase I and to develop a computer code to compliment the strategy
- developed plans for assessing uncertainties in multiplicative factors being developed by members of the Environmental Monitoring Task for correcting iodine-131 measurements of vegetation samples collected during 1945 through 1947
- prepared a memo report addressing data quality objectives for the project
- worked with HEDR scientists to develop uncertainties for model parameters such as average vegetation concentrations, diets, life-styles, and dose factors
- helped members of the Demographic, Agriculture, Food Habits Task develop preliminary sampling plans for surveying households in the study area to obtain information about lifestyles and diets of the general population (for work in future project phases, it is necessary).

3.11.4 Activities Required to Complete Phase I Work

The following activities will be completed as part of Phase I:

- work with HEDR staff in the Demographics, Agriculture, Food Habits Task to develop recommendations to the TSP for communicating the dose estimates and their uncertainties to scientists and the public
- ensure that appropriate statistical methods were used in the analysis of data reported in the Phase I summary report.

3.11.5 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- conduct sensitivity/uncertainty analyses for selected scenarios to determine whether the multiplicative lognormal analytical method of assessing uncertainties can be used for locations and scenarios in which the Monte Carlo method is not used
- revise, if necessary, the strategy for assessing uncertainties in dose estimates
- conduct additional sensitivity/uncertainty analyses to develop improved methods for the project
- help develop household survey sampling plans to obtain information on diets and lifestyles

- conduct additional statistical analyses of radionuclide measurements for vegetation, air, water, and fish to develop improved estimates of uncertainties of average concentrations for use in sensitivity/uncertainty analyses
- assist with developing model validation strategies and rationale
- work with members of other tasks to write papers for publication in leading scientific journals that describe the methods and results for uncertainty analyses for doses.

3.12 PROJECT TECHNICAL COORDINATION (WBS 12)

Task members provide technical guidance for members of other technical tasks. This role involves developing and maintaining conceptual models of the entire dose reconstruction process, conducting sensitivity analyses of input data such as assumptions and parameters, selecting key radionuclides for study, identifying pathways by which people may have been exposed to radionuclides, identifying potentially exposed populations for which to estimate doses, and providing guidance for expanding the study area in Phases II through IV. Methods and significant decisions will be submitted to the TSP for review, evaluation, and approval.

3.12.1 Background

Information generated by each of the technical tasks is funneled into the Environmental Pathways and Dose Estimates Task for calculating the final "product," radiation doses to populations. The leader of the Environmental Pathways and Dose Estimates Task provides a separate, technical coordination function to guide technical decisions so that all task members are working within the same limits and generating the proper information needed for the computer models that are used to calculate the ultimate doses. The TSP reviews and approves technical decisions by which technical staff are guided.

3.12.2 Task Objective and Approach

The objective of the Project Technical Coordination Task is to provide a general technical overview of the project to ensure that appropriate information is generated for performing the final dose calculations.

3.12.2.1 Conceptual Models/Influence Diagrams

Task members have developed and documented a general conceptual model of the entire dose reconstruction process, from source term calculation through dose calculation. The diagram in previous Figure 2.1 shows interactions of the various models used throughout the project and the parameters necessary to implement them. This diagram will be updated regularly as models are selected and parameter definitions are refined.

3.12.2.2 Initial Sensitivity Analyses

Researchers will perform sensitivity analyses of the various assumptions, model inputs, and potential transport modes. These studies will help to identify critical population groups, data limitations and model needs, and data gaps.

Initial sensitivity studies will be performed using several different techniques--such as Monte Carlo and Taylor series expansion--to identify the most appropriate techniques for later use on large-scope analyses. Selection of sensitivity methods will be coordinated with members of the Statistics Task and subject to TSP approval.

Task members conducted an initial sensitivity study for the release of iodine-131 to the atmosphere. The study identified several key parameters and emphasized the importance of the atmospheric modeling effort. Similar studies are being initiated for releases of reactor-derived radionuclides to the Columbia River and sensitivities to diet assumptions.

3.12.2.3 Selection of Radionuclides

Past operations at the Hanford Site have resulted in the production of hundreds of different radionuclides. Most of these have had no significant impact on individual doses because the quantities released have been small, the radiological half-lives have been short, or exposure of people was minimal. Nonetheless, it is important to determine which radionuclides have had the potential to result in offsite doses.

Essentially all radionuclides produced at Hanford through either fission or activation have been identified by means of computer simulation. All radionuclides with half-lives longer than 10 minutes are being investigated. Preliminary calculations are based on normalized inventories projected for the conditions existing at various operating times. This effort will be coordinated with and will support Source Terms Task activities.

Radionuclides of public interest will also be included, regardless of their contribution to the final dose. A list of radionuclides proposed for study will be submitted to the TSP for consideration.

3.12.2.4 Pathways of Exposure

The modes of exposure to be investigated will include both external exposures resulting from immersion in air and water and from direct radiation from radionuclides deposited on soils and sediments, and internal doses resulting from inhaling air that contains radioactive materials or from ingesting contaminated water or foods. The general exposure categories are listed.

Plant food types to be considered include

- leafy vegetables
- other vegetables
- grains
- fruits.

Animal products to be considered include

- meat (and game)
- poultry (and wild birds)
- eggs
- cow milk
- goat milk.

Aquatic foods to be considered include

- marine fish
- marine crustacea
- mollusca
- algae/seaweed
- anadromous fish
- freshwater fish
- freshwater crustacea
- freshwater mollusca.

Additional pathways may be defined in conjunction with research performed by members of the Demographics, Agriculture, Food Habits Task.

3.12.2.5 Population Distributions for Dosimetric Calculations

Radiation doses will be calculated for actual individuals, "reference" individuals, and specific population groups. Potentially exposed populations will be defined on the basis of criteria such as geography, dietary habits, and lifestyle. The doses developed for hypothetical "reference" individuals, covering a range of exposure patterns, will provide data necessary for understanding the possible upper limits of potential doses. Dose estimates for specific individuals will be developed to assist the CDC in their initial effort to determine the feasibility of detecting health impacts. To respond to inquiries from people who live, or have lived around the Hanford Site, task members will develop the capability for calculating dose estimates for individuals based on their own personal dietary and lifestyle history. This capability will not be used in Phase I work, however. In Phase I, doses will be calculated only for selected subpopulation groups as a demonstration of the calculational ability. These subgroups represent areas of high and low radionuclide concentrations in the environment, and will include only adults and children. The doses will be selected to address geographical and demographic areas of interest.

The following types of dose will be calculated:

Specific Individual Dose. A system will be developed to allow individuals to estimate their doses by reconstructing a life-history profile that takes into account the following:

- geographic locations
- occupation/lifestyle
- dietary habits
- time frames of changes in each.

Reference Individuals. Potential doses received by hypothetical individuals will be calculated based on the following:

geographic location
age
occupation
lifestyle
dietary habits
ethnic group.

Realistic parameters will be used as input to the same model used for calculating the specific individual dose. These parameters will serve as benchmarks for reporting results.

Specific Population Doses - Doses received by specific populations will be calculated. The groups will be identified according to

geographic location
lifestyle
ethnic group.

The collective dose received by a specific population group can be calculated either by summing the estimated doses received by all individuals in the group or by calculating an average dose and multiplying it by the number of people in the population. Either technique uses the general model provisions defined above for actual or reference individuals.

Doses to individuals within any group will be reported on the basis of age at the time of exposure. Age groups for which dosimetric data for the thyroid are available are

fetus
newborn
1 - 4 years
5 - 9 years
10 - 14 years
15 - 20 years
adult.

Doses for individuals of intermediate ages will be scaled appropriately, at monthly intervals, on the basis of these ages. Doses will be calculated separately for individuals of either sex. However, for Phase I of the study, only the newborn and adult age groups will be examined in detail, and radiation dose factors are unlikely to be sex-dependent.

Specific groups within each exposed population will be reported on the basis of "lifestyle;" these will be coupled with the age groups listed above, as appropriate. The lifestyle groups now being considered are

urban
rural non-farm
rural farm.

For Phase I, the rural non-farm and rural farm categories may be combined, but both rural and urban categories may be subdivided by according to whether the source of milk is private or commercial.

3.12.2.6 Definition of Study Areas

The complete study will be performed in a series of phases. Task members will provide guidance on the areas of interest for each phase. In Phase I, task members will examine the potential for doses within the 10-county area immediately surrounding the Hanford Site in southeastern Washington and northern Oregon. In future phases, the study area will be expanded and data for within the area will be refined.

3.12.3 Activities and Milestones Completed to Date

Accomplishments to date include the following:

- prepared initial project conceptual model and influence diagrams
- identified key parameters via iodine-131 sensitivity study
- identified Phase I study domain
- coordinate surface-water sensitivity study
- **Milestone 12-F:** selected dominant radionuclides for TSP review, evaluation and approval - May 1989
- **Milestone 12-G:** coordinated Native American diet sensitivity study, air pathway - September 1989
- **Milestone 12-A:** defined age groups, urbanization, and subpopulation categories - May 1989
- **Milestone 12-B:** coordinated Native American diet sensitivity study, river pathway - September 1989

- **Milestone 12-C:** completed definition of atmospheric and demographic grids - March 1989
- **Milestone 12-D:** determined feasibility of using iodine-129 as an indicator of iodine-131 in the environment - May 1989
- **Milestone 12-E:** defined list of preferred food types - May 1989
- **Milestone 12-H:** recommend form for deposition velocity/interception/retention model - April 1989.

3.12.4 Activities and Milestones Required to Complete Phase I Work

None.

3.12.5 Work Beyond Phase I

Activities in Phases II, III, and IV will include the following:

- recommend areas for experimental verification
- investigate variability of background radiation in the Northwest
- continue to identify and resolve issues of importance to the project
- expand the numbers, locations, and types of populations for which doses will be calculated.

- Milestone 12-C: completed definition of atmospheric and demographic data - March 1983
- Milestone 12-D: determined feasibility of using Isotop-129 as an indicator of radon-222 in the environment - May 1983
- Milestone 12-E: defined list of oriented food types - May 1983
- Milestone 12-F: recommended form for decision validity/indecision relation model - April 1983

8.12.4 Activities and Milestones Required to Complete Phase I Work

- #### 8.12.5 Work Beyond Phase I
- Activities in Phase II, III, and IV will include the following:
- recommend areas for experimental verification
 - investigate variability of background radiation in the Northwest
 - continue to identify and resolve areas of importance to the project
 - expand the number, locations, and types of populations for which doses will be calculated

4.0 MANAGEMENT

This chapter describes the project organization, responsibilities and authorities of project participants, and administrative procedures needed to ensure that project activities conform to the scope of work, schedule, and budget.

4.1 PROJECT ORGANIZATION

The HEDR Project is conducted by PNL under the direction of a TSP. Figure 4.1 shows PNL's organization for the project.

4.1.1 Technical Steering Panel

The TSP consists of experts in environmental pathways, epidemiology, surface-water transport, ground-water transport, statistics, demography, agriculture, meteorology, nuclear engineering, radiation dosimetry, and cultural anthropology. Included among the members are appointed members representing the states of Oregon and Washington, cultural and technical experts nominated by the Indian tribes in the region, and an individual representing the public.

The TSP is responsible for the technical direction of the project and for reviewing and approving project reports. The TSP holds periodic technical progress meetings that are open to the public and provides public and media liaison.

The TSP uses several methods for directing, reviewing, and approving HEDR work conducted by Battelle staff:

- The TSP reviews, evaluates, and approves the HEDR work plan, which describes the approach, general activities, and schedule proposed to complete the work. The work plan is updated as needed to address subsequent project phases and to reflect technical decisions or scope changes. The TSP reviews and approves all revised work plans.
- The TSP issues written directives to the HEDR Project Manager requiring that HEDR staff conduct specific activities. These activities may supplement or modify work described in the HEDR work plan. TSP directives are publicly available.
- The TSP reviews and evaluates each HEDR formal technical report that documents completed project work, notes any required changes, and approves the final version for public release, as indicated by the TSP Chairman's signature on a page at the beginning of the report.

FIGURE 4.1. PNL Organization for HEDR Project

- The TSP reviews and comments on the HEDR Project status presentations given at the TSP public meetings.
- The TSP review monthly progress reports from HEDR staff.
- TSP members meet individually with HEDR staff to review progress and to monitor ongoing work.

4.1.2 Pacific Northwest Laboratory

The Laboratory prepares and implements the scope of work under the technical direction of the TSP. Communications concerning contractual matters of funding and evaluation of performance against contractual schedule and budget commitments will be with DOE through PNL's Office of Hanford Environment. The project is organized into 12 tasks as previously depicted in Figure 3.1.

4.2 RESPONSIBILITY ASSIGNMENTS

Project performance is measured by comparing planned vs. actual costs and by adherence to the milestone schedule (Figure D.1). This information is published in monthly progress reports. The TSP issues technical directives to PNL to augment or modify work described in this plan.

Project accountabilities and approval authorities are shown in Table 4.1. Task leaders, section managers, the project manager, and the Internal Peer Review Group mutually agree on a scope of work, schedule, and budget. The TSP reviews, evaluates, and approves the technical aspects of the scope of work and schedule, and DOE approves contractual matters, including the budget.

4.2.1 Task Leaders

Task leaders are responsible for the scope, schedule, and budget of their respective tasks and for implementing QA requirements. Task leaders will inform the project manager of any proposed modifications in the scope of work, schedule, or budget.

4.2.2 Project Staff, Sub-Task Leaders, and Subcontractors

Project staff and subcontractors will inform subtask or task leaders, as applicable, of any need for modifications in the scope, schedule, or budget. Changes will be implemented only upon written direction from task leaders and the project manager.

TABLE 4.1. Project Accountabilities and Approvals(a)

<u>Items Requiring Approval</u>	<u>PNL/ External Technical Review</u>	<u>PNL Project Manager</u>	<u>PNL Internal Peer Review Group</u>	<u>OHE(b) Program Manager</u>	<u>Technical Steering Panel</u>
Budget Submittal		X	X	X	
Subcontracts		X			
Deliverables					
• Work plan	X	X	X	X	X
• Monthly reports		X		X	
• Technical reports	X	X	X	X	X
• Presentations	X	X	X	X	

(a) Deliverables subject to PNL clearance only; DOE clearance not required.

(b) OHE = Office of Hanford Environment.

4.2.3 Project Manager

The project manager is responsible for ensuring that all elements of the project scope are accurately completed, on schedule, and within budget and that the work is conducted in accordance with QA requirements as specified by PNL's QA Program. The project manager will guide and monitor the technical progress of work and act as the principal liaison between PNL and the TSP on all technical matters.

4.2.4 Office of Hanford Environment

PNL's Office of Hanford Environment is responsible for contractual communications with DOE, including negotiating agreements on changes in schedule and budget that result from changes in technical direction approved by the TSP; reviewing the work plan, monthly and formal technical reports; and conducting routine business communications with DOE.

4.3 COMMUNICATION PROCEDURES

This section identifies the communication procedures that will be implemented by each project participant to ensure that all project information is properly prepared, disseminated, documented, and filed for ready retrieval.

4.3.1 Public Access to HEDR Work

All meetings with HEDR staff and TSP members, whether one-on-one or involving a TSP subcommittee, will be open to the public at the discretion of the TSP. Copies of material presented at TSP meetings will be provided to each TSP member and made available to the public as specified in TSP Directive 89-6 in Appendix A.

4.3.2 Review, Clearance, and Format

All verbal and written HEDR communications with the TSP concerning plans, data, conclusions, status reports, and other sensitive project information will be limited to material that has received PNL peer review and has been cleared by PNL. All documents generated by HEDR staff for distribution outside PNL will be reviewed at the appropriate technical levels and internally cleared. Authors of correspondence that transmit data or reports requiring formal review will indicate the level of review on the Document Cover Sheet. Project monthly reports will follow the format specified in Appendix C. Any proposals to the TSP will follow the format specified in TSP Directive 88-1 in Appendix A.

4.3.3 Copies to Project File

All project correspondence (internal and external) will be distributed to a project file in accordance with an approved records management plan.

4.3.4 Control Codes

A Document Cover Sheet (Figure 4.2) will be attached to all project documents and correspondence. Each piece of project correspondence originated by or received by the project will be assigned 1) a task number by the originator or addressee and 2) a Project Document Control Number, entered on a Document Cover Sheet by the Project Office.

4.3.5 Distribution

The author of each HEDR project correspondence is responsible for identifying its recipients. The recipient of incoming correspondence is responsible for internal distribution.

4.3.6 Correspondence Logs

All incoming and outgoing correspondence will be logged by the Project Office.

HEDR PROJECT DOCUMENT COVER SHEET

(required on all project correspondence)

FROM: _____ TASK NAME: _____
(individual initiating document)

DATE: _____ TASK NO: _____

ACTION REQUIRED: _____

FROM: _____ BY: _____
(individual[s] action required from) (date required by)

DISTRIBUTION:	Action	Info		Action	Info
Alamia, D.	_____	_____	Morgan, L.	_____	_____
Andrews, G.	_____	_____	Napier, B.	_____	_____
Beck, D.	_____	_____	Ramsdell, V.	_____	_____
Bruneau, C.	_____	_____	Rhoads, R.	_____	_____
Cuello, R.	_____	_____	Roberts, A.	_____	_____
Dennis, B.	_____	_____	Rutherford, D.	_____	_____
Freshley, M.	_____	_____	Templeton, W.	_____	_____
Gilbert, D.	_____	_____	Woodruff, R.	_____	_____
Gydesen, S.	_____	_____	File	_____	_____
Haerer, W.	_____	_____		_____	_____
McMakin, A.	_____	_____		_____	_____

DOCUMENT DESCRIPTION

DOCUMENT TITLE: _____

AUTHOR(S): _____

DOCUMENT DATE: _____ NO. OF PAGES: _____

FILE INDEX NO: _____ FILE INDEX NAME: _____

(to be entered by Project Records Custodian) (to be entered by Project Records Custodian)

IDENTIFYING NUMBER: _____ LOCATION: _____

HEDR Project Document No. _____
(to be entered by Project Records Custodian)

FIGURE 4.2. HEDR Document Cover Sheet

4.3.7 Communications Between PNL and the TSP

Written and verbal contacts with the TSP on a new topic will be coordinated through the Project Office. Project telephone contacts will be documented with a "telecommunications" note, which is distributed to the telephone contact, applicable project personnel, and the project file. Telecommunications are listed in monthly progress reports.

4.3.8 Communications Between PNL and DOE

Communications between PNL and DOE concerning contractual matters are made through PNL's Office of Hanford Environment, as described in Section 4.2.4. The Project Office will originate or approve all written communications with DOE. Communications from DOE to PNL will be directed through the Office of Hanford Environment.

4.3.9 Outside Requests for Information

Verbal and written requests for information from external sources other than the TSP will be forwarded to PNL Public Relations. A telecom note stating the name and affiliation of the requester, the type of information requested, and date of request will be forwarded to the Project Office. Project staff and subcontractors are not to discuss the HEDR Project with the media or the public without direction from the TSP.

4.3.7 Communications Between PNL and the TSP

Written and verbal contacts with the TSP on a new topic will be coordinated through the Project Office. Project teleconference contact will be coordinated with a teleconference note, which is distributed to the telephone contact, and cable project personnel, and the project file. Telecommunications are listed in monthly progress reports.

4.3.8 Communications Between PNL and DOE

Communications between PNL and DOE concerning contract matters are made through PNL's Office of Hazardous Environment, as described in Section 4.3.4. The Project Office will originate or approve all written communications with DOE. Communications from DOE to PNL will be directed through the Office of Hazardous Environment.

4.3.9 Outside Requests for Information

Verbal and written requests for information from external sources other than the TSP will be forwarded to PNL Field Office. A request note stating the name and affiliation of the requester, the type of information requested, and date of request will be forwarded to the Project Office. Project staff and subcontractors are not to discuss the HDR Project with the media or the public without direction from the TSP.

5.0 RESOURCE ALLOCATION

This chapter discusses allocation and commitment of personnel, subcontractors, and other resources.

5.1 LABOR REQUIREMENTS

Support staff and subcontractors have been identified. Contracts are in place as described in Section 5.4.

5.2 FACILITIES REQUIREMENTS

The DOE Public Reading Room in the DOE Federal Building in Richland, Washington, has been expanded and shelving added to accommodate the increased volume of documents from the HEDR Project. Any other facility needs will be identified as the project progresses.

5.3 EQUIPMENT REQUIREMENTS

No new equipment needs have been identified for FY89.

5.4 SUPPORT SERVICES, PROCUREMENT, AND SUBCONTRACT REQUIREMENTS

Contracts have been established with TSP members, whose roles are defined in Section 4.1. Contracts have been negotiated with the States of Oregon and Washington to provide clerical support to the TSP and to provide a public information program.

A subcontract is also in place with Golder Associates of Redmond, Washington, to provide ongoing support for sensitivity/uncertainty analysis and decision analysis. Subcontracts are in place with various technical experts to provide technical advice and to peer-review methods and results. Such contracts are being negotiated with Native American tribes to conduct portions of the research on Native American populations, food consumption patterns, and lifestyles.

Occasional workshops and meetings require agreements for services associated with hotels, court reporters, and Native American representatives.

Services within PNL are occasionally required from Subcontracts, Project Management Support, and Public Relations.

6.0 REFERENCES

Anderson, J. D. 1974. *Emitted and Decayed Values of Radionuclides in Gaseous Wastes Discharged to the Atmosphere From the Separation Facilities Through Calendar Year 1972*. ARH-3026, Atlantic Richfield Hanford Company, Richland, Washington.

ANSI/ASME NQA-1-1986, *Quality Assurance Program Requirements for Nuclear Facilities*. American Society of Mechanical Engineers, New York City, NY.

A. G. Croff. 1980. *ORIGEN2: A Revised and Updated Version of ORIGEN*. Transactions of the American Nuclear Society, Volume 34, pp. 349-350, June 1980.

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- Anderson, J. D. 1971. Collected and Analyzed Values of Radiochemicals in Gaseous Wastes Discharged to the Atmosphere from the Savannah Plant, Savannah, Georgia, Calendar Year 1970. AEC-3025, Atomic Energy, Hartford, Connecticut, Hartford, Connecticut.
- ANSI/ASME NQA-1-1985. Quality Assurance Program Requirements for Nuclear Facilities. American Society of Mechanical Engineers, New York City, NY.
- A. E. G. 1980. ORIGEN-2: A Revised and Updated Version of ORIGEN. Transactions of the American Nuclear Society, Volume 54, no. 349-357, June 1980.

APPENDIX A

TSP DIRECTIVES

APPENDIX A

TSP DIRECTIVES

Through written directives, the TSP requests HEDR staff at PNL to conduct specific activities as additions or modifications to the work plan. Directives received to date are included in this appendix; Table A.1 identifies where the directives are addressed in this work plan.

TABLE A.1. Where TSP Directives Are Addressed in Work Plan

Directive		Where Addressed
88-1	Source Terms for 44-45 Proposal Formats	Appendix D (Schedule), Sections 2.2.1, 3.3, 4 Section 4.3.2
88-2	Vegetation Monitoring Data	Section 3.5
88-4	Groundwater Contamination	Section 3.4.3
88-5	Maps Requests	Completed (not addressed in work Plan)
88-6	Staff CV Requests	Completed (not addressed in Work Plan)
89-1	Tribal Research	Section 3.6.4
89-2	Bioassay Data	Section 3.7.4
89-3	List Classified Documents	Section 3.8
	Computerize Documents	Being reconsidered by TSP
89-4	River Activity After Reactor Purging	Section 3.4.2
89-5	Modeling Approach	Sections 2.2.1, 3.11, 3.7
89-6	Meeting Materials	Section 4.3.5
89-7	Public Presentation of Uncertainty	Section 3.6.6

TECHNICAL STEERING PANEL RESEARCH DIRECTIVE

Directive Number: 88-1
Date: November 23, 1988
Subject: PROPOSALS FOR RESEARCH

Action to be Taken:

In reviewing the proposals given to us in October the TSP asked me to forward two comments related to the development of proposals.

First, we believe initial priority should be given to proposals which help to define the source terms using either release data or environmental measurements, with particular emphasis on the years 1945-1955. We must decide how the source terms will be characterized as a function of time, radionuclide, pathway, and quantity as soon as possible.

The second point deals with the preparation of proposals for research. The TSP would like to have proposals submitted in a more standard format, specifically stating what action is proposed to be carried out. We would like proposals to contain the sections shown below.

1. Introduction (includes a description of the research and how it fits into the overall dose reconstruction plan)
2. Scope of work (listing of individual tasks)
3. Schedule for completion of work
4. Expected level of effort
5. Quality assurance plan
6. Qualifications of staff expected to carry out the research,
7. References

This standard format will help us to respond to your proposals more quickly and avoid misunderstanding about exactly what is being proposed. Further, we believe this approach will streamline your preparation of proposals and permit a more rapid TSP response.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

Technical Steering Panel
Hanford Environmental Dose
Reconstruction Project
P. O. Box 1734
Richland, Washington 99352

TECHNICAL STEERING PANEL
RESEARCH DIRECTIVE

Directive Number: 88-2
Date: November 23, 1988
Subject: VEGETATION MONITORING DATA

Action to be Taken:

Reading of early literature indicates that analysis of vegetation has the longest history of continuous information available off-site. The TSP recommends all the methods of analysis, over time, for vegetation be evaluated and intercalibrated so the Panel can decide if vegetation can serve as a continuous monitor for early off-site contamination. The time of vegetation measurements should be correlated with time of releases to see if any releases were missed.

A handwritten signature in dark ink, appearing to read "John E. Till". The signature is fluid and cursive, with a large loop at the beginning and a long, sweeping tail.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

Technical Steering Panel
Hanford Environmental Dose
Reconstruction Project
P. O. Box 1734
Richland, Washington 99352

TECHNICAL STEERING PANEL
RESEARCH DIRECTIVE

Directive Number: 88-3
Date: November 23, 1988
Subject: STATUS REPORTS

Action to be Taken:

The TSP requests that a status report be presented at every TSP meeting on the overall project and any actions taken on previous recommendations.

A handwritten signature in dark ink, appearing to read "J. E. Till", is written over the printed name.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

Technical Steering Panel
Hanford Environmental Dose
Reconstruction Project
P. O. Box 1734
Richland, Washington 99352

TECHNICAL STEERING PANEL
RESEARCH DIRECTIVE

Directive Number: 88-4
Date: November 23, 1988
Subject: GROUND WATER CONTAMINATION DATA
Action to be Taken:

The TSP recommends that three activities be carried out by Battelle in their ground water transport subtask. These activities should be carried out immediately.

1. (a) List all wells on and adjacent to the Hanford Reservation which may have supplied ground water (for irrigation or domestic use) which was contaminated by radionuclides originating on the Hanford Reservation.
(b) Make estimates of the level of contamination and the number of people affected.
2. Make some reasonable estimates of the location and number of irrigation and municipal supply wells which are near enough to the Columbia River to have been affected significantly by radionuclides discharged into the river by operations at Hanford.
3. Make an estimate of the radionuclides discharged into the Columbia River by unconfined ground water flow which originates in the 200 Area and seeps southward into the river.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

Technical Steering Panel
Hanford Environmental Dose
Reconstruction Project
P. O. Box 1734
Richland, Washington 99352

TECHNICAL STEERING PANEL
RESEARCH DIRECTIVE

Directive Number: 88-5
Date: November 23, 1988
Subject: REQUESTS FOR MAPS
Action to be Taken:

The TSP requests that members receive for its use copies of the base map of the Pacific Northwest used in the Battelle briefing on Friday morning, September 23. This map is prepared by the U.S. Geological Survey as part of their national atlas. Copies could be made available at the next TSP meeting or could be mailed in advance of that meeting.

A handwritten signature in dark ink, appearing to read "John E. Till". The signature is fluid and cursive, with a large loop at the beginning and a long, sweeping tail.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

Technical Steering Panel
Hanford Environmental Dose
Reconstruction Project
P. O. Box 1734
Richland, Washington 99352

TECHNICAL STEERING PANEL
RESEARCH DIRECTIVE

Directive Number: 88-6
Date: November 23, 1988
Subject: CURRICULUM VITAE ON STAFF
Action to be Taken:

The TSP requests that it be provided with one copy of a curriculum vitae on Battelle staff who are working on the project. This information will be maintained by our staff in Olympia and will be made available to the TSP upon request.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

TECHNICAL STEERING PANEL RESEARCH DIRECTIVE

Directive Number: 89-1
Date: January 29, 1989
Subject: PHASE I RESEARCH INVOLVEMENT WITH
INDIAN TRIBES

Action to be Taken:

Accepting the plan for Phase 1 to emphasize the 1944-1947 period and the doses- in a 100 kilometer area, we direct that Battelle staff devote special attention to estimating the role and importance of Native Americans in the 100 km area - as fishermen, farm and construction workers, or residents, whatever tribal areas they may have come from. This will require some level of Phase 1 research involvement with at least the four major tribes, Yakama, Umatilla, Nez Perce, and Coville. The migration behavior of the tribes should be a specific topic at the lifestyle workshop.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

TECHNICAL STEERING PANEL RESEARCH DIRECTIVE

Directive Number: 89-2
Date: January 29, 1989
Subject: BIOASSAY DATA

Action to be Taken:

A systematic search should be made for human bioassay data such as worker and population whole-body counts, thyroid measurements, and urinalysis and an evaluation should be made to see if and how it can contribute to the dose estimation process. At some point in the order of priorities this information should be made available to the TSP for evaluation.

A handwritten signature in black ink, appearing to read "John E. Till". The signature is fluid and cursive, with the first name "John" being more prominent than the last name "Till".

John E. Till, Ph.D.
Chairman, Technical Steering Panel

TECHNICAL STEERING PANEL
RESEARCH DIRECTIVE

C5.2.5.2
T1 p. 4 of 7

Directive Number: 89-3
Date: January 29, 1989
Subject: DOCUMENT HANDLING

Action to be Taken:

1. List unclassified titles for presently classified documents that might be useful to the HEDR project as soon as possible.
2. Computerize the catalogue of publicly available documents in the Public Reading Room so that it can be queried by the public.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

TECHNICAL STEERING PANEL RESEARCH DIRECTIVE

Directive Number: 89-4
Date: January 29, 1989
Subject: ACTIVITY IN THE COLUMBIA RIVER FOLLOWING
REACTOR PURGING

Action to be Taken:

Documents cite "purging" of reactors to remove film deposited in pipes. This action was performed by sending a slug of diatomaceous earth or other materials through the cooling channels. The resultant purged material was emptied into the Columbia River and could have raised the level of activity in the River.

Battelle staff must investigate the effects of purging the production reactors and the resulting impact on radioactivity content in the Columbia River.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

TECHNICAL STEERING PANEL RESEARCH DIRECTIVE

Directive Number: 89-5
Date: January 29, 1989
Subject: MODELING APPROACH

Action to be Taken:

The Uncertainty Workshop held in Richland January 16-18, 1989 helped the TSP to better define the approach that should be used to carry out the dose reconstruction research. The procedures given below evolved from discussions at the workshop and should be used for achieving the objectives of the HEDR Project.

1. Determine "Art of the Possible."

What quality can be achieved with the data and budget limitations? The pilot study approach using information, for I-131 assessment, from 1944-1947 should be used to obtain "best" estimates of dose. These estimates may be ranges rather than averages.

2. Evaluate and rank models to minimize the set of models useful for HEDR purposes.

Evaluate models using best relevant data (not necessarily 1944-1947). Possibly "Green Run," 1964 release, or 1983-1986 data.

3. Better characterize necessary model parameters to reach the following objectives:

- (a) epidemiological - determine doses to individuals in cohorts,
- (b) population - average doses, and
- (c) maximum credible dose to any individual in a population group.

4. Obtain a minimum set of models and parameters that can be supported by available knowledge/data. Minimum means smallest complete and validated set necessary to obtain objectives.

5. Sensitivity and uncertainty analysis.

At the workshop, HEDR staff made the following statement: "Probability Distribution is the preferred description of uncertainty." This may be a desirable goal, but not an exclusive one. Therefore we recommend that if information cannot define a probability distribution function, investigate other representations. If supported by a sufficient weight of scientific evidence, subjective probability distribution functions may be used.

In settings where alternative approaches to sensitivity and uncertainty analysis are applicable, the "pilot" study should be used to evaluate and rank the possible approaches in subsequent phases of the study.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

TECHNICAL STEERING PANEL RESEARCH DIRECTIVE

Directive Number: 89-6
Date: March 18, 1989
Subject: TSP AND PUBLIC ACCESS TO MEETING MATERIALS

ACTION TO BE TAKEN:

The Technical Steering Panel finds that its members's and the publics' access to written material presented at TSP meetings must be improved.

Copies of prepared materials (tables, graphs, lists, including those used in slides) that are part of a formal presentation at a TSP meeting shall be given to each member at the meeting. Sufficient copies shall also be available at that meeting for interested parties and the news media. One copy of all material shall be given to TSP staff for distribution to the Public Reading Rooms and TSP files. Exceptions to this directive will be handled on a case by case basis with the approval of the TSP Chair.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

TECHNICAL STEERING PANEL RESEARCH DIRECTIVE

Directive Number: 89-7
Date: May 20, 1989
Subject: PRESENTATION OF TECHNICAL MATERIAL TO
THE PUBLIC

DISCUSSION:

The Technical Steering Panel (TSP) recognizes that the characterization of uncertainty in dose estimates will be an essential result of the HEDR Project. A thorough and accurate accounting of uncertainties must be available to all interested persons. Such an accounting must be understood in order to be truly available. While scientific and technical audiences will be able to deal with information presented in a technical format, interested lay persons will require clear, nontechnical explanations of the causes and magnitudes of uncertainties. An understanding of the causes of uncertainties is required for dose estimates and their uncertainties to be credible and to enhance the meaning and limitations of dose estimates.

The TSP is responsible for selecting the methods that will be used to present information about HEDR results, including uncertainties, to the lay public. However, the TSP recognizes that Battelle Pacific Northwest Laboratories (PNL) and the United States Department of Energy (DOE) may continue to be a source of this information after completion of the HEDR project. The TSP, therefore, needs to examine all possible methods for communication that might be used during and after the HEDR Project, in order to select methods that will be most effective.

ACTION TO BE TAKEN:

The TSP hereby directs the Battelle staff to investigate methods for presenting to the lay public information about both the causes and the magnitudes of uncertainties in dose estimates. Past examples of communication of technical information to lay audiences, both by PNL and by other organizations, should be critically reviewed. In addition, PNL should seek out and consider innovative methods for such communication. Methods of communicating both to mass audiences and to individuals should be considered; the latter should include persons for whom dose estimates are calculated.

Battelle is further directed to prepare a report of the investigation for delivery to the TSP no later than February, 1990. This report should include descriptions of the methods of communication that are considered, along with critical evaluations of each method's cost and effectiveness.

John E. Till, Ph.D.
Chairman, Technical Steering Panel

APPENDIX B

QUALITY ASSURANCE PLAN

APPENDIX B

QUALITY ASSURANCE PLAN

PNL-MA-70 Quality Assurance Plan

No. OHE-3, Rev. 3

QA PLAN FOR THE
HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT
(PHASE I)

ISSUE DATE: May 2, 1989

HA Haerer *HA Haerer* 5/1/89
Project Manager (Concurrence) Date

R Cuello *R Cuello* 5/1/89
Project Quality Engineer (Concurrence) Date

JW Smith *JW Smith* 5/1/89
Process Quality Department (Concurrence) Date

EC 5/1/89
JW Falco *JW Falco* 5/1/89
Earth and Environmental Sciences Date
Center Manager, D7D00 (Approval)

WL Templeton *WL Templeton* 5/1/89
Office of Hanford Environment Date
Manager (Approval)

PROJECT IMPACT LEVEL II

TITLE:

QA PLAN FOR HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT (PHASE I)

SCOPE:

The primary objective of the Hanford Environmental Dose Reconstruction Project is to develop estimates of the radiation doses that populations could have received from nuclear operations on the Hanford site, with descriptions of the uncertainties inherent in such estimates. A secondary objective is to make project documentation (project reports and referenced documents) available to the public. Preliminary dose estimates will be available in December 1989; complete results will be reported in 1993.

Representatives from four northwest universities selected members of an independent Technical Steering Panel to oversee the dose reconstruction effort, which is conducted by the Pacific Northwest Laboratory and funded by the U.S. Department of Energy.

CLIENT:

Technical: Technical Steering Panel
Contractual: U. S. Department of Energy (USDOE)

AUTHORIZING DOCUMENT:

12578

QA REQUIREMENTS SPECIFICATION(S):

☒ ANSI/ASME NQA-1 as delineated in PNL-MA-70

☐ Other _____

This QA Plan supersedes QA Plan OHE-3, Rev. 2, dated August 8, 1988.

Impact Level II activities must comply with the requirements in Parts 1 and 3 of PNL-MA-70 as identified here, as appropriate for the work being performed. Any activity identified as Impact Level III must comply with the PNL Good Practices Standard (GPS), located in Part 2 of PNL-MA-70. If other quality-related activities are later performed, the appropriate PNL-MA-70 procedures must be applied to them irrespective of whether they appear here, unless specifically excluded.

Applicable PNL-MA-70 administrative and software control procedures are identified in Attachment A.

Applicable HEDR specific procedures are identified in Attachment B.

Any activity completed prior to the issuance of this QA Plan is exempt from the requirements delineated here. However, these activities are subject to the requirements identified in the QA Plan in place at the time they were performed. Activities in progress at the time this QA Plan is issued must be converted to meet the requirements identified here as rapidly as practicable.

CONCURRENCES AND APPROVAL:

Concurrences and approvals are listed on the title page.

ORGANIZATION:

The project organization with key personnel identified is illustrated in the Work Plan. Key organizational interfaces are shown in Attachment C.

IMPACT LEVEL:

The Hanford Environmental Dose Reconstruction Project has been classified overall as Impact Level II. Specific project WBS elements and corresponding Impact Levels are identified in Attachment D. The project is designated Impact Level II because:

- deliverables will provide the bases for potential health effects studies and might be used to support litigation
- detailed documentation is needed because of the high public visibility (public meetings,, public access to all final project deliverables), to assure scientific credibility, and to support potential litigation
- the project has received, and will continue to receive, management attention at the highest level to assure public and scientific credibility

SPECIAL CLIENT REQUIREMENTS:

No special client quality assurance requirements have been identified.

OTHER REQUIREMENTS, DIRECTION OR PLANNING:

A. MAJOR KNOWN PROCUREMENTS

At time of issuance of this QA Plan, identified subcontractors included the following: Golder Associates and JP Corley for consulting purposes. No QA requirements are necessary for consulting purposes. As new subcontracts are identified, appropriate requirements shall be applied as needed.

B. DISPOSITION OF RECORDS

Records must be indexed and subsequently maintained in accordance with HEDR Technical Procedures RMP-1, HEDR Records Control, and RMP-2, Storage and Maintenance of HEDR Project Records as identified in Attachment B.

C. TECHNICAL REPORTS

All technical reports shall contain a summary of the quality assurance requirements that were followed. This summary should be brief and concise and should only address the QA requirements pertinent to the work/data addressed in the report. A Quality Process Representative shall be involved in the review process, for all reports, to ensure correct application of the quality assurance requirement summaries.

APPLICABLE ADMINISTRATIVE AND SOFTWARE CONTROL PROCEDURES

The following administrative procedures apply to Impact Level II activities performed under the Hanford Environmental Dose Reconstruction Project.

- PAP-70-101 COMMUNICATION AND COMMITMENT (INTERFACE) CONTROL
- *PAP-70-201 INDOCTRINATION AND TRAINING
- PAP-70-205 QUALITY ASSURANCE PLANS
- PAP-70-208 IMPACT LEVELS
- PAP-70-301 HAND CALCULATIONS, GENERAL
- PAP-70-401 PREPARATION, REVIEW, AND APPROVAL OF PURCHASE REQUISITIONS
- PAP-70-404 OBTAINING SERVICES VIA WORK ORDERS
- PAP-70-501 PREPARATION AND APPROVAL OF ADMINISTRATIVE PROCEDURES
- PAP-70-601 DOCUMENT CONTROL
- PAP-70-602 PROCEDURE AND INSTRUCTION CHANGE CONTROL AND CHANGE REQUEST
- *PAP-70-604 INDEPENDENT TECHNICAL REVIEW
- *PAP-70-606 PEER REVIEW
- PAP-70-1101 TEST PLANNING, PERFORMANCE AND EVALUATION
- PAP-70-1401 INSPECTION AND TESTING STATUS AND TAGGING
- PAP-70-1501 NONCONFORMANCE REPORTS
- PAP-70-1502 CONTROLLING DEVIATIONS FROM QA REQUIREMENTS AND ESTABLISHED PROCEDURES
- PAP-70-1602 CORRECTIVE ACTION
- *PAP-70-1701 RECORDS SYSTEM
- SCP-70-312 DETERMINATION OF SOFTWARE REQUIREMENTS
- **SCP-70-313 FINAL INTERNAL DEVELOPMENT REVIEW OF SOFTWARE AND DOCUMENTATION
- **SCP-70-314 SOFTWARE CONFIGURATION MANAGEMENT
- **SCP-70-315 CONVERSION TESTING, VERIFICATION, AND/OR VALIDATION OF SOFTWARE
- **SCP-70-316 SOFTWARE APPLICATION CONTROL
- **SCP-70-317 TRANSFER OF SOFTWARE, DATA AND/OR DOCUMENTATION
- **SCP-70-318 CONTROL OF DATA BASES

* See Exclusions or Limitations of Applicability below.

** Applicable SCPs determined by SCP-70-312.

EXCLUSIONS OR LIMITATIONS OF APPLICABILITY

a. PAP-70-201: Indoctrination and Training

In lieu of procedure PAP-70-201, Indoctrination and Training, project specific technical procedure HEDR-TP-2, HEDR Indoctrination and Training shall be implemented.

b. PAP-70-604: Independent Technical Review

Independent technical review (ITR) of deliverables such as letter, topical, and final reports in accordance with the requirements of PAP-70-604 shall be performed at the discretion of the project manager. The format used to document reviews may be different than that required by PAP-70-604 if approved by the project manager provided equivalent information is contained in document review

records. Technical documents prepared and clearly identified as "preliminary drafts", "working papers" or for "information only" do not require an ITR unless specified by the Project Manager.

ITR should not be confused with reviews required by the HEDR Project Document Control Form or those of the clearance process, although each of the latter, if performed and documented in accordance with PAP-70-604, could qualify as an ITR.

c. PAP-70-606: Peer Review

In lieu of procedure PAP-70-606, Peer Review, project specific technical procedure HEDR-TP-5, HEDR Peer Review shall be implemented.

d. PAP-70-1701: Records System

In lieu of procedure PAP-70-1701, Records System, project specific technical procedures RMP-1, HEDR Records Control, and RMP-2, Storage and Maintenance of HEDR Project Records, must be implemented.

e. Delegation of Project Manager's Responsibilities

The project manager responsibilities delineated in the following procedures shall be delegated to the technical task leaders (with exceptions as noted below):

- PAP-70-301 - Hand Calculations
- SCP-70-312 - Determination of Software Requirements
- SCP-70-313 - Final Internal Development Review of Software and Documentation
- SCP-70-314 - Software Configuration Management
- SCP-70-315 - Conversion Testing, Verification, and/or Validation of Software
- SCP-70-316 - Software Application Control
- SCP-70-317 - Transfer of Software, Data and/or Documentation
- SCP-70-318 - Control of Data Bases

Out of the procedures listed above, the Project Manager will retain responsibility for the following requirements:

For all Software Control Procedures:

Evaluating and documenting the effect of deficiencies that require use of a Deficiency Report form in accordance with PAP-70-1502.

SCP-70-317 - Transfer of Software, Data and/or Documentation

Section 4.1 - To approve any transfer of software, data and/or documentation to any organization outside of PNL.

HEDR SPECIFIC PROCEDURES

<u>Procedure Number</u>	<u>Rev #</u>	<u>Title</u>	<u>Date Issued</u>
RMP-1	0	HEDR Records Control	7/31/87
RMP-2	0	Storage and Maintenance of HEDR Project Records	8/14/87
HEDR-TP-1	0	Documentation of Primary Data Collection	4/17/89
HEDR-TP-2	0	HEDR Indoctrination and Training	3/1/89
HEDR-TP-3	0	HEDR Documentation of Critical Decisions	TBI
HEDR-TP-4	0	HEDR Data Quality Objectives	TBI
HEDR-TP-5	0	HEDR Peer Review	4/10/89

TBI - To Be Issued

Key Organizational Interfaces

Legend:
 — Line Organization/Technical Management
 Contractual Management
 == Quality Assurance Support

This organization and responsible personnel may change without necessitating a revision of this QA Plan.

B.9

Program: <u>HEDR</u>							WBS IMPACT LEVEL						Page <u>1</u> of <u>2</u>	
Date: <u>04/10/89</u> Rev. No. <u>2</u>														
Index No.	WBS Level						WBS Element Title	WBS Element Code	Impact Level			Remarks		
	1	2	3	4	5	6			I	II	III			
1	x						Hanford Environmental Dose Reconstruction Project			x		Overall Project Impact Level II		
2		x					Project Management	01		x				
3			x				Project Control	0101		x				
4			x				Communications Support	0102		x				
5			x				Records Control	0103		x				
6		x					Internal Peer Review	02		x				
7			x				Peer Review	0201		x				
8		x					Source Terms	03		x				
9			x				Task Management	0301		x				
10			x				Hanford Site Facilities/Operations	0302		x				
11			x				Hanford Site Radioactive Emissions	0303		x				
12		x					Environmental Transport	04		x				
13			x				Task Management	0401		x				
14			x				Atmospheric Transport	0402		x				
15			x				Surface-Water Transport	0403		x				
16			x				Ground-Water Transport	0404		x				
17		x					Environmental Monitoring	05		x				
18			x				Task Management	0501		x				
19			x				Terrestrial Data	0502		x				
20			x				River Data	0503		x				
21			x				Aquatic Data	0504		x				
22			x				Air Data	0505		x				

Program: <u>HEDR</u>							WBS IMPACT LEVEL				Page <u>2</u> of <u>2</u>	
Date: <u>04/10/89</u> Rev. No. <u>2</u>												
Index No.	WBS Level						WBS Element Title	WBS Element Code	Impact Level			Remarks
	1	2	3	4	5	6			I	II	III	
23		x					Demographics, Agriculture, Food Habits	06		x		
24			x				Task Management	0601		x		
25			x				Population Data	0602		x		
26			x				Food Consumption	0603		x		
27			x				Agricultural Research	0604		x		
28			x				Indian Tribes	0605		x		
29		x					Dose Estimates	07		x		
30			x				Task Management	0701		x		
31			x				Technical Coordination	0702		x		
32			x				Model Evaluation	0703		x		
33			x				Geographical Information Systems Evaluation	0704		x		Impact Level H/A
34			x				Bioassay Data Investigation	0705		x		
35			x				Transfer Factor Development	0706		x		
36			x				Preliminary Dose Estimates	0707		x		
37		x					Information Resources	08			x	
38		x					Records Management	09		x		
39		x					Quality Assurance	10				
40		x					Statistics	11		x		

B.10

APPENDIX C

FORMAT FOR MONTHLY PROGRESS REPORTING

APPENDIX C

FORMAT FOR MONTHLY PROGRESS REPORTING

1. IDENTIFICATION NUMBER		2. PROGRAM/PROJECT TITLE		3. REPORTING PERIOD										
4a. PARTICIPANT NAME AND ADDRESS		4b. CLIENT NAME AND ADDRESS		5. START DATE										
				6. COMPLETION DATE										
7. FY	8. MONTHS	O	N	D	J	F	M	A	M	J	J	A	S	FY99
9. COST STATUS														
10. EXPRESSED IN														
11. BUDGET & REPORTING NO. SUB. ACCT. NO.														
12. F.N. NO.														
13. ACTUAL COSTS PRIOR YEARS														
14. FY BUDGET														
15. TOTAL BUDGET														
16. FY FUNDS AUTH.														
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10. LEGEND: PLANNED _____ ACTUAL _____ COLLECTED _____ FUNDS AUTH. _____ UNPL. FUNDS SPENT _____

11. MILESTONES

12. SCHEDULED

13. COMPLETED

14. TO TSA

15. DEVIATION

16. IN PROGRESS

17. TIME NOW

18. APPROVED DEVIATION

19. APPROVED DEVIATION

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101. NAME SIGNATURE OF PARTICIPANT'S PROJECT/MANAGER'S DATE

Hanford Environmental Dose
Reconstruction Project

OBJECTIVE

This paragraph should be a concise statement of the objectives of the project.

PROGRESS DURING REPORT PERIOD (by WBS Element)

This section should summarize key technical activities and significant results. Note completion of reportable milestones. List conferences, trips, submission of reports, and visitors only when an impact on the project is explained. This section may be organized by task, WBS, or written at the project level.

MAJOR PROBLEMS AREAS AND ACTION TAKEN

Note major problems that may alter the outcome of the project or impact on a project deliverable. Emphasis should be placed on action taken to eliminate the problem. A review of future milestones should be made each quarter, and any milestones not anticipated to be met as scheduled should be addressed in this section. If a milestone is slipped, establish and state a new completion date.

PLANNED WORK FOR SUBSEQUENT MONTHS

Statement of work to be performed in the next quarter. Status of milestones scheduled for completion during this period should be addressed.

BUDGET AND SCHEDULE STATUS

Planned expenditures through mo/yr _____.

Actual expenditures through mo/yr _____.

VARIANCE EXPLANATION

The words "No significant variance" should be used unless there is to be an explanation. A variance of $\pm 10\%$ of budget should be explained.

CAPITAL STATUS

The capital status may be addressed in narrative form. Example: The FY 1989 capital funding is \$_____; to date \$_____ has been committed for capital expenditures.

APPENDIX D

SCHEDULES

APPENDIX D

SCHEDULES

The project schedule and milestone diagram for FY 1989 is shown in Figure D.1. All milestones are internal unless otherwise indicated and are designated with triangles. Deliverables that will go to the TSP are designated with circles. Project milestones are tracked on a monthly basis on the Project Summary Report (Appendix C), which appears in project monthly reports.

PROJECT SUMMARY REPORT

PROJECT SUMMARY REPORT

FIGURE D.1. Milestone Schedule (contd)

APPENDIX E

BUDGET

APPENDIX E

BUDGET

Budgeted amounts by task for Fiscal Year 1989 are shown in Table E.1. Costs for the Project Technical Coordination Task (Task 12) are included in the Environmental Pathways and Dose Estimates Task (Task 07). This budget does not include TSP costs.

Budgets for subsequent years will be provided when annual funding allocations are received from the Department of Energy.

TABLE E.1. HEDR Budget, October 1988 - September 1989

<u>Task Number</u>	<u>Budgeted Amount, \$K</u>
01(a)	571
02(b)	0
03	272
04	378
05	273
06	517
07	273
08	117
09	78
10(b)	0
11	<u>210</u>
Total	2689

(a) PROJECT MANAGEMENT BUDGET INCLUDES:

- project management
- project management support services
- secretarial/administrative support
- communications specialist
- records custodian
- TSP support
- subcontracts

(b) Not funded by HEDR.

APPENDIX F

GLOSSARY

APPENDIX F

GLOSSARY

aquifer - a subsurface formation containing sufficient saturated permeable material to yield significant quantities of water

background radiation - radiation that is produced by sources such as naturally occurring radioactive minerals in the earth, cosmic rays, and naturally occurring radionuclides in living organisms

code - the transcription of the mathematical representation or model into computer software; see "model"

confined aquifer - a subsurface water-bearing region having defined, relatively impermeable upper and lower boundaries and whose pressure is significantly greater than atmospheric throughout

decay, radioactive - a spontaneous nuclear transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide by emission of particles and/or photons (see half-life)

diffusion - phenomenon by which a material placed in a medium gradually spreads and occupies an ever-increasing portion of the medium

dose - a measure of the energy absorbed in tissue by the action of ionizing radiation on tissue. The unit of absorbed dose is the gray (1 Gy = 100 rad)

dose assessment - the estimation of the dose received by individuals or populations from radionuclides or radiation sources

dose equivalent - expresses doses from different types of radiation on a common biological effects basis; it is the product of the actual absorbed dose (gray) and certain modifying factors. The unit of dose equivalent is the sievert (1 Sv = 100 rem)

dose rate - the radiation dose delivered per unit time

effluent - the liquid or gaseous waste streams released to the environment from a facility

effluent monitoring - sampling or measuring specific liquid or gaseous effluent streams for the presence of pollutants

exposure - the condition of being made subject to the action of radiation

fallout - those radioactive materials deposited on the earth's surface and in the atmosphere following the detonation of nuclear weapons

fission - the division of atomic nuclei into nuclides of lower mass, usually accompanied by the emission of gamma rays, neutrons, and significant energy

fission product - a nuclide produced by the fission of a heavier element

gray - a special unit of measure for the absorbed dose of radiation (1 Gy = 100 rad)

ground water - subsurface water in the saturated pore spaces of geologic units

half-life - the time required for a radionuclide's activity to decay to half its value, used as a measure of the persistence of radioactive materials. Each radionuclide has a characteristic, constant half-life

Hanford Health Effects Review Panel - a panel convened by the Centers for Disease Control at the request of the states and Indian tribes to review and evaluate epidemiological data concerning possible health effects that might have resulted from Hanford operations

irradiate - to expose to radiation

isotope - different forms of the same chemical element that are distinguished by having different numbers of neutrons in the nucleus. A single element may have many isotopes

milestone - an event or product representing work "output," used to monitor and control project progress

model - a set of mathematical equations that represent physical/chemical systems

nuclide - a species of atom having a specific mass and atomic number

offsite - any place outside the Hanford Site boundary

parameters - any one of a set of independent variables in a model whose values determine the characteristics or behavior of the model

plutonium - a heavy, radioactive, man made, metallic element. Its most important isotope is fissionable ^{239}Pu , which is produced by the irradiation of ^{238}U

population dose (population exposure) - summation of individual radiation doses received by all those exposed to the source or event being considered

quality assurance - a total integrated program for ensuring the validity, defendability and reproducibility of project results

radiation - a general term referring to energy traveling in the form of waves, particles, or bundles called photons

radiation dose - amount of radiation absorbed by individuals or a population. This dose is usually expressed in rads (grays); the dose equivalent is usually expressed in terms of rem (sievert)

radiation (ionizing) - radiation that produces charged particles when passing through matter

radioactive (decay) - the undergoing of spontaneous nuclear transformation in which nuclear particles are emitted (see half-life)

radioactivity - a property possessed by some elements, such as uranium, whereby alpha, beta, or gamma rays are spontaneously emitted

radionuclide - a radioactive nuclide. There are several hundred known radioactive nuclides, both man made and naturally occurring; nuclides are characterized by the number of neutrons and protons in an atom's nucleus

reference individuals- representative, hypothetical members of population groups, representing selected age groups, subpopulations, and lifestyles at various locations

rem - the special unit of the dose equivalent; the radiation dose equivalent in rems is numerically equal to the absorbed dose in rads at the point of interest in tissues, multiplied by a quality factor, distribution factors, and all other modifying factors; one rem approximately equals one rad for X, gamma, or beta radiation

sensitivity analysis - an analysis that estimates the amount of variation in a model's output due to the variation in model's input

sievert - a unit of radiation exposure that indicates the potential impact on human organs (1 Sv = 100 rem)

source term - the amount and type of radioactive materials released to the environment

Technical Steering Panel (TSP) - The panel that provides independent technical direction for the Hanford Environmental Dose Reconstruction Project. The TSP is composed of experts in fields related to the project

unconfined aquifer - an aquifer that has a water table or surface at atmospheric pressure

uncertainty - the lack of sureness in the model's predictions or parameters

uncertainty analysis - analysis of the uncertainty in model predictions or parameters

validation - the process of confirming that the conceptual model and the derived computer code provide a good representation of the actual processes occurring in the real system. It is carried out by comparing calculations with field observations and experimental measurements

verification - the process of confirming that the conceptual model is adequately represented by the mathematical solution; it may be carried out by intercomparison of codes or by comparison of outputs of numerical codes with analytical solutions

APPENDIX G

ABBREVIATIONS FOR UNITS OF MEASURE AND CONVERSION TABLE

APPENDIX G

ABBREVIATIONS FOR UNITS OF MEASURE AND CONVERSION TABLE

TABLE G.1. Abbreviations for Units of Measure

<u>Radioactivity</u>		<u>Volume</u>	
<u>Symbol</u>	<u>Name</u>	<u>Symbol</u>	<u>Name</u>
Ci	curie	cm ³	cubic centimeter
mCi	millicurie (10 ⁻³ Ci)	L	liter
μCi	microcurie (10 ⁻⁶ Ci)	mL	milliliter (10 ⁻³ L)
nCi	nanocurie (10 ⁻⁹ Ci)	m ³	cubic meter
pCi	picocurie (10 ⁻¹² Ci)	ppm	parts per million
fCi	femtocurie (10 ⁻¹⁵ Ci)	ppb	parts per billion
aCi	attocurie (10 ⁻¹⁸ Ci)		
Bq	becquerel		
Sv	sievert		

<u>Length</u>		<u>Mass</u>	
<u>Symbol</u>	<u>Name</u>	<u>Symbol</u>	<u>Name</u>
km	kilometer (10 ³ m)	g	gram
m	meter	kg	kilogram (10 ³ g)
cm	centimeter (10 ⁻² m)	μg	microgram (10 ⁻⁶ g)
mm	millimeter (10 ⁻³ m)	ng	nanogram (10 ⁻⁹ g)
μm	micrometer (10 ⁻⁶ m)	t	metric ton (or tonne; 10 ³ kg)

<u>Area</u>		<u>Time</u>	
<u>Symbol</u>	<u>Name</u>	<u>Symbol</u>	<u>Name</u>
ha	hectare (10,000 m ²)	yr	year
		d	day
		h	hour
		min	minute
		s	second

TABLE G.2. Conversion Table

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>	<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
in.	2.54	cm	cm	0.394	in.
ft	0.305	m	m	3.28	ft
mi	1.61	km	km	0.621	mi
lb	0.454	kg	kg	2.205	lb
liq qt	0.946	L	L	1.057	liq qt
ft ²	0.093	m ²	m ²	10.76	ft ²
ha	2.47	acres	acres	0.405	ha
mi ²	2.59	km ²	km ²	0.386	mi ²
ft ³	0.028	m ³	m ³	35.7	ft ³
nCi/mi ²	0.386	mCi/km ²	mCi/km ²	2.57	nCi/mi ²
dpm	0.450	pCi	pCi	2.22	dpm
nCi	1000	pCi	pCi	0.001	nCi
pCi/L	10 ⁻⁹	μCi/mL	μCi/mL	10 ⁹	pCi/L
pCi/m ³	10 ⁻¹²	Ci/m ³	Ci/m ³	10 ¹²	pCi/m ³
pCi/m ³	10 ⁻¹²	mCi/cm ³	mCi/cm ³	10 ¹²	pCi/m ³
mCi/km ²	1.0	nCi/m ²	nCi/m ²	1.0	mCi/km ²
becquerel	2.7 x 10 ⁻¹¹	curie	curie	3.7 x 10 ¹⁰	becquerel
gray	100	rad	rad	0.01	gray
sievert	100	rem	rem	0.01	sievert
ppb	0.001	ppm	ppm	1000	ppb
ppm	1.0	mg/L	mg/L	1.0	ppm

TABLE G.3. Table of Unit Prefixes

<u>Factor</u>	<u>Prefix</u>	<u>Symbol</u>
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10^1	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

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