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OVERVIEW OF THE HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT

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Overview of the Hanford Environmental Dose Reconstruction Project

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BACKGROUND

The Hanford Environmental Dose Reconstruction (HEDR) Project was initiated as a result of public interest in the historical releases of radioactive materials from the Hanford Site. The Hanford Site, a 560-square-mile government reservation in Washington State (Figure 1)(PNL 1991c), produced weapons-grade plutonium beginning in 1944 . By 1986, over 38,000 pages of environmental monitoring documentation from the early years of Hanford operations had been released to the public. Special committees reviewing the documents recommended initiation of the HEDR Project, which began in October 1987.

OBJECTIVES

The objective of the HEDR Project is to estimate the radiation doses that specific and representative individuals and populations may have received as a result of releases of radioactive materials from historical operations at the Hanford Site. These dose estimates would account for the uncertainties of information regarding facilities operations, environmental monitoring, demography, food consumption and lifestyles, and the variability of natural phenomena. Other objectives of the HEDR Project include

- supporting the Hanford Thyroid Disease Study (HTDS),
- declassifying Hanford-generated information and making it available to the public,
- performing high-quality, credible science, and
- conducting the project in an open, public forum.

TECHNICAL APPROACH

The project was planned in phases. Phase I, completed in July 1990, was to determine the feasibility of conducting the study, including determining whether enough information of adequate quality could be found to accurately reconstruct doses. Another object of Phase I was to select existing models and adapt them to calculate preliminary dose estimates.

The technical approach taken in Phase I to reconstruct dose estimates and associated uncertainties was to

- reconstruct releases of radioactive materials based on facility operating information;
- select and adapt existing transport, pathways and dose models and computer codes;
- reconstruct environmental, meteorological, and hydrological monitoring information;
- reconstruct demographic, agricultural, and lifestyle characteristics of potentially affected populations;
- apply statistical methods to all forms of uncertainty in the information, parameters, and models; and
- peer-review the information acquisition, data evaluation, model development, calculations, and documentation.

The pathways by which people and the environment could have been exposed to radioactive materials from Hanford are shown in Figure 2 (PNL 1991c). Thus atmospheric releases would follow several pathways of exposure: submersion in contaminated air, inhalation of contaminated air, exposure to surfaces contaminated from atmospheric deposition, consumption of contaminated food crops, and consumption of contaminated animal products. Calculations for animal products such as milk were complicated by the fact that the milk could have been shipped to accumulation centers and then redistributed. Because of the interconnected nature of milk distribution, doses cannot be calculated for individuals in a particular location without knowledge of environmental conditions in many other locations. This model supports the calculation of doses to both reference individuals and specific individuals. (PNL 1991a). For surface-water releases, the exposure pathways are immersion (swimming or boating) in contaminated water, consumption of contaminated water, consumption of fish and other aquatic foods, and consumption of foods contaminated by irrigation with contaminated water.

The overall calculation of radiation dose is a sum of parallel pathway calculations. Although data for early atmospheric releases are limited, detailed effluent data are available for the releases from the operating production reactors during the period 1964-1966. In many instances, weekly or even daily rates are known. This information was used directly as source-term input to the surface-water transport calculation, without any need for to modeling. Dilution in the time-varying flow of the river as well as decay for the various associated travel times to locations of interest were accounted for by applying a simple routing model to the effluent data. The results of this model are in excellent agreement with the measured values. Data about radionuclide concentrations in fish have also been extensively monitored (PNL 1991b).

The Phase 1 study area for the air pathway covers the 10 counties nearest the Hanford Site (PNL 1991c). This area was selected to encompass those populations nearest the releases and therefore most likely to have been in the path of highest concentrations of radioactive materials. The radionuclide likely to have contributed most to doses to off-site populations was determined to be iodine-131 (Napier 1991a,b). More than 90% of the iodine-131 released since startup of the facilities was released in the period 1944-1947 (Anderson 1974). The Phase I air release studies therefore encompassed this period.

The Phase I study area for the Columbia River pathway includes the portion of the river between Priest Rapids Dam upstream of the Hanford Site and McNary Dam downstream (Figure 1). Several radionuclides are of interest for this pathway; eight were included in the Phase I calculations (Napier 1991b). Of these, phosphorus-32, neptunium-239, and zinc-65 were frequently the most significant. The period of 1964-1966 was investigated because during that period all eight river-cooled production reactors at Hanford were operating at high power levels, and also because significant quantities of historical monitoring data were available. Pathways of exposure included direct contact with the river water, drinking river water, and consumption of river fish.

PRELIMINARY RESULTS

Dose estimates for the air pathway from atmospheric releases were grouped according to whether representative individuals

- were infants or adults during 1944-1947
- drank or did not drink milk
- lived upwind or downwind of the site
- obtained milk from upwind or downwind of the site
- obtained milk from a commercial source or a family cow
- obtained milk produced by cows on pasture or on feed.

Dose ranges for representative individuals who may have lived downwind of the site and drank milk during the 1944-1947 period are given in Figure 3. Doses range from about 0.01 rad to the thyroid to about 700 rad to the thyroid.

Dose estimates for representative individuals who may have been exposed via the Columbia River were grouped according to whether they

- ate or did not eat Columbia River fish
- ate or did not eat more than 20 fish meals per year

- fished upstream of Richland and downstream of the reactors (near Ringold) or downstream of the City of Richland

- lived or did not live in Richland, Pasco, or Kennewick (cities closest to the Hanford Site that used water from the river for drinking)

Dose ranges for representative individuals in the most exposed groups--those who drank raw river water and ate more than 20 meals a year of fish caught between Hanford and Richland--are given in Figure 4. These doses range from about 0.02 rem effective dose equivalent to about 0.20 rem effective dose equivalent; these values are more than three orders of magnitude less than thyroid doses from the air pathway.

STATUS

Phase I of the Project was completed in July 1990, when the feasibility of reconstructing dose estimates was demonstrated for representative individuals who lived near the Hanford Site during early operation periods.

Current work emphasizes the reevaluation of the Phase I transport, pathways, and dose-estimating models. The models are being restructured to address deficiencies identified during Phase I and subsequent evaluations. Statistical methods are being modified to more appropriately reflect lack of knowledge and uncertainties in information, models, and computing processes. Source terms, monitoring data, demographics, agricultural practices, food consumption, and life habits of specific and representative individuals are being reconstructed for a wider area and for the entire Hanford operational period.

Five major reports have recently been released to the Technical Steering Panel, which leads the project, and to the public. These reports establish 1) the design criteria for restructuring the pathway and dose models and describe the current status of 2) the air transport model, 3) the pathway and dose models, 4) the impacts of radioactive materials in ground water, and 5) the Columbia River flow, related monitoring data, and potential doses from radioactive materials in the river.

SCHEDULE

The project is planned to continue through FY 1995. Currently planned major milestones are

- computer codes for estimating source terms, environmental transport, pathways, and radiation doses will be functional - early 1994

- preliminary radiation dose estimates will be performed for Native Americans - 1992

- dose estimates for the feasibility phase of the HTDS will be performed - late

1992

- source term, meteorological, demographic, agricultural, life-habit, and other parametric input data for models will be developed - end of 1993

- dose estimates for specific and representative individuals, the HTDS, and Native Americans will be completed - 1994-1995.

FIGURES

1. Location of Hanford Site and Key Operating Facilities

2. Ways People Could Have Been Exposed to Hanford Radioactive Materials

3. Adult and Infant Thyroid Dose Estimates for Downwind Locations in the HEDR Ten-County Study Area, 1944-1947

4. Bounding Case, Columbia River Pathway Dose Estimates, 1964-1966

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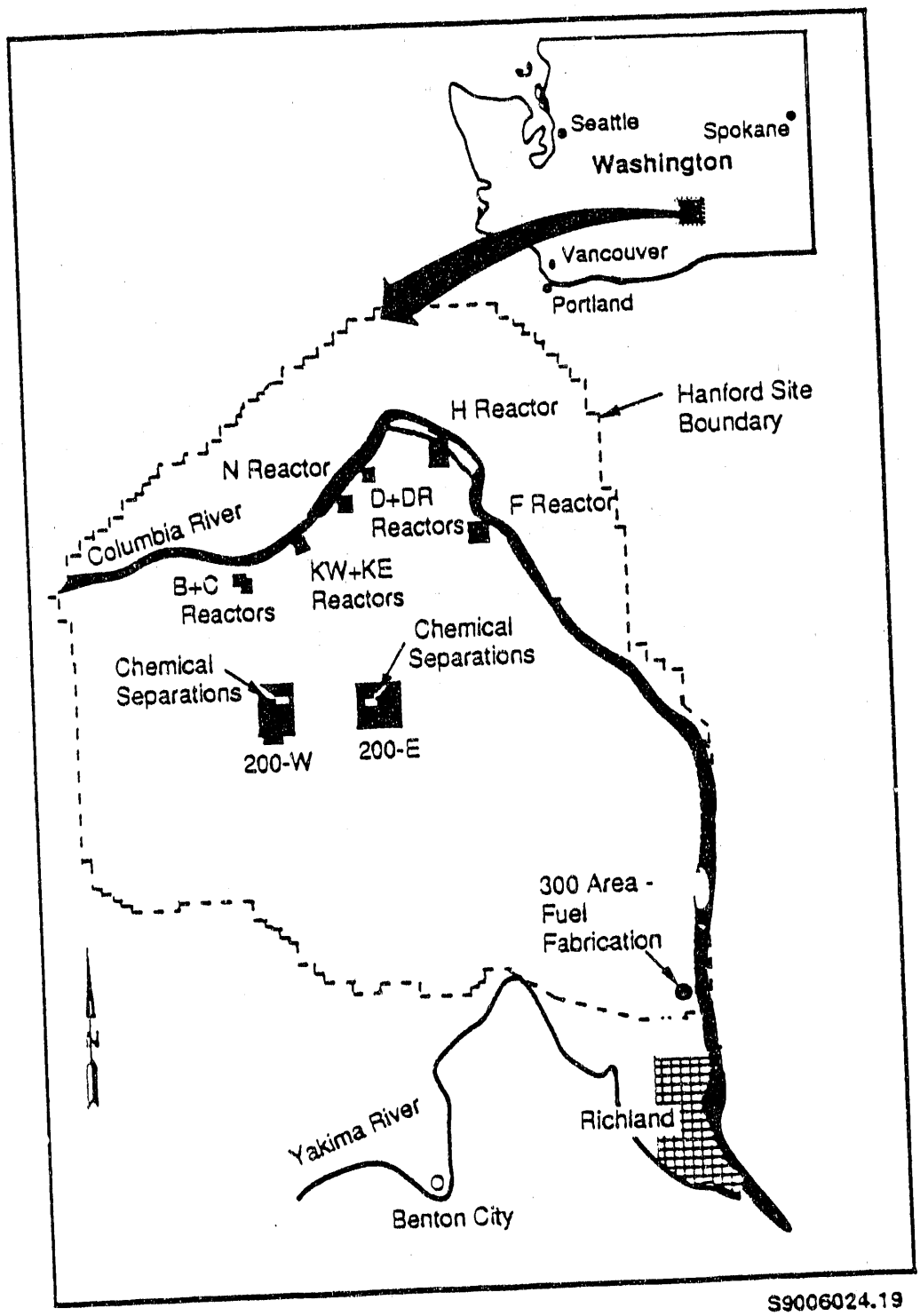

Hanford Site

Figure 1

Ways People Could Have Been Exposed to Hanford Radionuclides

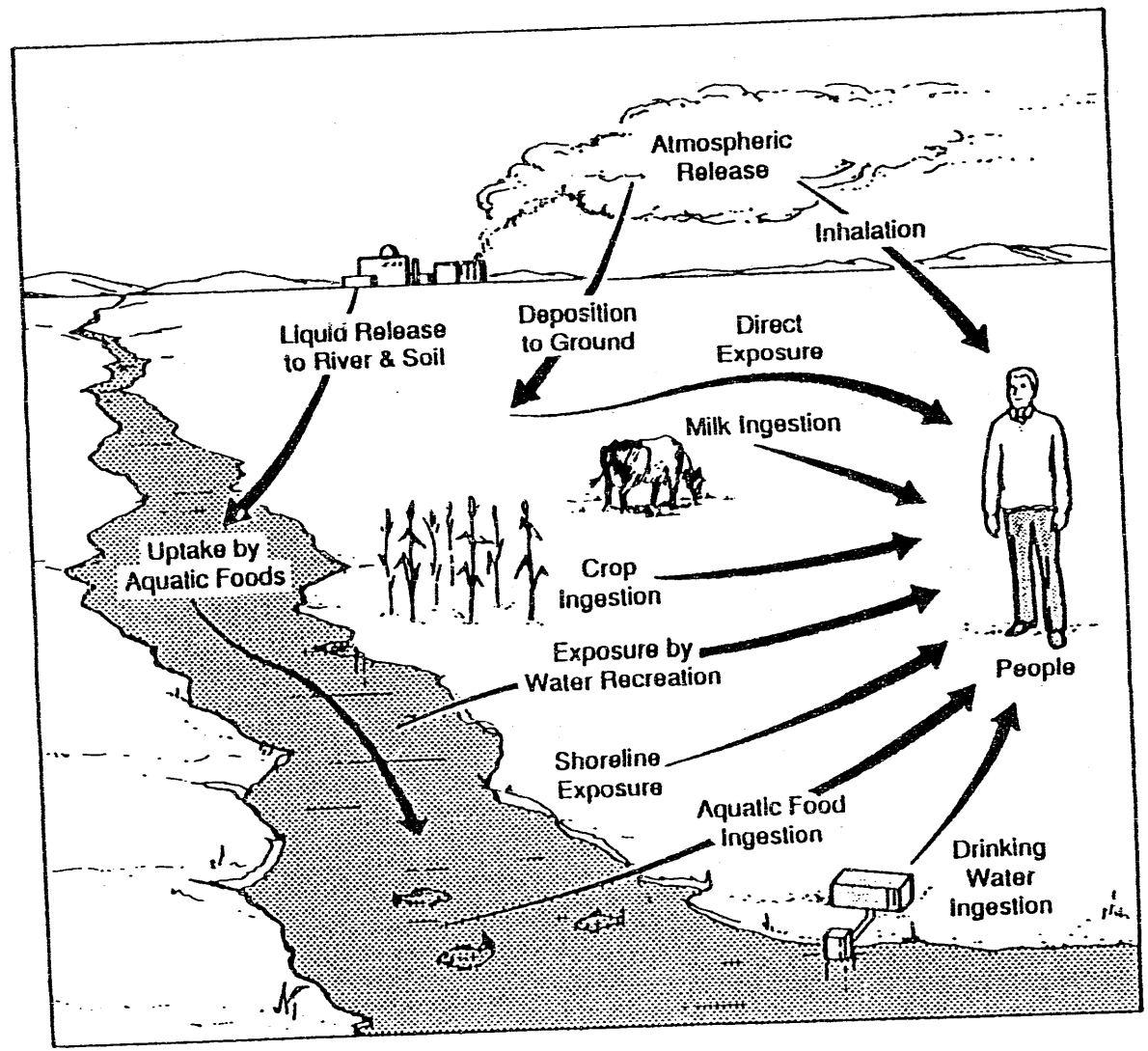

Figure 7

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Figure 1. Adult and Infant Thyroid Dose Estimates for Downwind Locations in the HEDR 10-County Study Area, 1944-1947

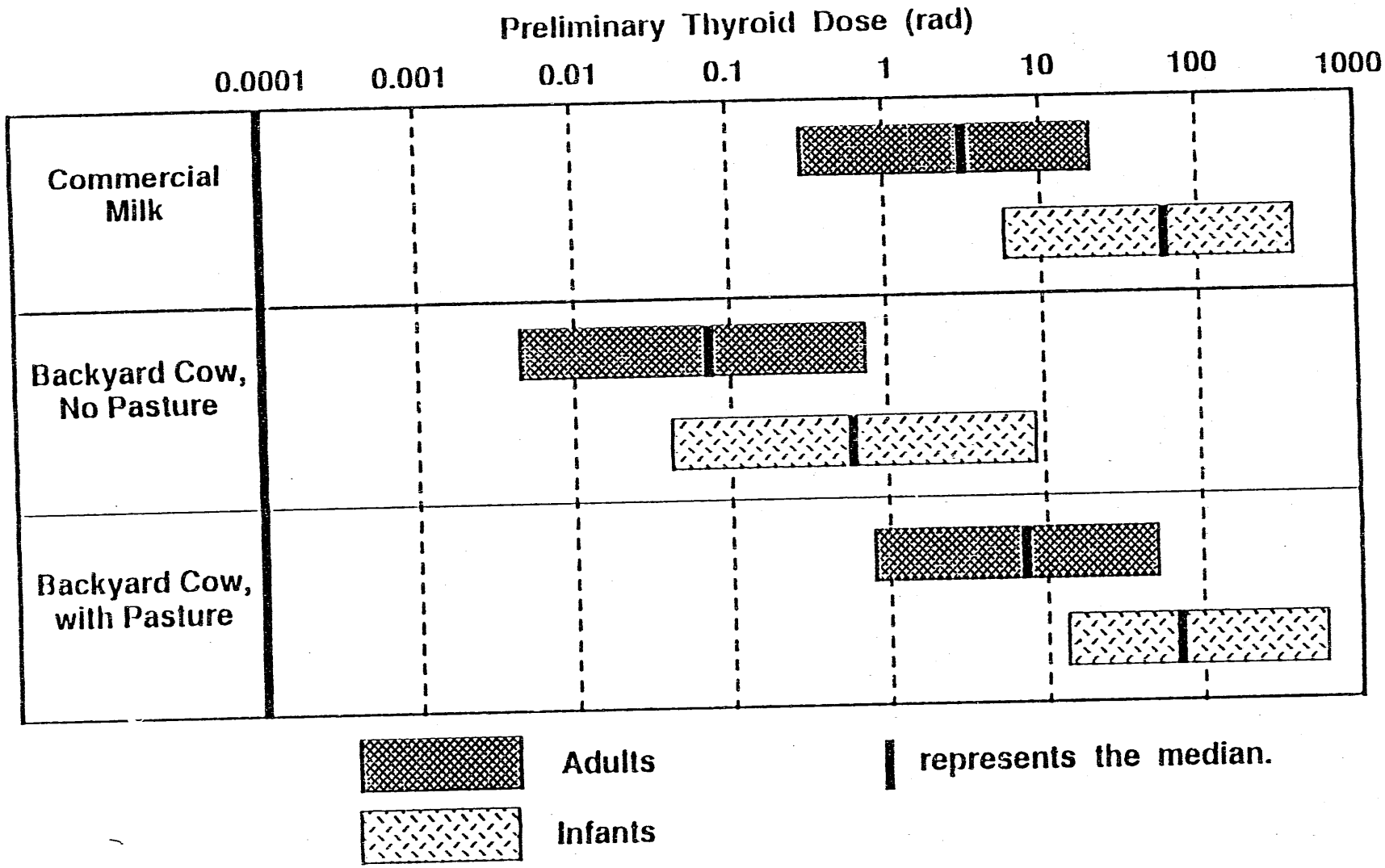
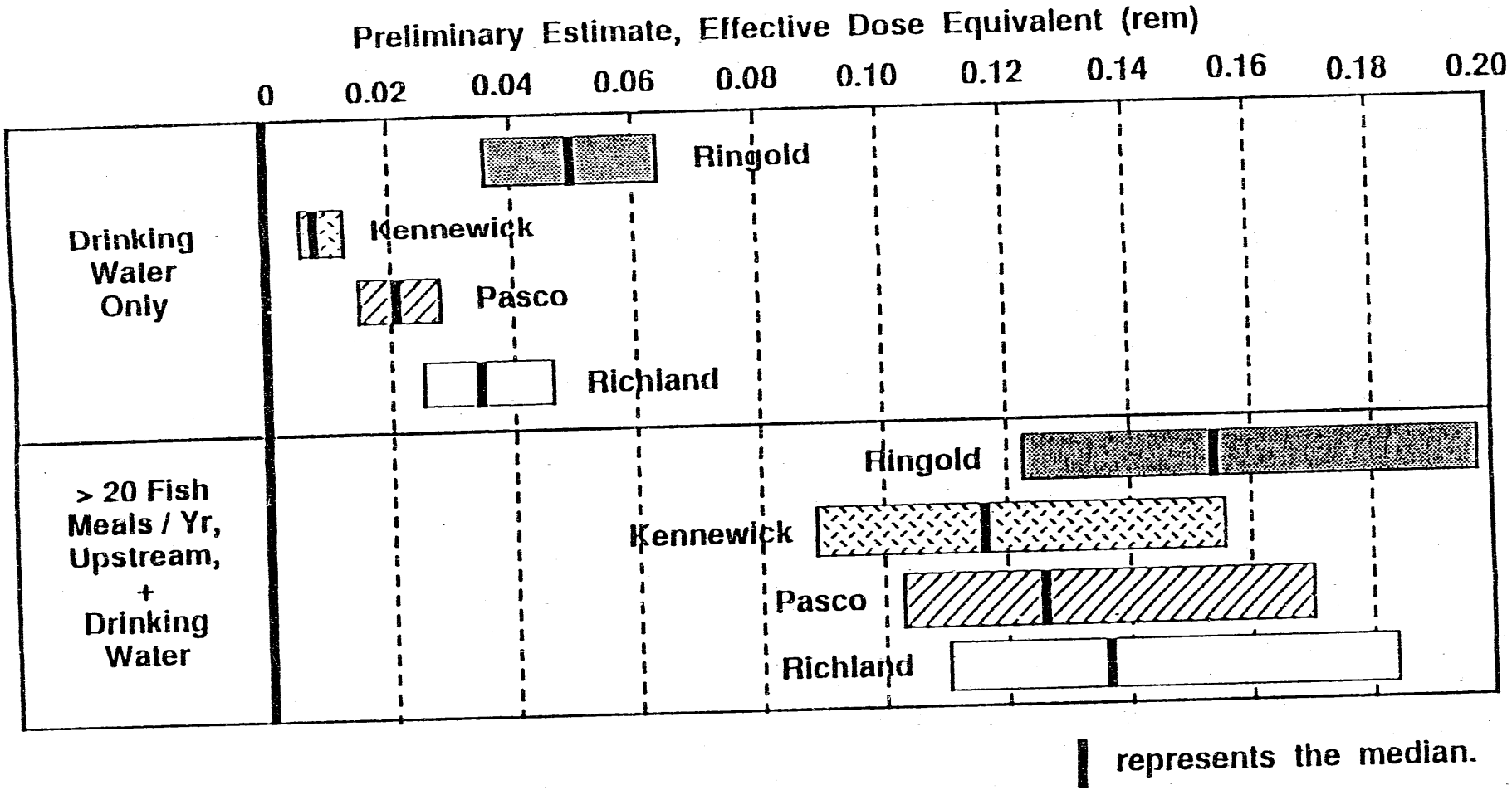


Figure 4. Bounding-Case Columbia River Pathway Dose Estimates, 1964-1966



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