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DRAFT AIR PATHWAY REPORT

Phase I of the Hanford Environmental
Dose Reconstruction Project

July 1990

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This report was prepared by staff at the Pacific Northwest Laboratory, which is operated by Battelle Memorial Institute, under the direction of an independent TSP. The work described here was directed and monitored by the TSP; however, this report has not yet been reviewed and approved by the TSP. At the TSP's direction, the report is being made available to the public at the same time it is provided to the TSP. The information contained herein is considered preliminary until it undergoes review by the TSP.

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PREFACE

This is one of three draft reports that summarize the first phase of a four-phase historical radiation dose assessment effort titled the Hanford Environmental Dose Reconstruction (HEDR) Project. This, the Draft Air Pathway Report, is directed to technical audiences, as is the Draft Columbia River Pathway Report. The Draft Summary Report, which presents both the air and river pathways, is intended for a general audience. Detailed descriptions of all aspects of the HEDR Project and the dose reconstruction process are available in more than 20 supporting documents (Appendix A).

The air pathway portion of Phase I has several objectives. Foremost among these is to determine that sufficient historical information exists or can be reconstructed from incomplete records to enable a dose reconstruction study to proceed and to demonstrate that this is the case. A second objective is to design conceptual and computational models to specifically deal with uncertainties in the dozens of variables needed to estimate historical doses to offsite populations. The final objective is to determine whether the data and models are sufficient to enable credible doses to be calculated. In summary, Phase I is a pilot or demonstration phase. The Phase I preliminary dose estimates, which were calculated to demonstrate the feasibility of reconstructing doses, will definitely change as input and model structures are refined in later phases.

The reader must recognize the preliminary nature of the dose estimates that are presented and discussed in this and the two companion reports. As the HEDR Project continues, the averages, ranges, and distributions of dose estimates will change, for at least three reasons. First, the input to models will be refined. Second, the models will be refined. Third, the extent of the study area will change. In general, a larger study area yields lower average doses, a greater range of doses, and a greater proportion of lower doses.

It is also important to note that the objectives of the HEDR Project do not include estimating risk or extrapolating to health effects that might have resulted from radiation exposures. A related epidemiological study, the

Hanford Thyroid Disease Study, is being conducted for the Centers for Disease Control by the Fred Hutchinson Cancer Research Center. This study will seek to determine whether there is a correlation between thyroid disease and estimated thyroid doses for residents near the Hanford Site.

The HEDR Project is directed by an independent Technical Steering Panel (TSP) of scientists and representatives of the states of Oregon and Washington, of regional Native American Tribes, and of the public. The TSP's charter is to direct, review, evaluate, and approve all HEDR Project work. Funding for the project is provided by the U.S. Department of Energy, but the agency is not in the review or approval cycle.

The work described here was conducted by Battelle staff at the Pacific Northwest Laboratory and was directed by the Technical Steering Panel (TSP). The U.S. Department of Energy funds the project, but provides no technical direction or oversight.

ABSTRACT

This report summarizes the air pathway portion of the first phase of the Hanford Environmental Dose Reconstruction (HEDR) Project, conducted by Battelle staff at the Pacific Northwest Laboratory under the direction of an independent Technical Steering Panel. The HEDR Project is estimating historical radiation doses that could have been received by populations near the Department of Energy's Hanford Site, in southeastern Washington State.

Phase I of the air-pathway dose reconstruction sought to determine whether dose estimates could be calculated for populations in the 10 counties nearest the Hanford Site from atmospheric releases of iodine-131 from the site from 1944-1947. Phase I demonstrated the following:

- HEDR-calculated source-term estimates of iodine-131 releases to the atmosphere were within 20% of previously published estimates.
- Calculated vegetation concentrations of iodine-131 agree well with previously published measurements.
- The highest of the Phase I preliminary dose estimates to the thyroid are consistent with independent, previously published estimates of doses to maximally exposed individuals.
- Relatively crude, previously published measurements of thyroid burdens for Hanford workers are in the range of average burdens that the HEDR model estimated for similar "reference individuals" for the period 1944-1947.

Preliminary median dose estimates summed over the years 1945-1947 for the primary pathway, air-pasture-cow-milk-thyroid, ranged from low median values of 0.006 rad (0.00006 Gy) for upwind adults (4.5% of the Phase I population) who obtained milk from backyard cows not on pasture to high median values of 68.0 rad (0.68 Gy) for downwind infants who drank milk from pasture-fed cows (0.5% of the Phase I population).

About 0.004% of the Phase I population was estimated to have received thyroid doses exceeding a previously published estimate (Washington State Department of Social and Health Services 1986) of 2,530 rem to a maximally exposed infant in Pasco, 1945-1947. Future work will expand the time, area, and radionuclides considered.

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EXECUTIVE SUMMARY

This is one of three draft reports that summarize Phase I of a four-phase historical radiation dose assessment effort titled the Hanford Environmental Dose Reconstruction (HEDR) Project. Preliminary dose estimates were calculated to demonstrate the feasibility of reconstructing doses. These estimates will definitely change as input and model structures are refined in later phases.

BACKGROUND

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. The Site was selected in 1943 (Figure 1) as the location for the plutonium-production facilities for producing atomic bombs used in World War II. The first three nuclear reactors began operating in 1944 and 1945. Chemical separation plants T and B were started up in December 1944 and April 1945. The greatest releases of radionuclides to the atmosphere from Hanford operations came from these separations facilities.

Releases of radioactive materials from Hanford were controlled through several steps, beginning with process controls and ending with feedback from personnel monitoring. Each of these control measures and their relative contribution in controlling emissions changed as experience was gained in control and monitoring technology and as knowledge was gained about the potential for health effects from radiation exposure.

Effluent monitoring, which began with the startup of Hanford facilities in 1944, consisted of measuring the amounts of radioactive materials vented to the atmosphere and released to soils and to the Columbia River. Efforts to develop technology to accurately measure atmospheric releases continued for several years before measurements became reliable. In the interim, atmospheric releases were estimated from process information and from estimated filter efficiencies, when effluent filters were installed beginning in 1948 (Ballinger and Hall 1989).

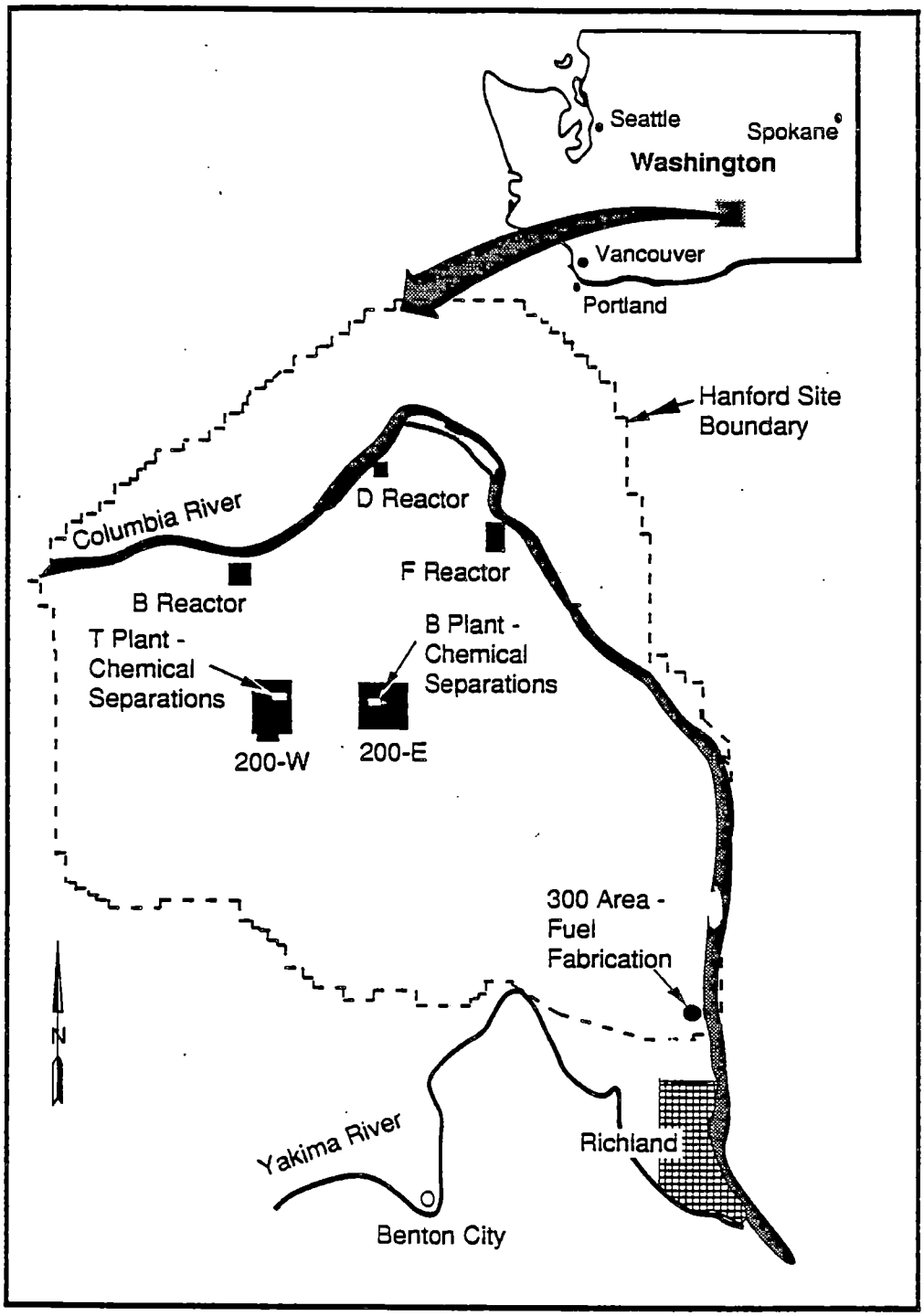

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FIGURE 1. Hanford Site and Key Operating Facilities, 1944-1947

Meteorological measurements and observations of plume behavior began in 1943 in efforts to predict the path and concentrations of atmospheric releases of radioactive materials. Not until the mid-1950s, however, did researchers discover the possibility of milk as an important pathway for radioactive iodine (Parker 1956, Comar et al. 1957). Consequently, milk, the major pathway for iodine-131, a pathway that resulted in exposures from 10 to more than 100 times as high as the pathway via inhalation, was not monitored during the period of highest releases of iodine-131, from 1944 through 1947.

Onsite personnel monitoring of radiation exposure began when Hanford employees first began working at the site (Wilson 1987). In addition to measuring external exposure using pencil dosimeters, hand and foot counters, and scans of clothing and extremities with Geiger counters, a bioassay program and limited scans of the thyroid glands of specific workers were also begun. The thyroid measurements provided an important check on exposures of offsite populations estimated by the HEDR Project.

PHASES

The HEDR Project consists of four distinct phases. The first phase of the air pathway portion of HEDR, a pilot or demonstration phase, was purposely limited to geographic coverage of 10 counties nearest Hanford (Figure 2), to the period from December 1944 through December 1947, and to one radionuclide, iodine-131. The unit of months was selected as the level of temporal resolution for Phase I. These factors influenced the selection of models and parameters and resulted in some conservatism in the designation of the ranges and forms of distributions.

Phase II is designated a review and testing phase, during which sensitivity analyses will be used to identify key parameters and the effects of model structure on dose estimates. Phases III and IV will be used to refine parameters, modify models, expand areas, extend time periods, and ensure that all key emissions of radioactive materials from Hanford will have been addressed.

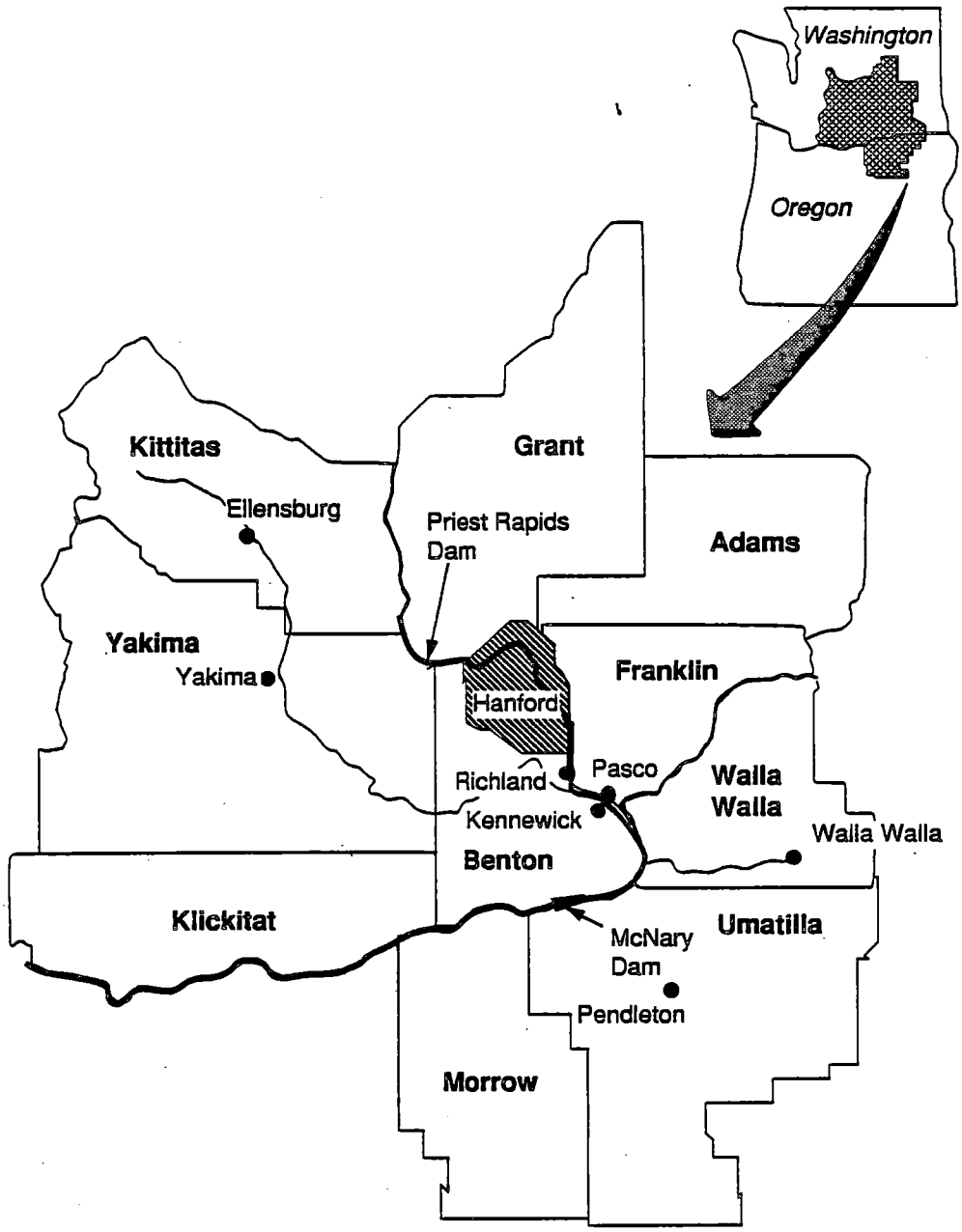

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FIGURE 2. Phase I Study Area (Counties) for the Air Exposure Pathway

APPROACH

A simplified project conceptual-logic diagram for calculating doses from atmospheric releases is shown in Figure 3. Generic pathways are 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. Input to the HEDR model consists of distributions for most of the parameters, rather than point estimates, an approach that results in distributions of dose estimates.

This approach incorporates estimates of uncertainties resulting from spatial and temporal variability, incomplete historical information, sampling errors, and unavoidable biases in individuals' recall of lifestyle and food-habit information from the 1940s. This approach also provides a basis for focusing project resources on reducing uncertainties of key parameters and refining the model structure through the application of sensitivity and uncertainty analyses. Distributions of doses were calculated for "reference" individuals, individuals who shared combinations of characteristics such as age, sex, lifestyle, food habits, geographic locations, etc. These distributions were also combined into distributions representing selected populations.

Source Term

In the early years of Hanford Site operations, technology did not permit monitoring for specific radionuclide emissions. Therefore, modeling of emissions was required for Phase I calculations. Estimates of amounts of irradiated fuel processed were based on records, reports, and a calculation of iodine-131 content in the spent fuel. The important input parameters of fuel irradiation history and cooling time were estimated from the previously published accounts. The calculations were within 20% of estimates made using other techniques (Anderson 1974).

Atmospheric Transport

An interim atmospheric transport and dispersion model was developed for Phase I by modifying an existing version of the MESOI code (Ramsdell, Athey,

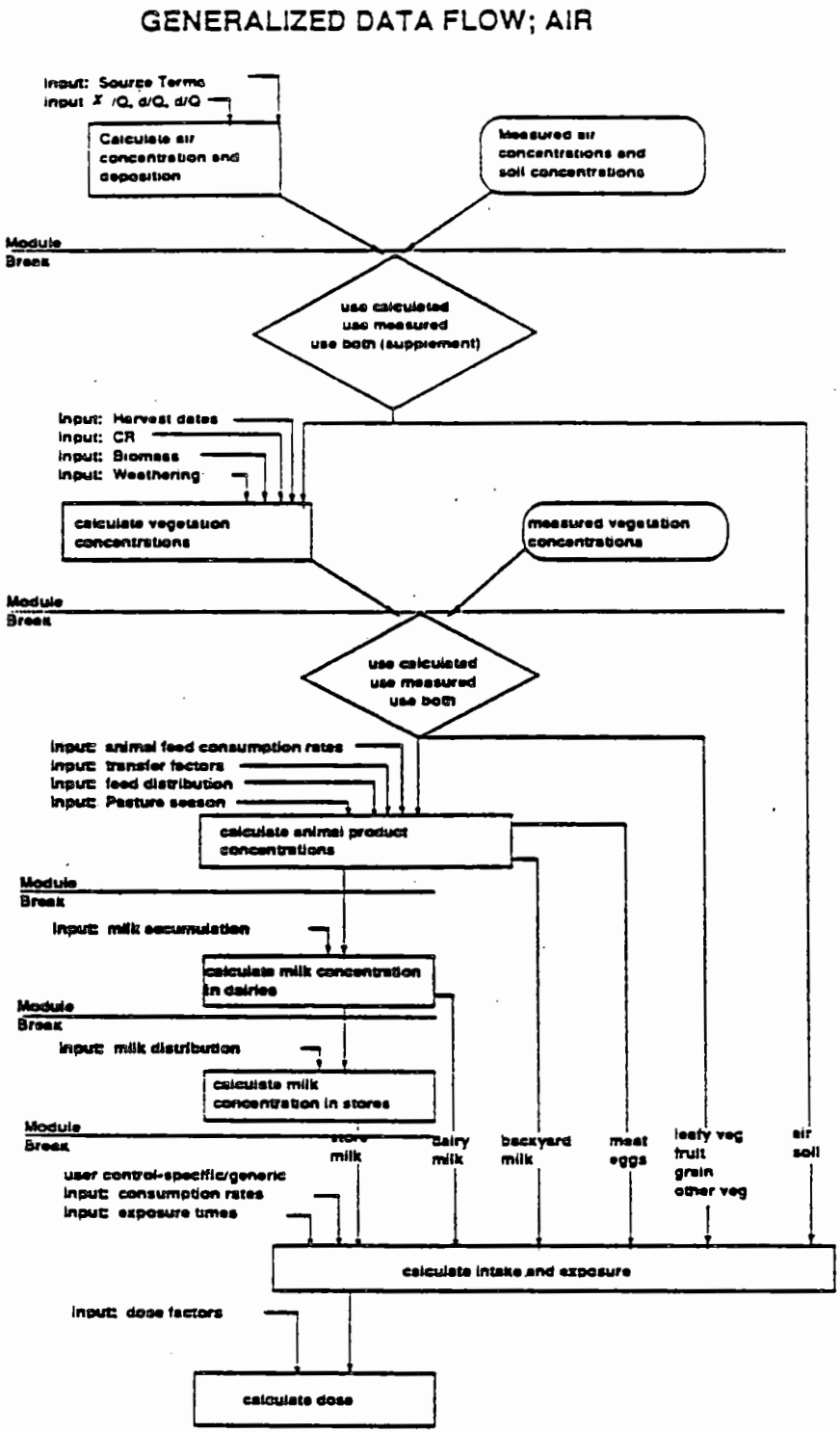

FIGURE 3. Conceptual-Logic Diagram for Calculating Doses from Atmospheric Releases

and Glantz 1983). The HEDR-modified version, called MESOILT2 (Ramsdell 1990), simulates the transport and diffusion of continuous plumes by dividing the plumes into discrete increments, referred to as "puffs." The code generates puffs every 15 minutes at the source; the puffs are transported by the wind until they leave the model domain. As the puffs move, they expand (i.e., diffuse) in response to turbulence, and airborne material is deposited as it comes in contact with the ground surface or is washed out by precipitation (washout was not considered in Phase I). The code also simulates radioactive decay. The wind fields and atmospheric stability data used by the model are updated each hour by interpolation from meteorological observations made at 3-h intervals.

A square model domain was selected for atmospheric transport modeling in Phase I. Physically, the domain extends east from the Cascade Mountains to approximately the Washington-Idaho border and south from Spokane to just below Pendleton.

MESOILT2 was used to compute monthly average radionuclide concentrations in the atmosphere, monthly average rates of radionuclide deposition, and month-end surface contamination at nodes within the model domain for a constant monthly release of iodine-131 from a stack between the 200-W and 200-E Areas. Atmospheric-transport calculations were based on meteorological conditions for January 1983 through December 1987, because the meteorological data for 1944 through 1947 were not available in time to be used in the Phase I atmospheric-transport calculations. Meteorological data for 1944-1947 became available after the Phase I atmospheric transport and diffusion calculations were completed. Estimates made with the 1983-1987 meteorological data do not differ greatly from those made with the 1944-1947 data. Thus, it is reasonable to conclude that using the 1983-1987 meteorological data in Phase I does not invalidate the results of the calculations or prevent the achievement of Phase I objectives.

Deposition/Interception

Most simulations of dry-deposition phenomena have attempted to lump many parameters into a "deposition velocity." This approach has been used in Phase I as a preliminary estimator. The project will eventually incorporate

a model that accounts for atmospheric conditions and radionuclide properties to provide the net wet and dry flux out of the plume. The current Hanford model (Napier 1988) uses a variable interception fraction that is a function of vegetation biomass. The interception fraction is based on the model of Chamberlain (1970). It generally results in a higher value of interception than the older constant-fraction characterization.

Concentrations in Foods

The concentration of radionuclides in animal products depends on the concentration in the animal's feed and on how much of the feed the animal consumes. In Phase I, which considered only dairy cattle, up to four types of feed (pasture, silage, hay, and grain) were considered. The location of feed production areas adds another dimension to the factors that influence milk concentrations.

Food products such as milk may be consumed directly by members of the producing farm family, or they may be sold. Most products that were sold were purchased for redistribution by distributors (such as milk purchases by creameries). These distributors tended to blend or average their inventory over a number of producers.

Demographic/Dosimetric Variables

The Phase I area was divided into 98 areas. With minor adjustments, these are county census divisions. The demographics of each census division are accounted for by providing estimates for individuals differentiated by age, sex, diet, and general lifestyle.

Eventually, seven age groups, based on the resolution provided by available data (with the inclusion of fetal thyroid), will be considered. For Phase I, only the adult and infant categories were investigated.

For each "reference individual" category (as defined earlier), distributions were prepared on monthly consumption rates of the following foods:

- leafy vegetables
- other (protected) vegetables and root vegetables
- grains (generally dried and stored)
- orchard fruits, berries, melons
- milk.

Because the aquatic pathway was not included for the 1944-1947 period, fish were not considered. Phase I assumed that all vegetables and fruits were produced locally. Most of the Phase I effort was focused on reconstructing the production and distribution of milk, because of the importance of the pasture-cow-milk-thyroid pathway for iodine-131.

Calculational Framework

The logic diagram of Figure 3 indicates "module breaks" for individual portions of the dose calculation. These module breaks define individual portions of the computer code that can be run in a stochastic simulation (Monte Carlo analysis). Because of the interconnected nature of the cow/feed/milk distribution model, no doses can be calculated for individuals in a particular census subdivision without knowing the environmental conditions in many other locations. The dose calculation has been structured into modules so that repetitive calculations are minimized, and information on the potential distributions of environmental parameters such as air concentration, vegetation concentration, or milk concentration can be saved and examined for each period. This approach results in the loss of some correlation information, but the losses do not detectably alter the dose distributions. This issue will be examined further in Phase II.

PRELIMINARY RESULTS

Phase I results demonstrate that the key objectives were attained. First, sufficient historical information was retrieved and reconstructed. Second, preliminary conceptual and computational models were constructed to deal with uncertainties and to establish the foundation for extensive sensitivity analyses to be conducted in Phase II. Finally, the data and modeling approach produced credible, although clearly preliminary, dose distributions. These objectives were attained by demonstrating that

- the source-term estimates agree well with previsouly published estimates
- calculated vegetation concentrations are consistent with previous measurements in several locations
- the range of preliminary dose estimates encloses independent estimates of doses to maximally exposed individuals, and

- relatively crude, previously published measurements of thyroid burdens of workers are in the range of average burdens that the HEDR model estimated for similar "reference individuals."

Dose Estimates

Preliminary doses estimated for 1945, 1946, and 1947 and summed over 1945-1947 for the entire Phase I study population from the consumption of milk contaminated with iodine-131 are illustrated by complementary cumulative distribution functions in Figure 4. Doses, clearly greatest in 1945, ranged over several orders of magnitude. About 10% of the population in the Phase I study area was likely to have received more than 15 rad to the thyroid (0.15 Gy) for the period January 1945 through December 1947 from the milk pathway. Distributions of dose estimates for other pathways are shown in Figure 5.

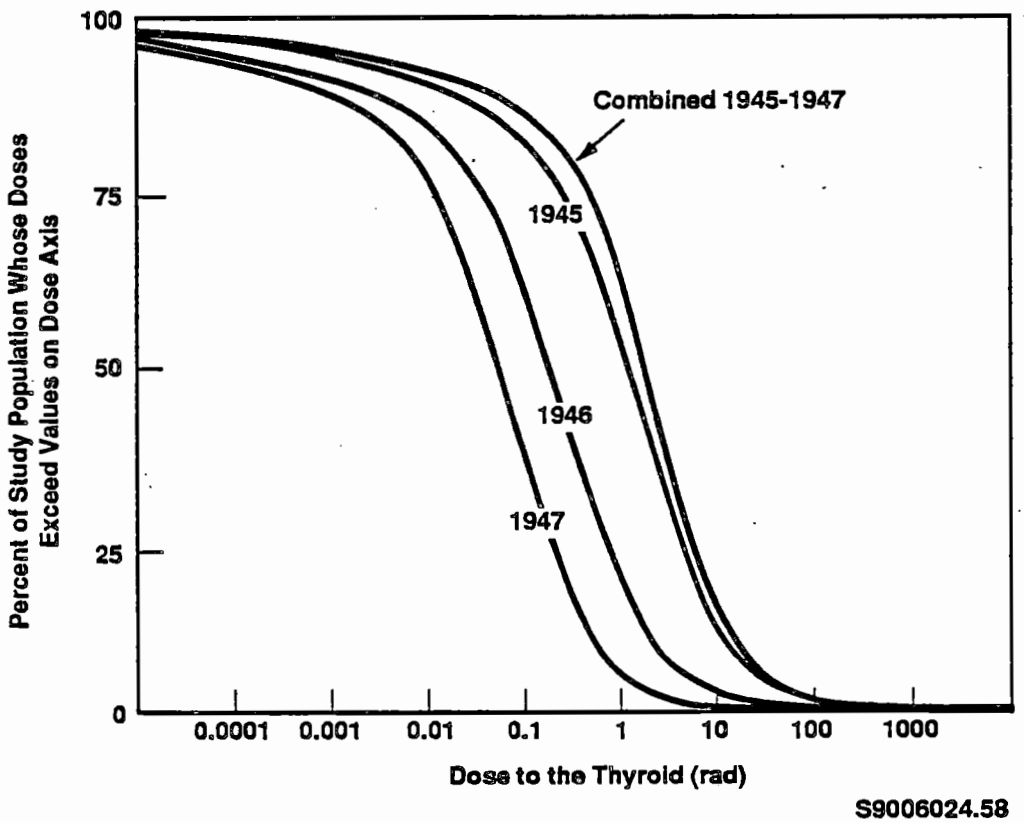

FIGURE 4. Preliminary Dose Estimates from the Milk Exposure Pathway, 1945, 1946, and 1947 and Total

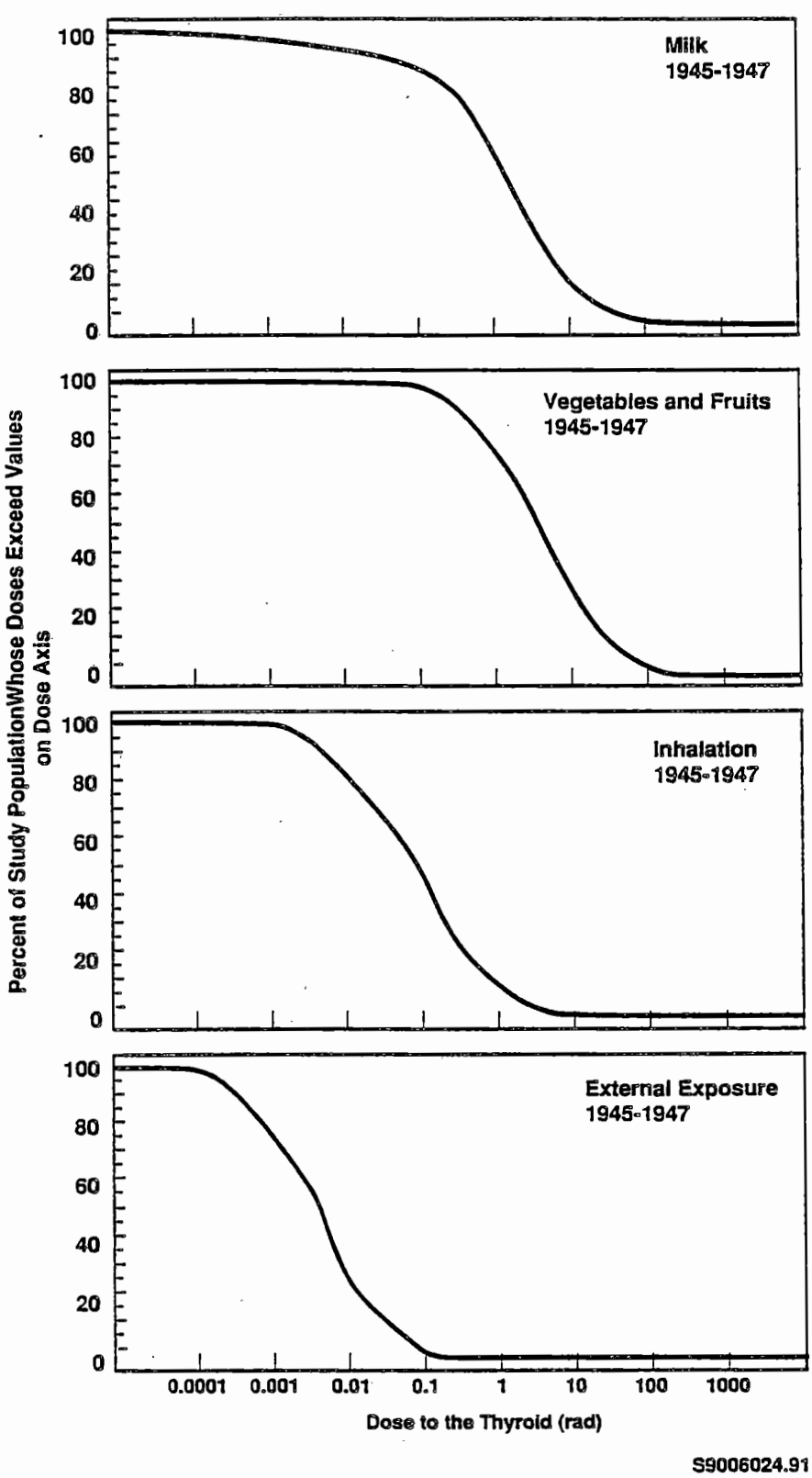

FIGURE 5. Distributions of Doses for All Pathways, for Phase I Area Population, 1945-1947

Doses from the separate pathways cannot be summed into a total dose. The preliminary dose distributions for produce and animal products other than milk are limited to the assumption that all fresh vegetables, fruits, and grain were grown within each census district. Consequently, these distributions reflect maximally exposed individuals only, and do not represent the true range of doses from the consumption of foods other than milk. Phase II will address the need to develop an agricultural production/distribution model similar to the milk model used in Phase I. Nevertheless, doses to infants from the consumption of locally produced milk are clearly several times greater than doses from the consumption of locally produced vegetables, fruit, and grain (Figure 6).

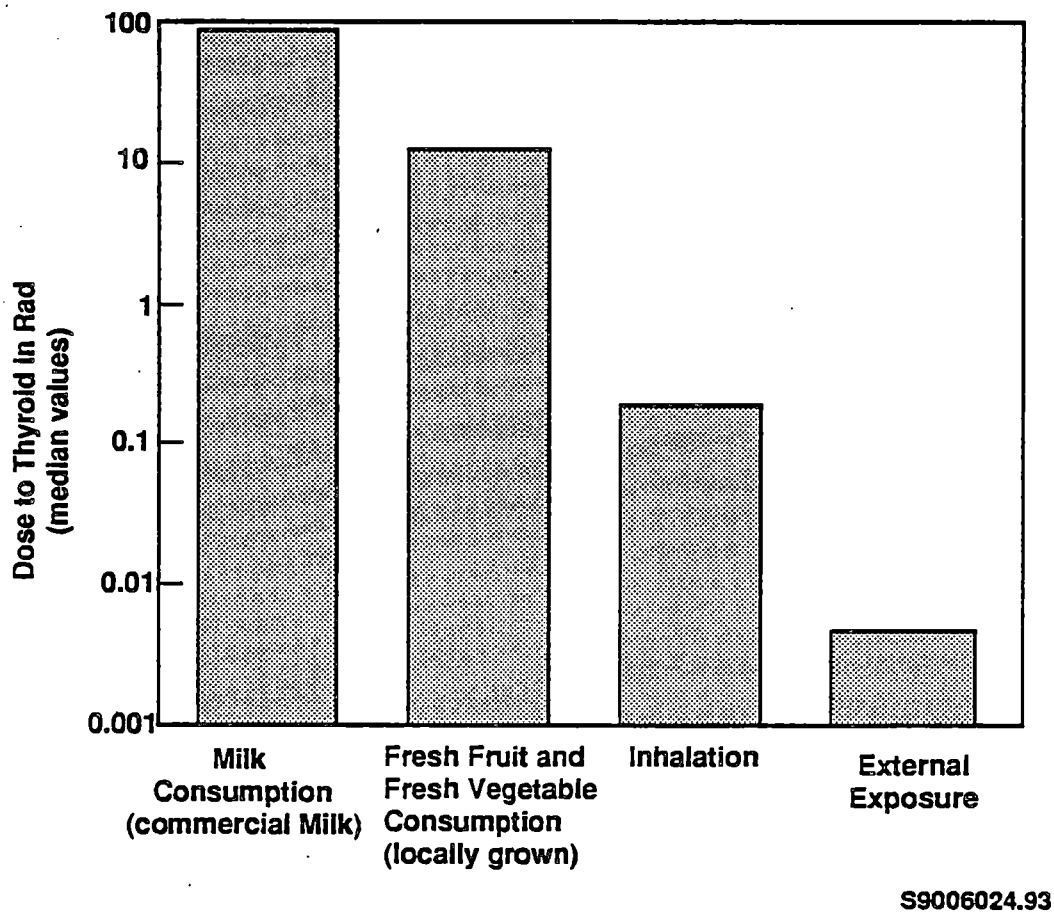

FIGURE 6. Relative Importance of Various Pathways, Based on Median Values (downwind Walla Walla infant, milk from dairy cows on pasture, locally grown vegetables and fruit, 1945-1947)

Comparison of Dose Estimates with Independent Information

In 1986, the Washington State Department of Social and Health Services (DSHS) (Washington State Office of Radiation Protection 1986) issued preliminary dose estimates for infants in Pasco. These preliminary estimates were based on previously published measurements of iodine-131 on sagebrush. The DSHS used a slightly modified model for a maximally exposed individual as provided in U.S. Nuclear Regulatory Commission (USNRC) Regulatory Guide 1.109 (USNRC 1977). About 0.004% of the Phase I population was estimated to have received thyroid doses exceeding the DSHS estimate of 2,530 rem to a maximally exposed infant in Pasco, 1945-1947.

From the time Hanford operations began, workers in areas likely to experience relatively higher air concentrations of iodine-131 had their thyroids checked with a portable radiation detector. The thyroid checks were used not to obtain highly accurate measurements but as a screening tool to detect potential exposures exceeding 10% of the then "tolerance" dose of about 1 rad/24 h. The median dose estimate based on the thyroid counts is somewhat greater than the median thyroid dose from inhalation calculated by the HEDR Project for adults in Richland during the non-grazing season of 1945-1946.

Comparison of Dose Estimates with Background Radiation

One way of placing the preliminary Phase I doses in perspective is to compare the doses with background radiation. Such a comparison requires the use of risk and weighting factors developed by the International Commission on Radiological Protection (ICRP). These factors were developed for radiation protection and therefore are purposely conservative. In particular, the ICRP factors are based on effects of high-dose, high-dose-rate external radiation, whereas major contributors both to background exposures and exposures from Hanford are relatively low-dose, low-dose-rate internally deposited radionuclides. With these caveats, the preliminary Phase I dose estimates for the air pathway are compared with cumulative doses from background radiation.

Approximately 5% of the Phase I study area population, or about 13,000 people, might have received cumulative doses [Effective Dose

Equivalent (rem)] from the milk pathway that were higher than the national, average background added over 3 years (0.36 rem annually, which includes radiation from natural and medical sources) (Figure 7). About 1% of the study population, or about 3,000 people, might have had doses from the milk pathway greater than the national average lifetime dose from background radiation.

Sources of Uncertainty and Future Work

Uncertainties in the preliminary Phase I dose estimates result from parameter uncertainties, model uncertainties, and variability (Finkel 1990; IAEA 1989). The extent of these uncertainties and their contributions to the uncertainty in dose estimates will be assessed during Phase II of the project.

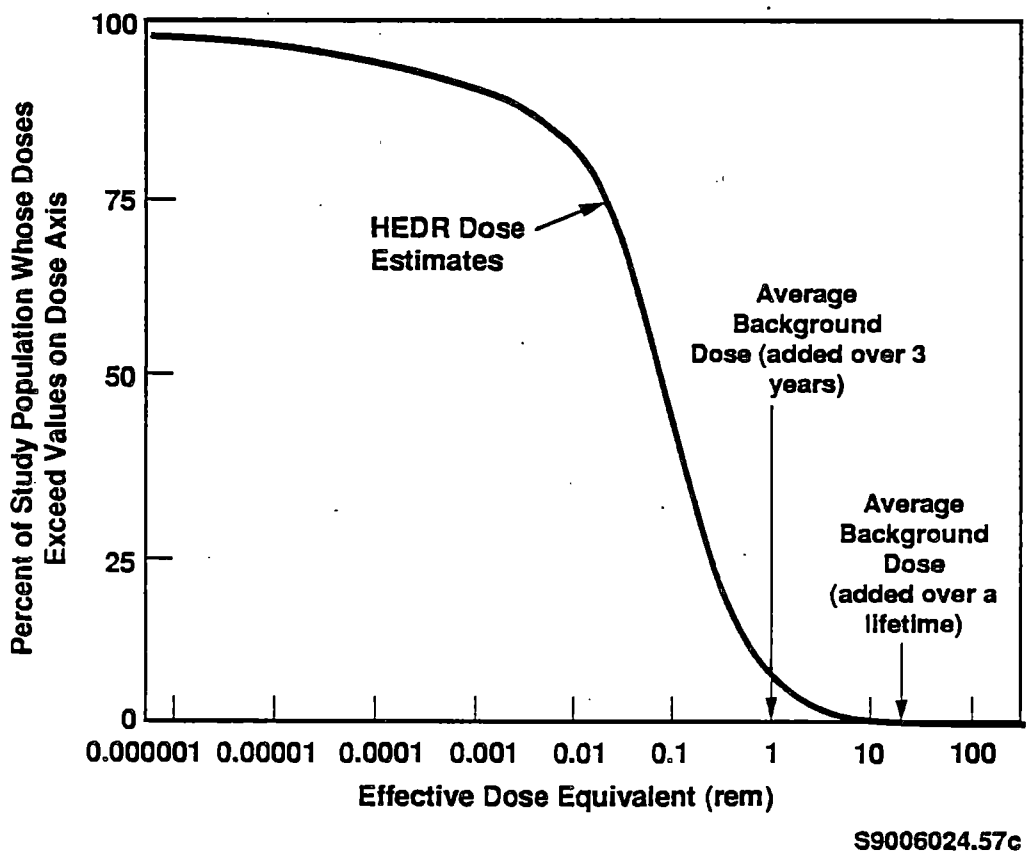

FIGURE 7. HEDR Preliminary Dose Estimates (milk exposure pathway) Compared with Background Radiation

Future dose estimates will change as efforts are made to reduce uncertainties in key variables and as the model structure is modified. These changes will include reductions in uncertainty and changes in mean and median values. Of the contributors to uncertainty/variability in dose estimates that were listed above, reductions in uncertainty in the atmospheric transport/deposition parameters and submodels are the most likely to result in the greatest reductions in uncertainties in the dose estimates.

In future HEDR work, doses will be estimated for an expanded time, a larger geographic area, a greater number of radionuclides, and additional pathways. In the interim, it is likely that iodine-131 releases accounted for more than 80% of cumulative doses to individuals in downwind areas from the atmospheric pathway from 1944 to the present. This is because most of the iodine-131 released from the Hanford Site from 1944 to the present was released during 1944-1947 and because iodine-131 accounted for more than 90% of the doses during 1944-1947.

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1.0 INTRODUCTION

1.1 PROJECT OBJECTIVES

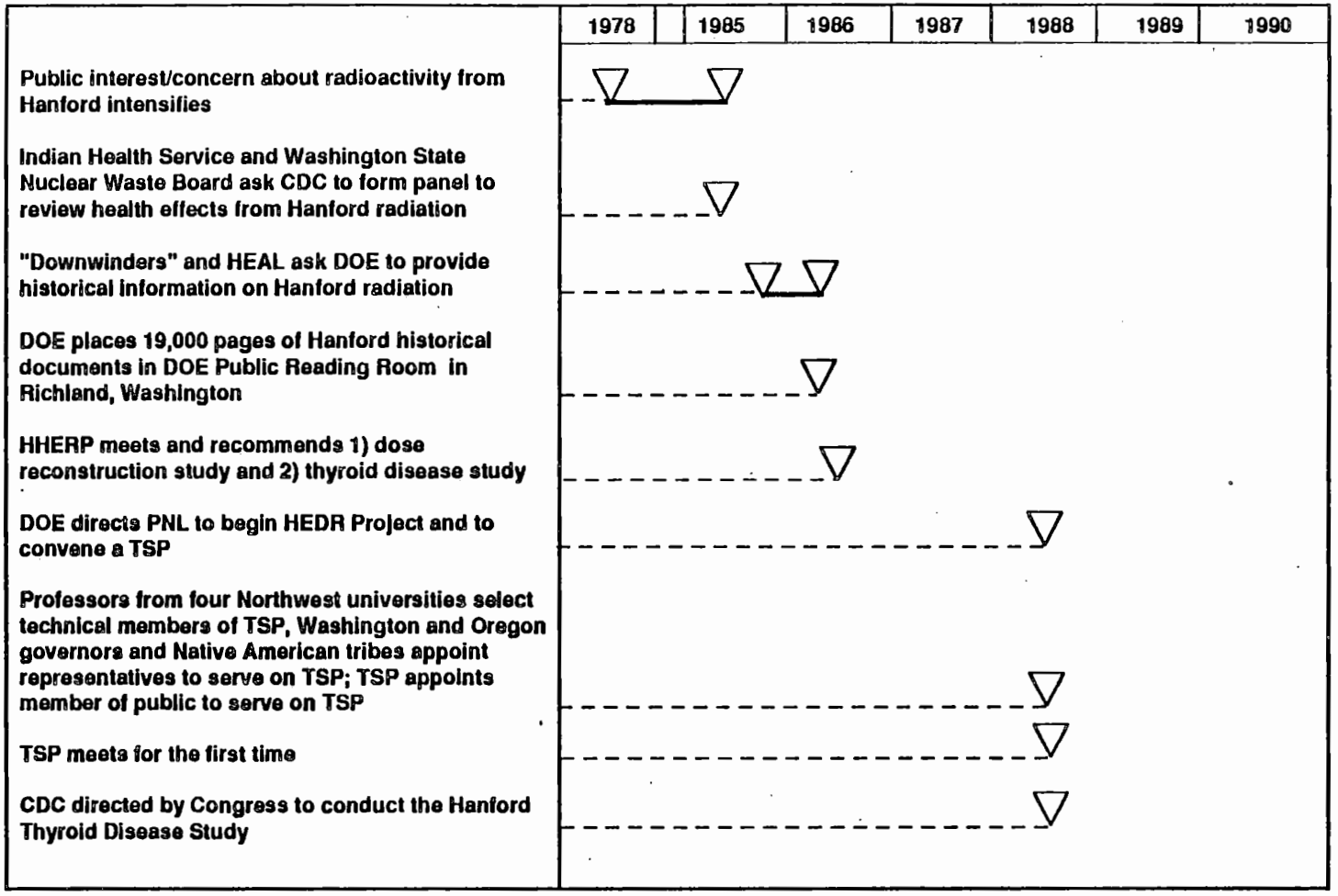
The primary objective of the HEDR Project is to estimate the radiation doses that people could have received from nuclear operations at the Hanford Site. The secondary objective is to make project records available to the public. Copies of project records are maintained in the Department of Energy - Richland Operations (DOE-RL) Public Reading Room in the Federal Building, Richland, Washington.

1.2 PROJECT HISTORY

The HEDR Project was prompted by mounting concern about possible health effects to the public resulting from more than 40 years of nuclear operations at the Hanford Site (Figure 1.1). In 1986, the Hanford Health Effects Review Panel--convened by the Centers for Disease Control at the request of the Washington State Nuclear Waste Board and the Indian Health Service--recommended as a top priority that potential doses from radioactive releases at the Hanford Site be reconstructed. The Panel also recommended that a thyroid disease study be initiated.

Representatives from the states of Washington and Oregon, from three regional Native American tribes, and from the U.S. DOE agreed that a dose reconstruction study should be funded by the DOE, be conducted by Battelle staff at the Pacific Northwest Laboratory, and be directed by an independent panel of scientists and state and Native American representatives. A TSP was deemed necessary to provide credible, independent scientific direction and to provide a forum for participation by the states, Native American tribes, and the public.

Representatives from four Northwest universities selected the technical members of the independent TSP, which directs the dose reconstruction work. The TSP includes members with technical expertise in environmental pathways, epidemiology, surface-water transport, ground-water transport, statistics, demography, agriculture, meteorology, nuclear engineering, radiation dosimetry, and cultural anthropology. The TSP also includes individuals



CDC = Centers for Disease Control
DOE = U.S. Department of Energy, Richland Operations
HEAL = Hanford Education Action League
HHERP = Hanford Health Effects Review Panel
PNL = Pacific Northwest Laboratory
TSP = Technical Steering Panel
HEDR = Hanford Environmental Dose Reconstruction (Project)

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FIGURE 1.1. Timeline of Events Leading to Establishment of HEDR Project

representing the states of Washington and Oregon, cultural and technical experts nominated by the Native American tribes in the region, and an individual representing the public. The TSP reviews, evaluates, and approves all technical decisions and reports.

A separate thyroid-disease study is being conducted in the Hanford area by the Fred Hutchinson Cancer Research Center for the Centers for Disease Control.

1.3 HANFORD SITE

The Hanford Site in southeastern Washington State (Figure 1.2) was selected in 1943 as the location for the facilities used to produce plutonium for atomic bombs used in World War II. The fuel cycle is illustrated in Figure 1.3. Of the three primary processes, fuel fabrication, irradiation, and separation, separation resulted in the greatest releases of radionuclides to the atmosphere. The separation process is the focus of the Air Pathway Report.

The first three nuclear reactors--B, D, and F--began operating in 1944 and 1945. Chemical separation plants T and B were started up in December 1944 and April 1945, respectively. After World War II ended in 1945, the reactors continued to irradiate uranium fuel and to produce plutonium. From 1949 through 1963, six new reactors--H, DR, C, KW, KE, and N--and four new separations plants--C, REDOX, U, and PUREX--began operating.

From 1964-1988, as the government needed less plutonium, it eventually closed all of its production reactors and separations plants, except the PUREX Plant. The PUREX Plant, which was shut down from 1972 to 1984, continues to be available to process plutonium from a backlog of irradiated fuel.

1.4 MONITORING OF RADIOACTIVE MATERIALS FROM HANFORD

The release of radioactive materials from Hanford was controlled through several steps (Figure 1.4). Operations were adjusted to meet guidelines of the time. Several types of guidelines were used (personnel exposure, environmental concentrations, emissions). Processes were controlled by adjusting

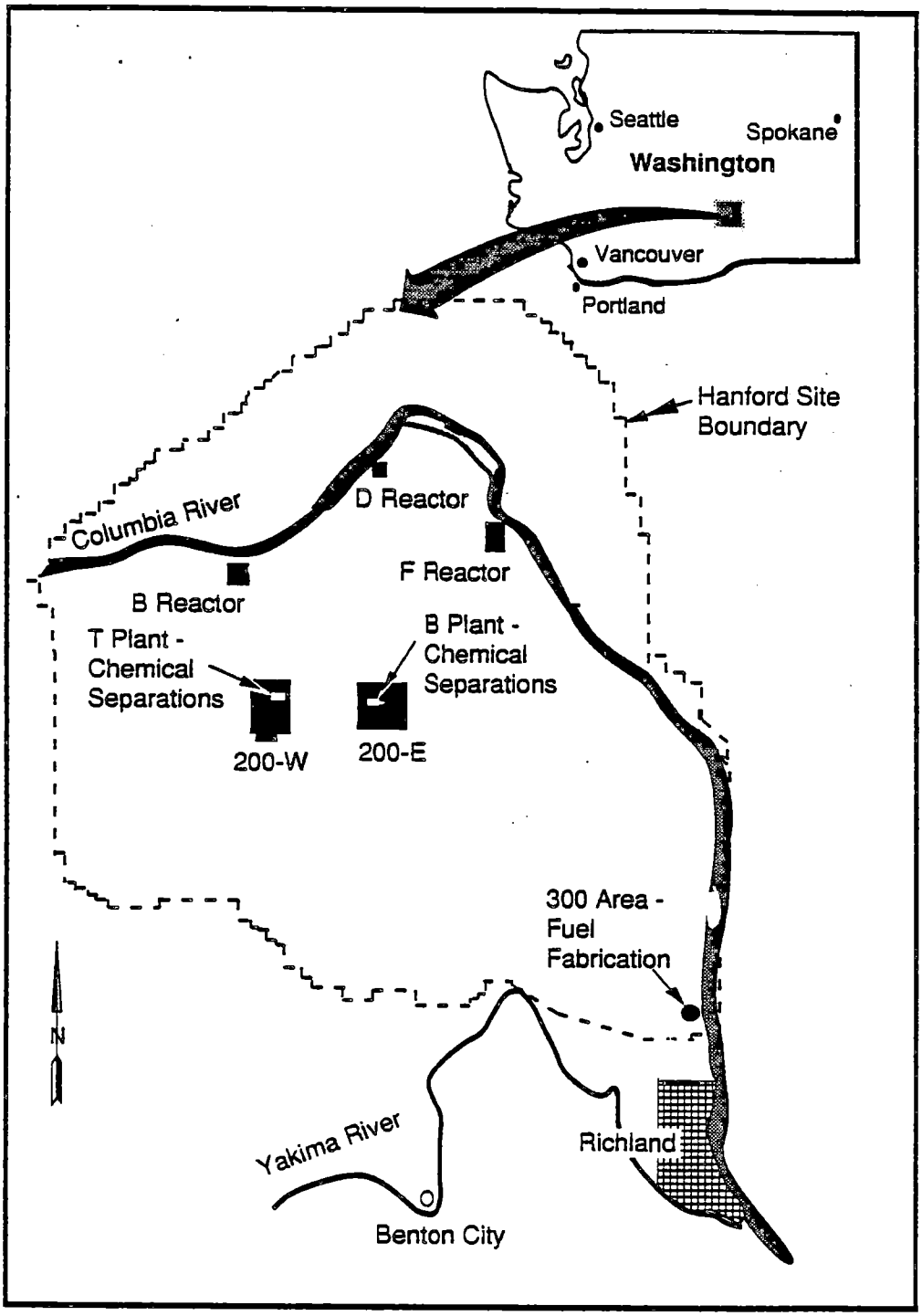

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FIGURE 1.2. Hanford Site and Key Operating Facilities, 1944-1947

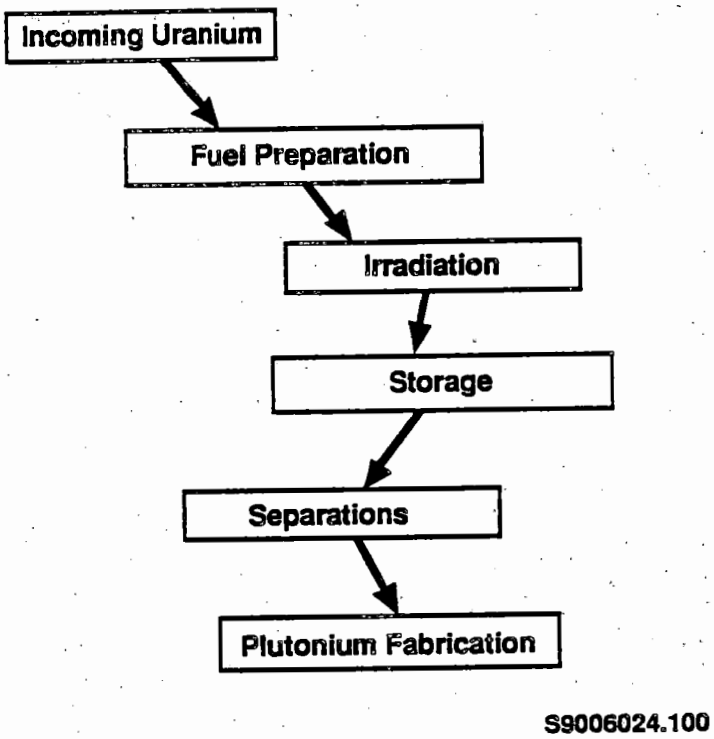

FIGURE 1.3. Nuclear Fuel Cycle

cooling times and process rates and by timing process operations to coincide with favorable weather conditions for diluting and dispersing releases to the atmosphere.

Each of these measures and its relative importance in controlling emissions changed as experience was gained in control and monitoring technology and as knowledge was developed about the potential for health effects from radiation exposure. Processes were adjusted and timed to result in releases that were considered safe (Gosline 1945). During early years of operation, releases and their potentials for exposing workers were compared with guidelines adopted from the medical community by Hanford health physicists (Wilson 1987, Parker 1980). Regulatory standards were not adopted until the 1950s.

Effluent monitoring, which began with the startup of Hanford facilities in 1944, consisted of measuring the amounts of radioactive materials vented to the atmosphere and released to soils and to the Columbia River. Measurements of materials released to the river were reliable from startup, but efforts to develop the technology to accurately measure atmospheric releases

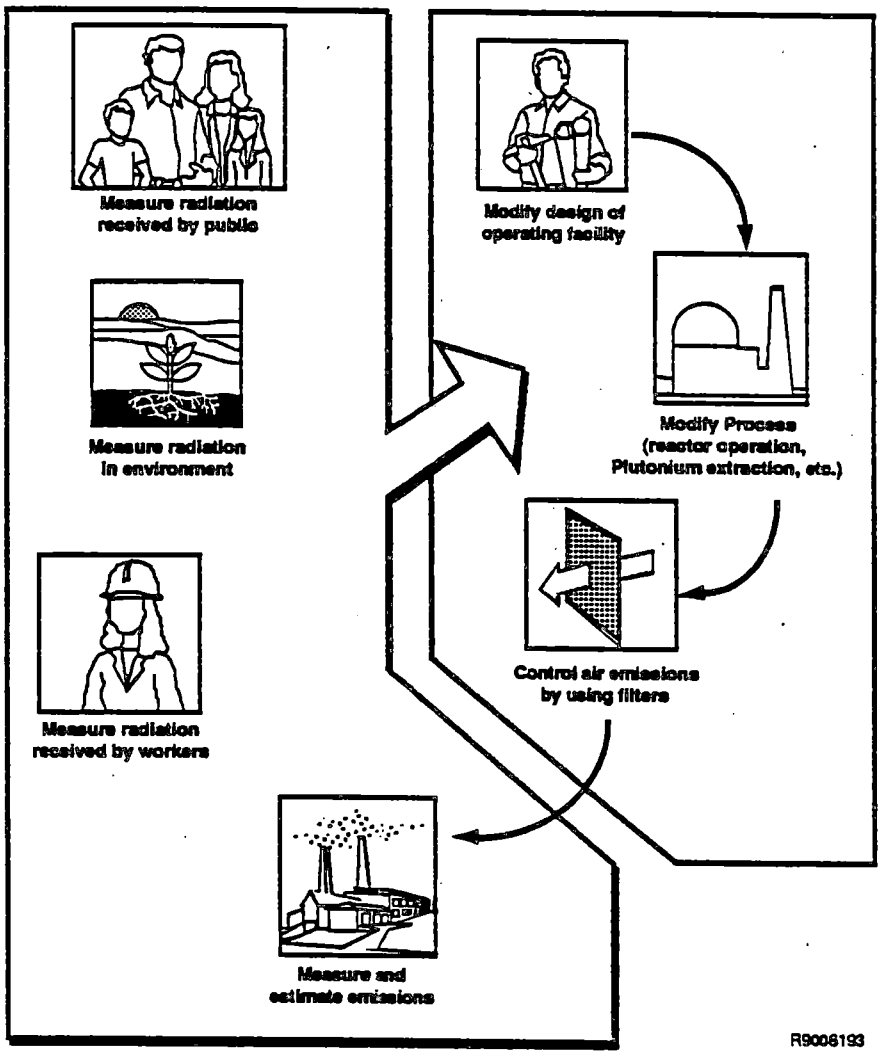

FIGURE 1.4. Methods Used to Control Releases from Hanford Site Facilities

continued for several years before measurements became reliable. In the interim, atmospheric releases were estimated from process information and from estimated filter efficiencies (effluent filters were installed beginning in 1948) (Ballinger and Hall 1989).

Meteorological measurements and observations of plume behavior began in 1943, in efforts to predict concentrations of atmospheric releases of radioactive materials. It was determined early that releases should be confined

to meteorological conditions that would limit the possibility of worker exposures and that would result in maximum dilution by the atmosphere (Gosline 1945).

Environmental monitoring was expanded to include measurements of radioactivity in the air, on the ground, on vegetation, in food and wildlife, and in Columbia River water, drinking water, ground water, sediment, fish, and other aquatic life. Not until the mid-1950s, however, did researchers discover the possibility of milk as an important pathway for radioactive iodine (Parker 1956; Comar et al. 1957). Consequently, milk, the major pathway for iodine-131 exposure, a pathway that resulted in exposures of from 10 to more than 100 times as high as the inhalation pathway, was not monitored during the period of highest releases of iodine-131, 1945-1947.

Monitoring of personnel for radiation exposure started when Hanford employees first began working at the site (Wilson 1987). In addition to measuring external exposure by using pencil dosimeters, hand and foot counters, and scans of clothing and extremities with Geiger counters, a bioassay program and limited scans of the thyroid glands of specific workers were also begun. The thyroid measurements provide an important check on exposures of offsite populations estimated by the HEDR Project, as described more fully by Ikenberry (1990).

Potential radiation doses to offsite populations were reported for the first time in 1957. Estimates of these doses have been included in annual environmental monitoring reports ever since. As technology has improved, dose-calculation methods have evolved and improved. Through 1973, dose estimates were based on measurements of radionuclides in the environment and in foods. By 1974, concentrations of radionuclides in the environment had decreased to the point where dose estimates had to be based on modeling from measured or estimated releases. The decreases in environmental concentrations of radionuclides originating from Hanford resulted from improved control technology, the closing of the original reactors, and the closing of major chemical processing facilities.

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2.0 METHODS

This section describes the conceptual and computational approaches used during Phase I to reconstruct potential radiation doses to offsite populations from atmospheric releases. Detailed descriptions of all aspects of the HEDR Project are available in the more than 20 supporting documents listed in Appendix A. Table 2.1 lists those HEDR reports that contain information about models and parameters used in Phase I. The approach is discussed in Appendix B.

2.1 PHASE I AREA, TIME PERIODS, AND RADIONUCLIDES

The HEDR project consists of four distinct phases (Figure 2.1). The first phase, a pilot or demonstration phase, was purposely limited in geographic coverage, time, radionuclides, and pathways. This limited scope influenced the selection of models and parameters and resulted in forms and ranges of distributions, some of which could have overestimated upper and lower values.

Phase II is designated a review and testing phase, during which sensitivity analyses will be used to identify the influences of key parameters, model structure, and dose estimates. Phases III and IV will be used to refine parameters, modify models, expand areas, extend time periods, and ensure that all key emissions of radioactive materials from Hanford will have been addressed.

2.1.1 Area

The Phase I study area for the air pathway covers the 10 counties nearest to the Hanford Site (Figure 2.2). This area was selected because it includes populations likely to have received a broad range of exposures, including the highest; because it includes a largely self-contained milk production/consumption area; and because atmospheric models applicable to a domain that encompassed the 10-county area were readily available.

TABLE 2.1. Applicable HEDR Reports - Air Exposure Pathway

Topic	Title	Author, Date
Demography, Food Consumption, Lifestyle	Demographic, Agricultural, Food Consumption, and Lifestyle Research for the Hanford Environmental Dose Reconstruction Project, PNL-6834 HEDR	Beck, DM, et al., 1989
	Population Estimates for Phase I, PNL-7263 HEDR	Beck, DM, 1990
	Estimates of Food Consumption, PNL-7260 HEDR	Callaway, M, 1990
Facility Operations	A History of Major Hanford Operations Involving Radioactive Material, PNL-6964 HEDR	Ballinger, MY, and Hall, RA, 1989
Thyroid Measurements	Evaluation of Thyroid Radioactivity Measurement Data From Hanford Workers, 1944-1946, PNL-7254 HEDR	Ikenberry, T, 1990
Atmospheric Transport	Atmospheric Transport and Dispersion Modeling for the Hanford Environmental Dose Reconstruction Project, PNL-7198 HEDR	Ramsdell, JV, 1989
	Atmospheric Transport Modeling and Input Data for Phase I of the Hanford Environmental Dose Reconstruction Project, PNL-7199 HEDR	Ramsdell, JV, and Burk, KW, 1989
	MESOILT2, A Lagrangian Trajectory Climatological Dispersion Model, PNL-7340 HEDR	Ramsdell, JV, 1990
Source Term	Radionuclide Sources and Radioactive Decay Figures Pertinent to the HEDR Project, PNL-7177 HEDR	Heeb, CM, 1989

TABLE 2.1. (contd)

Topic	Title	Author/Date
Source Term (contd)	Uncertainties in Source Term Calculations Generated by the ORIGEN2 Computer Code for Hanford Production Reactors, PNL-7223 HEDR	Heeb, CM, 1989
	Selection of Dominant Radionuclides for Phase I of the HEDR Project, PNL-7231 HEDR	Napier, BA, 1990
	Fission-Product Iodine During Early Hanford-Site Operations: Its Production and Behavior During Fuel Processing, Off-Gas Treatment, and Release to the Atmosphere, PNL-7210 HEDR	Burger, LL, 1989
	I-131 in Irradiated Fuel at Time of Processing From December 1944 Through December 1947, PNL-7253 HEDR	Morgan, LG, 1990
Milk Production and Distribution	Milk Cow Feed Intake and Milk Production and Distribution Estimates for Phase I, PNL-7227 HEDR	Beck, DM, 1989
	Summary of Workshop on Milk Production and Distribution, November 30, 1988 - HEDR Project, PNL-6975 HEDR	Beck, DM, et al., 1989
Vegetation Concentrations	Preliminary Summaries for Vegetation, River and Drinking Water and Fish Radionuclide Concentration Data (DRAFT), PNL-SA-17641 HEDR	Woodruff, RK, 1989

PHASE I

Model Development & Testing

- Select limited scope: geographical area, time period, radionuclides, populations
- Find, evaluate, and summarize historical data
- Develop conceptual & mathematical models and incorporate uncertainty
- Apply models/data to limited scope to test the model

PHASE II

Sensitivity/Uncertainty Analysis

- Evaluate Phase I model results
- Identify key parameters for dose calculation via sensitivity analyses
- Determine feasibility/value of reducing uncertainty in parameters
- Propose to expand scope (geographic area, time period, populations) in context of established dose threshold
- Recommend action to reduce uncertainties and recommend changes in conceptual/math models

PHASE III

Expansion and Refining

- Expand scope as warranted by Phase II work
- Reduce uncertainty in key parameters per Phase II recommendations
- Modify models per Phase II recommendations

PHASE IV

Dose Calculation

- Calculate final estimated doses

FIGURE 2.1. The HEDR Phased Approach

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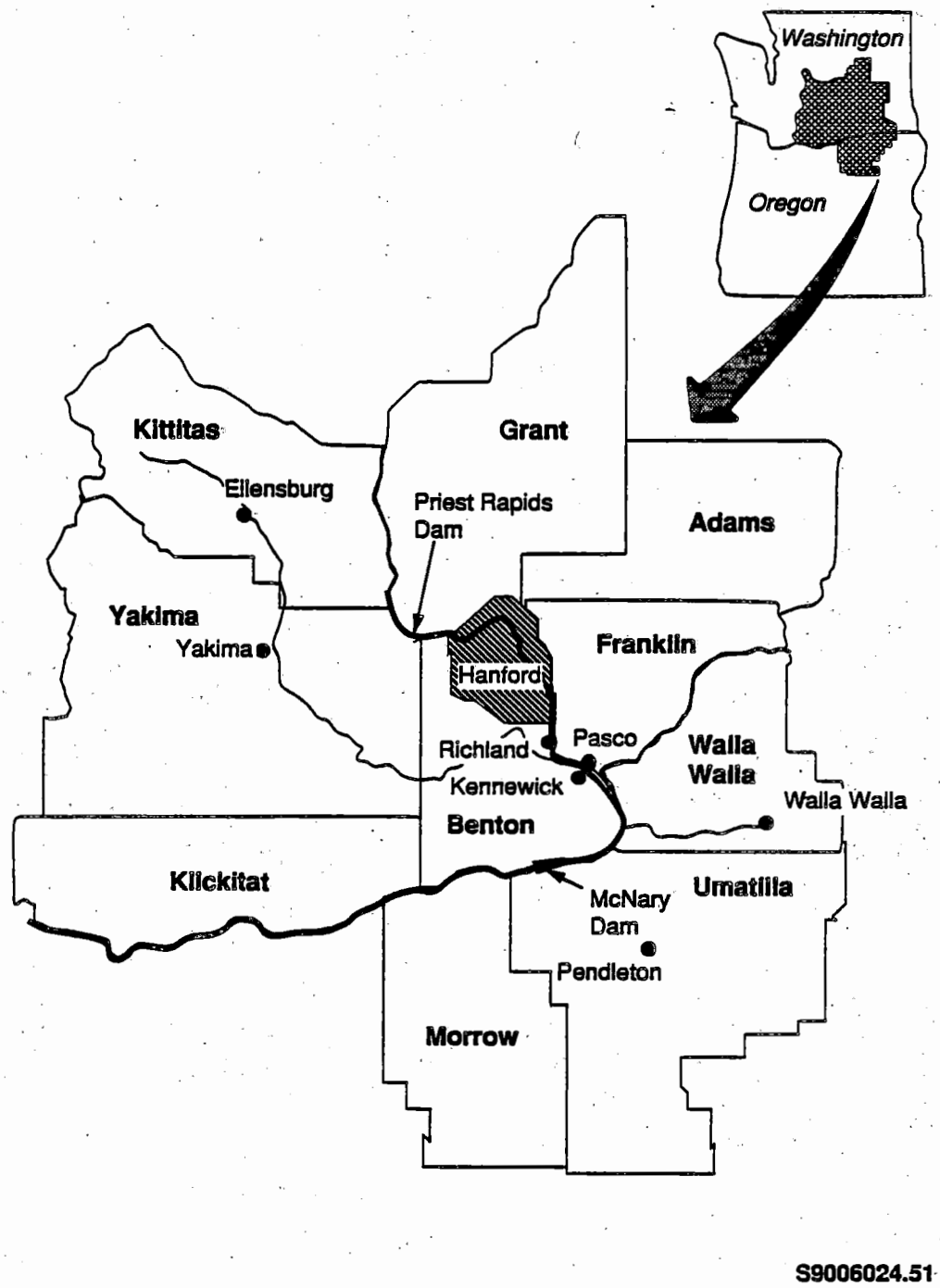

FIGURE 2.2. Phase I Study Area

2.1.2 Radionuclides and Time Periods

The largest atmospheric releases of radionuclides that could have resulted in significant doses to offsite populations originated from the

chemical separation of irradiated fuel during the early years of operation. During this time, effluent-control technology was limited, as was knowledge about the behavior of radionuclides in the environment and in man. Of the many radionuclides produced at Hanford that could have been released to the atmosphere during the early years, iodine-131 had the potential to result in large doses to offsite populations. Napier (1990), in a review of dominant radionuclides, concluded that atmospheric releases of iodine-131 could have accounted for more than 90% of doses received from all radionuclides and pathways from 1944-1947. Anderson (1974) also estimated this period to account for more than 90% of all atmospheric releases of iodine-131 from the Hanford Site (Figure 2.3). Therefore, for the air pathway portion of Phase I, iodine-131 was selected as the radionuclide of interest, and 1944-1947 was selected as the time period.

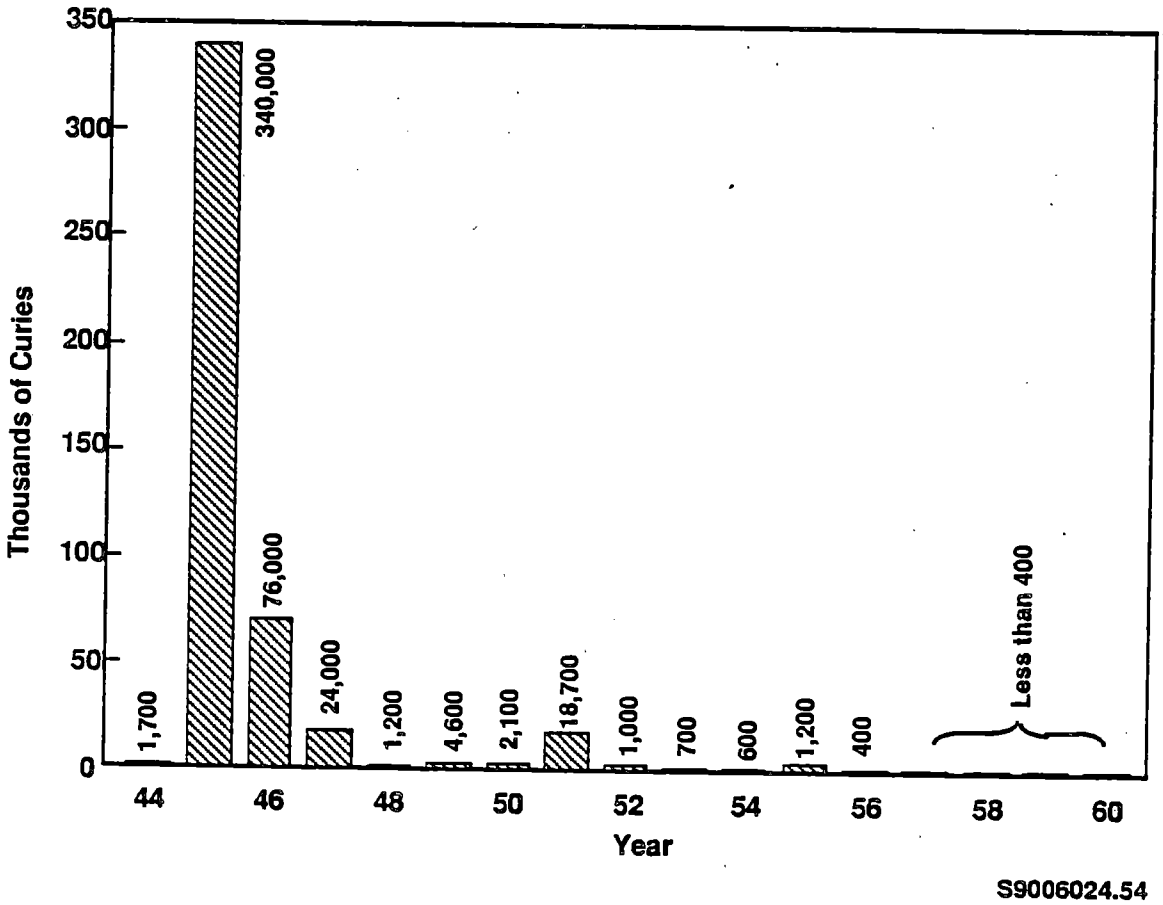

FIGURE 2.3. Estimated Releases of Iodine-131 from Separations Plants

2.2 EXPLICIT INCORPORATION OF UNCERTAINTY

An integral part of the dose-estimation process used in the project is assessing the uncertainties in those estimates using uncertainty and sensitivity analyses. Uncertainty and sensitivity analyses are needed because an individual's dose from exposure to radionuclides cannot be reconstructed with complete certainty. Uncertainty analyses are conducted to estimate lower and upper limits that are likely to include the true dose the person received. Moreover, a distribution of dose estimates is obtained to assess the likelihood of a person having received a dose anywhere within the upper and lower limits. The sensitivity portion of the analysis is conducted to identify those model parameters that most influence the estimates of dose and their uncertainties. Identifying important parameters helps to focus future work aimed at reducing dose uncertainties.

2.3 CONCEPTUAL AND COMPUTATIONAL APPROACHES

A simplified project conceptual-logic diagram for calculating doses from atmospheric releases is shown in Figure 2.4. Generic pathways are 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. Animal products complicate calculations, because the feed consumed by the animal may come from areas distant from the animal's location, and in the case of milk, the product may be shipped to processing and accumulation centers and then redistributed. The process of identifying parameters that describe each of the terms in the equation is described below.

Although the modular construction used for the dose code in Phase I has several advantages, it has the disadvantage that correlations are lost, and are not used in subsequent calculations. The effects of this loss of correlation information on Phase I dose estimates is being evaluated by coding a reduced version of the Phase I dose model. This reduced code conducts a nonmodular Monte Carlo estimation of doses such that correlation information is not lost.

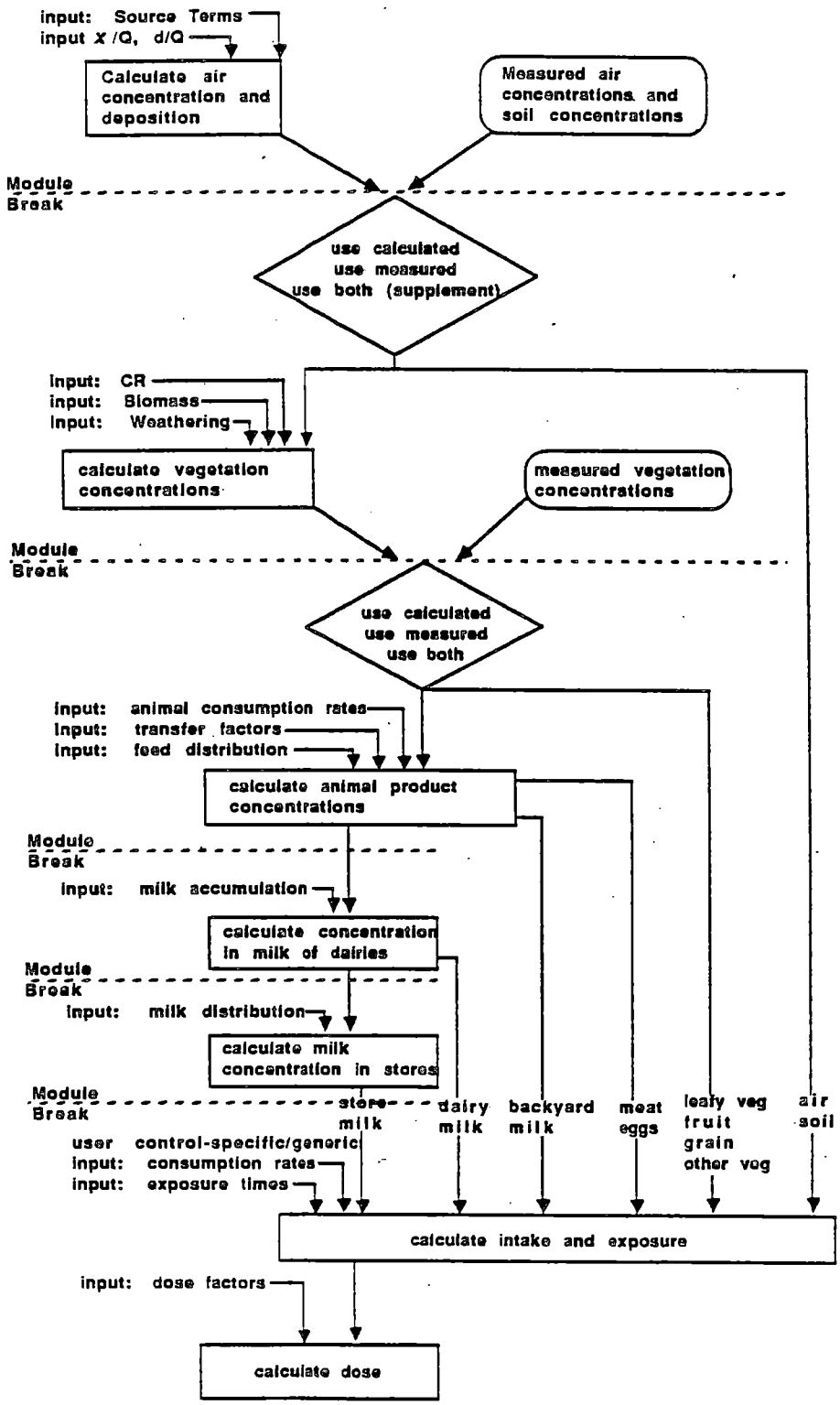

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FIGURE 2.4. Conceptual-Logic Diagram for Calculating Doses from Atmospheric Releases

The reduced code was used to obtain dose estimates for a county subdivision where relatively high doses from milk consumption were expected. A major concern with loss of correlation information is in calculating the total dose from the different pathways. Because the Phase I doses are reported in terms of individual pathways instead of the total dose, the bias in doses resulting from loss of correlation information is insignificant. Additionally, the project so far shows that even when combining the doses from the different pathways into a total dose, the loss of correlation information does not appear to significantly affect calculated doses. The modular approach will be evaluated further for iodine-131 and other radionuclides, and the dose code will be modified to eliminate any loss of correlation information that is found to significantly affect estimates of dose.

The computer code for estimating doses obtains a dose distribution for each of the 36 months in the 1945-1947 Phase I period for each type of reference individual. For each reference individual, these monthly distributions were converted to a dose distribution for each of the 3 years and for the 3 years combined by randomly selecting a dose from each month's dose distribution and adding these 12 dose estimates together to get the dose for 1 year. This random selection and addition process was repeated 1000 times to generate the dose distribution for the 12-month period. The same procedure was used to obtain the total (3-year) dose.

2.3.1 Scale for Spatial and Temporal Resolution

This section discusses how the scales for spatial and temporal resolutions were selected for the dose reconstruction model.

2.3.1.1 Spatial Resolution

A project similar to HEDR, the Off-Site Radiation Exposure Review Project (ORERP), is reconstructing doses from releases of radionuclides from the DOE's Nevada Test Site, using county-level grids, with specific locations sometimes superimposed (Dose Assessment Advisory Group, Final Report, 1987). For releases from the Hanford facilities, it was quickly determined that the county grid would be too coarse, because atmospheric concentrations and deposition could be shown to vary significantly within individual counties. A

simple rectilinear grid was found to be too inflexible, because no grid could be devised that did not have undesirable features such as the splitting of major population centers.

Demographic data are available mostly from the U.S. Census, and census divisions were found to be essentially unchanged over most of the potential study period, from initiation of Hanford operations in 1944 to the present. The census divisions were originally developed by the Census Bureau to create stable enumeration districts. Consideration was given in their development to trade and service areas, principal settlements, and major land uses and physiographic differences. The census divisions also tend to follow political boundaries such as township and range lines, which in much of the potential study area also tend to follow a fairly regular grid pattern. Each of these characteristics is favorable for use by the project. Therefore, the county division was selected as the basic unit of spatial area, with some minor modifications (usually combinations of very small adjacent divisions, although division of large areas into smaller ones also was done). The initial divisions selected for study are shown in Figure 2.5.

2.3.1.2 Temporal Resolution

Meteorological data used to describe the atmospheric transport of released radionuclides are available in hourly intervals for much of Hanford's history. Census data on locations and numbers of exposed individuals are available for every decade. Reference dietary data are available on a seasonal basis, at best. Furthermore, it seems unreasonable to expect most people to remember habits and activities from up to 45 years ago on anything better than a seasonal or monthly basis. For some periods, data on releases from the Hanford Site facilities and on monitoring of environmental contamination resulting from those releases are available only from archived monthly reports. From these considerations, the unit of months was selected as the project temporal resolution for Phase I.

2.3.2 Calculating and Compiling Source-Term Data

For the atmospheric releases in the 1940s, the project focused attention on releases from the two major sources: the B-Plant and T-Plant chemical-separations facilities that were used to dissolve the irradiated fuel and

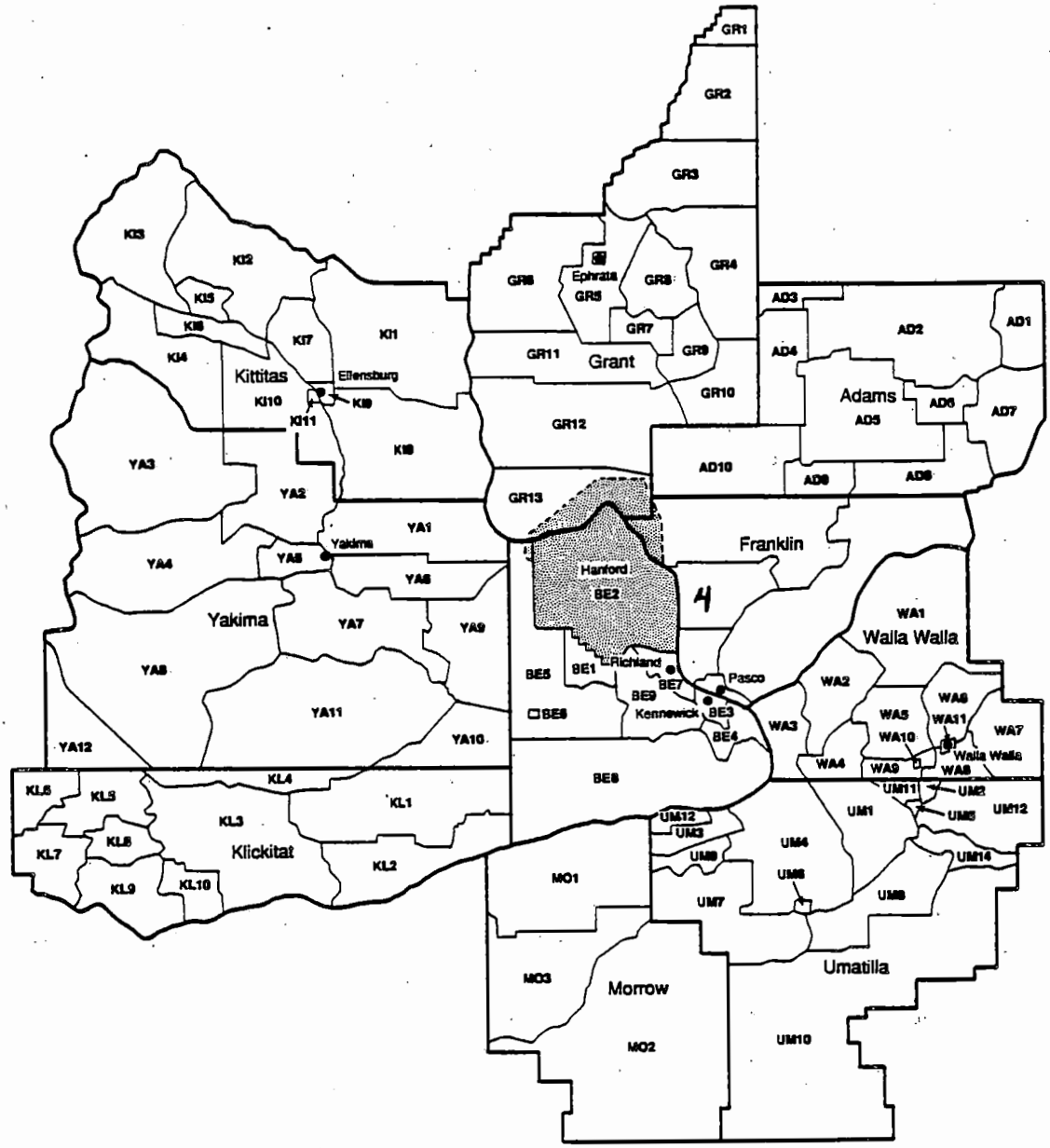

FIGURE 2.5. County Census Divisions in HEDR Phase I Study Area

extract the desired plutonium product (Figure 1.2). Specific process operations, emission controls, and waste-management practices were identified, and estimates of releases were prepared. These estimates were based on available emission-monitoring data and knowledge of probable operating conditions. In the early years of Hanford Site operations, technology did not permit

monitoring for specific radionuclide emissions. Therefore, for Phase I calculations, modeling of emissions was required.

The estimates of the iodine-131 content of discharged fuel were based on records and reports that provided the basic irradiation history and cooling time intervals between discharge from reactor and dissolution of the fuel at B-Plant and T-Plant. An equation that gives the iodine-131 content at the time of dissolution was used. The equation is a rigorous solution to the differential equation describing the buildup and decay of iodine-131 in the reactor and its decay after discharge. The values of nuclear parameters in the equation were taken from the ORIGEN2 (Croff 1980a,b) code and associated nuclear-data library. These values were chosen to assure continuity of data sources with subsequent HEDR Project activity, which will use ORIGEN2 to estimate amounts of other dominant radionuclides. The total iodine-131 inventory at dissolution was then calculated by multiplying the iodine-131 content by the amount of fuel dissolved.

Source-term data for iodine-131 releases were prepared as total activity per month released using estimates for the fraction of dissolved iodine-131 that was released to the atmosphere (release fraction). A triangular distribution bounded by upper and lower estimates of the potential releases was used to describe the uncertainty in releases resulting from a lack of knowledge. The upper and lower bounds were based on limits of the control technology in place at the time iodine-131 releases occurred.

2.3.2.1 Meteorological Model

Concentrations of radionuclides of Hanford origin in air and subsequent deposition rates onto vegetation and the ground can conceptually be determined either from monitored values or from calculations. For the period of interest in Phase I, reliable monitoring data are limited to areas on and immediately adjacent to the Hanford Site and are not available for most of the grazing season of the period of highest releases, 1945. It was necessary, therefore, to develop a modeling capacity. The model selection process is described in Ramsdell (1989).

An interim atmospheric transport and dispersion model was developed for Phase I by modifying an existing version of the MESOI code (Ramsdell, Athey,

and Glantz 1983). The HEDR-modified version, called MESOILT2 (Ramsdell 1990), simulates the transport and diffusion of continuous plumes by dividing the plume into discrete increments, referred to as "puffs." The code generates puffs every 15 minutes at the source; the puffs are transported by historical wind fields until they leave the model domain. As the puffs move, they expand (i.e., diffuse) in response to turbulence, and airborne material is deposited as it comes in contact with the ground surface or is washed out by precipitation. The code also simulates radioactive decay. The winds and atmospheric stability data used by the model are updated each hour. Additional details concerning the structure of MESOILT2 are given in Appendix A. The code has been fully documented in Ramsdell (1990).

A square model domain--240 km on a side centered at 46° 37′ 30" N latitude, 119° 00′ W longitude--was selected for atmospheric transport modeling in Phase I (Figure 2.6). Physically, the domain extends from the Cascade Mountains east to approximately the Washington-Idaho border and from Spokane south to just beyond Pendleton. Factors considered in selecting the model domain for Phase I included prevailing weather patterns, topography, and the limitations of the interim atmospheric-transport modeling approach.

MESOILT2 was used to compute monthly average radionuclide concentrations in the atmosphere, monthly average rates of radionuclide deposition, and month-end surface contamination. These estimates were made at nodes within the model domain for a constant monthly release of iodine-131 from a stack between the 200-W and 200-E Areas (Figure 1.2).

Atmospheric transport calculations were based on meteorological conditions for January 1983 through December 1987 because the meteorological data for 1944 through 1947 were not available in time to be used in the Phase I atmospheric-transport calculations. The data available for 1983 to 1987 included wind speeds and directions from more than 20 locations on and adjacent to the Hanford Site and from 12 additional locations in eastern Washington, eastern Oregon, and northern Idaho. Figure 2.6 shows these locations relative to the model domain and the 10-county region.

Meteorological data for 1944-1947 became available after the Phase I atmospheric transport and diffusion calculations were completed. Transport

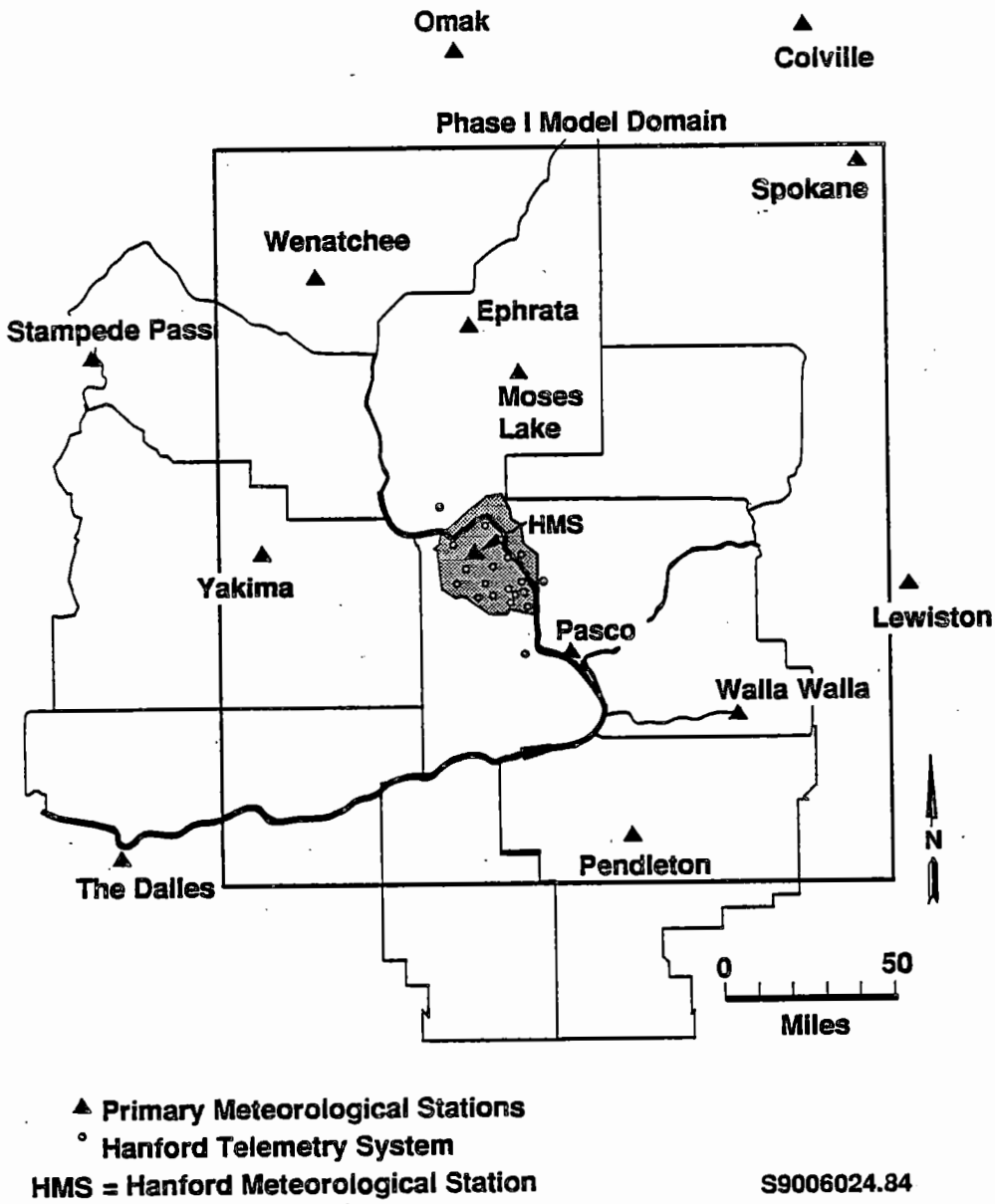

FIGURE 2.6. Model Domain Selected for Atmospheric Modeling

and diffusion were recalculated using these data, as can be seen from Figure 2.7, which compares estimates of concentrations of iodine-131 on sagebrush using both sets of meteorological data. Estimates made with the 1983-1987 meteorological data do not differ greatly from those made with the 1944-1947 data. Thus, it is reasonable to conclude that using the 1983-1987

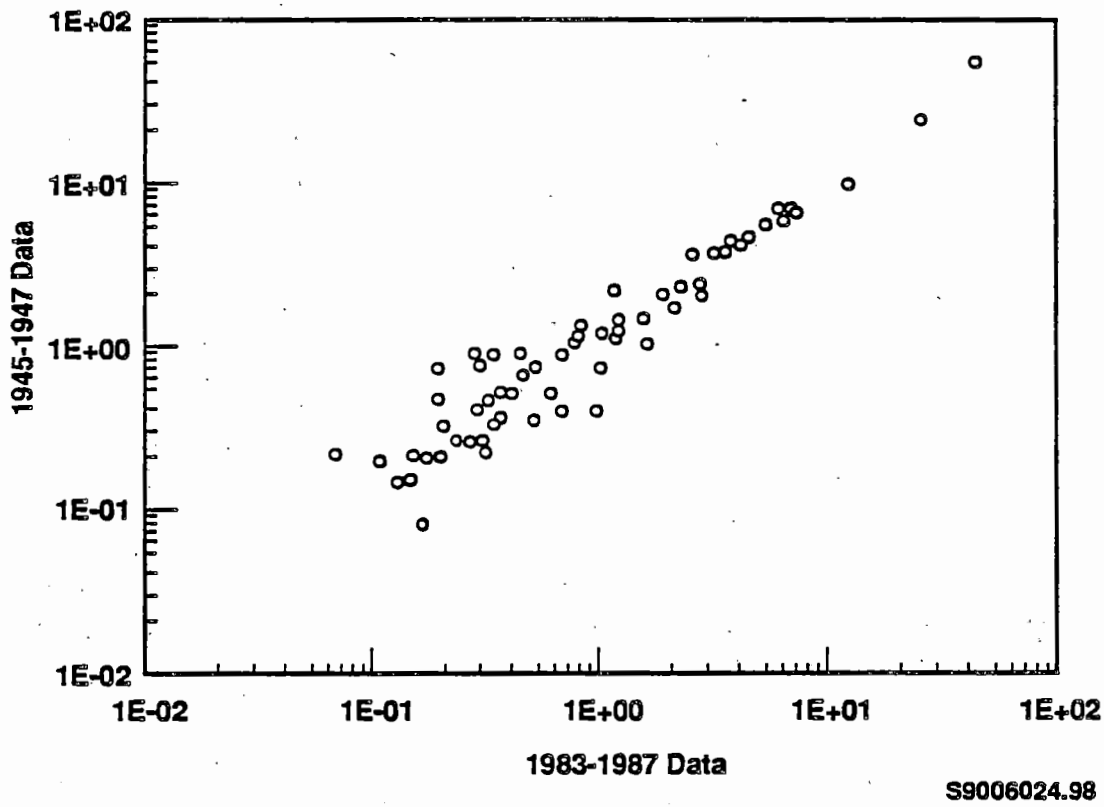

FIGURE 2.7. Calculated Concentrations of Iodine-131 on Sagebrush (μCi/kg) Based on 1944-1947 Meteorological Data Compared With 1983-1987 Meteorological Data (Benton and Franklin county census divisions)

meteorological data in Phase I does not invalidate the results of the calculations or prevent the achievement of Phase I objectives.

When the MESOILT2 computations were complete, a post-processor computer program was used to compute monthly average atmospheric concentrations, deposition rates, and month-end surface contamination for the HEDR census divisions. The post-processor program also computed a measure of the uncertainty of the census division values. The measure of uncertainty is a standard deviation for a log-normal distribution. The standard deviations are based on variations in meteorological conditions from year to year and within the census divisions. They also consider basic uncertainty in the model. Because meteorological data from 1983 to 1987, rather than the actual

meteorological data for 1944-1947, were used in the model, the concentrations for each census division should be considered typical values, rather than estimates, for any specific year.

The wind fields in the vicinity of the Hanford Site are well defined in the 1983 to 1987 data set because data from the Hanford Telemetry System are included. This system, which provides wind measurements at more than 20 locations on and adjacent to the Hanford Site, did not exist before 1979. Consequently, in future phases of the HEDR Project, when atmospheric transport is estimated for specific years, it will be necessary to model atmospheric transport with a meteorological data set that has limited data near the release points. Methods for minimizing the effects of this data limitation are being explored. In Phase I, the 1983 to 1987 telemetry data were examined to determine whether any well-defined, local (on the Hanford Site) wind-field patterns occur regularly. Six patterns were identified.

2.3.2.2 Deposition/Interception

Evaluation of the atmospheric transport and deposition of radionuclides on soil and vegetation is one of the major activities of the HEDR Project. Initial sensitivity studies for the iodine-air-cow-milk pathway indicated that the uncertainty of the deposition and vegetation uptake parameters accounted for much of the uncertainty in the dose estimates.

The flux of radionuclides to the ground and vegetation is proportional to the radionuclide concentration in the air just above the surface, with a constant of proportionality that is called a deposition velocity. Deposition velocities are generally determined experimentally. Sehmel (1980) summarizes the data for iodine-131 obtained prior to the Chernobyl reactor accident. The reported deposition velocities range from less than 0.001 to 0.1 m/s, with a large number of values near 0.01 m/s. Seinfeld (1986) also shows a larger range of deposition velocities for iodine, with a value of 0.01 m/s near the middle of the range. MESOILT2 assumes a constant value of 0.01 m/s for the deposition velocity of iodine-131 (see Section 2.3.2.3, "Vegetation Model," for further discussions).

Radionuclides deposited on the ground and vegetation are no longer available in the atmosphere. MESOILT2 uses source depletion to account for

the effects of deposition on air concentrations. This method maintains a mass balance, but it is not totally realistic from a physical standpoint. The use of a constant deposition velocity can overestimate surface contamination near the source and underestimate that at long distances. Other methods of accounting for deposition will be evaluated in later phases.

Theory, supported by research, indicates that deposition velocities are related to the type of material and its physical properties, wind speed, atmospheric stability, and the nature of the surface (Sehmel 1980, Seinfeld 1986). During Phase II, MESOILT2 will be modified to compute deposition velocities for each puff at each time based on radionuclide properties and atmospheric and surface conditions.

More detail on the evaluation of deposition and interception is found in Appendix B.

2.3.2.3 Vegetation Model

Radionuclide concentrations in vegetation may be obtained either from calculations based on source term, physical transport, and deposition or from environmental measurements. Both approaches are being used in the project's computational scheme.

Crop types considered in the model include those eaten directly by humans and those consumed by animals: leafy vegetables, other vegetables, fruits, and grains for direct consumption, and pasture, silage, hay, and grain for animals.

The original Hanford model for deposition/interception incorporated a "deposition velocity" term with a constant interception fraction (Soldat and Harr 1971). Combined with a feed-to-milk transfer factor, this model provided an accurate prediction of milk concentrations for the Hanford environment. Recent results of the Biospheric Model Validation Study (BIOMOVS), presented at the VII Workshop in Tokyo, Japan, November 7-10, 1988, but not yet published, indicate that this formulation tends to underpredict the concentrations on the grass but to overpredict the transfer from grass to

milk, so that the final answer is in the right range. The observation of underprediction of deposition/interception is observed by Pinder et al. (1989).

The current Hanford model (Napier et al. 1988) uses a variable interception fraction that is a function of vegetation biomass. The interception fraction, based on the model of Chamberlain (1970), generally results in a higher value of interception than the older constant fraction. The Chamberlain model is an empirical fit to a large amount of data, relating both to iodine and particulate radionuclides.

The model for interception fraction is variable as a function of plant biomass and moisture content, which means it is a function of crop type and time of year. This model should explain most of the variability seen in previously published environmental measurements. Monthly values of biomass of each type of crop were developed for use in this model (Appendix C).

Uptake of radionuclides by plants through the roots was addressed through the application of a soil-to-plant concentration ratio. This is a steady-state concept, but it is approximately correct for the month-long accumulation periods used in the remainder of the model.

Weathering of deposited material from vegetation surfaces was estimated with a weathering half-life. This rate constant can vary between about 5 and 18 days. A triangular distribution centered on 14 days, with upper and lower limits of 5 and 18 days, respectively, was used to describe the uncertainty in the correct value.

Monitoring data for the mid-1940s provide a second estimate of the vegetation concentrations resulting from Hanford releases. These data were corrected to account for past errors in estimating iodine-131 concentrations on vegetation.

The corrected, previous vegetation data were then compared with Phase I calculated results.

2.3.2.4 Agricultural Model

The concentration of radionuclides in animal products depends on the concentration in the animals' feed and on how much feed the animal consumes. Four basic types of feed (pasture, silage, hay, and grain) were considered.

Four prototypical feeding regimes are considered for milk cows. The simplest of these is a family cow that is fed grass hay year round, with a minor grain supplement. This regime was used in nonirrigated areas. Another feeding regime used in nonirrigated areas combines locally produced alfalfa hay with a grain supplement. A slightly more complicated feeding pattern is pasture supplemented with both hay and grain. This pattern could fit either a family cow or a small herd of dairy cows. The most complicated regime includes pasture, hay, grain, and silage. The feed may be stored for a period of time before being fed to the cow.

The feeding regimes were developed from information in the Yakima County Dairy Herd Improvement Association publications and from the expert opinions of dairymen, farmers, ranchers, and agricultural extension agents who are familiar with conditions in the dairy industry during 1944-1947 (Beck et al. 1990). The feeding regimes were allocated to the county census divisions based on the availability of irrigation during 1944-1947. The dates used to start and stop the various portions of the feeding regimes are linked to local variations in climate during the Phase I period.

A graphical representation of the most complicated feeding pattern is given as Figure 2.8 (adapted from Ward and Whicker 1987). Because there is considerable uncertainty in the reconstruction of these feeding patterns from over 40 years ago, associated uncertainties are addressed by using high and low estimates in addition to the central estimate. These are incorporated in the model through a triangular distribution of each fraction.

The amount of contaminant transferred from the feed to the animal product depends on the time of year and on the age, health, and state of lactation of the producing animal. The transfer of radionuclides to products also varies naturally for individual animals. These variabilities are addressed

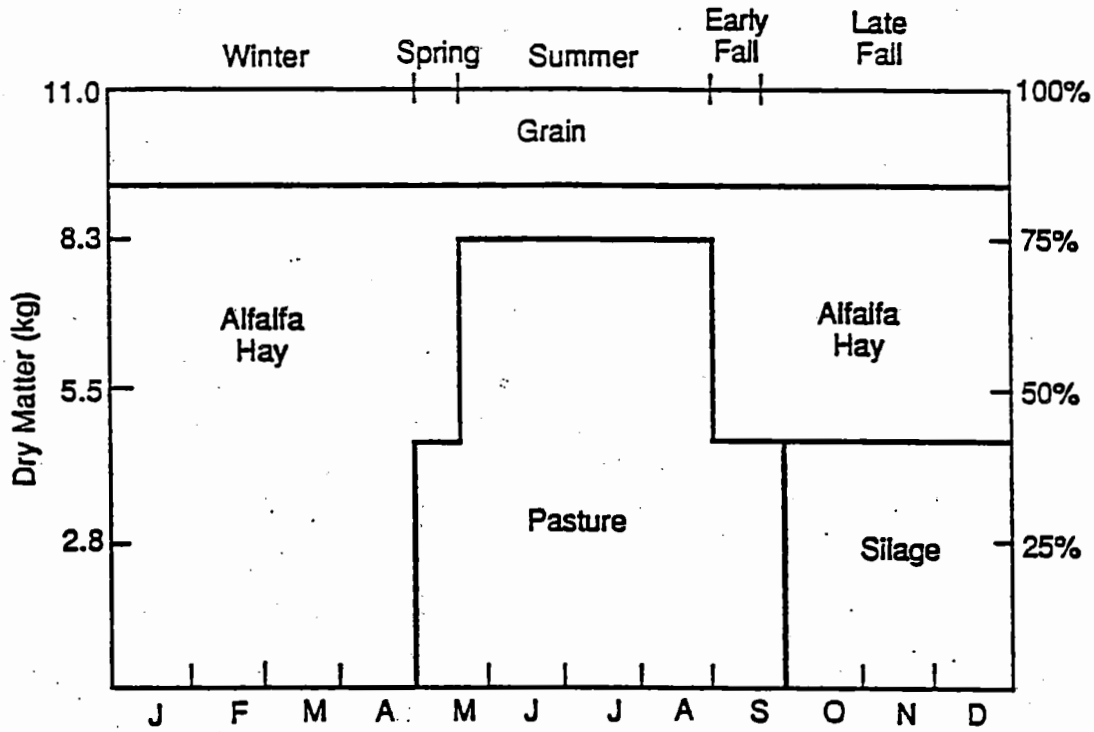

FIGURE 2.8. Most Complicated Feeding Regime (pasture, alfalfa hay, grain, and silage) used in the 10-County HEDR Area, 1944-1947

through the use of a distribution of transfer factors. A matrix of radionuclide- and product-dependent transfer factors from the literature has been established, with the distributions incorporated through associated high and low values (see Appendix B).

Food Product Distribution. Food products such as milk may be consumed directly by members of the producing farm family, or they may be sold. Most products sold were purchased for redistribution by distributors (e.g., milk purchases by creameries). These distributors tend to blend or average their inventory over a number of producers. The average radionuclide concentration of a product (fresh milk, cottage cheese, sour cream, etc.) available from a distributor is calculated via accumulation-fraction arrays, defining the fraction of the product at each distribution center that originated in the HEDR county subdivision by month. These, too, have associated estimates of high and low values to account for uncertainty in the reconstruction of the actual distribution patterns for the times of interest (Beck et al. 1990).

Information on milk production and distribution was gathered from U.S. Census of Agriculture data, Washington State Dairy Products Commission statistics, and interviews with retired dairy-industry employees. This information was used to identify the major milk-producing regions and the names of the commercial dairy producers and processing plants (Figure 2.9). Dairy brand market shares for each HEDR county census division were developed by eliciting information from a dairy-industry expert (Beck et al. 1990).

Some individuals consumed products from grocery stores, which may at times have changed distributors or sold items from competing distributors. Concentrations in these instances are averaged over the possible sources through distribution arrays. These distribution arrays provide the fraction of the product consumed in each county subdivision tract that was provided by each distributor (Beck et al. 1990). Associated uncertainty arrays were also prepared to provide triangular distributions of the probability of the distribution fraction.

2.3.2.5 Biological and Demographic Models

The demographics of each county census subdivision are accounted for by providing estimates for individuals with different ages, sexes, diets, and general lifestyles.

Calculations of radiation doses require information on intake of radionuclides, uptake by the body, distribution and retention of the radionuclides in various organs, and information on the impacts on the various organs of radionuclide decay in other organs. The intake information is being developed as a major portion of the HEDR Project. Uptake, distribution, and retention of radionuclides in the body are functions of the chemical and physical forms of each particular element. For metabolism, data are available for adults, and limited data for other age groups are available.

2.3.2.6 Age Groups

Seven age groups (with the inclusion of fetal thyroid) will eventually be considered. For Phase I, only the adult (20 years and older) and infant (0-1 years) categories were investigated. Each age group will also be subdivided into males and females.

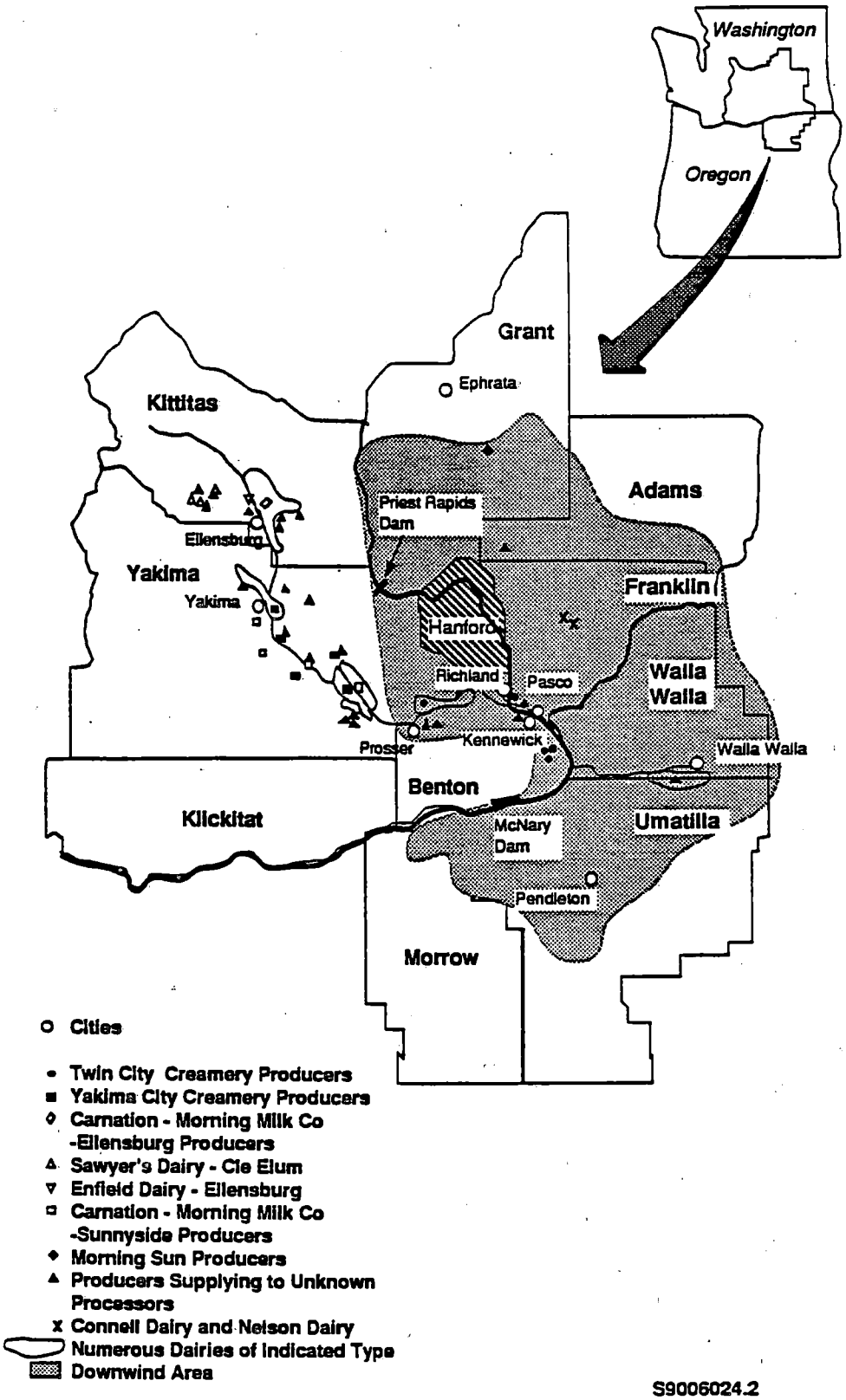

FIGURE 2.9. Milk Producers and Processing Plants Located to Date, 1944-1950

2.3.2.7 Population Groups

County population estimates were developed using the ratio-correlation procedure. County census division population shares and age-group estimates were developed using various census-year interpolation techniques (Beck et al. 1989).

The general population determined for each of the census subdivisions within the Phase I 10-county study area is further subdivided into urban and rural "lifestyle" categories. With the large number of subpopulation categories, and the very limited occupation information available, the data could not support a further breakdown of the population into smaller groups. Data on the food habits of Native Americans in and near the Phase I area are being collected and will be incorporated in later runs of the Phase I model.

2.3.2.8 Food Types

The consumption of contaminated food was a major pathway of exposure for people who lived in the Hanford environs from 1944-1947. A number of different general food types were identified as potentially important. These general categories are the ones typically used in radiological evaluations and are available in the preliminary mathematical models being used for HEDR sensitivity studies and Phase I initial development. Unfortunately, these categories do not correspond very well with the raw dietary survey information available.

The raw data available from U.S. Department of Agriculture dietary surveys tend to list foods under the common names, brand names, or mixture names (e.g., stew), which do not correspond to generic "meat" or "grain" categorizations.

Various ways of categorizing foods were investigated. Some overlap of categories is probably inevitable. Early HEDR sensitivity studies indicate that the primary exposure pathways for the atmospheric releases in the mid-1940s were fresh milk and other fresh milk products and fresh leafy vegetables. Fresh fruits were also important, depending on the quantities consumed. Other farm products such as grains or meats were of lesser

importance. These results imply that most of the dose will be received from eating locally produced fresh produce and dairy products.

For each category of "reference individual" (individuals that share location, lifestyle, age, etc.), distributions were prepared on the monthly consumption rates of the following foods (Callaway 1990):

- leafy vegetables
- other (protected) vegetables and root vegetables
- grains (generally dried and stored)
- orchard fruits, berries, melons
- milk.

Because the aquatic pathway was not included for the 1944-1947 period, fish were not considered. Phase I assumed that all vegetables and fruits were produced locally. HEDR modeled in detail the production and distribution of milk, because this product is the most important for iodine-131.

Input to the calculational system is via arrays of consumption rates as a function of age, lifestyle, and month. Associated arrays of high and low estimates of consumption rates are used to describe uncertainty in the consumption-rate values.

2.3.2.9 Model Structure

The logic diagram of Figure 2.4 indicates that the calculation of dose is broken into modules. These modules represent individual portions of the computer code that can be run in a stochastic simulation (Monte Carlo analysis). The modular structure was used for three reasons. First, because the cow/feed/milk distribution model is interconnected, doses cannot be calculated for individuals in a particular census subdivision without knowing the environmental conditions in many other locations. The dose calculations have been structured so that repetitive calculations are minimized; information on the potential distributions of environmental parameters such as air, vegetation, or milk concentrations can be saved and examined for each period.

Second, the modular structure of the model allows the input of either calculated or measured data at each step of the calculation. For Phase I only calculated values were used.

Finally, the modular structure supports the calculation of doses to both reference and specific individuals. This flexibility is important, because the dose reconstruction project is supporting a parallel project being conducted by Fred Hutchinson Cancer Research Center (FHCRC) for the Centers for Disease Control. The FHCRC is investigating thyroid disease that might have been caused by the atmospheric releases from Hanford in the 1940s and 1950s. The FHCRC will be interviewing many individuals about their past lifestyle and dietary habits and will be attempting to correlate estimated doses with thyroid disease. The HEDR computational model will be used to calculate doses for the FHCRC interviewees.

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3.0 RESULTS AND DISCUSSION

This section presents preliminary results of the Phase I air pathway dose reconstruction. The results are compared with previously published source-term, vegetation-monitoring and thyroid-count data, to background radiation, and to historical regulatory standards. Potential sources of uncertainty in the results are also discussed.

3.1 SOURCE TERM

Monthly estimates of iodine-131 releases from the separations plants during December 1944 through December 1947 are tabulated in Table 3.1 and illustrated in Figure 3.1 (Morgan 1990). The estimates of average annual total releases agree well with previously published estimates of annual releases (Anderson 1974), as illustrated in Figure 3.2. Much of the uncertainty in these estimates is due to uncertainties in the release fraction, the proportion of potentially releasable iodine that actually was vented (released to the atmosphere). Previously published estimates of the release fraction vary from 50 to about 80%. The Phase I values that were used were 50 to 85%, with a best-estimated value of 75%. Several other factors, such as incomplete historical records and imprecision in cooling-time estimates, were likely to contribute to uncertainty in the source term.

3.2 AIR AND VEGETATION CONCENTRATIONS

Figures 3.3 and 3.4 show typical winter and summer modeled concentrations of iodine-131 on sagebrush are shown as monthly average values by county subdivision. These geographic patterns also reflect air concentrations of iodine-131. The pattern of concentrations is seasonally dependent. Because of these fluctuations, monthly air concentrations at specific locations do not necessarily reflect monthly differences in iodine-131 releases.

Comparisons of calculated sagebrush concentrations with measured values at locations where sufficient measured values exist indicate that the

TABLE 3.1. Estimated Monthly Iodine-131 Releases from Separations Plants, 1944-1947, curies

Year	Month	50 % Release	75 % Release	85 % Release
1944	December	1055	1583	1794
1945	January	675	1013	1148
1945	February	835	1253	1420
1945	March	1120	1680	1904
1945	April	13600	20400	23120
1945	May	38000	57000	64600
1945	June	19861	29791	33763
1945	July	17206	25808	29249
1945	August	24055	36082	40893
1945	September	29490	44234	50132
1945	October	31264	46896	53149
1945	November	13077	19616	22231
1945	December	22005	33007	37408
1946	January	6321	9482	10746
1946	February	2740	4109	4657
1946	March	2507	3761	4262
1946	April	5398	8097	9177
1946	May	5190	7784	8822
1946	June	2450	3674	4164
1946	July	2632	3948	4474
1946	August	4607	6911	7832
1946	September	3567	5350	6063
1946	October	2578	3866	4382
1946	November	2780	4169	4725
1946	December	3095	4643	5262
1947	January	3474	5210	5905
1947	February	1562	2342	2655
1947	March	1984	2976	3373
1947	April	1995	2993	3392
1947	May	1949	2923	3312
1947	June	721	1082	1226
1947	July	891	1337	1515
1947	August	554	831	942
1947	September	490	734	832
1947	October	208	312	354
1947	November	169	253	286
1947	December	183	275	311

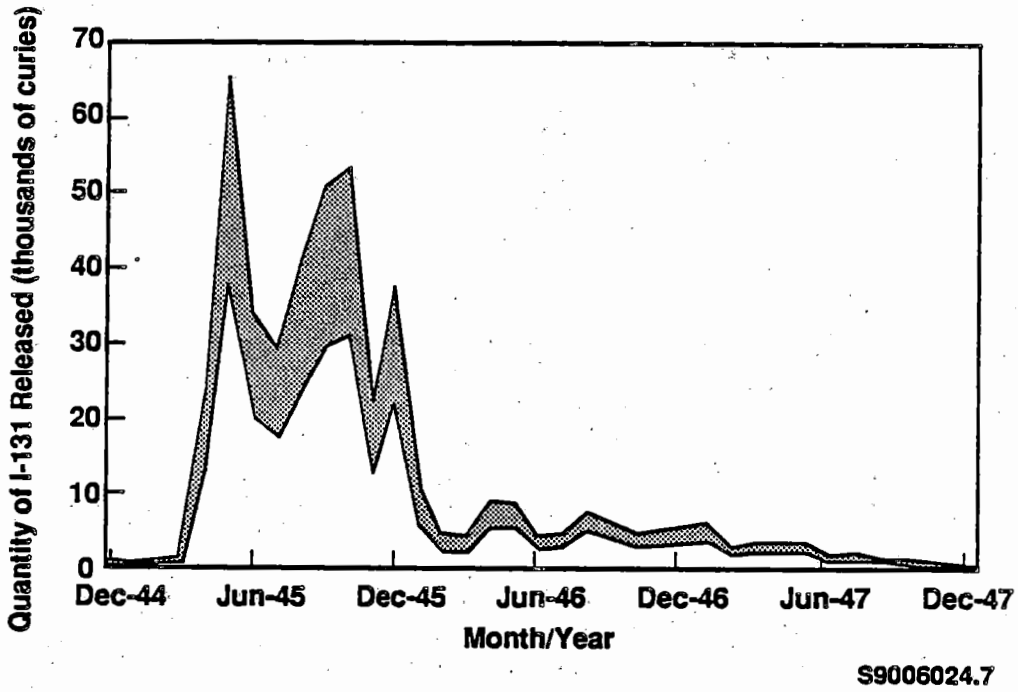


FIGURE 3.1. Monthly Estimates of Iodine-131 Releases from the Separations Plants, 1944-1947

calculated (modeled) and measured values are in good agreement (Figure 3.5). The modeled values appear to underestimate winter concentrations at the selected locations and to slightly overestimate summer concentrations. Because of detection-limit problems, the substantially greater measured concentrations in the latter part of 1947 do not accurately indicate differences. Agreements between cumulative modeled and cumulative measured values for a period when the measured values are most reliable indicate remarkably good agreement (Figure 3.6).

3.3 MILK PRODUCTION AND DISTRIBUTION

Thyroid doses are highly sensitive to the location of milk production. A considerable amount of the milk in the Phase I area was produced upwind and consumed downwind. Figure 3.7 illustrates excess and deficit milk production by county. Also, most of the milk sold during Phase I was used for producing

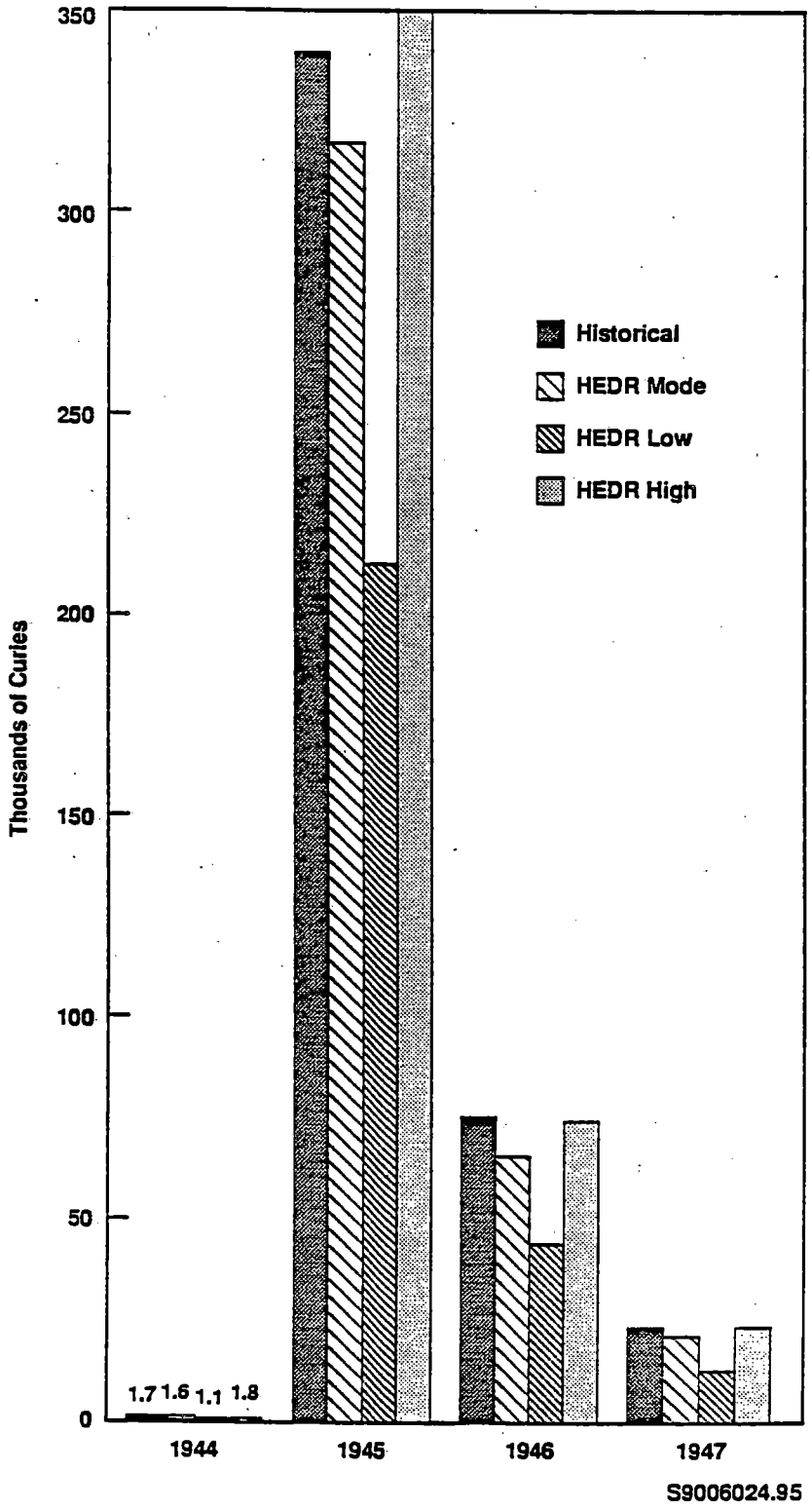


FIGURE 3.2. Comparison of HEDR and Previously Published (Anderson 1974) Estimates of Annual Iodine-131 Releases

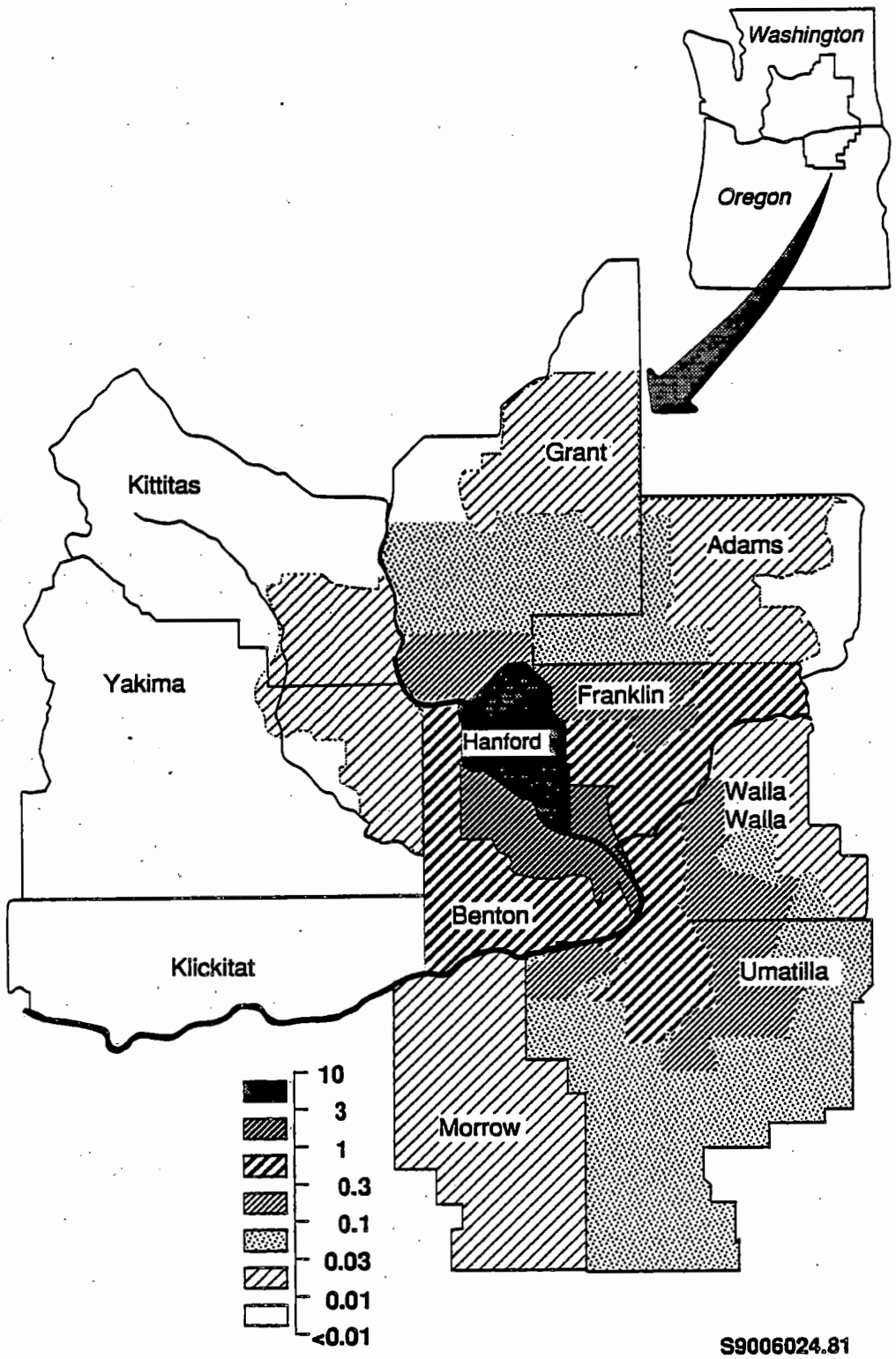


FIGURE 3.3. Calculated Concentrations (μCi/kg) of Iodine-131 on Sagebrush, December 1945

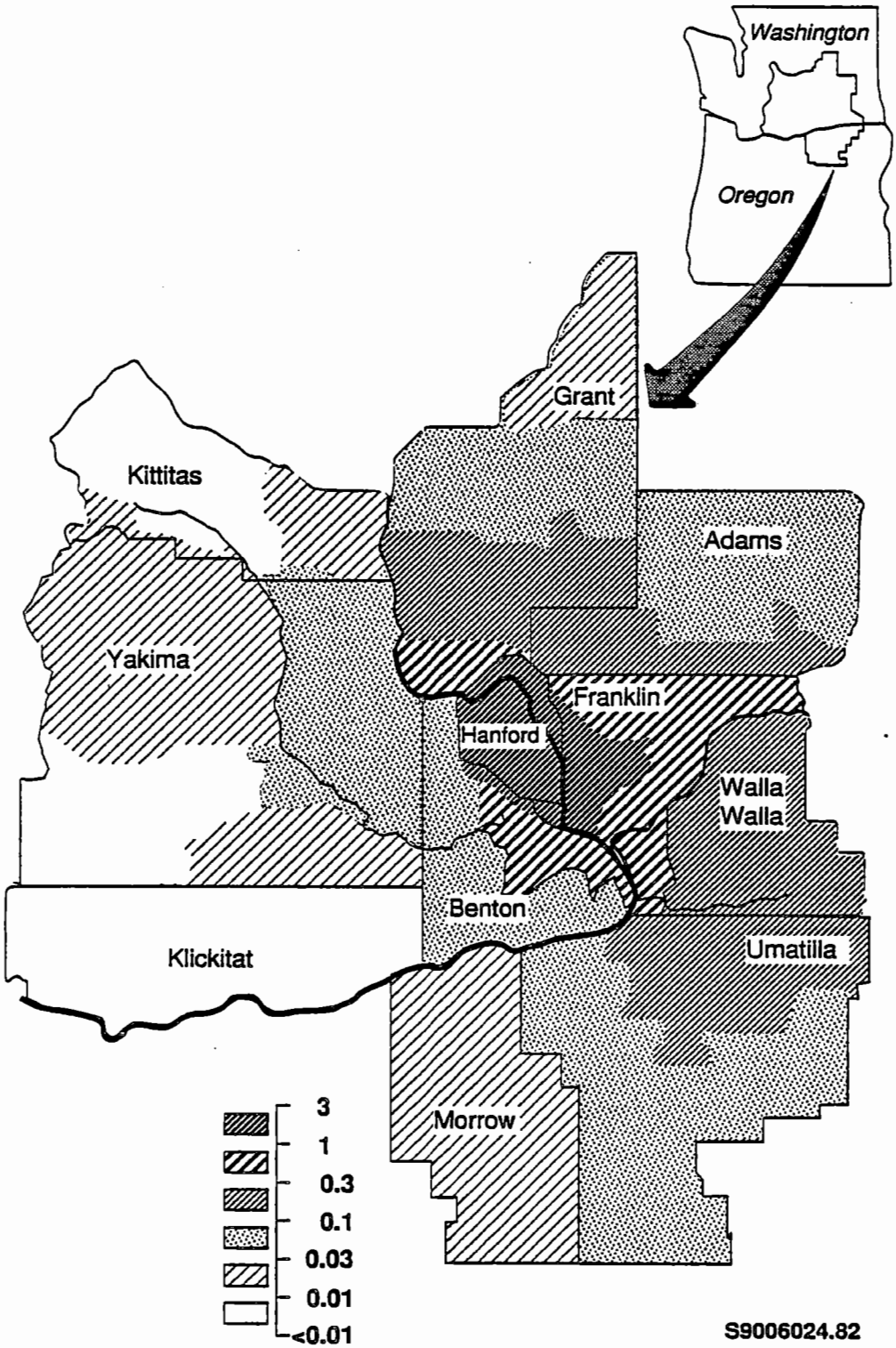


FIGURE 3.4. Calculated Concentrations (μCi/kg) of Iodine-131 on Sagebrush, June 1945

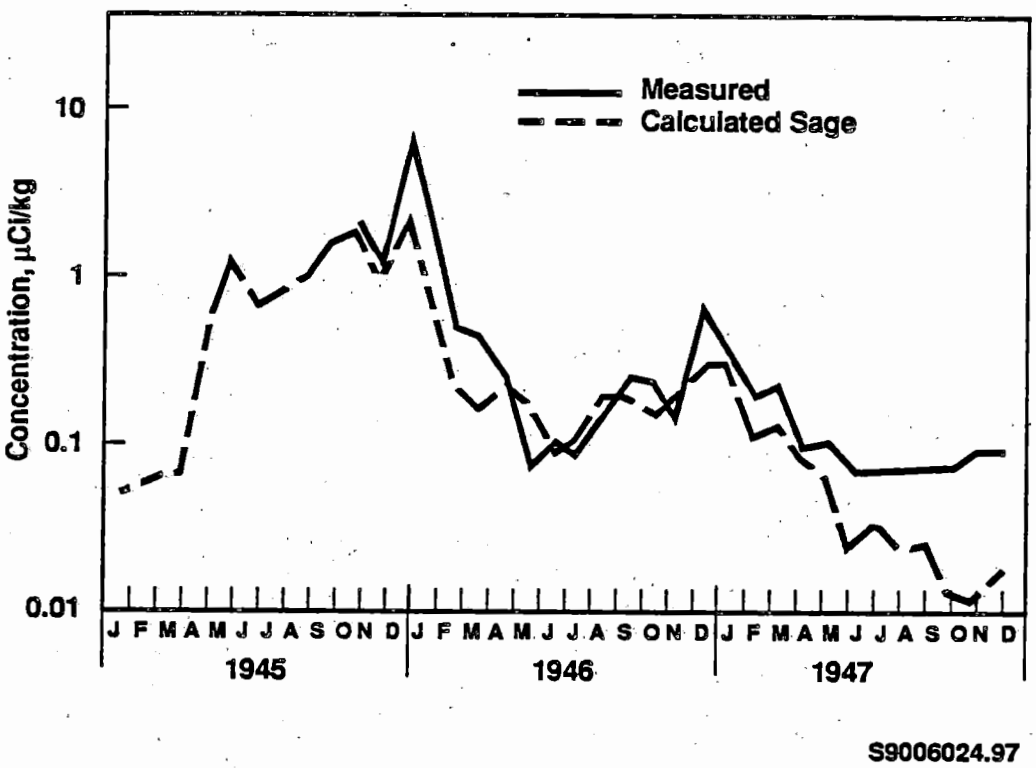


FIGURE 3.5. Calculated and Measured Concentrations of Iodine-131 on Sagebrush at Pasco, 1945-1947

milk products such as cheese, powdered milk, sour cream, and canned milk. Details concerning the dairy industry during the Phase I period are available in Beck et al. (1990).

3.4 MILK CONCENTRATIONS

Geographic patterns of estimated concentrations of iodine-131 in milk produced locally reflect typical air and vegetation concentrations during the summer. Seasonal changes in milk concentrations doe not include possible contributions to iodine-131 in milk from the ingestion of contaminated soil and inhalation of contaminated air by the dairy cows; these factors will be addressed in Phase II. Differences in milk concentrations as influenced by dairy cow feeding practices range widely. It is clear that the highest concentrations of iodine-131 in milk can be expected immediately downwind in areas where dairy cows were on pasture. Lowest concentrations occurred upwind and in milk from dairy cows not on pasture during the grazing season.

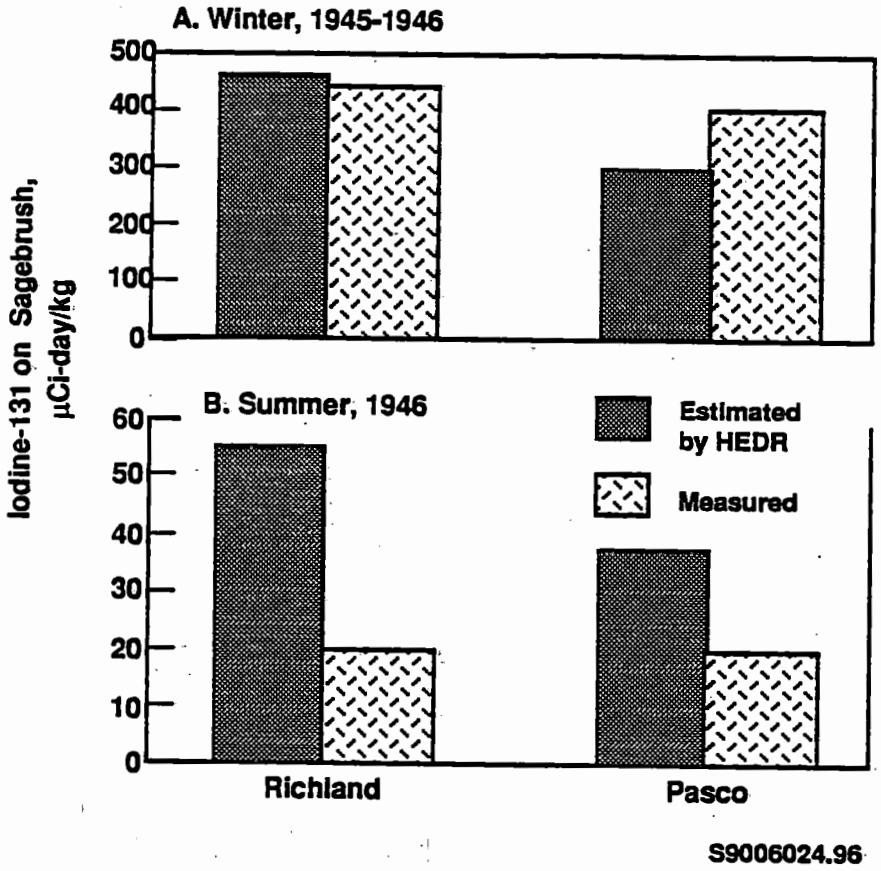


FIGURE 3.6. Comparison of Concentrations (median values) of Iodine-131 on Sagebrush Estimated by HEDR and Measured

3.5 POPULATION DISTRIBUTIONS

The relative size of the county census divisions within the Phase I study area reflect relative populations densities. The greatest changes in populations near the Hanford Site, and therefore the most critical changes for developing an assessment of population doses, occurred in Richland, as depicted in Figure 3.8.

3.6 INGESTION DOSES

Distributions of doses were calculated for "reference" individuals, individuals who shared combinations of characteristics such as age, sex, lifestyle, food habits, and geographic location. These distributions were also combined into distributions representing selected populations.

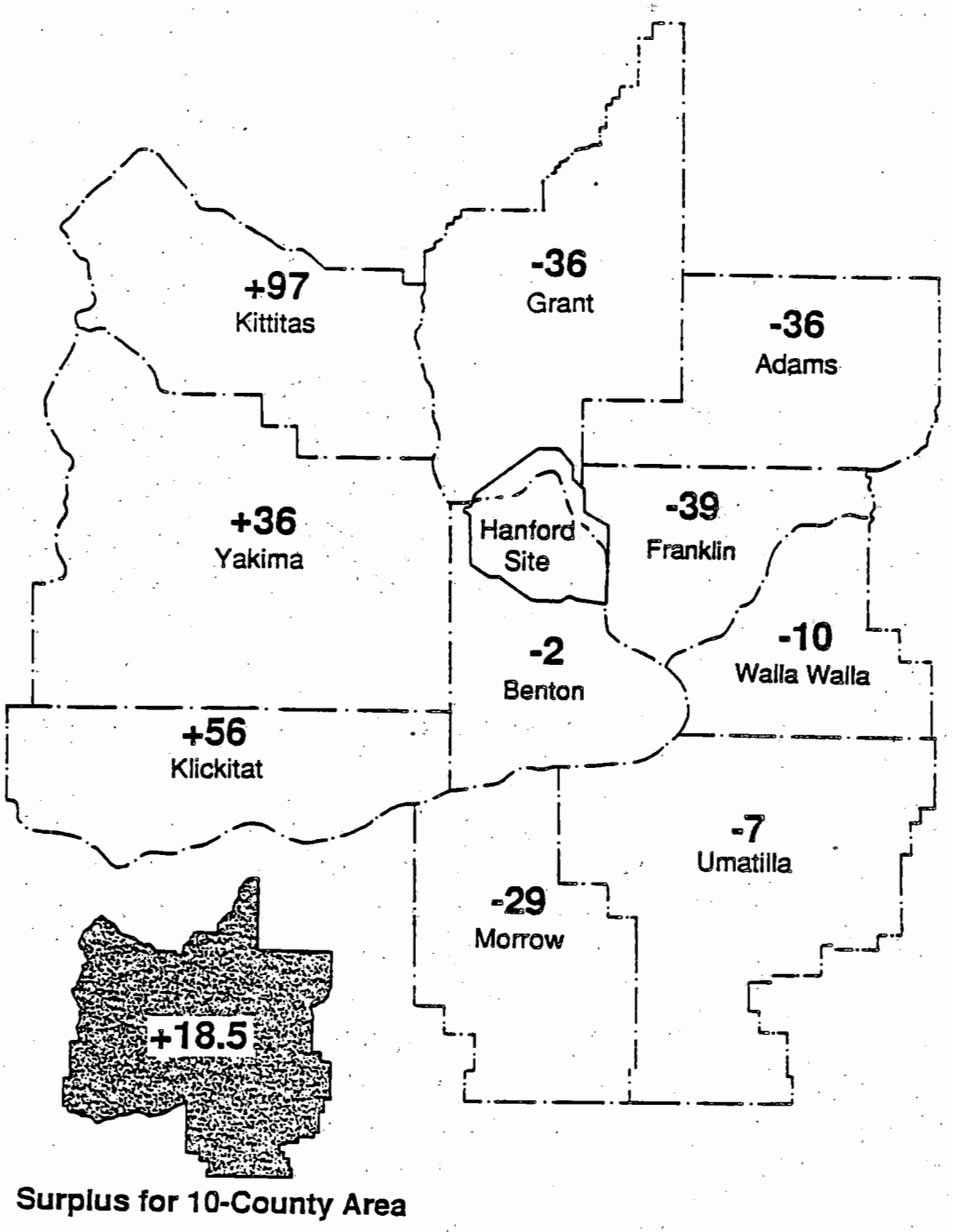


FIGURE 3.7. Per Capita Milk Surplus/Deficit (numbers indicate gallons per person)

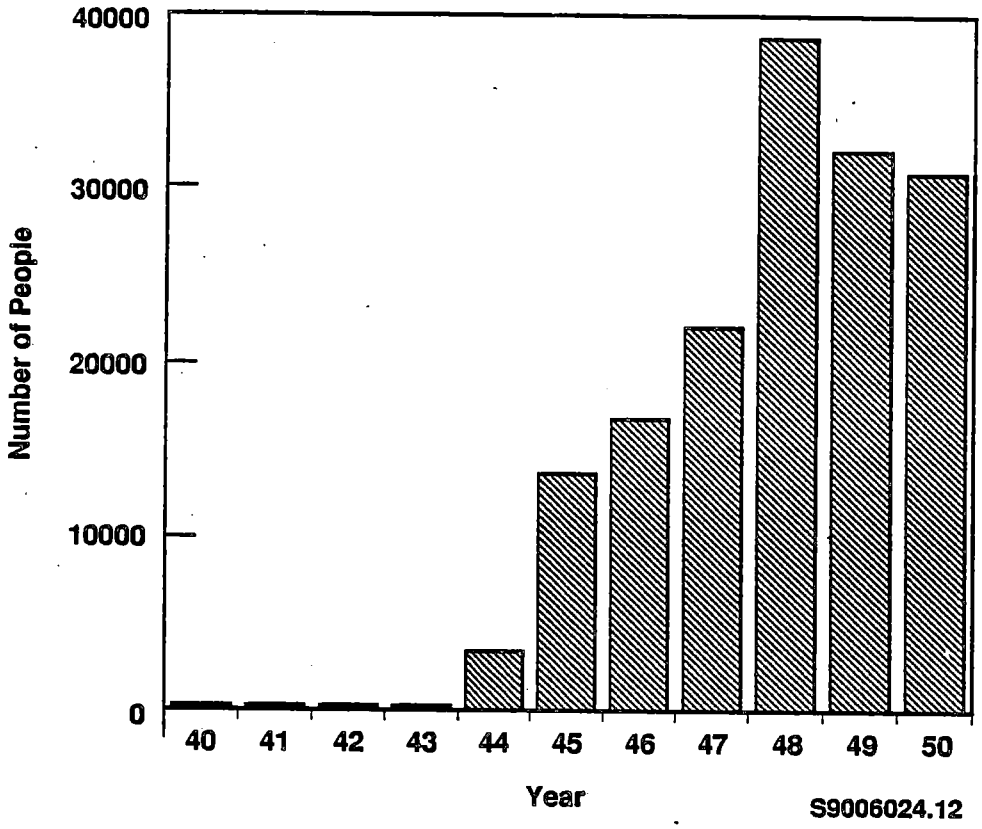
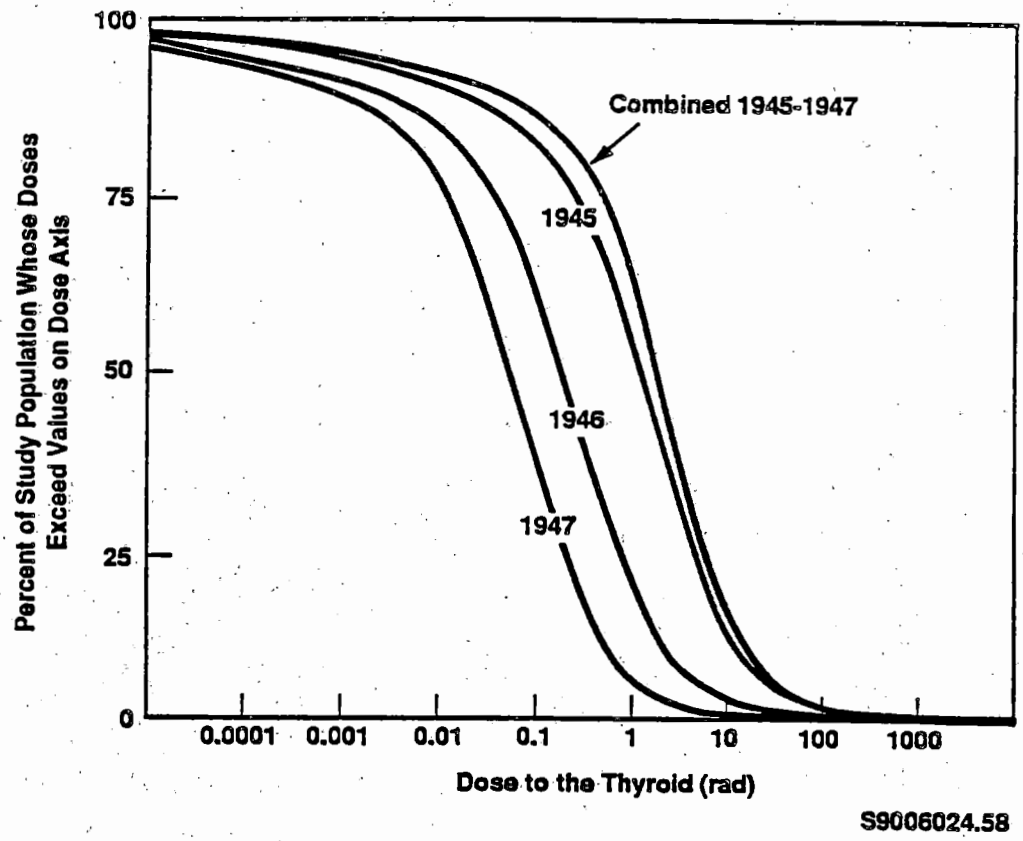


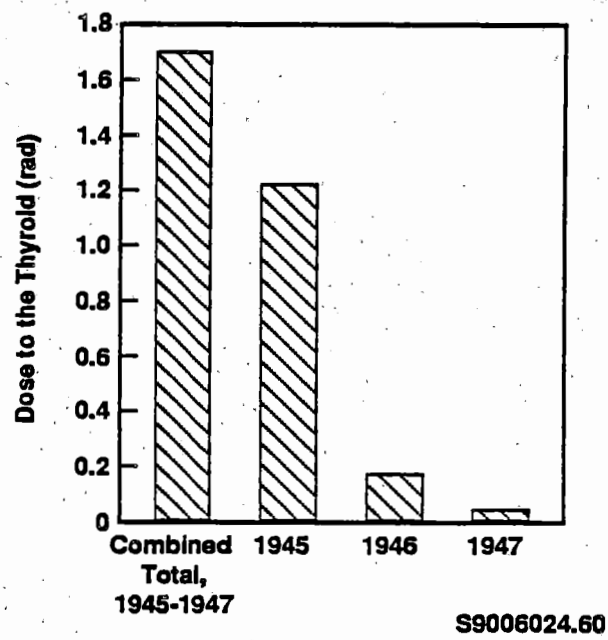
FIGURE 3.8. Changes in the Population of the Richland Area

Preliminary Phase I doses estimated for the period 1945, 1946, and 1947 and summed over 1945-1947 from the consumption of milk contaminated with iodine-131 for the Phase I study area population are illustrated in Figure 3.9. These population distributions provide information about the range of doses, the percent or probability of doses being greater than any selected dose value, the percent or estimated number of individuals whose doses range between any two values, and the median dose. Distributions for each county census division, age group, milk source, and dairy cow feeding regime considered during Phase I can be found in Appendix D.

One approach to enabling individuals who lived in the Phase I study area during 1945-1947 to roughly gauge their doses from the milk pathway is a decision diagram such as Figure 3.10. By answering questions with either yes or no, individuals can narrow uncertainties about their relative doses to one of 13 categories. The ranges and medians for each of the categories are



(a) Dose Distributions, 1945-1947



(b) Median Dose Estimates, 1945-1947

FIGURE 3.9. Dose Estimates From the Milk Exposure Pathway, for the Phase I Study Area Population, 1945-1947

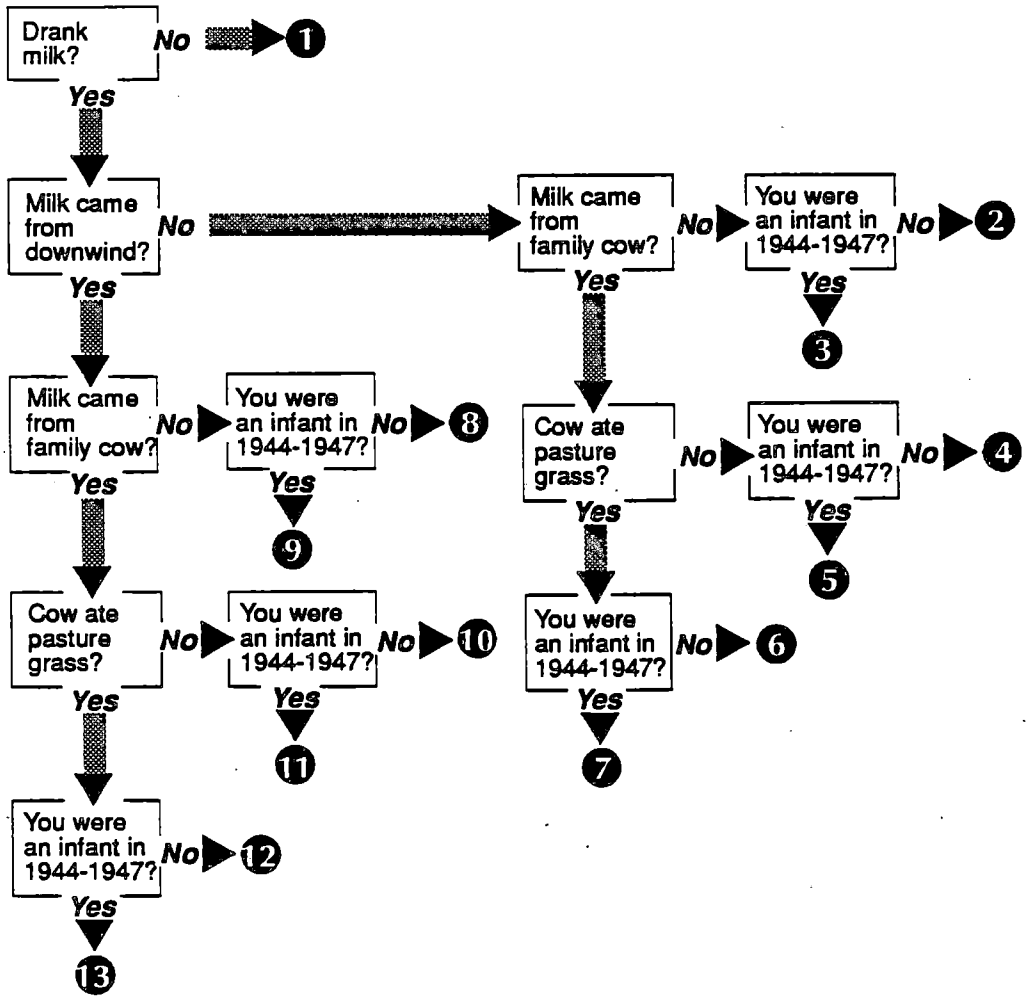


FIGURE 3.10. Decision Diagram for Estimating a Dose Category (See Figure 3.11 for estimated dose ranges)

shown in Figure 3.11. Category 13 consists of infants who lived downwind(especially in 1945) and consumed milk from cows grazed on local pastures, potentially received the highest doses from the milk pathway. Figure 3.12 shows locations of downwind and upwind dairy producers.

The population dose distributions for each of the 13 categories in Figure 3.11 were computed as the weighted average of the estimated dose distributions for the various types of people in that category. The "weight" for the distribution of a given type of person is the proportion of people of that type in the total population of the Phase I study area.

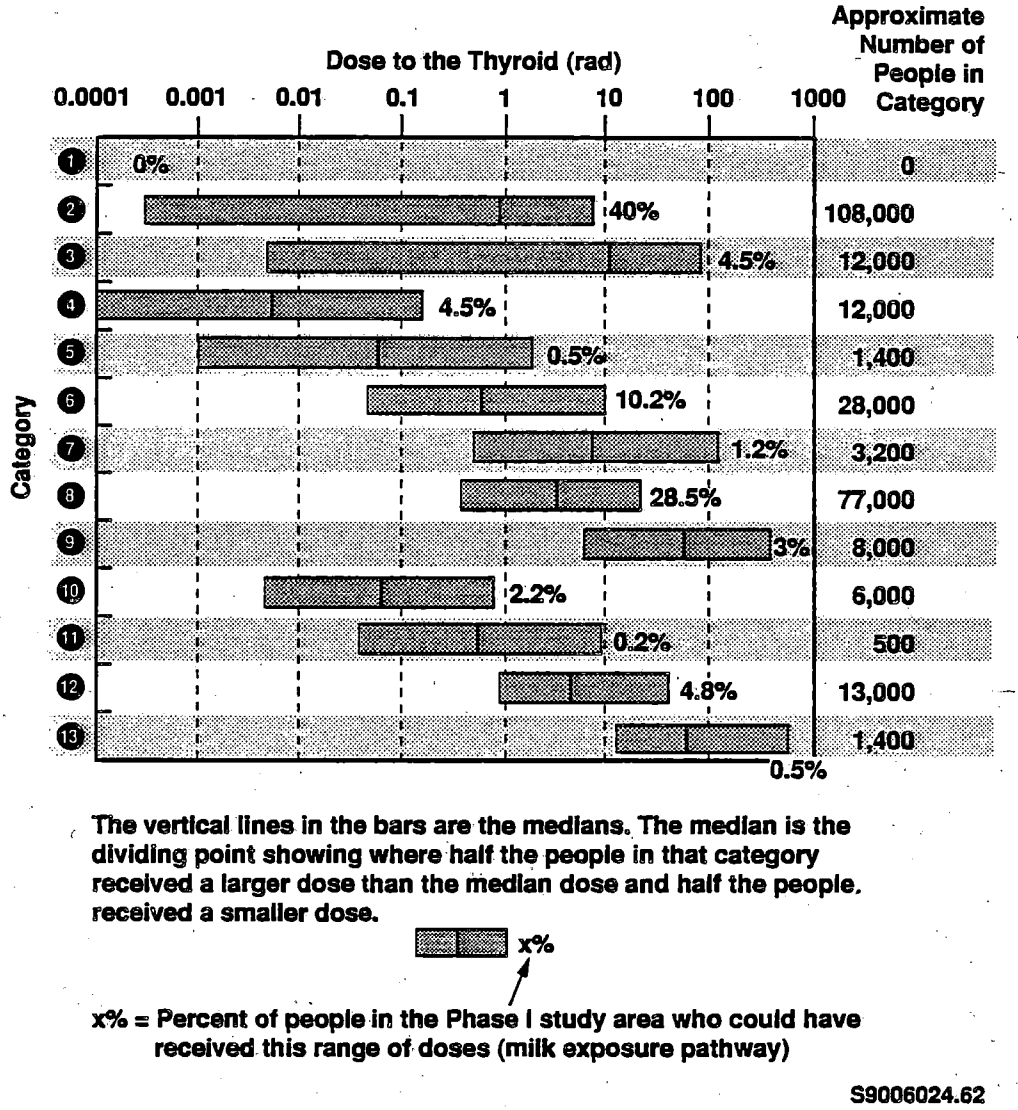


FIGURE 3.11. Preliminary Dose Estimates for Milk Exposure Pathway, 1945-1947. (Each bar shows the range of doses that people in the category opposite the bar could have received. Each bar covers 90% of the people in that category. Estimated radiation doses for people in both the lowest and highest 5% of each category are not included, because the numbers are much less accurate.)

Of pathways other than the milk pathway, doses from fresh vegetables grown in the backyards of downwind populations were the highest. For adults, the vegetable pathway was more important than the milk pathway, because of assumptions discussed in Section 3.8. For Phase I, it was assumed that all fresh vegetables eaten by individuals in a given census division during

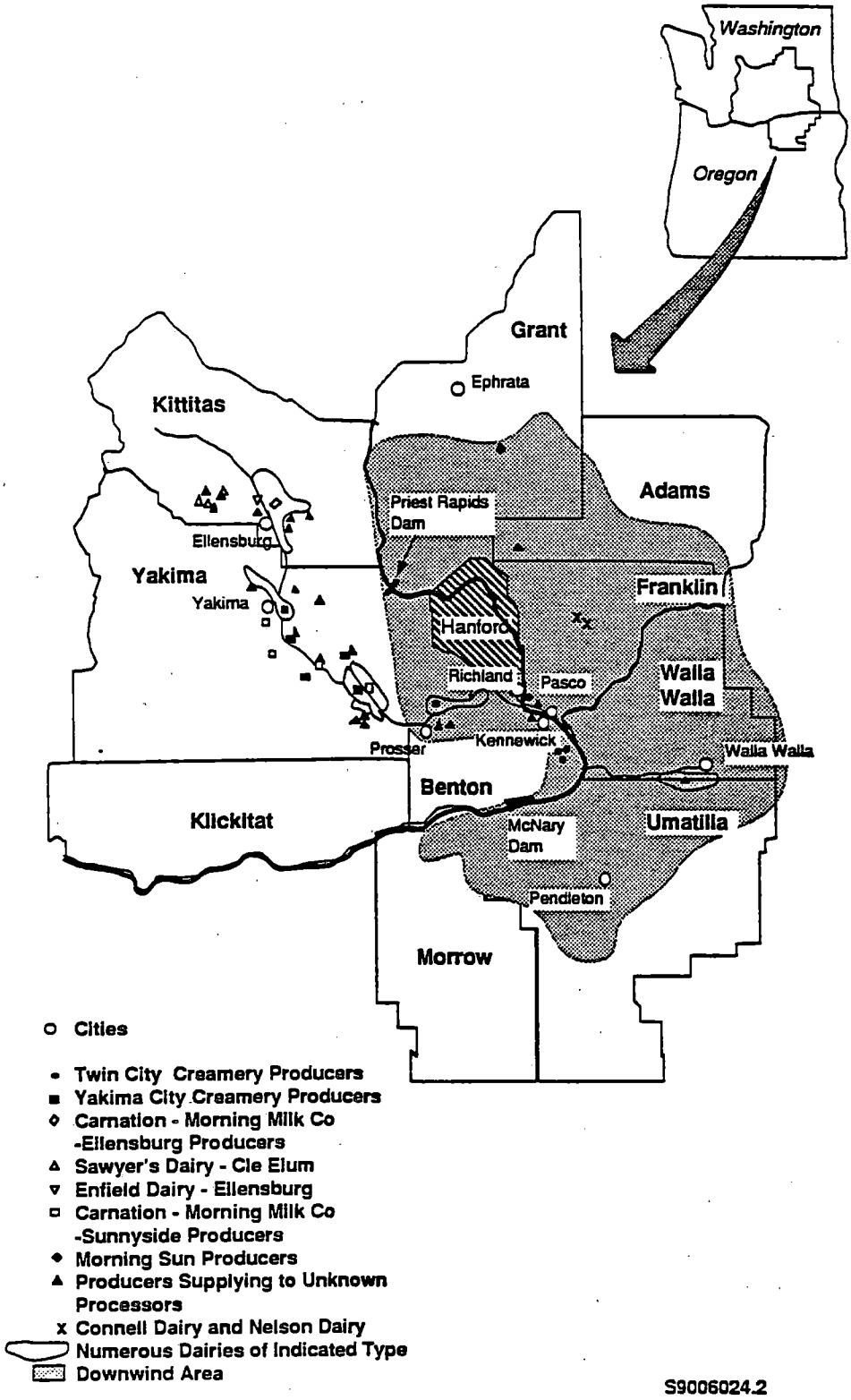


FIGURE 3.12. Milk Producers and Processing Plants Located to Date, 1944-1950 (shaded = downwind)

the Phase I growing season were grown within that census division. The distribution of doses for vegetables is shown in Figure 3.13.

3.7 DOSES FROM INHALATION AND FROM IMMERSION AND GROUND SHINE

Preliminary dose estimates for inhalation and for immersion and ground shine are depicted as CCD functions in Figure 3.14.

3.8 RANKING OF DOSES

The preliminary dose estimates vary with location, time, pathway, age, origin of milk, and dairy cow feeding regime. The relative importance of each pathway, for the case of infants downwind who drank milk from cows on local pasture, is illustrated in Figure 3.15. Doses generally decrease in the following order of pathways: milk from local cows on pasture, local vegetables, inhalation, and immersion and ground shine (external exposure).

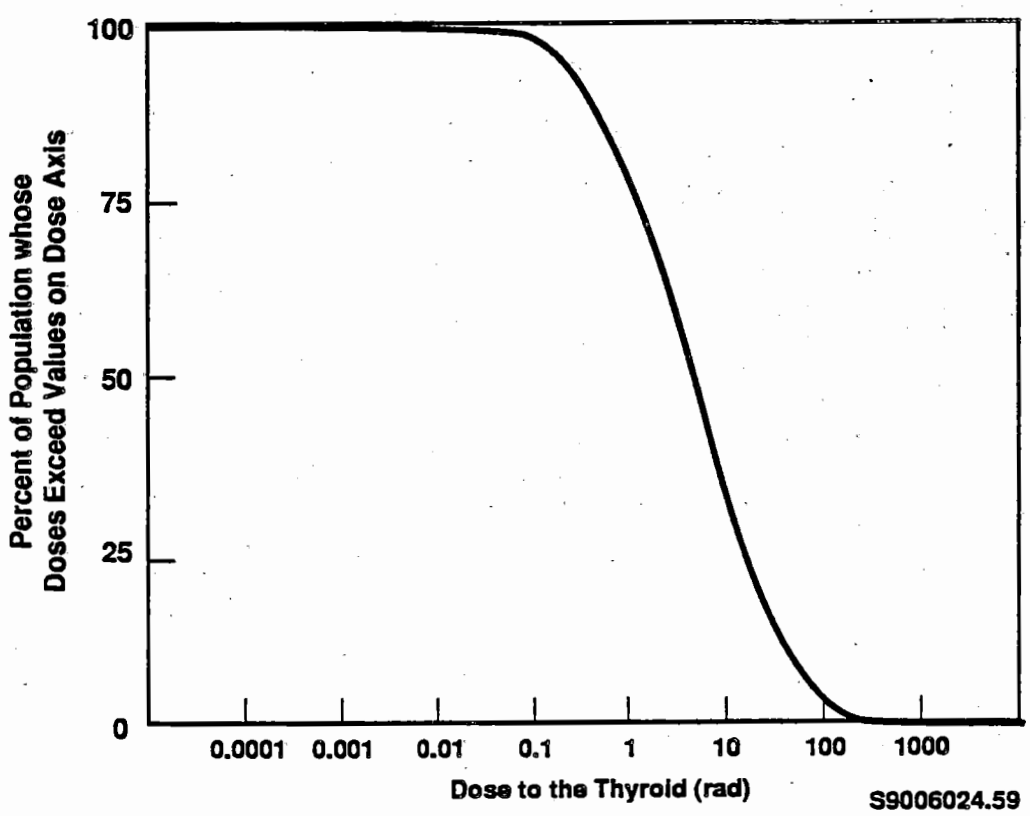
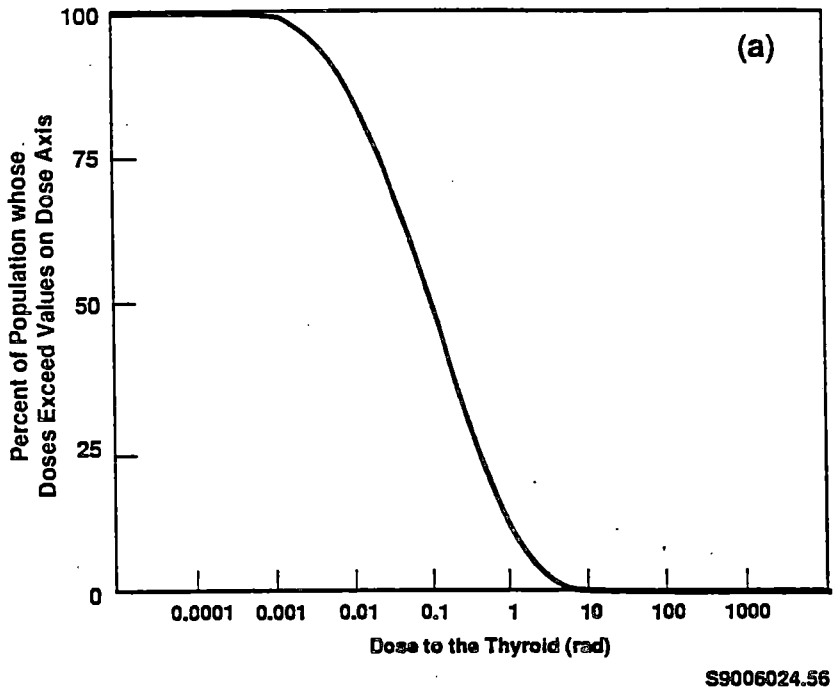


FIGURE 3.13. Distributions of Doses from Vegetables (assumes all vegetables are from local growers)



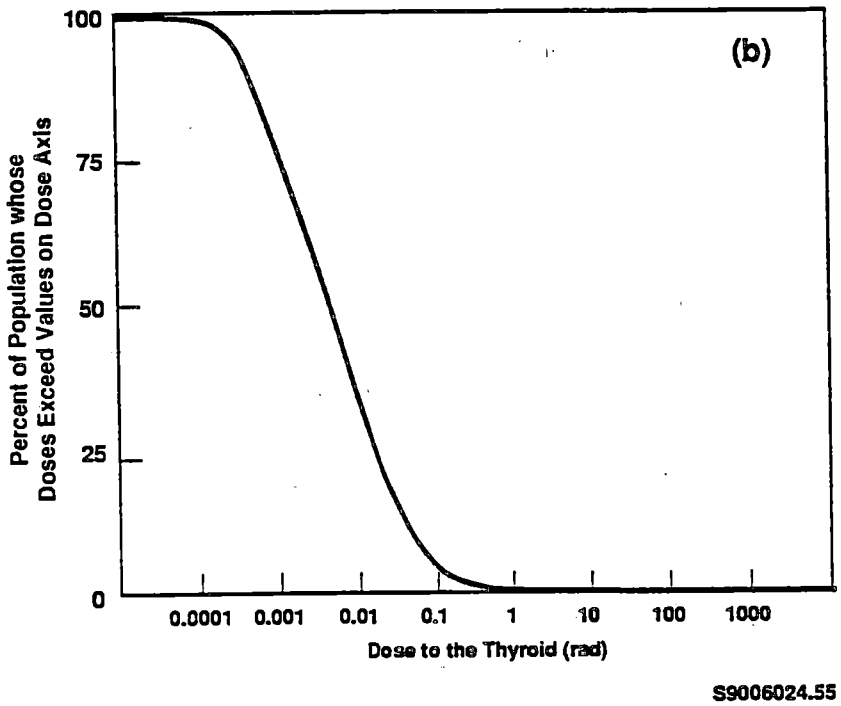


FIGURE 3.14. Estimated Doses to Phase I Study Area Populations from (a) Inhalation and (b) External Pathways

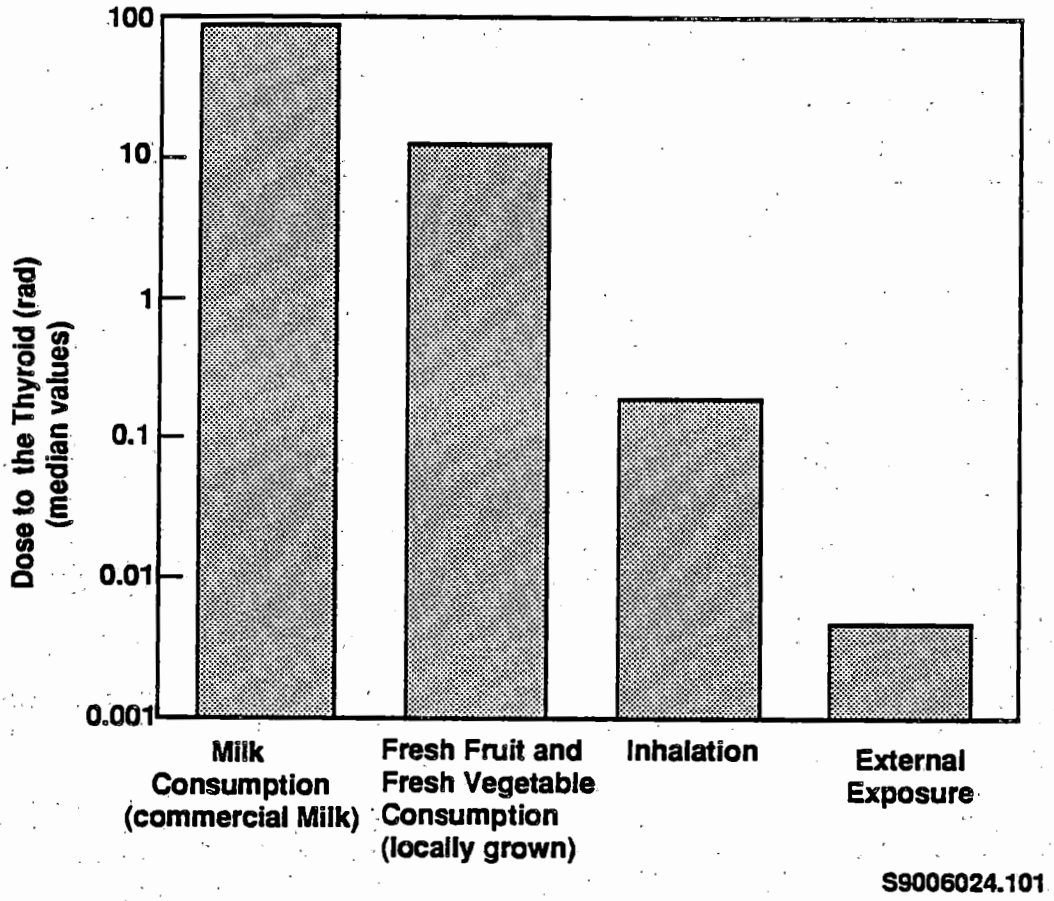


FIGURE 3.15. Relative Importance of Various Pathways Based on Median Values (downwind Walla Walla infant, local milk from dairy cows on pasture, locally grown vegetables and fruit, 1945-1947)

Doses from the separate pathways cannot be summed into a total dose. The preliminary dose distributions for produce and animal products other than milk are limited to the assumption that all fresh vegetables, fruits and grain were grown within each census division. Consequently, these distributions reflect maximally exposed individuals only, and do not represent the true range of doses from the consumption of foods other than milk. Nevertheless, doses downwind to infants from the consumption of locally produced milk are clearly several times greater than doses from the consumption of locally produced vegetables, fruit, and grain. Phase II will address the need to develop an agricultural production/distribution model similar to the milk model used in Phase I.

3.9 EVALUATION OF PHASE I OBJECTIVES

The Phase I results demonstrate that the key objectives were attained. First, sufficient historical information was retrieved and reconstructed. Second, preliminary conceptual and computational models were constructed to deal with uncertainties and to establish the foundation for extensive sensitivity analyses to be conducted in Phase II. Finally, the data and modeling approach produced plausible, although clearly preliminary, dose distributions. These objectives were attained by demonstrating

- that, as shown in Section 3.1, the source-term estimates agreed well with previously published estimates
- that calculated vegetation concentrations agree well with previously published measurements in several locations, as shown in Section 3.2
- that the range of preliminary dose estimates includes independent estimates of doses to maximally exposed individuals, as discussed below, and
- that relatively crude, previously published measurements of thyroid burdens of workers are in the range of average thyroid burdens estimated by the HEDR Project model for similar "reference individuals," as also presented below.

3.9.1 Previous Dose Estimate

In 1986, the Washington State Department of Social and Health Services (DSHS) (Washington State Office of Radiation Protection 1986) issued a preliminary dose estimate for 1945-1956. This preliminary estimate was based on past measurements of iodine-131 on sagebrush. The DSHS used a slightly modified model for a maximally exposed individual as provided in U.S. Nuclear Regulatory Commission (USNRC) Regulatory Guide 1.109 (USNRC 1977). The DSHS estimates for 1945-1947 of 2,530 dose to the thyroid in rem from this effort are indicated in Figure 3.16. About 0.004% of the Phase I population was estimated to have received thyroid doses exceeding the DSHS estimate of 2,530 rem to a maximally exposed infant in Pasco, 1945-1947.

The 95th percentiles of estimated doses to infants in county census division FR4 who drank milk from cows on local pasture (Appendix D) exceed the DSHS cumulative estimate for a Pasco infant from 1945-1947 (2,530 rem).

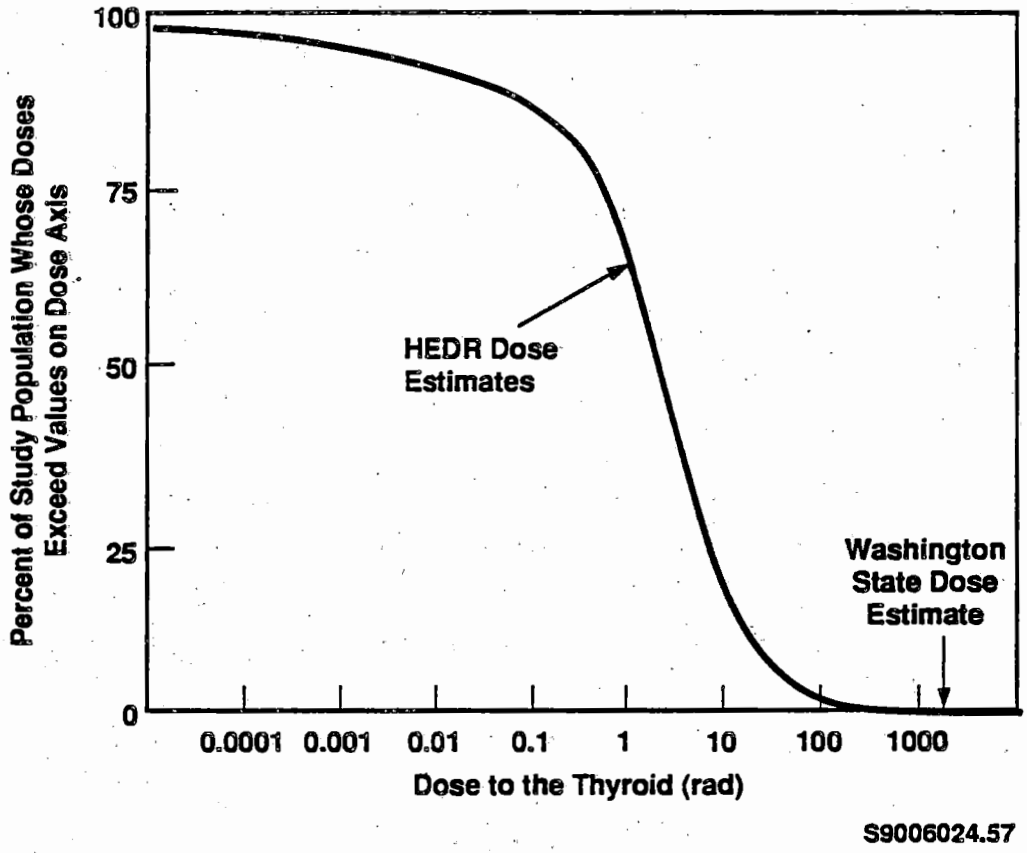


FIGURE 3.16. HEDR Preliminary Dose Estimates Compared with Washington State Dose Estimates (Pasco infant, 1945-1947)

The total population in FR4 is estimated to have been between 110 and 125 people in the period 1945-1947 (Beck et al. 1990).

3.9.2 Thyroid Counts

From the time Hanford operations began, workers in areas likely to experience relatively higher air concentrations of iodine-131 had their thyroids checked with a portable radiation detector. The thyroid checks were used not to obtain highly accurate measurement but as a screening tool. The intent was to detect levels above some arbitrary threshold, which was chosen to be 10% of the adopted radiation protection guideline.

Records of more than 7,900 measurements of thyroids from the period 1944-1946 were examined. More than one-third of the measurements did not register above background radiation, because of a combination of relatively high background levels, relatively insensitive instrumentation, and,

presumably, low amounts of iodine-131 in the thyroid glands of the workers who were monitored. Nevertheless, the measurements can be used to suggest the exposures that the workers might have received offsite from breathing contaminated air and drinking contaminated milk if the exposures were assumed to originate entirely offsite. The distribution of dose estimates based on the thyroid counts is compared with estimates calculated by the HEDR Project for adults living in Richland (Figure 3.17).

3.9.3 Background Radiation

One way of placing the preliminary Phase I doses in perspective is to compare the doses with background radiation. Such a comparison requires the use of risk and weighting factors developed by the International Commission on Radiological Protection (ICRP). These factors were developed for

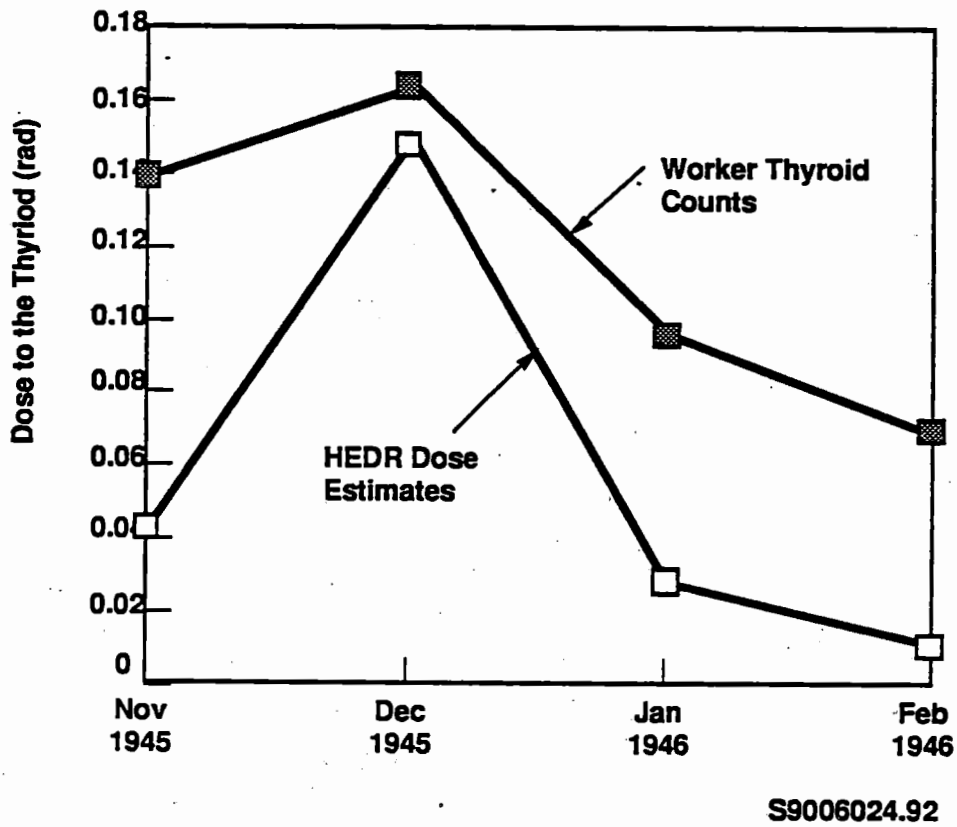


FIGURE 3.17. HEDR Preliminary Dose Estimates (Richland adults, inhalation exposure pathway, median values) Compared with Measurements (median values) of Iodine-131 in Thyroid Glands of Hanford Workers

radiation protection and therefore are purposely conservative. In particular, the ICRP factors are based on effects of high-dose, high-dose-rate external radiation, whereas major contributors both to background exposures and exposures from Hanford are relatively low-dose, low-dose-rate internally deposited radionuclides. With these caveats, the preliminary Phase I dose estimates for the milk pathway are compared with cumulative doses from background radiation.

According to recent publications (National Council on Radiation Protection and Measurements 1987), the average person in the U.S. is exposed to about 0.36 Effective Dose Equivalent (EDE) (rem) (0.0036 Sv)[a] a year [of which radon accounts for about 0.2 EDE (rem) (0.002 Sv)] or to about 25 EDE (rem) (0.25 Sv) during an average lifetime. Approximately 5% of the Phase I study area population, or about 13,000 people, might have received doses from the milk pathway that were higher than the annual, national, average background dose added over 3 years. About 1% of the Phase I population, or about 3,000 people, might have had doses from the milk pathway greater than an average, national lifetime dose from background radiation (Figure 3.18).

3.9.4 Historical Regulatory Standards

Some readers may be interested in what guidelines were used to control radiation exposures in 1944-1947. Hanford Site officials adopted guidelines recommended by the medical profession for exposure of medical employees and reduced the allowable exposures for Hanford employees to half of those guidelines (Wilson 1987). Exposures to iodine-131 were based on amounts that could be inhaled during a 24-hour period. The guideline translates roughly to about 1 rad to the thyroid per day. (There was also a guideline for vegetation in efforts to protect sheep and cattle that might graze on contaminated forage.) The guideline was not based on doses that might result to offsite populations from drinking contaminated milk because that pathway was not recognized as being the critical pathway until the mid-1950s (Comar et al. 1957; Parker 1956).

(a) All doses here are Effective Dose Equivalent (EDE), rather than organ dose.

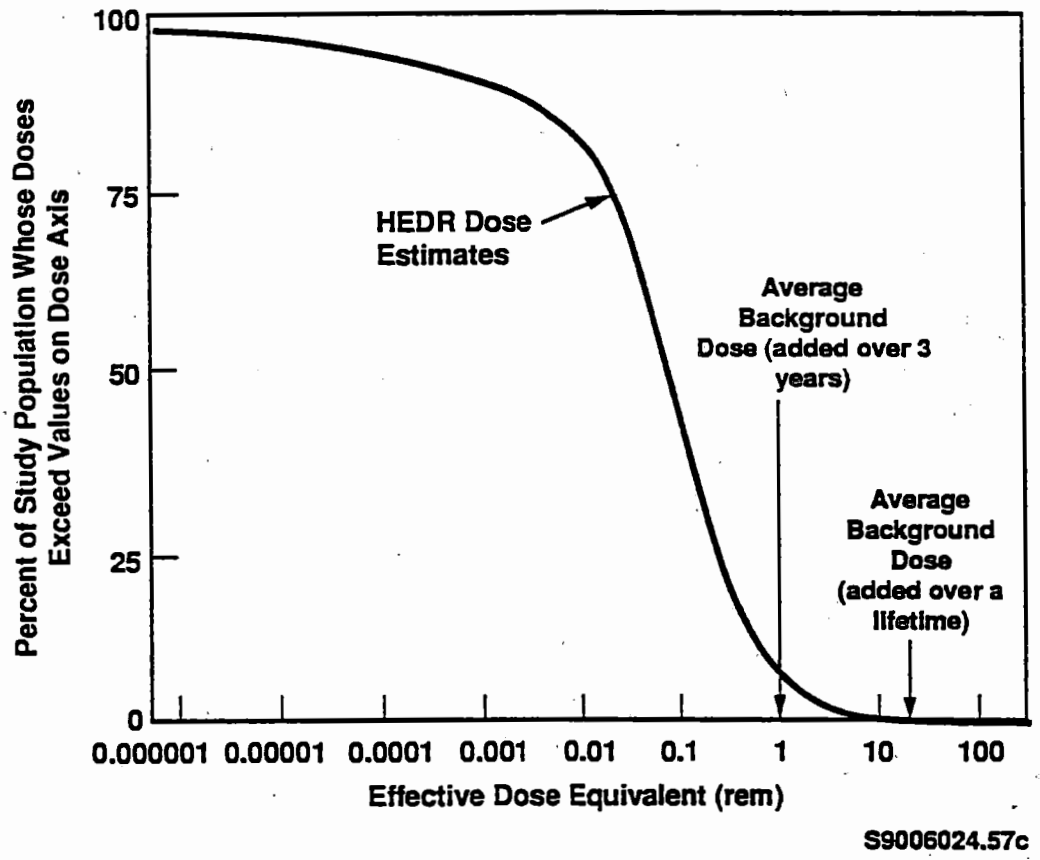


FIGURE 3.18. Average Background Radiation Received by U.S. Residents over a 3-Year Span and over a Lifetime Compared with Preliminary Radiation Doses from the Milk Exposure Pathway

3.10 UNCERTAINTIES IN PRELIMINARY DOSE ESTIMATES

Preliminary dose estimates were calculated during Phase I to demonstrate the feasibility of the dose-reconstruction process, rather than to provide definitive dose estimates for offsite populations. The degree to which these preliminary dose estimates might represent actual or relative doses that populations in the Phase I area during 1944-1947 received from atmospheric releases from Hanford is discussed briefly here.

Uncertainties in the preliminary Phase I dose estimates result from parameter uncertainties, model uncertainties, and variability as these terms are discussed in Finkel (1990) and IAEA (1989). The extent of these uncertainties and their contributions to the uncertainties in dose estimates will

be assessed during Phase II of the project. Examples of some of the variabilities and uncertainties that are known to be inherent in the preliminary Phase I estimates include

- Uncertainty regarding the time elapsed between reactor shutdown and dissolution of irradiated fuel. Because of the short half-life of iodine-131 (8 days), uncertainties of 1 to 3 days result in uncertainties of up to 20% in the amount of iodine in irradiated fuel at irradiation.

- Uncertainty in the release fraction. Estimates of the release fraction range from 50 to 85%, resulting in uncertainties that are reflected in the dose estimates.

- Uncertainty in concentrations of iodine-131 in air and in vegetation at any specific location or time. These concentrations vary because of variability in amounts released from Hanford and because of variability in wind speed, wind direction, and factors that affect the degree of mixing of contaminated with uncontaminated air during transport to a specific geographic location. Concentration estimates are also uncertain because of uncertainties in the model(s) used to describe the complex meteorological and physical/chemical phenomena that affect the dispersal of iodine-131 in the atmosphere.

- Uncertainties arising from the use of average meteorological data from 1983 to 1987 in place of data for 1944-1947, which were not available in time for the Phase I calculations.

- Uncertainty about the iodine-131 release rate. For Phase I, releases during a month were assumed to be continuous, when in fact they were episodic. (Information about release times is still being retrieved and assessed.)
- The inclusion and exclusion of certain parameters in the model structure.

- The applicability of values of iodine-131 deposition onto vegetation obtained under circumstances that differ from conditions in the Phase I area.

- The structure of the model(s) used to describe the process of deposition of iodine-131 from the atmosphere onto vegetation or the interception of deposited iodine-131 by vegetation.

- The amount of contaminated pasture consumed by dairy cows.

- The amount of iodine-131 transferred from the pasture to milk by individual cows, by location and time.

- The pooling of contaminated milk from different locations and times.
- The dairy cow feeding regime actually used by individuals with backyard cows.
- The amount of milk distributed to various outlets by a producer/distributor.
- The source(s) of milk consumed by an individual.
- The amount of milk consumed by an individual.
- The amount of iodine transferred to and retained by an individual's thyroid.
- The metabolic condition and thyroid mass of an individual.

Future dose estimates will change as a result of efforts to reduce uncertainties in key variables and as a result of modifications in model structure. These changes will include reductions in uncertainty and changes in mean values and distributions of dose. Of the contributors to uncertainty/variability in dose estimates listed above, reductions in uncertainty in the atmospheric-transport/deposition parameters and submodels are the most likely to result in reductions in uncertainties in the dose estimates.

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APPENDIX A

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Hanford Environmental Dose Reconstruction Project Monthly Report	Haerer, HA	Monthly	PNL-6450 HEDR
Work Plan for the Hanford Environmental Dose Reconstruction Project	Haerer, HA	1989	PNL-6696 HEDR REV 1
Proposed Approach for Developing Information on Population Food Consumption and Lifestyles of Native Americans in the HEDR Study Area	Rhoads, RE, and Bruneau, CL	1989	PNL-6803 HEDR
Summary Report of HEDR Workshop on Sensitivity and Uncertainty Analysis	Sagar, B., and Liebetrau, AM	1989	PNL-SA-16804 HEDR
Demographic, Agricultural, Food Consumption, and Lifestyle Research for the Hanford Environmental Dose Reconstruction Project	Beck, DM, et al	1989	PNL-6834 HEDR
Response to TSP Directive 88-4, Ground-Water Contamination Data	Freshley, MD	1989	PNL-6847 HEDR
A History of Major Hanford Operations Involving Radioactive Material	Ballinger, MY, and Hall, RA	1989	PNL-6964 HEDR
Summary of Workshop on Milk Production and Distribution, November 30, 1988 - HEDR Project	Beck, DM, et al.	1989	PNL-6975 HEDR
Feasibility of Using ^{129}I Concentrations in Human Tissue to Estimate Radiation Dose From ^{131}I	McCormack, WD	1989	PNL-6889 HEDR
Hanford Environmental Dose Reconstruction (brochure)	Bruneau, CL	1989	PNWD-1323 HEDR
Radionuclide Sources and Radioactive Decay Figures Pertinent to the HEDR Project	Heeb, CM	1989	PNL-7177 HEDR
Uncertainties in Source Term Calculations Generated by the ORIGEN2 Computer Code for Hanford Production Reactors	Heeb, CM	1989	PNL-7223 HEDR
Atmospheric Transport and Dispersion Modeling for the Hanford Environmental Dose Reconstruction Project	Ramsdell, JV	1989	PNL-7198 HEDR
Preliminary Summaries for Vegetation, River and Drinking Water and Fish Radionuclide Concentration Data (DRAFT)	Woodruff, RK	1989	PNL-SA-17641 HEDR

Title	Author	Publication Date	Publication No.
Atmospheric Transport Modeling and Input Data for Phase I of the Hanford Environmental Dose Reconstruction Project	Ramsdell, JV, and Burk, KW	1989	PNL-7199 HEDR
Fission-Product Iodine During Early Hanford-Site Operations: Its Production and Behavior During Fuel Processing, Off-Gas Treatment, and Release to the Atmosphere	Burger, LL	1989	PNL-7210 HEDR
The Hanford Environmental Dose Reconstruction Project: Background Information (flier)	Byram, SJ	1989	PNL-SA-17658 HEDR
Summary of Literature Review of Risk Communication	Byram, SJ	1989	PNL-7226 HEDR
Milk Cow Feed Intake and Milk Production and Distribution Estimates for Phase I	Beck, DM	1989	PNL-7227 HEDR
Estimations of Traditional Native American Diets in the Columbia Plateau	Hunn, ES and Bruneau, CL	1989	PNL-SA-17296
Estimates of Columbia River Radionuclide Concentrations: Data for Phase I Dose Calculations	Richmond, Walter	1990	PNL-7248 HEDR
Evaluation of Thyroid Radioactivity Measurement Data From Hanford Workers, 1944-1946	Ikenberry, T	1990	PNL-7254 HEDR
I-131 in Irradiated Fuel at Time of Processing From December 1944 Through December 1947	Morgan, LG	1990	PNL-7253 HEDR
Population Estimates for Phase I	Beck, DM	1990	PNL-7263 HEDR
Estimates of Food Consumption	Callaway	1990	PNL-7260 HEDR
Soil Ingestion by Dairy Cattle	Darwin, RF	1990	PNL-SA-17918 HEDR
Computational Model Design Specification for Phase I of the Hanford Environmental Dose Reconstruction Project	Napier, BA	1990	PNL-7274 HEDR
Selection of Dominant Radionuclides for Phase I of the HEDR Project	Napier, BA	1990	PNL-7231 HEDR
A Preliminary Examination of Audience-Related Communications Issues: Hanford Environmental Dose Reconstruction Project	Holmes, CW	1990	PNL-7321 HEDR
MESOILT2, A Lagrangian Trajectory Climatological Dispersion Model	Ramsdell, JV	1990	PNL-7340 HEDR
Draft Summary Report	HEDR Staff	1990	PNL-7410 HEDR
Draft Air Pathway Report	HEDR Staff	1990	PNL-7412 HEDR
Draft Water Pathway Report	HEDR Staff	1990	PNL-7411 HEDR

APPENDIX B

COMPUTATIONAL MODEL DESIGN SPECIFICATION FOR PHASE I OF THE HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT

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COMPUTATIONAL MODEL DESIGN SPECIFICATION FOR PHASE I OF THE HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT

HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT

B. A. Napier

February 1990

Prepared for
review, evaluation, and approval
by the Technical Steering Panel

Pacific Northwest Laboratory
Richland, Washington 99352

COMPUTATIONAL MODEL DESIGN SPECIFICATION FOR PHASE I
OF THE HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT

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

J. E. Till, Chair
Technical Steering Panel

Date

PREFACE

In recent years, concern has been mounting about possible health effects to the public from over 40 years of operations at the Hanford Site. This concern prompted the Washington State Nuclear Waste Board and the Indian Health Service to request the Centers for Disease Control (CDC) to convene a Hanford Health Effects Review Panel to review and evaluate epidemiological and environmental data relevant to Hanford operations. In 1986, based on this review, the Panel recommended a study be initiated to reconstruct radiation doses potentially received by the public residing in the vicinity of Hanford, and a separate study of thyroid morbidity in the same population. The HEDR Project is the outgrowth of that recommendation.

The HEDR Project is divided into the following technical tasks. These tasks address each of the primary steps in the path from radioactive releases to dose estimates:

- Source Terms
- Environmental Transport
- Environmental Monitoring Data
- Demographics, Agriculture, and Food Habits
- Environmental Pathways and Dose Estimates.

The Source Terms Task will develop estimates of radioactive emissions from Hanford facilities since 1944. These estimates will be based on historical measurements and production information.

The Environmental Transport Task will reconstruct the probable movement of radioactive materials from the areas of release to populations. Movement via the atmosphere, surface water (Columbia River), and ground water will be studied.

The Environmental Monitoring Task will assemble, evaluate, and report historical monitoring data.

The Demographics, Agriculture, and Food Habits Task will develop the data needed to determine which population groups could have been affected by the releases. Population and demographic information will be developed for

the general population within the study area. This information will also be developed for several special population groups including the Native American tribes in the study area, military personnel stationed at Hanford, Hanford construction workers, and migrant farm workers. The food and water consumption patterns and practices and sources of food and water must also be estimated.

Historical dairy farming practices and milk distribution systems will be studied because milk is a significant pathway for iodine-131 to enter the human body. Cows could have eaten vegetation contaminated with this radionuclide.

The Environmental Pathways and Dose Estimates Task will use the information produced by the other tasks to estimate the radiation doses people could have received from Hanford operations.

This report is the result of a collaboration of the Statistics Task and the Environmental Pathways and Dose Estimates Task. This report outlines the computations that will be needed to incorporate all of the data collected by the various tasks to produce radiation dose estimates. Preliminary models are defined and the structure and logic of the envisioned computer code are outlined.

SUMMARY

The objective of the Hanford Environmental Dose Reconstruction (HEDR) Project is to estimate the radiation dose that individuals could have received as a result of emissions from nuclear operations at Hanford since their inception in 1944. The purpose of this report is to outline the basic algorithm and necessary computer calculations to be used to calculate radiation doses to both specific and hypothetical individuals in the vicinity of Hanford. The system design requirements, those things that must be accomplished, are defined. The system design specifications, the techniques by which those requirements are met, are outlined. Included are the basic equations, logic diagrams, and preliminary definition of the nature of each input distribution.

ACKNOWLEDGMENTS

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1.0 INTRODUCTION

The objective of the Hanford Environmental Dose Reconstruction (HEDR) Project is to estimate the radiation dose that individuals could have received as a result of emissions from nuclear operations at Hanford since their inception in 1944.[a] This report documents the algorithms that will be implemented for initial computer calculations.

In response to a directive from HEDR's Technical Steering Panel, the reconstruction of doses to offsite populations is being performed in a series of phases. The first phase is the development of basic techniques and proof of principle. The objective of Phase I is to demonstrate through calculation that adequate models and support data exist or can be developed to allow estimation of realistic doses to individuals from releases of radionuclides to the environment that occurred as long as 45 years ago. Later phases will expand the capabilities and refine the dose estimations. Much of the data being used in Phase I is preliminary or approximate and, therefore, the doses calculated must also be considered preliminary approximations. Within the constraints of Phase I, a computational methodology has been developed. This report documents the requirements that the resulting computer code must meet and outlines a method of meeting the requirements.

The work described in this report was conducted in accordance with the requirements of ANSI/ASME NQA-1 1986 Edition (ASME 1986), Quality Assurance Program Requirements for Nuclear Facilities, as interpreted by the Pacific Northwest Laboratory (PNL) Quality Assurance (QA) Program.

Development of the HEDR computer code(s) will be guided by the PNL QA program requirements, which are embodied in a series of Software Control Procedures (SCPs). There are seven applicable procedures, dealing with 1) determining and documenting software requirements (SCP-312), 2) final review and acceptance of codes and documentation (SCP-313), 3) software configuration management (SCP-314), 4) conversion testing, verification, and/or validation of software (SCP-315), 5) application control (SCP-316),

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(a) The project is being managed and conducted by Battelle staff at the Pacific Northwest Laboratory under the direction of an independent Technical Steering Panel.

6) transfer of software, data, and documentation into and out of the project (SCP-317), and 7) control of databases (SCP-318).

Preparation of this document partially fulfills the requirements of SCP-312, which stipulates code design requirements, design specifications, data input and output, testing, and verification. Upon completion of the code, a Final Internal Development Review (FIDR) will be performed according to SCP-313, resulting in a documented review of the code for adequacy, applicability, and correctness. Following the FIDR, the code will be placed under configuration management, which controls methods of backup, storage, user access control, change requests, and updating. All applications of the code will be tracked and documented under the requirements of SCP-316.

All procedures used to support this report were written and controlled in accordance with PNL QA program requirements. Records that support the derivations in this report were created and stored in accordance with applicable HEDR Project record control requirements, including requirements on the generation of computer output, verification of computer codes, and review of all intermediate output.

Drafts of this document underwent internal independent technical review. Review comments were satisfactorily resolved, and there were no controversial resolutions to the comments.

2.0 SYSTEM DESIGN REQUIREMENTS

This section identifies the system design requirements needed to make the computer codes easy to use, compatible with current computer facilities, and well-suited to the calculational requirements of the project.

The goal of the project is the calculation of estimates of radiation dose, with associated variability and uncertainty, for both hypothetical Reference Individuals and actual Specific Individuals. For representative Reference Individuals, information is being developed on the basis of geographic location, age, lifestyle, ethnic group, and dietary habits. For Specific Individuals, additional information will be required on actual values for each of these data categories, along with definitions of the time frames of changes in each. It becomes immediately obvious that the number of variables and potential permutations is very large, and the level of detail is very fine, so a major undertaking is simply the control and explanation of this much information.

All final dose results are being provided in terms of a range of potential doses, with a distribution of expected values. The calculations incorporate the uncertainty caused by both natural variability and lack of knowledge.

2.1 GENERAL COMPUTATIONAL APPROACH

Appropriate scales for spatial and temporal resolution have been identified. Recent similar projects that attempt to reconstruct doses for releases of radionuclides from the Department of Energy's (DOE's) Nevada Test Site have used county-level grids, with specific locations sometimes superimposed (Dose Assessment Advisory Group 1987). For releases from the Hanford facilities, it was quickly determined that the county grid would be too coarse because atmos-pheric concentration and deposition could be shown to vary significantly within individual counties. A simple rectilinear grid, such as that used in most atmospheric dispersion models, was found to be too inflexible; that is, no grid could be devised that did not have such undesirable features as splitting major population centers. Demographic data are mostly available from the U.S. Census Bureau, and census subdivisions

were found to be essentially unchanged over most of the potential study period from initiation of Hanford operations in 1944 to the present. The census subdivisions were originally developed by the Census Bureau to create stable enumeration districts. Consideration was given in their development to trade and service areas, principal settlements, major land uses, and physiographic differences. Additionally, the census tracts tend to follow political boundaries such as township and range lines, which in much of the potential study area also tend to follow a fairly regular grid pattern. Each of these characteristics is favorable for use by the project with the added advantage of tending to follow a regular grid. Therefore, the census subdivision was selected as the basic unit of spatial area, with some minor modifications (usually combinations of very small adjacent subdivisions, although decomposition of large areas into smaller ones was also done). A map of the initial subdivisions selected for study is shown in Figure 2.1.

Selection of a unit of temporal measure proceeded in a manner similar to that for spatial resolution. The Hanford releases have for the most part been routine and continuous. Meteorological data used to describe the atmospheric transport of released radionuclides are available for 15-minute intervals for much of Hanford's history. Census data on locations and numbers of exposed individuals are available for every decade since 1944. For some time periods, data on releases from the Hanford facilities and monitoring of environmental contamination resulting from those release are available from archived monthly reports. However, other information cannot be expected to be so well documented. Reference dietary data are available, at best, on a seasonal basis. For lifestyle surveys, also, it seems unreasonable to expect most people to remember habits and activities up to 45 years ago on anything more than a seasonal or monthly basis. Based on these considerations, therefore, the month was selected as the project's unit of temporal resolution.

For the Phase I work to date, the 10-county area shown in Figure 2.1 has been investigated. The years of initial interest have been 1944-1947 for the atmospheric releases and 1964-1966 for the surface water releases. These were selected to represent periods of relatively high release and, in the case of the surface water releases, comprehensive monitoring data.

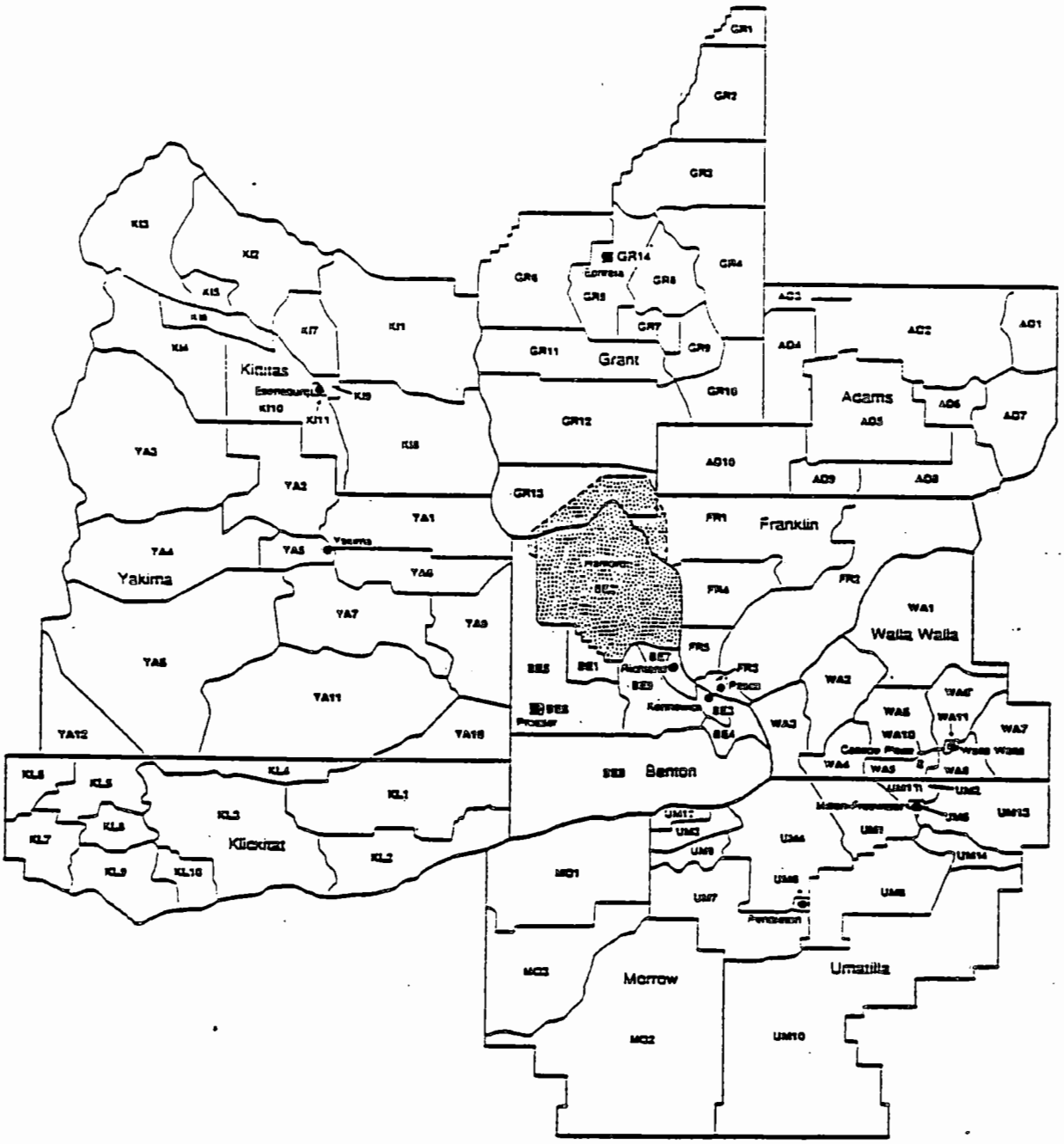


FIGURE 2.1. HEDR Census Divisions

2.2 COMPUTATIONAL FACILITIES, HARDWARE, AND DATABASES

The computer code shall be designed for implementation on the PNL Y-VAX in conjunction with the Sequent database system. The code shall be secondarily designed for in-house microVAX and other minicomputer systems. If it is necessary to improve data processing speeds, provision should be made for the code to run on the NAS-9060 LSIS (large-scale information system) Cray computer.

Input data will be generated in several of the technical tasks on the project. Each task will be responsible for maintaining its own separate database and transferring the documented results to the main HEDR database. The main HEDR database should be kept on a central PNL mainframe, such as the Sequent system in the Sigma V Building. A database management system, e.g., Oracle, should be considered for controlling and accessing this data.

Because of the large quantities of spatially related data that must be maintained and analyzed, provisions shall be made to adapt the calculated outputs to a Geographic Information System (GIS). Input and output data stored in a coherent form on the Sequent should facilitate transfer to a GIS.

2.3 CODE LANGUAGE

The computer code shall be written in standard ANSI FORTRAN-77 language. This choice will facilitate the communication and understanding of the code calculations, conversion to other computing systems, modifications to the code, and necessary updating.

2.4 CODING STANDARDS

Programming shall follow the guidelines of the following coding standard. This coding standard is intended to provide a concise, uniform, and complete form of documentation and quality control; to streamline review efforts; and to simply software maintenance. All FORTRAN routines shall consist of three blocks:

1. Definition block (routine name, limitations and prerequisite, arguments, logical names and files used, routines used),

2. Implementation block (development information, modification history, algorithms, constants, parameter statements, common blocks, and variables), and

3. Code block (data statements and executable statements).

Where applicable, the programmer should

- localize system-dependent calls
- avoid dependency on internal word size
- place constants in an up-front parameter file
- put variables in common blocks
- use logical device names in front of file names
- hold to a limit of one routine per file.

2.5 DATA INPUT

The code will need to access the following types of information in arrays of data logically prepared as functions of spatial location and time period:

Source Terms

- source terms by radionuclide (probably only two or three nuclides in Phase I, up to 20 later)
- number of curies released for each month
- associated low and high estimates for each nuclide and time period
- atmospheric releases assigned to a single location mid-site for Phase I.

Transport

- atmospheric dispersion data in terms of time integrated air concentrations, curie-second/cubic meter per curie released at each location for each month
- best estimate and uncertainty descriptors given as the mean and standard deviation of the logarithm (base 10) of the time-integrated air concentration

- atmospheric deposition data in terms of monthly averaged deposition rates, curies/square meter/second per curie released at each location for each month

- cumulative atmospheric deposition data in terms of curies/square meter at the end of each month per curie released at each location for each month

- best estimate values and an uncertainty descriptor - The transport model will perform this calculation on a single-month basis and the subsequent software models will aggregate the running total in order to allow the statistical portion of the calculation to proceed.

- river water concentrations in terms of curies/liter monthly average with an uncertainty descriptor for each river-adjacent location (approximately one for each river-adjacent census tract)

- sediment concentrations in terms of curies/square meter monthly average, if available (probably not available for Phase I) with an uncertainty descriptor for each river-adjacent location.

Monitoring Data

- measured vegetation concentrations in terms of curies/kilogram monthly average for each location - This requires prior averaging of data, which results in a distribution descriptor. This is likely to be a sparse matrix.

- measured fish concentrations in terms of curies/kilogram monthly average at each of the locations used above for water and sediment concentrations - This requires prior averaging of data, which results in a distribution descriptor. This has the potential to be a fairly sparse matrix.

- for later phases, measured air concentrations in terms of curies/cubic meter for each location for each month - This requires some averaging of data, which should result in a distribution descriptor. This is likely to be a sparse matrix.

- for later phases, measured animal product concentrations in terms of curies/kilogram or liter for each location for each month - This requires some averaging of data, which should result in a distribution descriptor. This is likely to be a sparse matrix.

Demography and Food Habits

- animal feeding practices (kilogram/day per animal for each feed type) by location and month - Five feed types will be used for Phase I. Associated uncertainty descriptors will be defined as high and low estimates.

- for later phases, feed distribution arrays (the fraction of feed consumed in one location that is produced in another location) by feed type and month - Associated uncertainty arrays, probably high and low estimates. This may be a sparse matrix. For Phase I, it will be assumed that all feeds are produced locally.

- milk accumulation arrays, the fraction of milk received at a distribution center (dairy) from each location - We anticipate about 20 dairies for Phase I. Associated uncertainty arrays, probably high and low estimates. This may be a sparse matrix.

- milk distribution arrays, the fraction of milk available to be consumed in each location from each distribution center - We anticipate about 20 dairies for Phase I. Associated uncertainty arrays, probably high and low estimates. This may be a sparse matrix.

- dietary consumption rates, in terms of kilograms/month for each food type, as a function of age, sex, lifestyle, and month. Associated distributions derived from the 1977 National Food Consumption Survey.

Environmental Pathways and Doses

- radiation dose factors in terms of rem/curie ingested or inhaled, by age and sex - There will probably be only two age groups in Phase I. Uncertainty distributions parameterized as log-normal.

2.6 OUTPUT REQUIREMENTS

Radiation doses will be calculated for various intakes of radionuclides, including uptake by the body, distribution and retention of the radionuclides in various organs, and information on the resulting dose in the various organs from radionuclide decay in other organs. Seven age groups, based on the resolution provided by available data (with the inclusion of fetal thyroid), will eventually be used for interpolation to specific ages. For Phase I, only the adult and infant categories are being investigated. Provisions for the age groups shown in Table 2.1 will be made in the code structure. Each age group is also subdivided into male and female, with the adult female further subdivided into pregnant and non-pregnant. Dosimetry for male and female children through about age 15 will be the same; the only potential variable would be uptake if there is a sex difference in food consumption. After age 15, the dosimetric calculations vary, as well. The number of people in the seven age groups will be provided for each of the major

TABLE 2.1. Age Groups Included in Code Structure

Age Group	Age	Nominal Mass
Prenatal	0 - 270 days	Variable
Newborn	About 0 days	3.4 kg
1 - 4 yr	1 yr	9.8 kg
5 - 9 yr	5 yr	19 kg
10 - 14 yr	10 yr	32 kg
15 - 20 yr	15 yr	55 kg (58 kg adult female)
Adult	20+yr	70 kg (male)

subpopulations defined below, subdivided by spatial location on the census subdivision grid.

2.6.1 Population Groups

Population groups specifically identified in the HEDR Work Plan approved by the TSP include Native American tribes, Army personnel stationed at Hanford, unbadged Hanford construction workers, migrant workers, and the general population. The subcategories of population groups included in Table 2.2 are required. Those having a higher emphasis are needed for the Phase I study area in FY 1989-1990. Those having lower emphasis will be addressed in future work; however, this does not preclude some data collection when appropriate.

The groups of higher emphasis are being investigated for each of the census subdivisions within the Phase I 10-county study area. Each will be

TABLE 2.2. Population Groups Emphasized in Code

Subpopulation	Emphasis	Additional Notes
General population	Higher	Air and river releases
Native Americans	Higher	Air and river releases
Unbadged site workers	Lower	Air releases
On-site military	Lower	Air releases
Migrant workers	Lower	Air and river releases

further subdivided into the lifestyle categories, urban and rural. With the number of subpopulation categories, and the very limited occupation information available, a further breakdown probably could not be supported by the data at this time. We have deliberately not included race as a discriminator for Phase I.

2.6.2 Food Types

The consumption of contaminated food was a major pathway of exposure for people who lived in the Hanford area during the years 1944-1947. A number of different general food types, which were identified as potentially important, are typically used in radiological evaluations and are available in the preliminary mathematical models being used for HEDR sensitivity studies and Phase I initial development. For each subpopulation/age/sex/lifestyle category, distributions of monthly consumption rates of the locally produced foods listed in Table 2.3 are required. Because of the similarity of the lists of general population and Native American foods, the same basic models will be used for each. All foods will be examined as both fresh and stored.

2.7 GRAPHICS

Although no graphics have been explicitly identified as necessary, a future need is expected for displaying numbers calculated by the computer code, for instance, a plot of air concentration versus distance from the point of release. A mechanism shall be designed to retain output in files for later graphics applications.

2.8 DOCUMENTATION AND INSTRUCTIONS

Documentation shall be prepared during code development. Documentation shall include code algorithms as well as a user manual that is updated as changes are made. A record of changes made once the code is under configuration management shall be retained as project records.

2.9 ERROR MESSAGES

Error messages shall assist the user when improper input parameters or formats are used, or when illegal calculations are requested. All input

TABLE 2.3. Local Foods Requiring Calculation of Monthly Consumption Rates for Population Categories

General Population
- Leafy vegetables
- Other (protected) vegetables and root vegetables
- Legumes (if they can be broken out of other vegetables)
- Grains (generally dried and stored)
- Orchard fruits, berries, melons
- Milk (subdivided into cow and goat, if possible)
- Eggs
- Beef, pork, lamb
- Poultry
- Fish
  - -anadromous
  - -piscivorous
  - -benthic
- Any other aquatic biota

Native American
- Exposed produce (leafy vegetables, pine moss, etc.)
- Other vegetation (roots, bulbs, etc.)
- Legumes (if available)
- Grains and seeds
- Fruit, berries, melons, etc.
- Milk (subdivided, if possible)
- Eggs (chicken and others as applicable)
- Beef, pork, lamb, elk, deer, other native mammals
- Birds (including chicken, pheasant, partridge, quail, geese, etc.)
- Fish
  - -anadromous
  - -piscivorous
  - -benthic
- Other aquatic biota (freshwater clams, any water plants, etc.)
- Miscellaneous other protein sources

errors shall be identified by the input routines prior to main program execution. Messages shall identify the issuing subroutine and provide a concise definition of the error.

2.10 UPDATES AND REVISIONS

Notices of code updates and revised instructions shall be provided to known users. A list of potential users shall be maintained so that revisions and notices may be distributed as appropriate. This shall be performed by a designated code custodian.

2.11 SECURITY

The computer code and associated databases are to be considered sensitive. Security measures shall be implemented to protect the code from access by unauthorized users. A control mechanism with sign-off procedures shall be implemented to protect the software from unauthorized modifications. Needed changes shall be verified before modifications are permitted to the final versions.

3.0 SYSTEM DESIGN SPECIFICATIONS

The computer codes developed for Phase I of the HEDR Project are to be fully modular and stochastic (using Monte Carlo techniques). The codes will use distributions of input data and produce dose estimates in the form of distribution rather than simply producing deterministic (single-point) estimates.

A simplified project diagram for calculating doses from atmospheric releases is shown in Figure 3.1. Generic pathways are 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. Animal products such as milk are complicated by the fact that the feed consumed by the animal may come from areas distant from the animal's location, and the milk itself may be shipped to accumulation centers and then redistributed.

A similar diagram has been prepared for surface water releases (Figure 3.2) and similar pathways are considered: immersion (swimming or boating) in contaminated water, drinking of contaminated water, consumption of fish and other aquatic foods, and consumption of foods contaminated via irrigation with contaminated water. The overall calculation of radiation dose will be the sum of parallel pathway calculations. Parameterization of each of the terms in the equation is described in this section.

The initial calculation of dominant radionuclides indicates no important decay chains that cannot be treated as either single radionuclides or pairs in equilibrium (Napier 1989). For the equilibrium pairs, the decay energies of the daughter can be effectively considered to be included in the energies of the parent. Therefore, calculation of radioactive decay in the HEDR Monte Carlo routines is greatly simplified. Decay can be explicitly written into each module as a simple exponential term.

GENERALIZED DATA FLOW; AIR

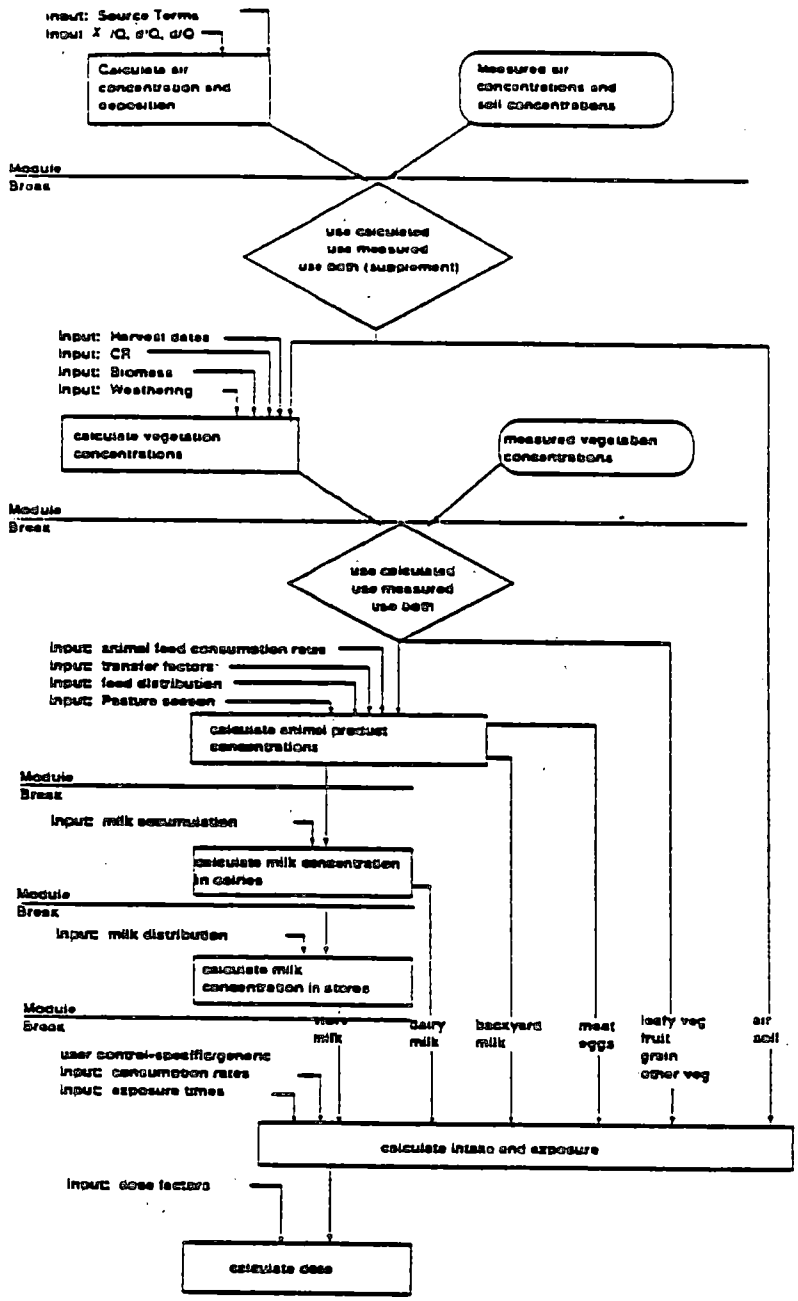


FIGURE 3.1. Project Steps Required for Calculating Doses from Atmospheric Releases of Radionuclides

GENERALIZED DATA FLOW: SURFACE WATER

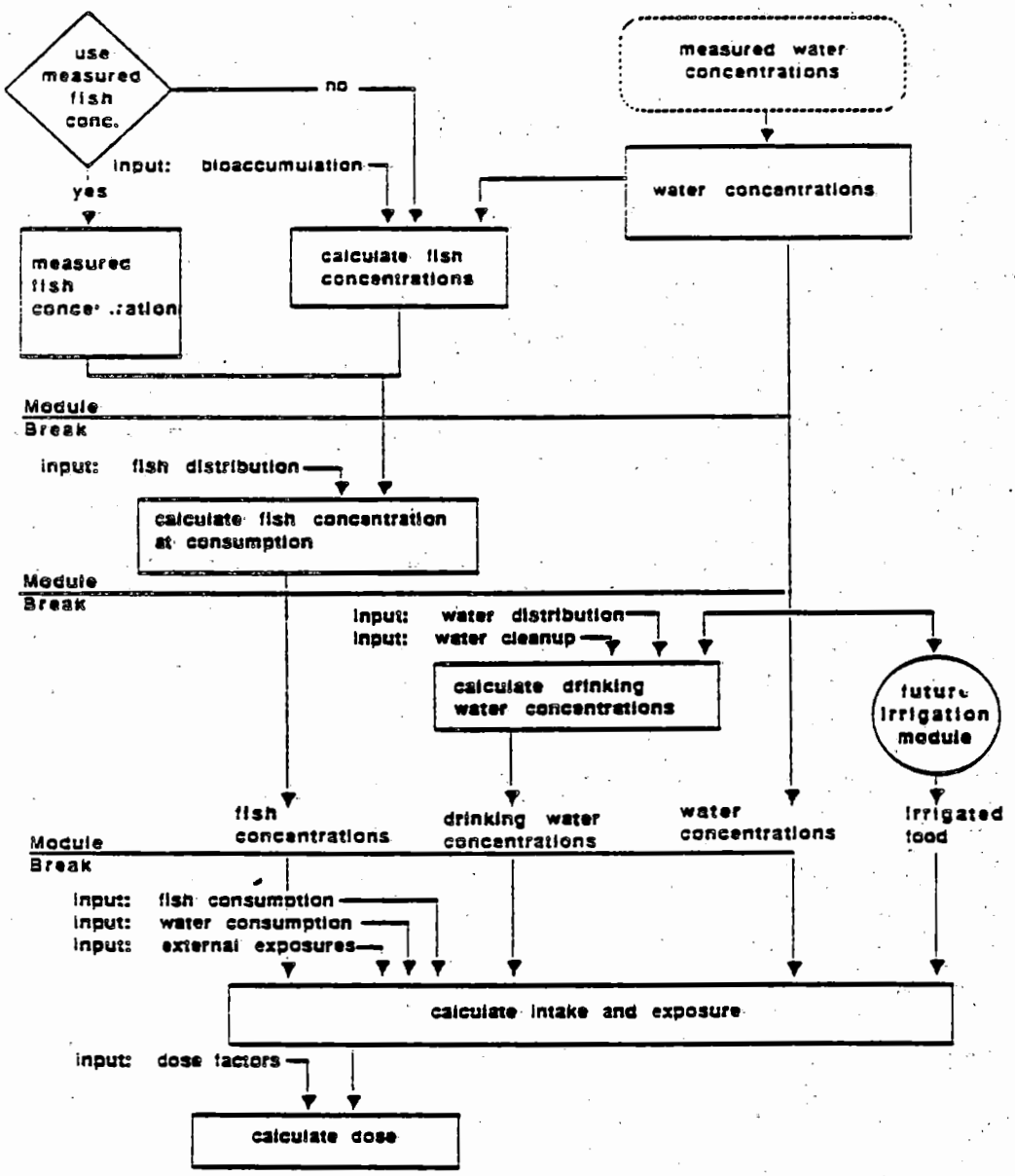


FIGURE 3.2. Project Steps Required for Calculating Doses from Surface Water Releases of Radionuclides

3.1 ATMOSPHERIC RELEASE MODEL

The logic diagram of Figure 3.1 indicates "module breaks" for individual portions of the calculation. These represent individual portions of the computer code that can be run in a stochastic simulation (Monte Carlo analysis). There are three reasons for structuring the calculation with module breaks: the interdependence of information, the need to input data during calculations, and the use of the code in another ongoing Hanford study.

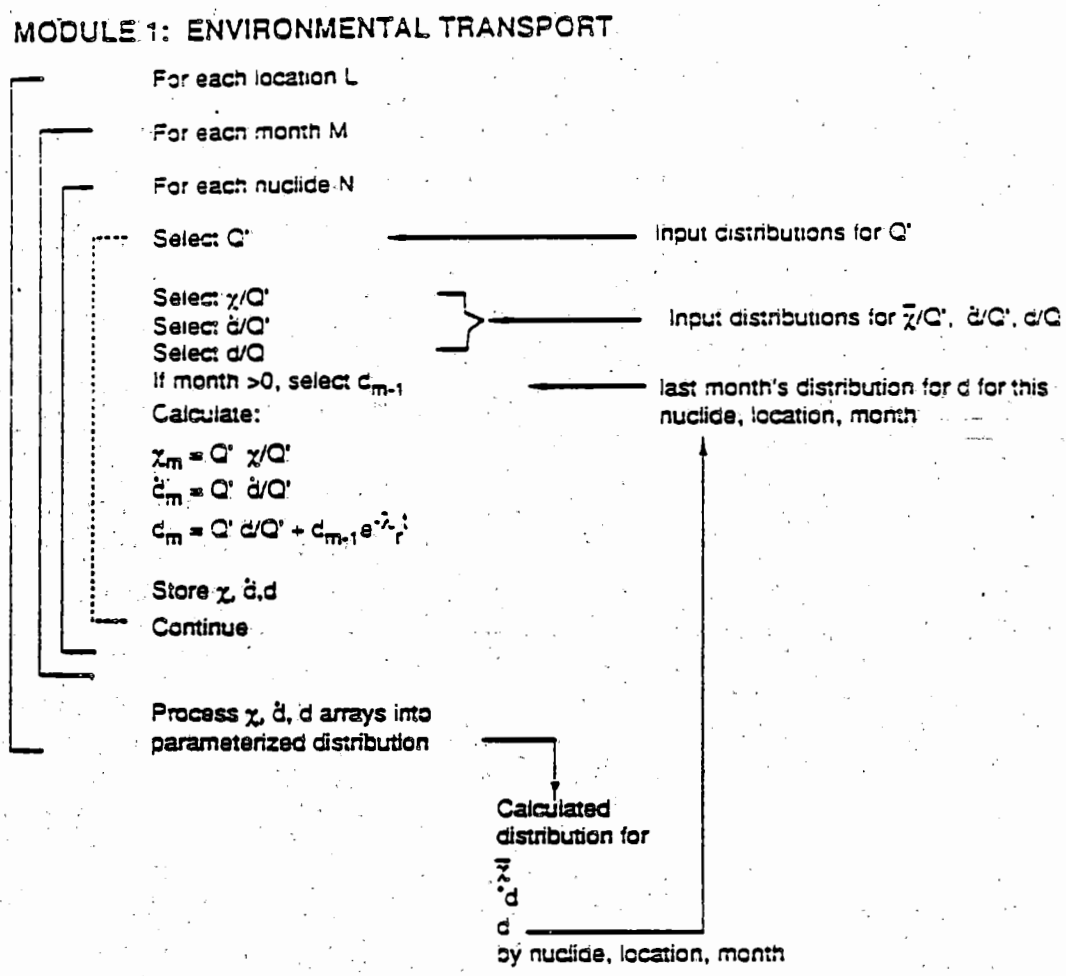
Because of the interconnected nature of the cow feed/milk distribution model, no doses can be calculated for individuals in a particular census subdivision without knowledge of the environmental conditions in many other locations. The calculation has been structured so that repetitive calculations are minimized, and information on the potential distributions of environmental parameters such as air concentration, vegetation concentration, or milk concentration can be saved and examined for each time period.

A second reason for the structure of the model is that it allows the input of either calculated or measured data at each step of the calculation. Where monitoring data are available, it makes sense to rely on it rather than on simulated data. However, since the monitoring is not complete over all times, locations, and pathways, the structure allows use of measurement data supported by calculations when necessary.

This structure also supports the calculation of doses to both reference individuals and specific individuals. This is important because the dose reconstruction project supports a parallel project being conducted by the CDC, which is investigating potential thyroid morbidity caused by the early Hanford releases. The a CDC contractor will be interview-ing many individuals about their past lifestyle and dietary habits and attempting to correlate dose with thyroid disease. The HEDR computational model will be used for the calculation of doses for those interviewed by the CDC's contractor.

3.1.1 Module 1: Atmospheric Transport and Deposition

The proposed logic for Module 1 is illustrated in Figure 3.3. The objective of this module is to initiate calculations by providing



Notes: 1) dotted line (_____) indicates Monte Carlo routine
2) "Select" means pick from distribution systematically
3) "Store" means add to histogram array
4) "Process" means convert stored histogram array into a mean + standard deviation or other distribution parameters and save as output.

FIGURE 3.3. Proposed Logic for Module 1: Environmental Transport

time-integrated air concentrations, deposition rates, and month-end concentrations of radionuclides on the ground for each of the census divisions and monthly increments. (See Appendix A for equations used in calculating these parameters.) The solid lines in Figure 3.3 represent the computer looping structure, i.e., the code routines which repeat the same type of calculations for each location, each month, and each radionuclide. The dashed line indicates that portion of the code that must operate in a Monte Carlo fashion, repetitively calculating multiple values of each output variable on the basis of randomly selected parameter values from the multiple input distributions. The inputs to this module are the source-term vectors and atmospheric dispersion, deposition rate, and month-end deposition arrays described in Section 2.5. The techniques for selecting realizations from these distributions for the Monte Carlo analysis are defined in a memo by A. Leibetrau (see Appendix B).

The definitions of the equations for calculating air concentration, deposition rate, and total month-end ground deposition are presented in Appendix A. Variables and units are also presented. The anticipated nature of each of the input distributions is presented in Table 3.1.

The output of Module 1 will essentially contain intermediate values for input to Module 2. Output shall be stored in the form of histograms of the Monte Carlo results. The use of histograms provides a convenient mechanism for storing arbitrary distribution shapes. Histograms should contain a minimum of 20 bins. A memo by A. Leibetrau defining the nature of storing and retrieving data from histograms is provided as Appendix C.

Source terms for Phase I will include only iodine-131. Allowance should be made in the code for expansion to additional radionuclides, as illustrated in Figure 3.3. Atmospheric transport results for Phase I will be the result of an interim model. In later phases, it may be found to be more convenient to combine source terms with dispersion modelling. The modular structure of the HEDR code should allow this with minimal disruption.

TABLE 3.1. Anticipated Parameter Distribution Types for Module 1

Parameter Distribution	Type of Data Input
X / Q'	Lognormal
$\dot{d} / Q'$	Lognormal
d / Q'	Lognormal
Q'	Triangular
λ_r	Constant
χ	Calculated Histogram
$\dot{d}$	Calculated Histogram
d	Calculated Histogram

3.1.2 Module 2: Vegetation Concentrations

The proposed logic of Module 2 is shown in Figure 3.4. The purpose of this module is to calculate or input concentrations of radionuclides on vegetation. The nomenclature of this figure is the same as that of Figure 3.3. Input to this module may be either the histograms of deposition rate and total deposition from Module 1 or measured values of air concentration from the monitoring database. For Phase I, it may be assumed that no monitoring data will be available, but the coding should anticipate the possibility that it may become available in later phases. Vegetation types that must be considered are those for human consumption (leafy vegetables, other vegetables, fruits, and grains) and for animal consumption (grains, pasture grass, silage, and alfalfa hay). The grains for human and animal consumption may be considered to be the same. An additional category, sagebrush, will be added to allow direct comparison to monitoring measurements.

The equations to be used for Module 2 are presented and the parameters defined and units given in Appendix A. Additional detail on the interception/retention model is presented in a memo by B. A. Napier provided as Appendix D. These equations are derived from differential equations of the rate of increase and weathering of the various types of vegetation. They have been integrated over the monthly time increment to a quasi-steady-state formulation. Important parameters include time-dependent biomass, rates of wash-off and weathering, and soil-to-plant concentration ratios. Provision should be made to incorporate periodic harvesting of certain types of

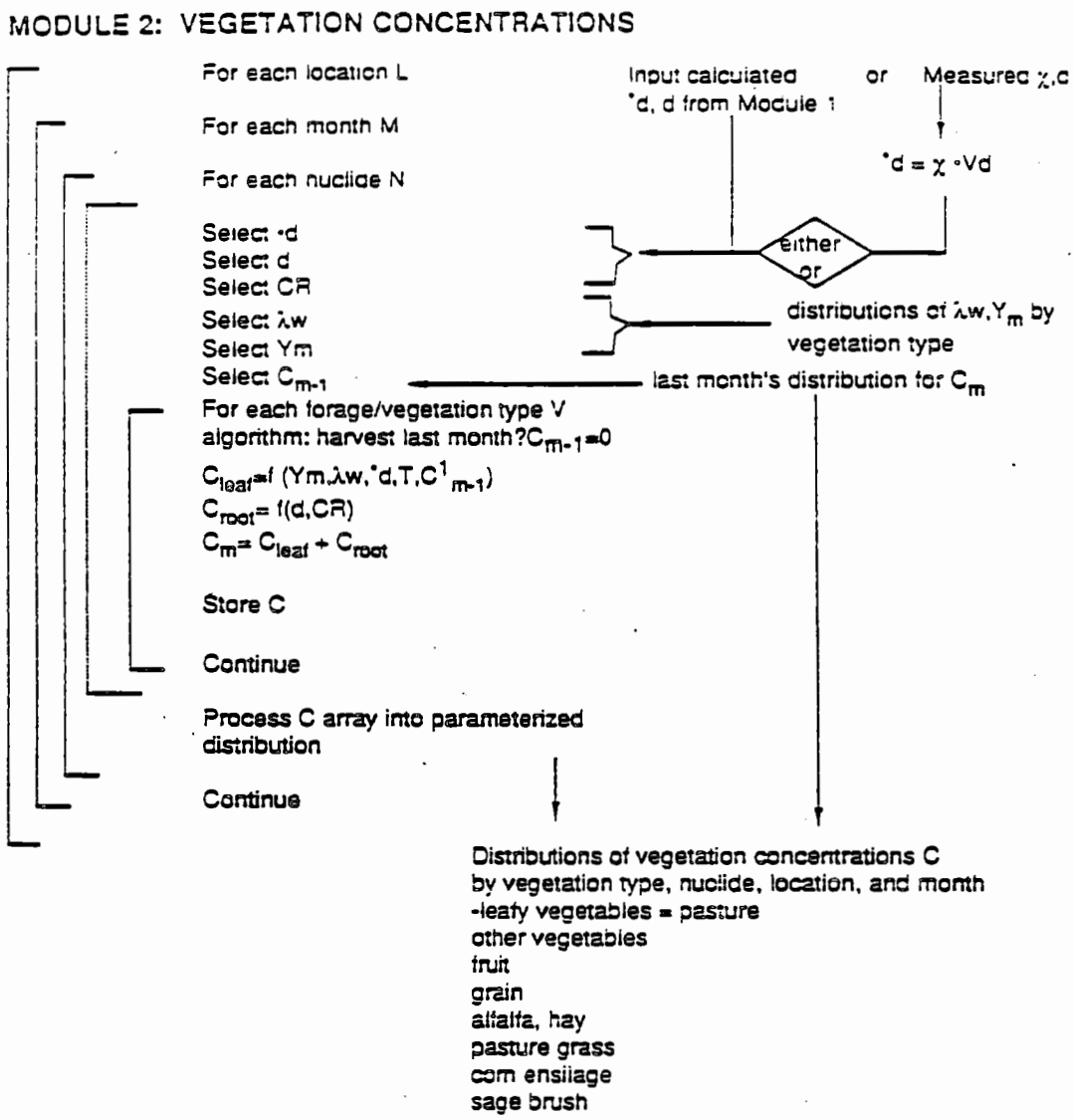


FIGURE 3.4. Proposed Logic for Module 2: Vegetation Concentrations

vegetation by biomass reduction and concentration reduction. The anticipated distributions of the input parameters are provided in Table 3.2.

3.1.3 Module 3: Animal Product Concentrations

The proposed logic structure for Module 3 is given in Figure 3.5. The purpose of this module is to calculate concentrations of radionuclides in meat, milk, and eggs produced in each census division for each monthly increment. Input to this module is either calculated vegetation concentrations from Module 2 or measured vegetation concentrations from the monitoring database. Data structures for monitoring data should be established in formats similar to those for the calculated values. These may be used to supplement or replace the calculated values. Additional input shall include information on the diets of farm animals as a function of location and time, provided to the main database by the Demographics, Agriculture, and Food Habits Task. (In later phases, this will include feed transport between census divisions.)

TABLE 3.2. Anticipated Parameter Distribution Types for Module 2

Parameter Distribution	Type of Data Input
T_p	Constant for leafy vegetables, alfalfa, forage, ensilage, sagebrush
Y_m	Constant for each plant type and month
λ_w	Triangular
B_v	Triangular distributions of Log(10) B
P	Constant
C_m	Calculated histogram
K	Constant for each plant type

MODULE 3: ANIMAL PRODUCT CONCENTRATIONS

For each location L

For each feed month M

For each nuclide N

For each animal product P

Select transfer factor, FM — Transfer factor distribution

For each feed type

Select feed transport and harvest fractions, F — distribution of animal feed fractions (may access prior months)

Select feed quantity, QF — Feed quantity distribution

Select feed concentrations, C (based on month from feed transport fraction, not necessarily current month) — C arrays from Module 2

A = animal product concentrations
= F (FM,QF, F,C,λ_r, month of harvest)

Store A

Continue

Continue

Process A arrays into parameterized distribution

A- Distributions of animal product concentrations by month, location, and nuclide
- meat
- milk
-cow milk
-goat milk
-eggs

FIGURE 3.5. Proposed Logic for Module 3: Animal Product Concentrations

The equations to be used in Module 3 are listed in Appendix A, with parameter definitions and units. Provision should be made for calculation of concentrations in meat, poultry, eggs, and milk. Milk may be assumed to be produced by cows or goats. Cows must be assumed to eat several types of diets. Each diet will be defined as a sum of fractional feed type intakes. The fraction of each feed type eaten by the various animals may be graphically represented, as illustrated in Figure 3.6. Currently, four feeding regimes are planned to be provided by the Demographics, Agriculture, and Food Habits Task.

Anticipated parameter distributions to be used as input to Module 3 are presented in Table 3.3.

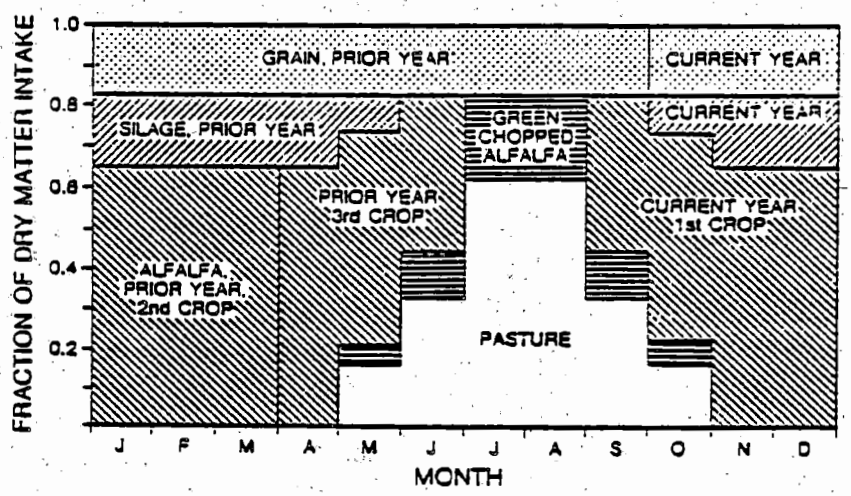


FIGURE 3.6. A Food-Chain Model to Predict Radionuclide Ingestion (Whicker and Kirchner 1987)

TABLE 3.3. Anticipated Parameter Distribution Types for Module 3

Parameter Distribution	Type of Data Input
f_t	Triangular
Qf	Triangular
FM_p	Log-normal
Aml	Calculated histogram

The use of fractional intakes of various types of feed introduces a minor complication within the Monte Carlo routine for Module 3. Each of these fractions has its own distribution. The results of the selection process of the fractions must, however, sum to 1, which implies a correlation structure. The means of handling this implied correlation is described in a memo by B. A. Napier, provided as Appendix D. This approach may be used in subsequent modules, as well.

The output of this module may be used directly in Module 6 (meat, eggs, and milk from backyard cows) or as input to Module 4.

3.1.4 Modules 4 and 5: The Milk Accumulation/Distribution Model

Milk produced in the various census divisions may be combined or pooled at creameries (milk-bottling plants). The proposed logic structure for Module 4 for handling the calculations in concentration of brand-name milk is presented in Figure 3.7. Input to this module is the output of Module 3, along with extensive data on sources of milk for creameries, from the Demographics, Agriculture, and Food Habits Task. Output of this module is the concentration of milk from each creamery in the Phase I study area as a function of time. This may be used directly in Module 6, if the milk source is known by name, or as input to Module 5.

Calculation of doses to certain classes of individuals will require knowledge of the average concentration of all milk available in a census tract. Module 5 is the milk distribution module. The proposed logic structure for this module is given in Figure 3.8. This module requires as input the pooled milk concentrations of Module 4, and a milk distribution database that is conceptually the inverse of that used to collect milk in Module 4.

Equations and parameter definitions for Modules 4 and 5 are presented in Appendix A. The anticipated distribution types of the variables for Modules 4 and 5 are listed in Table 3.4.

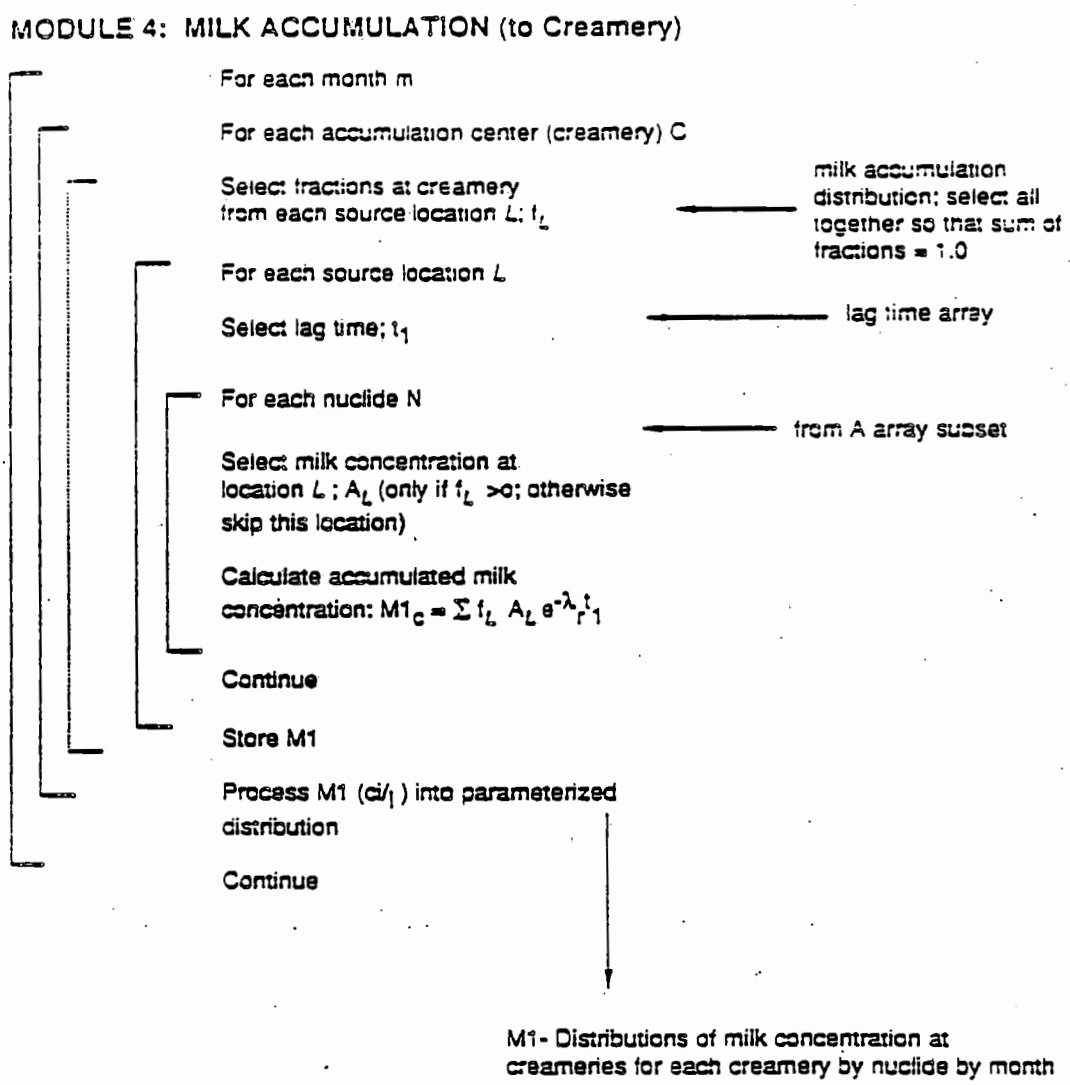


FIGURE 3.7. Proposed Logic for Module 4: Milk Accumulation at Creameries

MODULE 5: MILK DISTRIBUTION (to stores at each location)

For each month m

For each consumption location L

Select fraction at stores in location L from each creamery; F_C — milk distribution distribution; select all together so that sum of fractions = 1.0

For each creamery C

Select lag time t_2 — lag time array

For each nuclide N

if indicated by ($f_C > 0$), Select $M1_C$ — M1 array

calculate distributed milk concentration: $M2_L = \Sigma f_C M1_C e^{-\lambda_r t_2}$

Continue

Store M2

Process M2 into parameterized distribution

Continue

M2- Distributions of milk concentration available to be purchased in stores at location l, by nuclide and month

FIGURE 3.8. Proposed Logic for Module 5: Milk Distribution to Stores in Each Census Tract

TABLE 3.4. Anticipated Parameter Distribution Types for Modules 4 and 5

Parameter Distribution	Type of Data Input
t1	Triangular
t2	Triangular
t3	Probably = t2
f_i^c	Triangular
F_i^g	Triangular
M0	Calculated Histogram
M1	Calculated histogram
M2	Calculated histogram

3.1.5 Individual Exposure and Dose

Modules 1 through 5 establish the environmental concentrations of radionuclides in environmental media for all census subdivisions and months of interest. Module 6, however, introduces humans exposed to the radionuclides. Module 6 is designed for the calculation of doses to either "reference" or "specific" individuals. (Note that for Phase I, only input data for reference individuals will be available.) The proposed logic structure for Module 6 is shown in Figure 3.9. Inputs to this module are the outputs from all prior modules, plus an extensive database of generic consumption and exposure rates for each category of individual type (age, sex, and lifestyle) developed by the Demographics Task. For calculations to reference individuals, exposure conditions shall be selected stochastically from this database. For calculations to specific individuals, specific input values or distributions will be used, where known, and data from the generic database will be used for unspecified or unknown parameters.

Equations to be used for dose calculations are provided in the system design outline for Module 6 (Appendix A). These equations describe dose via inhalation and exposure to contaminated air, irradiation by contaminated surfaces and soils, and ingestion of local farm products. Note that, for this phase of the code development, the formulations imply that all foods other than milk are produced in the census tract in which they are consumed.

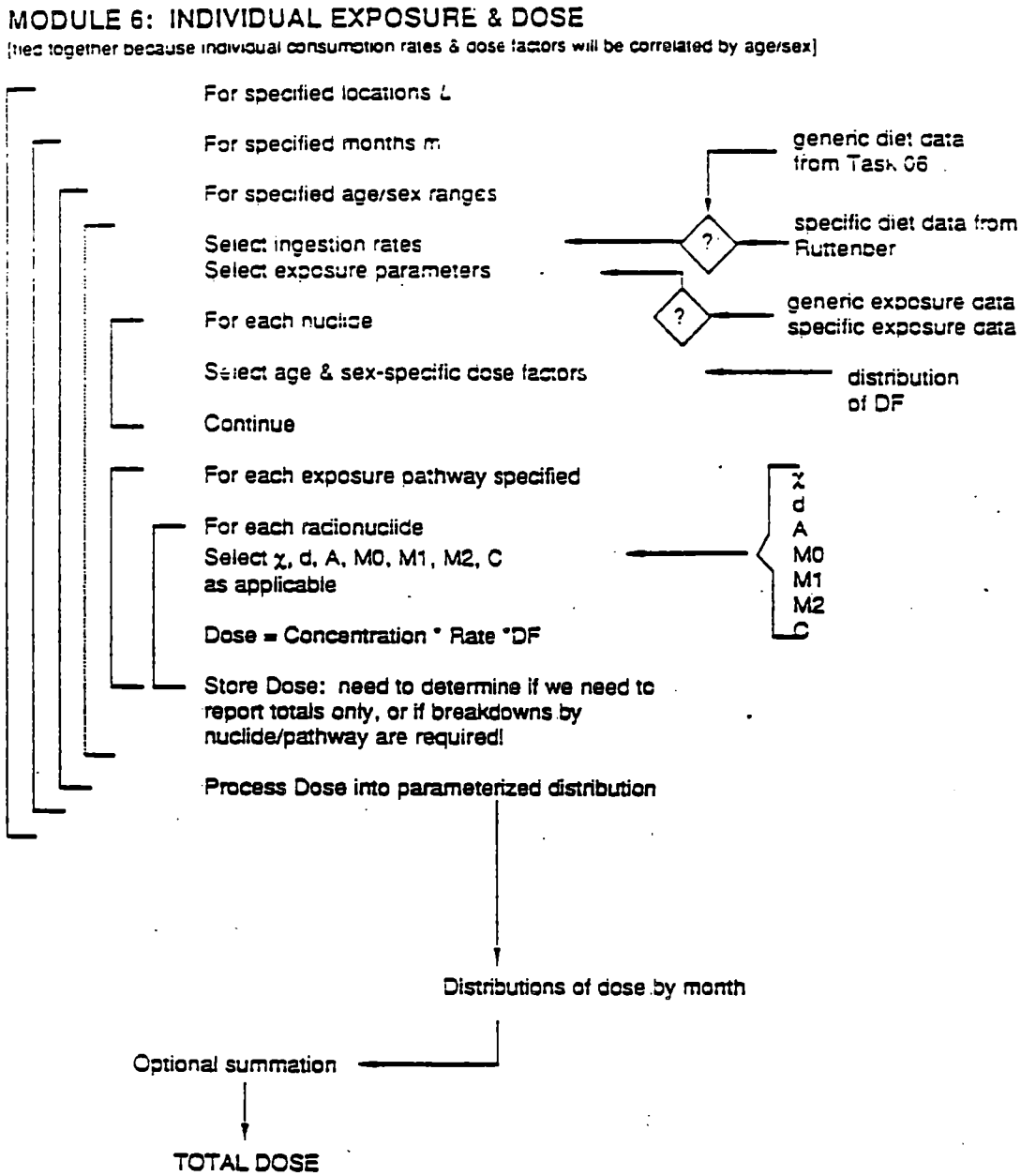


FIGURE 3.9. Proposed Logic for Module 6: Individual Exposure and Dose

For certain individuals, this practice will tend to overestimate the dose, while for others it may tend to underestimate. The magnitude of the error in estimation will be evaluated as the project progresses, and revised formulations (similar to the milk distribution model) may be used.

Because the results of Module 6 may be required to support projects other than HEDR (e.g., the CDC thyroid morbidity study), the input to Module 6 should be structured such that at a later time, a simple interactive driver may be developed for ease of use. This will simplify the calculation of large numbers of individual doses.

The dose calculations shown in Figure 3.9 do not fully reflect the number of calculations required. Doses must be provided for a number of internal organs, as must a weighted effective dose equivalent, which will require looping on the actual dose calculation once the radionuclide exposures are known. Thus, consideration must be given to convenient storage of multiple outputs.

The anticipated distributions of input and output parameters are listed in Table 3.5.

3.2 SURFACE WATER RELEASE MODEL

The HEDR Phase I dose model for surface water release is separate from the atmospheric release dose model. The surface water model is based much more on measured data than is the atmospheric model. However, its structure is modular (see Figure 3.2), in a fashion similar to that for the atmospheric release model.

Unlike data for the early atmospheric releases, detailed effluent data are available for the releases from the operating production reactors during the period 1964-1966. In many instances, these data were available on a daily or weekly basis. This information was used directly as source term input to the surface water transport calculation without recourse to modeling. Thus, estimation of surface water concentration from Hanford releases in the mid-1960s was straightforward. A simple routing model was applied to the effluent data, accounting for dilution in the time-varying flow of the

TABLE 3.5. Anticipated Parameter Distribution Types for Module 6

Parameter Distribution	Type of Data Input
E1	Uniform
E2	Uniform
DF_s	Constant
DF_G	Constant
DF_{Ha}, DF_{Ia}	Lognormal
BR_a	Constant
K	Constant
D_{sm}	Calculated histogram
D_{Gm}	Calculated histogram
D_{Hm}	Calculated histogram
RV_{ma}	Triangular
RP_{ma}	Triangular
ff_{va}	Triangular
ff_{pa}	Triangular
ff_{ma}	Triangular
Month-of-Harvest	Fixed
Holdup Times	Constant
f_o, f_1, f_2	Delta functions, Phase I Sum = 1.0 for specific
D_{Iv}	Calculated histogram
D_{Ip}	Calculated histogram
D_{Im}	Calculated histogram

river as well as decay for the various associated travel times of radionuclides to the locations of interest. The results of this model compare excellently to the measured values. The variability in the surface water estimates is derived from the upper and lower measured values found for each radionuclide at each sampling location and time. This database provides the input to the surface water dose model. With limited exceptions (e.g., FFTF visitor's center), ground water at the Hanford Site is not now and has not been used for any purposes by members of the general offsite public. Based on current understanding, radionuclide sources within the 200 Area did not contribute significantly to concentra-tions in the Columbia River until the early 1970s. Because of the proximity of the 100 and 300 Areas to the river, operations in these areas may have contributed more radionuclides to the river via the groundwater pathway. These additions are accounted for in the monitoring data and, thus, add to the variability of the estimates for Phase I.

The various stretches of the river can be conveniently associated with the census divisions used in the atmospheric release dose model. This is because the census tracts tend to use geographical divisions, such as tributaries to the Columbia River, as dividing lines. A memo from B. A. Napier defining the stretches of the river in relation to the census divisions is provided as Appendix F.

3.2.1. Modular Approach

As described above, modeling is not required for surface water concentrations. However, the measured data include parameterization of uncertainty, which must be included in the subsequent steps of the calculation. This includes monitored data for fish caught in the Columbia River. Fish concentration data have also been extensively monitored, and calculations are necessary only for interpolation between measurements. The availability of fish concentration data is reflected in the logic diagram for Module 1 of the surface water code (see Figure 3.2). Fish concentrations are calculated only if such data are not available from the database. A bioaccumulation model is to be used.

Module 2 is used simply to account for the quantities of fish that were caught at various locations of the river and consumed. It is similar in

concept to the milk distribution model described in Section 3.1.4, but the input is from a database from the Demographics, Agriculture, and Food Habits Task.

Module 3 accounts for the fact that drinking water is almost entirely processed prior to human consumption, and that processing can remove radionuclides found in the untreated river water. At this time, it has not been decided whether or not to include irrigated foods as an explicit exposure pathway, or whether it is of sufficiently minor importance that a simple "transfer factor" approach may be adequate. Additional sensitivity studies with simpler models will be performed before the final structure is determined.

Module 4 parallels Module 6 of the atmospheric release model. Calculations are required for both reference and specific individuals. The age groups, lifestyles, and dose factors are the same as those defined for the atmospheric release model.

3.2.2 Models and Parameters

The equations to be used in the surface water model are listed with Module 6 in Appendix A. The structure is similar to the more complex model described for atmospheric releases, but the equations are generally much simpler. The anticipated parameter distributions are listed in Table 3.6.

TABLE 3.6. Anticipated Parameter Distributions for the Surface Water Release Model

Parameter Distribution	Type of Data Input
W_{ml}	Triangular
$_{B}T_{m}$	Triangular
$CF1_{mst}$	Calculated histogram
f^{L}_{st}	Triangular
$CF2_{mst}$	Calculated histogram
DWCF	Uniform
tw	Triangular
DW_{ml}	Calculated histogram
DF_{Ia}	Lognormal
R^{F}_{amT}	Triangular
R^{W}_{aml}	Triangular
E3	Uniform
E4	Uniform
DF_{w}	Constant
$D_{FISH,a,l}$	Calculated histogram
$D_{WATER,a,l}$	Calculated histogram
$D_{SWIM,a,l}$	Calculated histogram
$D_{BOAT,a,l}$	Calculated histogram

4.0 REFERENCES

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Napier, B. A. 1989. Selection of Dominant Radionuclides for Phase I of the Hanford Environmental Dose Reconstruction Project. PNL-7231 HEDR, Pacific Northwest Laboratory, Richland, Washington.

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APPENDIX A

EQUATIONS FOR SYSTEM DESIGN MODULES

Module 1

EQUATIONS FOR CALCULATION OF

- AIR CONCENTRATION - χ_m
- AVERAGE DEPOSITION RATE - $\dot{d}_m$
- END-OF-MONTH SOIL CONCENTRATION - d_m
  (for each location)

$$\chi_m = \left(\chi/Q'_m\right) \cdot Q'_m$$

$$\dot{d}_m = Q'_m \cdot \left(\dot{d}/Q'_m\right)$$

$$d_m = Q'_m \cdot \left(d/Q'_m\right) + d_{m-1}\, e^{-\lambda_r t}$$

Q'_m = Ci/month

χ/Q'_m = Ci -sec/m^3 per Ci/month

$\dot{d}/Q'_m$ = Ci/m^2 -sec per Ci/month

d/Q'_m = Ci/m^2 per Ci/month at end of month

χ_m = time-integrated air concentration, Ci -sec/m^3 *

$\dot{d}_m$ = average deposition rate, Ci/m^2 -sec

d_m = month end soil concentration, Ci/m^2 *

t = 1 month

* Alternatively from Monitoring Data

Module 2

EQUATIONS FOR CALCULATION OF
•VEGETATION CONCENTRATION
(at production, for each location l & vegetation type T)

$$C_{leaf,m} = Tp\left[\frac{{}^{*}d_m\, r_m}{Y_m}\left(\frac{1-e^{-(\lambda r+\lambda w)t}}{\lambda r+\lambda w}\right)\right] + \frac{C_{m-1}\, e^{-(\lambda r+\lambda w)t}}{Y_m/Y_{m-1}}$$

$$C_{root,\,m} = \frac{d_m\, B_v}{P}$$

$$C_m = C_{leaf,m} + C_{root,m}$$

$r_m = 1-e^{-kY_m}$; interception fraction
k = function of plant type

Y_m = Biomass for month m for this plant type, kg/m^2
from a file (need to account for harvesting)
(will be function of growing season: function of location)

λr, λw = radiological & weathering decay constants, day^{-1}

t = number of days in current month

P = soil surface density ~ 240 kg/m^2

B_v = concentration ratio for plant type

Note: if plant cut or harvested in month m_{-1}, then $Cm_{-1}/(Y_m/Y_{m-1})$ term should go to zero

T_p = leave-to-edible-part translocation; T_p = 1.0 for pasture & leafy vegetation, alfalfa, ensilage, sagebrush

$^{*}C_m$ alternatively from monitoring data

Module 3

EQUATION FOR CALCULATION OF ANIMAL PRODUCT CONCENTRATIONS (AT PRODUCTION FOR EACH LOCATION AND MONTH)

For each nuclide r and each animal product:
For each location l and month m, compute:

$$A_{ml} = \sum_{j=1}^{m} \sum_{k=1}^{L} \sum_{t=1}^{T} f_{jkt}^{ml} \cdot QF_t^{ml} \cdot C_{jkt} \cdot FM \cdot e^{-\lambda_r (m-j)}$$

Over all feed types

Over all locations that supply feed to location l

Over all months prior to and including current month m

m = current month (when feed was eaten by animal)
l = current location (where feed was eaten by animal)
L = total number of locations (census divisions) in study area
T = total number of feed types
j = month in which feed was harvested
k = location where feed was grown and harvested

A_{ml} = nuclide concentration in animal product produced at location l during month m (Ci/l milk or Ci/kg meat and eggs). Calculated histogram.

f_{jkt}^{ml} = fraction of feed of type t eaten by animal at location l during month m that was harvested at location k during month j (from feed source/transport data). The sum of these fractions over all j and k for a given feed type t for the current location l and month m must equal 1.0. Triangular distribution.

QF_t^{ml} = quantity of feed of type t that animal at location l eats during month m (kg/day dry weight). This is from the data on distribution of feeding regimes to census divisions (Ward/Darwin/Beck). Triangular distribution.

C_{jkt} = radionuclide concentration (Ci/kg) in feed of type t harvested in month j at location k (from Module 2). Calculated histogram.

FM = intake-to-product transfer factor, days/l milk or days/kg meat or eggs. Triangular distribution.

λ_r = radioactive decay constant for nuclide r ($months^{-1}$).
= 0.693/(half-$life_r$). Constant.

(m-j) = decay correction time for feeds not consumed fresh (months).

Modules 4 & 5

EQUATIONS FOR CALCULATION OF
•MILK CONCENTRATION AT CONSUMPTION
(for each month m and location L)

1) Backyard Cow:

$$M\phi_{mL} = A_{mL}\, e^{-\lambda_r t h_1}$$

2) Specific Creamery

$$MA_{cm} = \sum_{L=1}^{L} f_L^{\,c} A_{mL}$$

$$M1_{cm} = MA_{cm} e^{-\lambda_r t h_2}$$

3) Grocery Milk at location L

$$M2_{mL} = \sum_{C=1}^{C} F_C^{\,L} MA_{cm}\, e^{-\lambda_r t h_3}$$

$M\phi_{mL}$ = Ci/l from family cow at consumption in location L

MA_{cm} = Ci/L at specific creamery C at accumulation (no decay)

$M1_{cm}$ = Ci/l from specific creamery C at consumption

$M2_{mL}$ = Ci/l from groceries at location L at consumption

t_1 = generic holdup, milking-to-consumption; family cow

t_2 = generic holdup, milking-to-consumption; creamery

t_3 = generic holdup, milking-to-consumption; grocery

$f_L^{\,c}$ = fraction of milk at creamery C from source location L

$F_c^{\,L}$ = fraction of milk at groceries in location L from creamery C

A_{mL} = milk concentration at production, Ci/l, at location l for month m

Module 6

EQUATIONS FOR CALCULATION OF

- SUBMERSION DOSE
- GROUNDSHINE DOSE
- INHALATION DOSE

1) Air submersion doses, by month at location 1 for lifestyle or specific

$$D_{sm} = \chi_{m1} \cdot E1 \cdot DF_s \cdot K$$

E1 = exposure time, hr/month for lifestyle or specific

DF_s = submersion dose rate factor, rem/hr per Ci/m^3

K = constant unit conversion, mo/sec

2) Groundshine doses, by month at location 1 for 1.Lifestyle or specific

$$D_{Gm} = d_{me} \cdot E2 \cdot DF_G$$

E2 = exposure time, hr/month

DF_G = groundshine dose rate factor, rem/hr per Ci/m^2

3) Inhalation doses, by month at location 1 for lifestyle or specific

$$D_{Hm} = \chi_{m1} \cdot E1 \cdot [DF_{Ha} \cdot BR_a] \cdot K$$

DF_{Ha} = inhalation dose factor, rem/Ci by age group a

BR_a = breathing rate for age group a, m^3/hr

Module 6 (contd)

EQUATIONS FOR CALCULATION OF

- INGESTION DOSE

1) Vegetables, for each vegetable type, age group, lifestyle, location

$$D_{\substack{iv \\ al}} = DF_{la}\, R^{v}_{ma}\, [ff_{vm}\, C_{ml} + (1 - ff_{vm})\, C_{HI} e^{-\lambda r(H-m)}]$$

2) Meat and eggs, for each age group, lifestyle, location

$$D_{IP} = DF_{la}\, R^{p}_{ma}\, [ff_{pm}\, A_{ml} + (1 - ff_{pm})\, A_{m-h,l} e^{-\lambda r(H-m)}]$$

3) Milk

$$D_{IM} = DF_{la}\, R^{M}_{ma}\, [ff_{Mm}\, \{M\emptyset_{m} \cdot f_0 + M1 \cdot f_1 + M2 \cdot f_2]\} +$$

$$+ (1 - ff_{Mm})\, \{M\emptyset_{M-H} \cdot f_0 + M1_{M-H} \cdot f_1 + M2_{M-H} \cdot f_2\}]$$

$R_{a,m}$ - ingestion rate, kg/month, for each age group (also probably lifestyle)

ff_v, ff_p, ff_m = fresh fraction

$DF_{l,a}$ = dose factor, rem/Ci, by age group

f_0, f_1, f_2 = fractions of milk for each source (probably delta function)

SURFACE WATER MODULES

EQUATIONS FOR CALCULATION OF

- FISH CONCENTRATION
- DRINKING WATER CONSUMPTION

1) At catch, if not using measured values, for each of Ted's "River stretches," l, for each month, for each fish type

$$CF1m_{ast} = W_{ml} \cdot B_{Tm}$$

W_{ms} = water concentration at river location s for month m, Ci/l

B^{Tm} = bioaccumulation factor for fish type T for month m (under development by Ted)

2) At consumption

$$CF2_{mLT} = \sum_{1}^{s} f^{L}_{st} \cdot CF1_{mst}$$

L^{L}_{st} = fraction of fish of type T consumed at location L caught at river stretch s (this is the "fish transport model")

3) Drinking water

$$DW_{ml} = W_{ml} \cdot DWCF \cdot e^{-\lambda rtw}$$

DWCF = drinking water cleanup factor, fraction removed by treatment facilities

tw = time in drinking water distribution system

Surface Water Modules

- FISH CONSUMPTION DOSE
- DRINKING WATER DOSE
- SWIMMING/BOATING DOSES

1) FISH CONSUMPTION, by age group, lifestyle, etc., at location L

$$D_{Fish,a,L} = \sum_{I}^{I} R^{F}_{amT} \cdot CF2_{mLT} \cdot DF_{Ia}$$

2) DRINKING WATER, by age group

$$D_{water,a,L} = R^{F}_{amL} \cdot DF_{Ia} \cdot DW_{ml}$$

3) SWIMMING

$$D_{swim,a,L} = E3_{mA} \cdot W_{mL} \cdot DF_{w}$$

$E3_m$ = exposure time, hr/month spent swimming, a function of age and lifestyle

DF_w = swimming dose factor rem/hr per Ci/L

4) BOATING

$$D_{boat,a,L} = E4_{ma} \cdot W_{mL} \cdot DF_{w}/2$$

$E4_{ma}$ = exposure time boating, hr/month, a function of age and lifestyle

APPENDIX B

TECHNIQUES FOR SELECTING REALIZATIONS FROM ARBITRARY DISTRIBUTIONS

ALGORITHMS FOR THE GENERATION OF SAMPLES FROM SELECTED PROBABILITY DISTRIBUTIONS

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January 15, 1990

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1.0 SUMMARY AND INTRODUCTION

The purpose of this report is to document algorithms for generating samples from the probability distributions that are being, or may be, used in the calculation of dose estimates and uncertainties. Algorithms are presented for generating realizations of random variables with the following distributions:

- $U(a,b)$ -- a uniform distribution over the interval (a,b), $a < b$
- $LU(\alpha,\beta)$ -- a loguniform distribution over the interval (α,β), $\alpha < \beta$
- $T(a,b,c)$ -- a triangular distribution over the interval (a,c) with mode at b, $a \leq b \leq c$
- $N(\mu,\sigma^2)$ -- a normal (Gaussian) distribution with mean μ and variance σ^2
- $LN(\theta,\tau^2)$ -- a lognormal distribution with mean θ and variance τ^2.

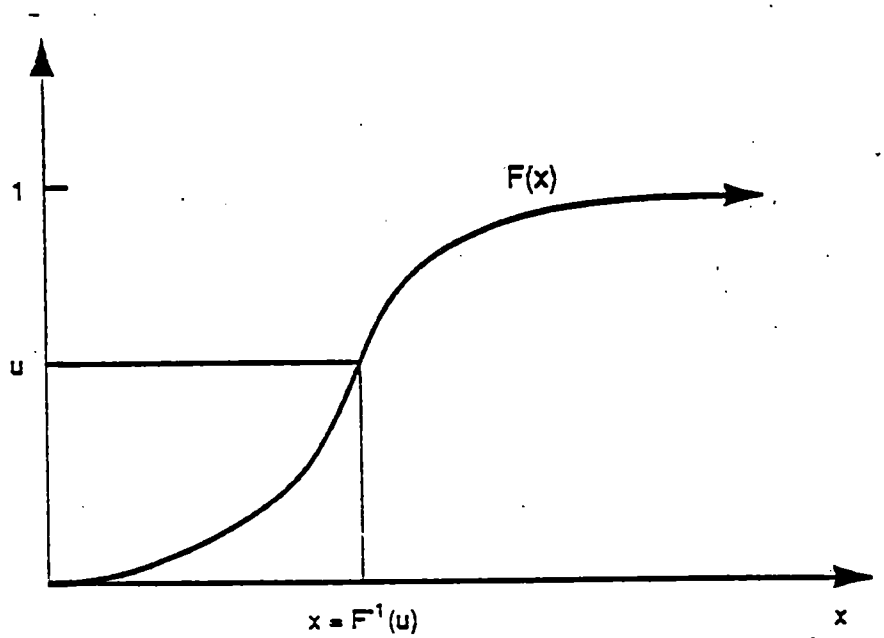
Each algorithm requires the generation of random numbers or values from a U(0.1) distribution. It is anticipated that (pseudo) random numbers will be generated using currently available system routines. Because random numbers are crucial to the generation of realizations from any distribution, an alternative algorithm is presented in Section 4.0 for generating (pseudo) random numbers in case the system random number generator proves unacceptable for some reason.

2.0 GENERAL METHODS FOR UNIVARIATE DISTRIBUTIONS

A fundamental method that theoretically works for any univariate distribution is the Inversion Method. This method, which requires the inversion of the cumulative distribution function (cdf), is based on the following theorem of probability (see Mood, Graybill, and Boes 1974, p. 202):

> If X is a random variable with cumulative distribution function F, then the random variable U, defined by U = F(X), has a uniform distribution over the interval (0,1).

In practice, realizations are obtained by generating a pseudo-random number u (a realization of a U(0,1) random variable), setting this number equal to U in the above theorem, and solving for X. For each realization u, this procedure yields the realization $x = F^{-1}(u)$ of the random variable X. The Inversion Method is shown schematically in Figure 1. The utility of the



R8912159.8

FIGURE 1. The Inversion Method of Generating Realizations from the Cumulative Distribution Function F: x is the realization that corresponds to the random number u.

Inversion Method is limited by the difficulty of obtaining F^{-1}; consequently, alternative methods are preferable for many distributions whose cdfs are difficult to invert. The Inversion Method is used to generate realizations from uniform and triangular distributions.

> Technical Note: If F is not continuous, then there exist values of u for which $F^{-1}(u)$ is not well defined. In this case, x should be taken as the largest value to x_0 such that $F(x) \leq u$, i.e., $x_0 = \sup x\ F(x) \leq u$.

A second method for generating realizations of specified distributions is by means of transformations. If Y is obtained by transformation from the variable X, say $Y = g(X)$, then realizations of Y can be obtained by applying the transformation g to realizations of X. Transformations are used to generate loguniform variates from uniform variates and lognormal variates from normal variates. Transformations may also be used to generate U(a,b) variates from U(0,1) variates and $N(\mu,\sigma^2)$ variates from N(0,1) variates.

In addition to the two general methods identified above, special methods exist that are efficient for specific distributions. The Box-Muller algorithm given in Section 3.4 is a special method for the generation of standard normal variables [e.g., N(0,1) variables].

The algorithms obtained by applying the methods in this section to the distributions listed in Section 1.0 are given in Section 3.0. A good overview of methods for generation of realizations from univariate distributions is given in Chapter 2 of Johnson (1987); a more extensive discussion is found in Chapter 5 of Bratley, Fox, and Schrage (1983).

3.0 ALGORITHMS FOR SELECTED DISTRIBUTIONS

3.1 The Uniform Distribution

The Inversion Method is used to obtain U(a,b) variates from pseudo-random variates. If X has a U(a,b) distribution, then the cdf of X is

$$F_U(x) = \begin{cases} 0, & x \le a \\ (x - a)/(b - a), & a \le x \le b \\ 1, & x \ge b \end{cases}$$

In the interval $a < x < b$, $F_U(x) = (x - a)/(b - a)$, so F_u^{-1} is given by

$$x = F_U(x)\ (b - a) + a$$

Therefore, we obtain the following algorithm for generating a realization x from a U(a,b) distribution.

Algorithm

Step 1. Generate a pseudo-random number u from the U(0,1) distribution.

Step 2. Compute $x = u\ (b - a) + a$.

References

Iman and Shortencarier (1984, p. 18)
Mood, Graybill, and Boes (1974, p. 105)
Any standard statistics textbook.

3.2 The Loguniform Distribution

Log uniform variates are obtained by transforming uniform variates. By definition, the random variable Y has a loguniform distribution over the interval (α, β), $\alpha < \beta$, $\alpha > 0$, $\beta > 0$, if, and only if, the random variable $X = \ln Y$ has a uniform distribution over the interval (a,b), where $a = \ln \alpha$ and $b = \ln \beta$. From this definition, it follows that

$$F_U(x) = (x - \ln \alpha)/(\ln \beta - \ln \alpha)$$

or

$$x = F_U(x)(\ln \beta - \ln \alpha) + \ln \alpha$$

for $\ln \alpha \le x \le \ln \beta$. Therefore, we obtain the following algorithm for generating a realization x from a $LU(\alpha, \beta)$ distribution.

Algorithm

Step 1. Generate a pseudo-random number u from a U(0,1) distribution.

Step 2. Compute $y = \exp[u(\ln \beta - \ln \alpha) + \ln \alpha]$.

Reference

Iman and Shortencarier (1984, p. 19)

3.3 The Triangular Distribution

The Inversion Method is used to obtain realizations from a triangular distribution. If X has a triangular distribution over the interval (a,c) with mode b, then the cdf of X is

$$F_T(x) = \begin{cases} 0, & x \le a \\ (x-a)^2 / [(c-a)(b-a)], & a \le x \le b \\ \dfrac{b-a}{c-a} - \dfrac{(x+b-2c)(x-b)}{(c-a)(c-b)}, & b \le x \le c \\ 1, & x \ge c \end{cases}$$

Note that at $x = b$, $F_T(x) = F_T(b) = (b-a)/(c-a)$. Inverting $F_T(x)$ yields the following algorithm for generating a realization x from a triangular distribution with parameters a, b, and c, $a \le b \le c$.

Algorithm

Step 1. Generate a pseudo-random number u from a U(0,1) distribution.

Step 2. If $u \le (b-a)/(c-a)$

Set $u = F_T(x) = (x-a)^2/[(c-a)(b-a)]$

Compute $x = a + [u(c-a)(b-a)]^{1/2}$

Step 3. Otherwise,

$$\text{Set } u = F_T(x) = \frac{b - a}{c - a} - \frac{(x + b - 2c)(x - b)}{(c - a)(c - b)}$$

$$\text{Compute: } x = c - [(b - c)^2 + (b - a)(c - b) - u(c - a)(c - b)]^{1/2}$$

References

Iman and Shortencarier (1984, p. 20)
Johnson and Kotz (1970)

3.4 The Normal Distribution

The inverse of the cdf of a normally distributed random variable X cannot be expressed in closed form, so the inversion method is not the method of choice for generating normal variates. The method used to generate normal variates, which is due to Box and Muller (1958), involves transformation of a pair of pseudo-random numbers to obtain a pair of standard normal variates. These are further transformed to obtain a pair of realizations from a normal distribution with mean μ and variance σ^2.

The Box-Muller algorithm is an efficient method for generating simple random samples of normal variates, but it may not be as efficient for Latin Hypercube Sampling, which involves partitioning the range of the simulated variables. To generate normal variates using Latin Hypercube Sampling, it is desirable to use an algorithm that generates specified percentage points of a normal distribution. The algorithm cited below, due to Beasley and Springer (1977), is used for this purpose.

The Box-Muller Algorithm

Step 1. Generate independent pseudo-random numbers u_1 and u_2 from the U(0,1) distribution.

Step 2. Compute

$$g_1 = (-2 \ln u_1)^{1/2} \cos(2\pi u_2)$$

$$g_2 = (-2 \ln u_1)^{1/2} \sin(2\pi u_2)$$

Step 3. Compute

$$x_1 = \sigma g_1 + \mu$$

$$x_2 = \sigma g_2 + \mu$$

The quantities x_1 and x_2 are independent realizations from a normal distribution with mean μ and variance σ^2.

Step 4. (optional) If

$$y_1' = g_1$$

$$y_2 = \rho g_1 + (1-\rho^2)^{1/2}\, g_2$$

are computed for some ρ, $-1 \le \rho \le 1$, then y_1 and y_2 are realizations from a standard bivariate ($\mu_1 = 0$, $\mu_2 = 0$, $\sigma_1^2 = 1$, $\sigma_2^2 = 1$) normal distribution with correlation coefficient ρ.

References

Box and Muller (1958)
Abramowitz and Stegun (1970, p. 953)
Johnson (1987, p. 29)

Algorithm for Computing Percentage Points of the Normal Distribution

Algorithm AS III, due to Beasley and Springer (1977), is used to calculate percentage points of the normal distribution in connection with Latin Hypercube Sampling methods. The algorithm is fast, numerically accurate, and portable without modification. FORTRAN code for implementing Algorithm AS III is given in the reference cited.

3.5 The Lognormal Distribution

Log normal variates are obtained by transferring normal variates. By definition, the random variable Y has a lognormal distribution with mean θ and variance τ^2 if, and only if, the random variable $X = \ln Y$ has a normal distribution with mean μ and variance σ^2, where

$$\mu = \ln\left[\theta^2 \,/\, \sqrt{\theta^2 + \tau^2}\,\right] \quad \text{and} \quad \sigma^2 = \ln\left[(\theta^2 + \tau^2) \,/\, \theta^2\right] \qquad (1)$$

This definition yields the following algorithm for generating a realization y from a lognormal distribution with mean θ and variance τ^2.

Algorithm

Step 1. Generate a realization x from a normal distribution with mean μ and variance σ^2, where μ and σ^2 are computed using Equation (1) above. (See algorithms in Section 3.4 for generating normal realizations.)

Step 2. Compute $y = \exp(x)$. Then y is a realization from a lognormal distribution with mean θ and variance τ^2.

References

Iman and Shortencarier (1984 p. 17)
Crow and Shimizu (1988)

4.0 THE GENERATION OF PSEUDO-RANDOM NUMBERS

Each algorithm in Section 3.0 requires the generation of values from a U(0,1) distribution. It is anticipated that the pseudo-random number generator available on the PNL VAX network will prove adequate for HEDR Project dose calculations and related uncertainty analyses. In case the system generator proves inadequate for some reason, and for the sake of completeness, a pseudo-random number generator is given here. The selected generator is due to Wichmann and Hill (1982) and produces U(0,1) realizations by combining the results of three multiplicative congruential generators. The algorithm is short, reasonably fast, statistically sound, and machine independent. A FORTRAN implementation is given below. On machines that use only 23 bits for representation of the fractional part of a real number, it is possible for this algorithm to produce exact zeros because of rounding error; see McLeod (1985) for a discussion of this problem and possible modifications. An extensive discussion of uniform random number generators, including the algorithm presented here, is found in Chapter 6 of Bratley, Fox, and Schrage (1983).

Algorithm AS 183 (Wichmann and Hill)

```
      REAL FUNCTION RANDOM(L)
C
C        ALGORITHM AS 183  APPL. STATIST. (1982) VOL.31, P.188
C
C        RETURNS A PSEUDO-RANDOM NUMBER RECTANGULARLY DISTRIBUTED
         BETWEEN 0 AND1.
C
C        IX, IY AND IZ SHOULD BE SET TO INTEGER VALUES BETWEEN
C        1 AND 30000 BEFORE FIRST ENTRY.
C
C        INTEGER ARITHMETIC UP TO 30323 IS REQUIRED.
C
      COMMON /RAND/ IX, IY, IZ
      IX = 171 * MOD(IX, 177) - 2  * (IX / 177)
      IY = 172 * MOD(IY, 176) - 35 * (IY / 176)
      IZ = 170 * MOD(IZ, 178) - 63 * (IZ / 178)
C
      IF (IX .LT. 0) IX = IX + 30269
      IF (IY .LT. 0) IY = IY + 30307
      IF (IZ .LT. 0) IZ = IZ + 30323
C
C        IF INTEGER ARITHMETIC UP TO 5212632 IS AVAILABLE,
C        THE PRECEDING 6 STATEMENTS MAY BE REPLACED BY
C
C        IX = MOD(171 * IX, 30269)
C        IY = MOD(172 * IY, 30307)
C        IZ = MOD(170 * IZ, 30323)
C
C        ON SOME MACHINES, THIS MAY SLIGHTLY INCREASE
C        THE SPEED. THE RESULTS WILL BE IDENTICAL.
C
      RANDOM = AMOD(FLOAT(IX) / 30269.0 + FLOAT(IY) / 30307.0 +
     $              FLOAT(IZ) / 30323.0, 1.0)
      RETURN
      END
```

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APPENDIX C

METHODS OF STORING AND RETRIEVING DATA FROM HISTOGRAMS

Battelle
Pacific Northwest Laboratories

Project Number _____

Internal Distribution

BS Dennis
RO Gilbert
HA Haerer
BA Napier
B Sagar
File/LB

Date June 26, 1989

To JT Caplinger

From AM Liebetrau

Subject Algorithm for Input of and Generation of Realizations from Cumulative Distribution Functions

The estimation of dose estimate uncertainties will involve simulating realizations of probability distributions. The distributions may be theoretical (i.e., expressed in a functional form) or empirical (estimated from real data or generated by simulation from a hypothetical distribution). The distributions may be used to describe the distribution of input parameters to the dose model or the variability of submodel output variable(s).

The following algorithm can be used to approximate a given distribution function regardless of whether it is theoretical or empirical. The notation used in Eq. (1) below is illustrated in the attached figure.

Step (a): Divide the range of the distribution into k intervals. For Phase I calculations, a maximum of k = 20 intervals will be used.

Step (b): The interval boundaries (denoted by x's) and the cumulative probabilities (denoted by h's) associated with the right-hand endpoints of the k intervals are:

$$(x_0, h_0 = 0), (x_1, h_1), (x_2, h_2), \ldots, (x_{k-1}, h_{k-1}), (x_k, h_k = 1) \qquad (1)$$

Where x_0 is the minimum value of the variable and x_h is the maximum value.

The intervals defined by Eq. (1) defined a k-segment piecewise linear approximation to the actual input distribution. A maximum of k = 20 intervals will be used for Phase I calculation. A smaller value of k may be used in cases where an adequate approximation to the actual input distribution does not require 20 intervals. Note that when the distribution is expressed in cumulative form, both the x's and the h's are nondecreasing sequences of numbers. It is convenient to choose the representation in Eq. (1) so that either the x's or the h's are equally spaced. For the Phase I study, we will use equal spacing of the x's.

After a distribution such as that in Step (b) has been assigned to a particular input variable, then realization of the variable may be generated from the assigned distribution as follows:

Step 1: Generate a pseudo-random number, from the uniform distribution over the interval (0,1)). Denote the value of this number by h, where $0 < h < 1$.

Step 2: Determine the index i, i = 1, 2, ..., k, such that $h_{i-1} < h < h_i$.

Step 3: Compute $x = x_{i-1} + \frac{h - h_{i-1}}{h_i - h_{i-1}} (x_i - x_{i-1})$ (2)

The quantity x obtained by (2) is the realization of a random variable x whose cdf is given by (1). Steps 1-3 can be repeated, as necessary, to generate the desired number of realizations from the given distribution.

AML/slc

APPENDIX D

HANDLING ATMOSPHERIC DEPOSITION AND INTERCEPTION BY VEGETATION

Battelle
Pacific Northwest Laboratories

Project Number HEDR

Internal Distribution

DA Cataldo	JK Soldat
DM Beck	JV Ramsdell
CL Bruneau	RE Rhoads
JM Callaway	JG Stephan
MD Freshley	DL Strenge
RO Gilbert	WH Walters
SP Gydesen	RK Woodruff
HA Haerer	Project Office
LG Morgan	File/LB

Date April 26, 1989

To Distribution

From Bruce Napier

Subject Recommendation for Treating Radionuclide Deposition and Interception on Vegetation on Phase 1

INTRODUCTION

Evaluation of the atmospheric transport and deposition of radionuclides on soil and vegetation is one of the major undertakings of the HEDR project. The initial sensitivity studies, as mentioned in the September 1988 Workplan to the TSP, performed by Dennis Strenge and Bruce Napier for the iodine air-cow-milk pathway, indicated that the parameterization of deposition and vegetation uptake was one of the most important to the final result. In addition, the demarcation between the Environmental Transport Task and the Environmental Pathways and Dose Estimates Task comes at the point of deposition. Van Ramsdell and I have had many discussions on the appropriate method of doing this and have reached a working agreement.

Deposition and interception have been widely studied. They seem to be correlated with atmospheric conditions (such as wind speed, turbulence), type of surface (measured in terms of a "friction velocity" or a "surface roughness"), as well as with type and state of vegetation. Most studies have attempted to lump many parameters into a "deposition velocity" (e.g., Heinemann and Vogt 1980). Often, the deposition velocity also includes the interception fraction (i.e., v_g is deposition onto grass rather than onto the soil).

DISCUSSION

The original Hanford model for deposition/interception incorporated a "deposition velocity" term with a constant interception fraction (Soldat and Harr 1971). Combined with a feed-to-milk transfer factor, this model provided a fairly accurate prediction of milk concentrations for the Hanford environment. Recent results of the Biospheric Model Validation Study (BIOMOVS), presented at the VII Workshop in Tokai, Japan, November 7-10, 1988, but yet unpublished, indicate that this formulation tends to underpredict the concentrations on the grass, but to overpredict the transfer from grass to milk, and therefore the final answer is in the right range. The observation of underprediction of deposition/interception is repeated by Pinder, McLeod, and Adriano (1989). The current Hanford model (Napier et al. 1988) uses a variable interception fraction that is a function of vegetation biomass. The interception fraction is based on the model of Chamberlain (1970). It generally results in a higher value of interception than the older constant fraction. The Chamberlain model is an empirical fit to a large amount of data, relating to both iodine and particulate radionuclides.

Chamberlain's approach is a filtration model of the form $r = 1 - e^{-\mu B}$, where r is the interception fraction, μ is an empirical constant, and B is the biomass. The constant μ and the variable B are usually defined to be in terms of dry biomass.

I performed a review of current modeling approaches to the problem of deposition/interception. Sehmel (1984) provides an extensive overview of deposition velocities, but does not differentiate between deposition on soils and surfaces and on vegetation (which is important because deposition velocities onto vegetation may incorporate an interception fraction implicitly). The IAEA Safety Series 57 (1982) suggests that for forage, the quotient of the interception fraction and the dry weight of the biomass be held a constant, and for food crops that the interception fraction be held at a constant value of 0.20. Use of a constant value of the quotient was investigated by the Nevada dose reconstruction and used in the Nevada "Sheep Study." Holding the quotient of interception to biomass, a constant is equivalent to using a series expansion of the Chamberlain model truncated at the first term - it gives roughly equivalent results for low biomass. The IAEA position is a restatement of the recommendations given in several Oak Ridge National Laboratory documents (e.g., Hoffman and Baes 1979, Miller et al. 1980). The newer ORNL code TERRA (Baes et al. 1985) uses the Chamberlain formulation for interception by hay and pasture grasses, and an ad hoc variant with the same mathematical form for other vegetation. The British code FOOD-MARC (Linsley, Simmonds, and Haywood 1982) uses a constant interception fraction approach. The German code ECOSYS (Prohl, Friedland, and Paretzke 1985) uses the Chamberlain formulation, in particular for iodine. The PATHWAY model used by the ORERP study (Whicker and Kirchner 1987) uses the Chamberlain interception fraction model. The most recent literature on the topic by Pinder (Pinder, Ciravolo, and Bowling 1988; Pinder, McLeod, and Adriano 1989) also recommend the Chamberlain formulation, with very minor revisions to the empirical constants. It appears that, over the past decade, most researchers have determined that the Chamberlain filtration approach provides the most adequate method of predicting the interception fraction.

Recently declassified Hanford information from early 1946 indicates that the concentrations of radioiodine measured on vegetation from Hanford releases varies from species to species by about a factor of eight (all measurements were done on the basis of activity per unit mass as collected - i.e., without drying). One-gram samples were spread on a surface and counted. Dry grass and weeds were found to be more active (per unit mass as collected) than live vegetation. Reproducibility of these measurements was said to be about plus or minus 30% (Healy 1946). This indicates to me that if these had been normalized to dry weight, the variability would have been less. A model using the interception fraction described by Chamberlain and corrected for the moisture content of the vegetation as a function of time of year would give a variability the same as seen in these original Hanford measurements. (Chamberlain (1970) also reports a variable weathering half-time, one that is longer in the winter. This seems also to be supported in the Hanford measurements.)

CONCLUSIONS

We propose to use a two-part description of deposition and interception. The total flux of radioactive material out of the passing atmospheric puff is needed by Van Ramsdell in the atmospheric dispersion model to maintain a mass balance and properly account for plume depletion. Van proposes to use a model that accounts for atmospheric conditions and radionuclide properties (particulate vs. noble gas vs. iodine) to provide the net wet and dry flux out of the plume. I propose to use the Chamberlain filtration model to account for interception of this flux on the vegetation. This two-part approach will allow convenient data transfer between the tasks. The approach is essentially the same as that used for data transfer in the ORERP project.

The model for interception fraction will be made variable as a function of plant biomass and moisture content, which means it will be a function of crop type and time of year. This model should explain most of the variability seen in the historical environmental measurements.

Additional sensitivity studies will be possible once this system becomes operational. This will allow us to investigate whether wind-tunnel experiments with iodine-131 or field experiments with iodine-129 from PUREX will add appreciable data to our study in the next fiscal year.

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BAN:cs

APPENDIX E

HANDLING CORRELATIONS IN COMPLEMENTARY FRACTIONS

Battelle
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Internal Distribution

JW Brothers
RO Gilbert
HA Haerer
AM Liebetrau
B Sagar
DL Strenge
Project Office
File/LB

Date August 18, 1989

To Distribution

From Bruce Napier

Subject Handling Correlations in Complementary Fractions

INTRODUCTION

In several of the calculations to be performed for the HEDR Phase 1 analyses, a series of fractions must be selected from input distributions. Each of these fractions has its own distribution. The results of the selection process of the fractions must, however, sum to one, which implies a correlation structure. A technique is needed to handle the correlations between the various fractions.

DISCUSSION

Several options are available. We could use a simple rule to adjust the randomly drawn fractions, or we could draw the fractions from a multivariate distribution with an assumed correlation structure.

In general, the fractions are being generated via expert opinion. There is considerable uncertainty about many of them. No information is currently available on correlations between the constituent parts of the sum desired, other than that it is constrained to add to unity. The structure of the proposed computer implementation also does not lend itself to incorporating large correlation matrices.

The question of how to handle these correlations was discussed by Bruce Napier, Al Liebetrau, Dick Gilbert, and Budhi Sagar at a meeting on July 31, 1989.

CONCLUSIONS

It was concluded that for Phase 1, at least, a simple adjustment rule would be adequate, given the lack of strong information on correlations. The various fractions should be drawn independently from their distributions, and then the sum of the results should be used to normalize each value so that the total then adds to one.

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APPENDIX F

CORRESPONDENCE BETWEEN COLUMBIA RIVER LOCATION AND HEDR CENSUS SUBDIVISION

Battelle
Pacific Northwest Laboratories

Project Number HEDR

Internal Distribution

HA Haerer
TM Poston
MC Richmond
Project Office
File/LB

Date August 17, 1989

To DM Beck

From BA Napier

Subject Correspondence Between Columbia River Location and HEDR Census Subdivision Grid Points

INTRODUCTION

Much of the Phase 1 effort has gone into defining parameters to use for the atmospheric dispersion portions of the HEDR calculations. Proportionally less effort has been expended on the surface water pathways. However, definition of the various locations of potential exposure to the river or to river-related products (water, fish, irrigated foods) is also necessary.

DISCUSSION

Ted Poston, who was asked to accumulate and evaluate data on radionuclide concentrations of fish in the Columbia River for 1964-1966, devised a convention for collecting data based on sampling locations. These areas are (memo, T. M. Poston to Distribution, June 12, 1989, "Location of Fish Sampling Sites"):

Site	Approximate River Mile
Priest Rapids	390
Hanford	365
Coyote Rapids	383
Ringold	354
Richland	345
Island View	335
Burbank	322
McNary	294

The first three of these locations are inside of the Hanford Site, and thus of minimal importance for public exposure considerations. The others, however, are stretches of the river for which public access is available.

CONCLUSIONS

I have compared Ted's river stretches to our HEDR census subdivisions on the map. There is a very convenient correspondence for the publicly available locations, as follows:

Site	HEDR Census Subdivision
Ringold	FR4
Richland	BE7, FR5
Island View	BE3, FR3
Burbank	WA3, BE4
McNary	BE8, UM4

Note that each stretch of the river touches two subdivisions, one on either side, if some minor overlaps are ignored. (The Benton County side of the Ringold stretch is still Hanford Site). Given the inexact nature of the selections, this would seem to be reasonable.

These divisions should be used for the transport, demography, and dose calculations required for Phase 1.

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APPENDIX C

TABULATION OF BIOMASS AND INTERCEPTION FRACTION

APPENDIX C

TABULATION OF BIOMASS AND INTERCEPTION FRACTION

This appendix includes the monthly biomass (Y) used for each vegetation type, and the resultant interception fraction (r).

Plant Type	
1	Leafy Vegetables
2	Other Vegetables
3	Grain
	Meat: Grain
	Poultry & Eggs: Grain
4	Fruit
5	Meat: Forage/Hay
	Milk: Hay
6	Milk: Fresh Forage
7	Milk: Ensilage
8	Sagebrush

Biomass (dry weight) (kg/m^2)

Plant Type	Month 1	2	3	4	5	Y 6	7	8	9	10	11	12
1				.04	.1	.2	.2	.2	.16	.1		
2				.05	.25	.4	.5	.5	.4	.25		
3			.014	.029	.058	.086	.115	.144	.072			
4	.27	.27	.27	.324	.378	.54	.54	.54	.432	.324	.27	.27
5			.05	.1	.15	.15	.15	.15	.15			
6	.03	.03	.06	.15	.27	.27	.27	.27	.24	.15	.06	.03
7				.03	.09	.15	.21	.3	.15			
8	.01	.02	.03	.04	.04	.04	.01	.01	.01	.01	.01	.01

Interception Fraction

Plant	Month 1	2	3	4	5	r 6	7	8	9	10	11	12
1				.11	.252	.44	.44	.44	.371	.252		
2				.165	.593	.763	.835	.835	.763	.593		
3			.041	.08	.154	.222	.284	.341	.188			
4	.622	.622	.622	.689	.744	.857	.857	.857	.789	.689	.622	.622
5			.135	.252	.353	.353	.353	.353	.353			
6	.083	.083	.16	.353	.543	.543	.543	.543	.501	.353	.16	.083
7				.083	.23	.353	.456	.581	.353			
8	.035	.069	.102	.134	.134	.134	.035	.035	.035	.035	.035	.035

APPENDIX D

DOSES BY CENSUS DIVISION, AGE GROUP, YEAR, AND EXPOSURE PATHWAY

APPENDIX D

DOSES BY CENSUS DIVISION, AGE GROUP, YEAR, AND EXPOSURE PATHWAY

The following 98 tables present summaries of the thyroid doses calculated for Phase I of the HEDR Project. All doses presented in these tables are in units of thyroid dose (rad) [essentially equivalent to thyroid dose (rem)]. Each table presents the results of calculations for a single census division. The census divisions are illustrated in Figure 2.5. Within each census division, the results are presented as annual summaries for 1945, 1946, and 1947 and as the cumulative dose that would have been received by an individual who lived in the division over the entire 3 years.

Doses are presented by exposure pathway. Those labelled "External" include contributions from air submersion and from material deposited on the ground. The doses labelled "Inhalation" are from breathing the contaminated air at the given location for the whole year. Doses from consumption of cow's milk are presented for a number of possible situations, including milk from four potential feeding regimes for family ("backyard") cows and two for commercial sources. The feeding regimes, which are defined in the main report, are the following:

Feeding Regime 1 (BYCow Regime 1): A diet consisting of grain, stored alfalfa hay, fresh irrigated pasture, and ensilage, similar to that of commercial dairy farms.

Feeding Regime 2 (BYCow Regime 2): A diet consisting of grain, stored alfalfa hay, and fresh irrigated pasture, similar to that of commercial dairy farms.

Feeding Regime 3 (BYCow Regime 3): A diet consisting of grain and alfalfa hay only, with no fresh pasture, similar to that of small family farms without irrigation.

Feeding Regime 4 (BYCow Regime 4): A diet consisting of grain and grass hay only, similar to that of small family farms without irrigation.

Commercial milk consisted of two sources, rural and urban. Milk collected by various creameries was redistributed to grocery stores, thus making commercially available milk at any one location a potential blend from

many sources. To illustrate the model capabilities, doses from milk available in rural groceries were calculated for each census division. For a few locations that were essentially entirely urban, doses from milk available in larger stores were also calculated.

Not all of these sources are listed for each census division. If a source was not considered to be applicable (e.g., milk from irrigated pasture in divisions in which irrigation was not practiced in the mid-1940s), no entry is shown.

Doses presented for consumption of fruits and vegetables are based on the assumption that the entire diet of fresh fruit and vegetables was supplied by local sources (i.e., sources from within the subject census division). This is a highly conservative assumption for all people except those with large private gardens.

Doses are presented for two age groups, infant and adult. Infants range in age from birth to 1 year old. Adults are assumed to be more than 20 years old.

For both groups, only doses to males were estimated, because the only differences between males and females dosimetrically is that their consumption rates for the various food types differ and that males tend to eat somewhat more than females.

The complete calculations performed for Phase I generated distributions of doses for each of the categories described above. The fifth percentile, median (fiftieth percentile), and ninety-fifth percentile thyroid doses from each distribution are presented in the tables. Because of the nature of the Monte Carlo calculation process, the uncertainty in doses outside of these ranges is large enough to invalidate their usefulnesses. The fifth and ninety-fifth percentiles define a range in which ninety percent of the potentially exposed population would fall, and are best used for comparative purposes.

Adams County Census Division 01

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.013	0.000	0.001	0.008
1945	Inhalation	0.009	0.035	0.193	0.008	0.027	0.178
1945	Milk from BYCow Regime 3	0.020	0.183	1.924	0.001	0.015	0.169
1945	Milk from BYCow Regime 4	0.001	0.019	0.584	0.000	0.002	0.051
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.315	1.515	9.747	0.248	1.092	6.379
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.002	0.007	0.034	0.002	0.005	0.027
1946	Milk from BYCow Regime 3	0.002	0.024	0.249	0.000	0.002	0.019
1946	Milk from BYCow Regime 4	0.000	0.005	0.082	0.000	0.000	0.006
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.045	0.220	1.172	0.035	0.151	1.059
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.001	0.002	0.009	0.001	0.002	0.006
1947	Milk from BYCow Regime 3	0.001	0.006	0.065	0.000	0.001	0.006
1947	Milk from BYCow Regime 4	0.000	0.001	0.035	0.000	0.000	0.004
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.008	0.041	0.246	0.007	0.031	0.193
1945-1947	External	0.001	0.002	0.015	0.001	0.002	0.011
1945-1947	Inhalation	0.018	0.050	0.221	0.014	0.038	0.197
1945-1947	Milk from BYCow Regime 3	0.053	0.270	2.635	0.003	0.022	0.218
1945-1947	Milk from BYCow Regime 4	0.006	0.048	0.721	0.000	0.004	0.055
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	0.602	1.989	11.065	0.451	1.480	6.816

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Adams County Census Division 02 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.004	0.000	0.001	0.004
1945	Inhalation	0.012	0.044	0.230	0.010	0.035	0.170
1945	Milk from BYCow Regime 3	0.029	0.227	1.693	0.002	0.018	0.139
1945	Milk from BYCow Regime 4	0.001	0.029	0.802	0.000	0.003	0.045
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.445	1.865	10.162	0.327	1.282	6.979
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.003	0.009	0.052	0.002	0.007	0.039
1946	Milk from BYCow Regime 3	0.003	0.033	0.287	0.000	0.002	0.023
1946	Milk from BYCow Regime 4	0.000	0.004	0.132	0.000	0.000	0.006
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.061	0.258	1.576	0.045	0.193	1.351
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.001	0.003	0.026	0.001	0.002	0.015
1947	Milk from BYCow Regime 3	0.001	0.007	0.076	0.000	0.001	0.010
1947	Milk from BYCow Regime 4	0.000	0.002	0.029	0.000	0.000	0.002
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.010	0.047	0.269	0.010	0.042	0.233
1945-1947	External	0.001	0.002	0.006	0.001	0.002	0.006
1945-1947	Inhalation	0.025	0.067	0.343	0.020	0.051	0.238
1945-1947	Milk from BYCow Regime 3	0.062	0.314	1.861	0.005	0.025	0.165
1945-1947	Milk from BYCow Regime 4	0.007	0.058	0.711	0.001	0.005	0.045
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	0.786	2.520	11.398	0.570	1.741	7.837

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Adams County Census Division 03

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.007	0.001	0.002	0.007
1945	Inhalation	0.016	0.055	0.263	0.014	0.045	0.185
1945	Milk from BYCow Regime 3	0.033	0.296	2.708	0.002	0.025	0.222
1945	Milk from BYCow Regime 4	0.001	0.044	0.773	0.000	0.003	0.045
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.503	2.143	12.455	0.361	1.617	8.816
1946	External	0.000	0.000	0.007	0.000	0.000	0.005
1946	Inhalation	0.004	0.013	0.153	0.003	0.010	0.127
1946	Milk from BYCow Regime 3	0.003	0.030	0.252	0.000	0.003	0.028
1946	Milk from BYCow Regime 4	0.000	0.006	0.071	0.000	0.000	0.011
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.068	0.278	1.747	0.051	0.215	1.092
1947	External	0.000	0.000	0.003	0.000	0.000	0.003
1947	Inhalation	0.001	0.004	0.077	0.001	0.003	0.064
1947	Milk from BYCow Regime 3	0.001	0.006	0.105	0.000	0.001	0.010
1947	Milk from BYCow Regime 4	0.000	0.002	0.050	0.000	0.000	0.002
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.012	0.053	0.263	0.009	0.042	0.265
1945-1947	External	0.001	0.003	0.020	0.001	0.003	0.015
1945-1947	Inhalation	0.033	0.089	0.571	0.027	0.073	0.454
1945-1947	Milk from BYCow Regime 3	0.071	0.399	3.214	0.006	0.034	0.191
1945-1947	Milk from BYCow Regime 4	0.009	0.081	0.946	0.001	0.005	0.042
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	0.860	2.753	12.956	0.658	2.091	10.355

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Adams County Census Division 04 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.006	0.001	0.002	0.006
1945	Inhalation	0.024	0.076	0.279	0.021	0.059	0.250
1945	Milk from BYCow Regime 3	0.045	0.437	4.126	0.003	0.030	0.286
1945	Milk from BYCow Regime 4	0.004	0.068	1.216	0.000	0.005	0.182
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.795	3.199	15.669	0.576	2.106	10.009
1946	External	0.000	0.001	0.003	0.000	0.000	0.002
1946	Inhalation	0.005	0.017	0.105	0.005	0.013	0.079
1946	Milk from BYCow Regime 3	0.005	0.048	0.455	0.000	0.004	0.034
1946	Milk from BYCow Regime 4	0.000	0.011	0.262	0.000	0.001	0.012
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.097	0.453	2.430	0.080	0.319	1.852
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.001	0.005	0.058	0.001	0.004	0.039
1947	Milk from BYCow Regime 3	0.001	0.015	0.156	0.000	0.001	0.011
1947	Milk from BYCow Regime 4	0.000	0.004	0.128	0.000	0.000	0.006
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.019	0.080	0.426	0.016	0.065	0.280
1945-1947	External	0.002	0.003	0.009	0.002	0.003	0.009
1945-1947	Inhalation	0.047	0.117	0.435	0.038	0.090	0.361
1945-1947	Milk from BYCow Regime 3	0.112	0.618	4.711	0.008	0.041	0.289
1945-1947	Milk from BYCow Regime 4	0.012	0.125	1.510	0.001	0.008	0.129
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	1.318	4.083	16.465	0.976	2.791	11.932

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Adams County Census Division 05

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.008	0.001	0.002	0.007
1945	Inhalation	0.022	0.077	0.361	0.019	0.060	0.249
1945	Milk from BYCow Regime 3	0.055	0.435	4.135	0.003	0.029	0.263
1945	Milk from BYCow Regime 4	0.003	0.087	1.319	0.000	0.006	0.087
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.847	3.271	16.307	0.605	2.345	11.214
1946	External	0.000	0.000	0.003	0.000	0.000	0.002
1946	Inhalation	0.005	0.016	0.069	0.004	0.013	0.060
1946	Milk from BYCow Regime 3	0.006	0.061	0.541	0.001	0.004	0.044
1946	Milk from BYCow Regime 4	0.000	0.008	0.277	0.000	0.001	0.011
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.122	0.483	2.340	0.089	0.344	1.743
1947	External	0.000	0.000	0.000	0.000	0.000	0.001
1947	Inhalation	0.001	0.005	0.020	0.001	0.004	0.016
1947	Milk from BYCow Regime 3	0.002	0.014	0.171	0.000	0.001	0.010
1947	Milk from BYCow Regime 4	0.000	0.003	0.062	0.000	0.000	0.007
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.020	0.081	0.445	0.017	0.069	0.378
1945-1947	External	0.001	0.003	0.009	0.001	0.003	0.010
1945-1947	Inhalation	0.044	0.107	0.397	0.035	0.084	0.313
1945-1947	Milk from BYCow Regime 3	0.116	0.595	3.809	0.009	0.041	0.325
1945-1947	Milk from BYCow Regime 4	0.015	0.134	1.543	0.001	0.009	0.090
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	1.467	4.388	17.541	1.096	3.147	12.623

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Adams County Census Division 06 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.008	0.001	0.002	0.007
1945	Inhalation	0.019	0.065	0.909	0.017	0.053	0.485
1945	Milk from BYCow Regime 3	0.046	0.378	2.715	0.003	0.024	0.259
1945	Milk from BYCow Regime 4	0.003	0.067	1.414	0.000	0.004	0.120
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.682	2.492	10.393	0.481	1.839	9.242
1946	External	0.000	0.000	0.006	0.000	0.000	0.006
1946	Inhalation	0.004	0.014	0.380	0.004	0.011	0.176
1946	Milk from BYCow Regime 3	0.006	0.043	0.363	0.000	0.003	0.023
1946	Milk from BYCow Regime 4	0.000	0.009	0.079	0.000	0.001	0.014
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.089	0.349	1.709	0.067	0.268	1.228
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.001	0.004	0.039	0.001	0.003	0.030
1947	Milk from BYCow Regime 3	0.001	0.010	0.105	0.000	0.001	0.011
1947	Milk from BYCow Regime 4	0.000	0.003	0.061	0.000	0.000	0.003
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.016	0.069	0.315	0.014	0.056	0.255
1945-1947	External	0.001	0.003	0.020	0.001	0.003	0.022
1945-1947	Inhalation	0.038	0.106	1.669	0.029	0.079	1.239
1945-1947	Milk from BYCow Regime 3	0.098	0.498	3.113	0.007	0.037	0.208
1945-1947	Milk from BYCow Regime 4	0.013	0.114	1.386	0.001	0.008	0.140
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	1.140	3.237	11.544	0.801	2.351	9.728

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Adams County Census Division 07

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.006	0.001	0.001	0.006
1945	Inhalation	0.017	0.057	0.301	0.014	0.045	0.210
1945	Milk from BYCow Regime 3	0.042	0.363	2.967	0.003	0.034	0.295
1945	Milk from BYCow Regime 4	0.001	0.056	1.093	0.000	0.004	0.113
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.568	2.284	11.073	0.474	1.752	8.828
1946	External	0.000	0.000	0.002	0.000	0.000	0.003
1946	Inhalation	0.004	0.013	0.087	0.003	0.009	0.077
1946	Milk from BYCow Regime 3	0.006	0.040	0.369	0.000	0.005	0.030
1946	Milk from BYCow Regime 4	0.000	0.007	0.139	0.000	0.001	0.017
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.083	0.324	1.671	0.065	0.264	1.300
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.001	0.004	0.045	0.001	0.003	0.037
1947	Milk from BYCow Regime 3	0.001	0.009	0.103	0.000	0.001	0.007
1947	Milk from BYCow Regime 4	0.000	0.002	0.076	0.000	0.000	0.004
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.014	0.058	0.311	0.012	0.047	0.220
1945-1947	External	0.001	0.002	0.010	0.001	0.002	0.011
1945-1947	Inhalation	0.033	0.086	0.479	0.028	0.070	0.450
1945-1947	Milk from BYCow Regime 3	0.108	0.495	3.408	0.008	0.046	0.328
1945-1947	Milk from BYCow Regime 4	0.010	0.101	1.259	0.001	0.007	0.107
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	1.019	2.933	11.638	0.773	2.312	9.886

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Adams County Census Division 08 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.009	0.001	0.002	0.007
1945	Inhalation	0.026	0.080	0.334	0.021	0.062	0.222
1945	Milk from BYCow Regime 3	0.051	0.531	4.599	0.004	0.042	0.360
1945	Milk from BYCow Regime 4	0.002	0.065	1.280	0.000	0.004	0.124
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	0.877	3.521	16.646	0.694	2.618	12.736
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.006	0.017	0.079	0.005	0.013	0.051
1946	Milk from BYCow Regime 3	0.008	0.075	0.582	0.001	0.005	0.076
1946	Milk from BYCow Regime 4	0.001	0.016	0.360	0.000	0.001	0.034
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.130	0.509	2.412	0.096	0.379	1.830
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.002	0.005	0.024	0.001	0.004	0.017
1947	Milk from BYCow Regime 3	0.002	0.014	0.118	0.000	0.001	0.014
1947	Milk from BYCow Regime 4	0.000	0.004	0.039	0.000	0.000	0.011
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.023	0.091	0.430	0.019	0.072	0.323
1945-1947	External	0.002	0.003	0.010	0.002	0.003	0.009
1945-1947	Inhalation	0.048	0.114	0.400	0.040	0.088	0.254
1945-1947	Milk from BYCow Regime 3	0.121	0.686	5.993	0.012	0.056	0.374
1945-1947	Milk from BYCow Regime 4	0.016	0.145	1.761	0.002	0.012	0.160
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	1.511	4.441	18.424	1.214	3.313	13.689

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Adams County Census Division 09

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.013	0.002	0.004	0.013
1945	Inhalation	0.048	0.153	0.627	0.041	0.115	0.404
1945	Milk from BYCow Regime 3	0.108	1.131	8.098	0.007	0.069	0.589
1945	Milk from BYCow Regime 4	0.003	0.130	3.143	0.000	0.012	0.188
1945	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945	Fruit and Vegetables*	1.691	6.302	28.201	1.263	4.993	26.944
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.011	0.031	0.124	0.009	0.025	0.078
1946	Milk from BYCow Regime 3	0.014	0.107	1.200	0.001	0.009	0.086
1946	Milk from BYCow Regime 4	0.001	0.019	0.391	0.000	0.001	0.025
1946	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.214	0.853	4.349	0.171	0.653	2.879
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.008	0.034	0.002	0.007	0.025
1947	Milk from BYCow Regime 3	0.003	0.028	0.193	0.000	0.002	0.024
1947	Milk from BYCow Regime 4	0.000	0.008	0.220	0.000	0.001	0.019
1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.043	0.171	0.798	0.034	0.133	0.734
1945-1947	External	0.003	0.006	0.014	0.003	0.006	0.014
1945-1947	Inhalation	0.087	0.210	0.715	0.072	0.160	0.462
1945-1947	Milk from BYCow Regime 3	0.259	1.357	8.473	0.019	0.104	0.683
1945-1947	Milk from BYCow Regime 4	0.025	0.273	2.629	0.002	0.020	0.201
1945-1947	Commercial Milk (Rural)	0.000	0.000	0.000	0.000	0.000	0.000
1945-1947	Fruit and Vegetables*	2.793	8.182	30.641	2.078	6.234	28.223

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Adams County Census Division 10 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.003	0.007	0.031	0.003	0.007	0.033
1945	Inhalation	0.076	0.246	1.420	0.066	0.201	0.992
1945	Milk from BYCow Regime 3	0.147	1.459	15.088	0.013	0.113	1.046
1945	Milk from BYCow Regime 4	0.007	0.182	2.832	0.001	0.019	0.465
1945	Commercial Milk (Rural)	0.304	1.932	18.166	0.024	0.183	2.096
1945	Fruit and Vegetables*	2.644	10.695	48.307	2.035	7.538	38.742
1946	External	0.001	0.002	0.007	0.001	0.002	0.007
1946	Inhalation	0.018	0.055	0.292	0.015	0.044	0.171
1946	Milk from BYCow Regime 3	0.019	0.158	2.457	0.001	0.013	0.126
1946	Milk from BYCow Regime 4	0.001	0.027	0.554	0.000	0.002	0.039
1946	Commercial Milk (Rural)	0.060	0.365	3.131	0.004	0.025	0.218
1946	Fruit and Vegetables*	0.330	1.424	7.152	0.255	1.023	5.262
1947	External	0.000	0.001	0.002	0.000	0.001	0.002
1947	Inhalation	0.005	0.016	0.073	0.004	0.012	0.049
1947	Milk from BYCow Regime 3	0.004	0.037	0.347	0.000	0.003	0.037
1947	Milk from BYCow Regime 4	0.000	0.012	0.225	0.000	0.001	0.017
1947	Commercial Milk (Rural)	0.016	0.151	2.024	0.001	0.011	0.122
1947	Fruit and Vegetables*	0.061	0.252	1.249	0.052	0.203	0.988
1945-1947	External	0.005	0.010	0.033	0.005	0.011	0.042
1945-1947	Inhalation	0.150	0.367	1.775	0.121	0.285	1.359
1945-1947	Milk from BYCow Regime 3	0.413	2.063	16.663	0.030	0.150	1.060
1945-1947	Milk from BYCow Regime 4	0.043	0.357	3.840	0.004	0.034	0.527
1945-1947	Commercial Milk (Rural)	0.781	3.202	20.397	0.061	0.255	2.644
1945-1947	Fruit and Vegetables*	4.371	13.406	51.376	3.314	9.742	42.054

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Benton County Census Division 01

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.008	0.020	0.061	0.008	0.020	0.064
1945	Inhalation	0.176	0.575	2.879	0.153	0.483	2.062
1945	Milk from BYCow Regime 1	15.754	103.117	680.336	1.159	7.091	58.231
1945	Milk from BYCow Regime 2	13.506	84.308	543.274	1.019	8.109	63.145
1945	Milk from BYCow Regime 3	0.242	2.566	29.954	0.031	0.224	1.401
1945	Milk from BYCow Regime 4	0.038	0.463	9.705	0.009	0.084	1.114
1945	Commercial Milk (Rural)	22.267	111.559	404.105	1.607	8.090	29.233
1945	Fruit and Vegetables*	6.075	26.054	113.725	4.314	16.713	76.452
1946	External	0.002	0.005	0.014	0.002	0.005	0.014
1946	Inhalation	0.048	0.142	0.564	0.039	0.117	0.453
1946	Milk from BYCow Regime 1	2.434	12.841	63.721	0.155	1.053	6.400
1946	Milk from BYCow Regime 2	2.186	13.127	77.639	0.147	1.017	8.203
1946	Milk from BYCow Regime 3	0.042	0.346	3.264	0.005	0.038	0.321
1946	Milk from BYCow Regime 4	0.007	0.077	2.490	0.001	0.010	0.085
1946	Commercial Milk (Rural)	3.492	14.095	56.267	0.264	1.179	5.984
1946	Fruit and Vegetables*	0.844	3.809	20.784	0.651	2.333	11.573
1947	External	0.001	0.001	0.004	0.001	0.002	0.005
1947	Inhalation	0.013	0.042	0.203	0.011	0.034	0.156
1947	Milk from BYCow Regime 1	0.612	3.769	23.360	0.045	0.335	1.858
1947	Milk from BYCow Regime 2	0.731	3.928	22.779	0.042	0.248	1.768
1947	Milk from BYCow Regime 3	0.015	0.122	1.686	0.002	0.011	0.119
1947	Milk from BYCow Regime 4	0.001	0.021	0.462	0.000	0.003	0.031
1947	Commercial Milk (Rural)	0.922	3.717	18.114	0.078	0.360	1.083
1947	Fruit and Vegetables*	0.155	0.615	3.186	0.125	0.460	2.524
1945-1947	External	0.014	0.028	0.075	0.014	0.028	0.070
1945-1947	Inhalation	0.353	0.874	3.248	0.302	0.690	2.373
1945-1947	Milk from BYCow Regime 1	34.298	129.080	686.048	2.593	9.864	66.659
1945-1947	Milk from BYCow Regime 2	30.082	120.983	582.833	2.385	11.045	65.364
1945-1947	Milk from BYCow Regime 3	0.809	4.085	33.200	0.080	0.308	1.722
1945-1947	Milk from BYCow Regime 4	0.125	0.922	8.570	0.026	0.121	1.156
1945-1947	Commercial Milk (Rural)	39.607	134.590	408.022	2.915	9.836	32.936
1945-1947	Fruit and Vegetables*	10.938	34.556	130.957	7.714	21.680	88.812

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Benton County Census Division 03 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.013	0.031	0.088	0.014	0.030	0.082
1945	Inhalation	0.339	0.961	3.633	0.281	0.757	2.561
1945	Milk from BYCow Regime 1	24.844	155.935	673.061	2.147	13.903	66.469
1945	Milk from BYCow Regime 2	23.609	142.973	728.004	2.046	11.869	68.538
1945	Milk from BYCow Regime 3	0.324	3.675	44.586	0.047	0.402	3.842
1945	Milk from BYCow Regime 4	0.040	0.620	18.188	0.012	0.106	1.421
1945	Commercial Milk (Rural)	34.816	164.178	635.036	2.467	12.169	43.033
1945	Commercial Milk (Urban)	57.488	197.874	784.783	2.504	11.096	43.829
1945	Fruit and Vegetables*	9.362	37.595	178.622	7.110	25.507	107.973
1946	External	0.004	0.008	0.018	0.004	0.008	0.017
1946	Inhalation	0.089	0.243	0.878	0.078	0.191	0.620
1946	Milk from BYCow Regime 1	4.235	22.610	138.124	0.382	1.824	9.589
1946	Milk from BYCow Regime 2	3.328	23.280	153.316	0.265	2.077	12.161
1946	Milk from BYCow Regime 3	0.082	0.655	5.892	0.009	0.060	0.656
1946	Milk from BYCow Regime 4	0.008	0.128	1.898	0.002	0.017	0.181
1946	Commercial Milk (Rural)	5.360	23.079	77.478	0.508	2.102	8.772
1946	Commercial Milk (Urban)	7.517	30.543	113.219	0.354	1.636	7.847
1946	Fruit and Vegetables*	1.374	5.448	24.817	1.006	3.565	15.161
1947	External	0.001	0.002	0.006	0.001	0.002	0.007
1947	Inhalation	0.024	0.073	0.311	0.021	0.058	0.230
1947	Milk from BYCow Regime 1	1.164	6.961	36.487	0.109	0.541	3.063
1947	Milk from BYCow Regime 2	1.243	5.800	29.880	0.102	0.527	3.020
1947	Milk from BYCow Regime 3	0.023	0.203	2.071	0.002	0.014	0.115
1947	Milk from BYCow Regime 4	0.002	0.034	0.463	0.000	0.004	0.056
1947	Commercial Milk (Rural)	1.110	3.757	14.305	0.088	0.357	1.293
1947	Commercial Milk (Urban)	1.246	4.932	19.199	0.071	0.284	1.232
1947	Fruit and Vegetables*	0.240	0.910	4.248	0.181	0.683	3.664
1945-1947	External	0.023	0.043	0.101	0.023	0.043	0.095
1945-1947	Inhalation	0.651	1.447	4.343	0.516	1.096	3.090
1945-1947	Milk from BYCow Regime 1	61.070	209.050	762.789	4.315	16.782	74.443
1945-1947	Milk from BYCow Regime 2	51.399	198.004	871.563	4.667	17.986	71.910
1945-1947	Milk from BYCow Regime 3	1.203	6.602	46.031	0.123	0.581	4.047
1945-1947	Milk from BYCow Regime 4	0.179	1.155	16.402	0.033	0.164	1.314
1945-1947	Commercial Milk (Rural)	58.645	205.878	671.565	4.948	16.378	49.524
1945-1947	Commercial Milk (Urban)	93.894	258.026	951.247	4.416	14.354	50.263
1945-1947	Fruit and Vegetables*	15.761	48.403	189.696	11.516	31.629	114.674

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Benton County Census Division 04

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.010	0.022	0.064	0.010	0.021	0.064
1945	Inhalation	0.235	0.689	2.475	0.203	0.530	1.788
1945	Milk from BYCow Regime 1	23.622	118.840	674.846	1.655	10.404	75.012
1945	Milk from BYCow Regime 2	15.793	107.019	879.343	1.165	8.039	44.703
1945	Milk from BYCow Regime 3	0.295	3.346	32.937	0.043	0.323	2.690
1945	Milk from BYCow Regime 4	0.052	0.644	10.428	0.010	0.093	0.697
1945	Commercial Milk (Rural)	40.113	163.258	789.131	2.696	12.644	42.393
1945	Fruit and Vegetables*	7.388	28.204	156.356	5.504	19.778	92.052
1946	External	0.003	0.005	0.013	0.003	0.005	0.012
1946	Inhalation	0.063	0.171	0.554	0.055	0.134	0.425
1946	Milk from BYCow Regime 1	2.901	18.733	113.505	0.301	1.558	9.512
1946	Milk from BYCow Regime 2	2.589	18.615	110.582	0.213	1.248	8.376
1946	Milk from BYCow Regime 3	0.071	0.481	3.869	0.006	0.038	0.342
1946	Milk from BYCow Regime 4	0.006	0.073	1.933	0.002	0.015	0.134
1946	Commercial Milk (Rural)	5.448	23.795	102.257	0.455	2.139	7.712
1946	Fruit and Vegetables*	1.029	4.185	21.420	0.734	2.705	12.630
1947	External	0.001	0.002	0.004	0.001	0.002	0.004
1947	Inhalation	0.018	0.052	0.199	0.014	0.040	0.151
1947	Milk from BYCow Regime 1	1.217	5.960	30.861	0.060	0.381	2.563
1947	Milk from BYCow Regime 2	0.975	5.149	31.163	0.065	0.433	2.606
1947	Milk from BYCow Regime 3	0.020	0.167	1.382	0.002	0.016	0.187
1947	Milk from BYCow Regime 4	0.002	0.027	0.572	0.001	0.004	0.030
1947	Commercial Milk (Rural)	1.584	7.632	26.798	0.131	0.522	2.178
1947	Fruit and Vegetables*	0.182	0.751	3.571	0.141	0.525	2.306
1945-1947	External	0.017	0.031	0.073	0.017	0.029	0.073
1945-1947	Inhalation	0.446	0.992	2.852	0.372	0.762	2.054
1945-1947	Milk from BYCow Regime 1	47.261	160.407	744.781	3.113	12.769	67.653
1945-1947	Milk from BYCow Regime 2	39.700	155.017	818.839	3.079	11.781	52.725
1945-1947	Milk from BYCow Regime 3	1.023	5.012	41.012	0.100	0.458	2.651
1945-1947	Milk from BYCow Regime 4	0.157	1.257	13.523	0.031	0.139	0.949
1945-1947	Commercial Milk (Rural)	72.826	206.692	763.043	5.689	17.402	50.394
1945-1947	Fruit and Vegetables*	12.677	36.859	158.245	9.029	25.381	104.336

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Benton County Census Division 05

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.008	0.069	0.002	0.008	0.073
1945	Inhalation	0.049	0.219	2.764	0.039	0.160	2.429
1945	Milk from BYCow Regime 1	4.453	34.044	216.915	0.431	2.622	21.662
1945	Milk from BYCow Regime 2	4.425	30.925	252.496	0.426	2.764	18.609
1945	Milk from BYCow Regime 3	0.107	0.962	12.458	0.010	0.091	0.933
1945	Milk from BYCow Regime 4	0.018	0.337	7.724	0.003	0.036	0.429
1945	Commercial Milk (Rural)	3.629	24.064	174.369	0.288	2.041	11.176
1945	Fruit and Vegetables*	2.062	9.760	69.625	1.678	6.715	36.701
1946	External	0.001	0.002	0.015	0.001	0.002	0.015
1946	Inhalation	0.012	0.049	0.453	0.010	0.039	0.335
1946	Milk from BYCow Regime 1	0.622	4.330	37.128	0.072	0.512	3.484
1946	Milk from BYCow Regime 2	0.771	5.933	38.881	0.045	0.337	2.561
1946	Milk from BYCow Regime 3	0.013	0.131	1.253	0.002	0.013	0.095
1946	Milk from BYCow Regime 4	0.002	0.043	0.837	0.000	0.005	0.086
1946	Commercial Milk (Rural)	0.617	3.812	27.947	0.042	0.280	1.813
1946	Fruit and Vegetables*	0.298	1.277	6.736	0.239	0.946	4.497
1947	External	0.000	0.001	0.004	0.000	0.001	0.004
1947	Inhalation	0.003	0.014	0.138	0.003	0.012	0.128
1947	Milk from BYCow Regime 1	0.213	1.437	8.879	0.013	0.102	0.656
1947	Milk from BYCow Regime 2	0.232	1.444	9.383	0.014	0.092	0.711
1947	Milk from BYCow Regime 3	0.004	0.049	0.672	0.000	0.004	0.038
1947	Milk from BYCow Regime 4	0.000	0.007	0.191	0.000	0.001	0.015
1947	Commercial Milk (Rural)	0.170	1.048	5.913	0.012	0.080	0.609
1947	Fruit and Vegetables*	0.056	0.249	1.442	0.043	0.184	1.071
1945-1947	External	0.005	0.012	0.084	0.005	0.012	0.094
1945-1947	Inhalation	0.111	0.367	3.500	0.088	0.277	3.774
1945-1947	Milk from BYCow Regime 1	11.337	48.974	261.390	0.902	3.565	26.247
1945-1947	Milk from BYCow Regime 2	11.019	45.306	312.118	0.841	3.528	17.465
1945-1947	Milk from BYCow Regime 3	0.252	1.425	11.867	0.029	0.129	1.053
1945-1947	Milk from BYCow Regime 4	0.062	0.551	6.049	0.009	0.055	0.541
1945-1947	Commercial Milk (Rural)	8.969	35.999	177.290	0.669	2.946	11.309
1945-1947	Fruit and Vegetables*	3.890	12.554	70.261	2.877	8.556	39.053

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Benton County Census Division 06

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.004	0.027	0.001	0.004	0.019
1945	Inhalation	0.024	0.102	0.871	0.020	0.079	0.890
1945	Milk from BYCow Regime 1	3.233	21.456	144.883	0.170	1.413	8.516
1945	Milk from BYCow Regime 2	3.009	20.621	137.078	0.213	1.575	11.451
1945	Milk from BYCow Regime 3	0.056	0.526	7.256	0.007	0.056	0.529
1945	Milk from BYCow Regime 4	0.015	0.179	3.082	0.003	0.031	0.470
1945	Commercial Milk (Rural)	3.480	29.072	192.386	0.263	1.968	15.150
1945	Commercial Milk (Urban)	6.871	35.292	242.167	0.382	1.894	9.648
1945	Fruit and Vegetables*	1.208	5.482	33.012	0.940	3.703	17.112
1946	External	0.000	0.001	0.005	0.000	0.001	0.005
1946	Inhalation	0.005	0.023	0.357	0.005	0.018	0.261
1946	Milk from BYCow Regime 1	0.546	3.460	28.656	0.037	0.248	1.719
1946	Milk from BYCow Regime 2	0.374	2.635	29.077	0.028	0.208	1.827
1946	Milk from BYCow Regime 3	0.009	0.097	0.774	0.001	0.009	0.105
1946	Milk from BYCow Regime 4	0.001	0.024	0.455	0.000	0.003	0.041
1946	Commercial Milk (Rural)	0.543	3.680	21.787	0.041	0.281	2.085
1946	Commercial Milk (Urban)	0.888	3.811	20.539	0.051	0.232	1.173
1946	Fruit and Vegetables*	0.169	0.828	5.241	0.134	0.519	2.439
1947	External	0.000	0.000	0.002	0.000	0.000	0.002
1947	Inhalation	0.002	0.007	0.088	0.001	0.006	0.047
1947	Milk from BYCow Regime 1	0.137	0.870	7.242	0.009	0.058	0.383
1947	Milk from BYCow Regime 2	0.103	0.662	3.615	0.010	0.068	0.429
1947	Milk from BYCow Regime 3	0.003	0.027	0.272	0.000	0.003	0.028
1947	Milk from BYCow Regime 4	0.000	0.005	0.125	0.000	0.001	0.006
1947	Commercial Milk (Rural)	0.181	1.014	5.556	0.014	0.076	0.395
1947	Commercial Milk (Urban)	0.309	1.177	5.585	0.012	0.060	0.293
1947	Fruit and Vegetables*	0.029	0.136	0.754	0.027	0.104	0.595
1945-1947	External	0.002	0.006	0.037	0.002	0.006	0.025
1945-1947	Inhalation	0.052	0.171	1.627	0.043	0.135	1.408
1945-1947	Milk from BYCow Regime 1	8.392	33.246	154.022	0.506	2.020	10.071
1945-1947	Milk from BYCow Regime 2	7.149	29.403	143.653	0.492	2.388	11.891
1945-1947	Milk from BYCow Regime 3	0.172	0.842	5.923	0.019	0.084	0.552
1945-1947	Milk from BYCow Regime 4	0.037	0.296	3.138	0.007	0.043	0.428
1945-1947	Commercial Milk (Rural)	8.888	36.856	203.842	0.629	2.711	17.017
1945-1947	Commercial Milk (Urban)	13.704	44.302	214.933	0.707	2.573	9.925
1945-1947	Fruit and Vegetables*	2.246	7.419	36.907	1.628	4.888	19.913

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Benton County Census Division 07 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.023	0.050	0.140	0.023	0.050	0.130
1945	Inhalation	0.586	1.746	6.506	0.485	1.350	4.606
1945	Milk from BYCow Regime 1	45.343	249.192	1534.472	3.705	21.827	121.847
1945	Milk from BYCow Regime 2	42.776	279.042	1541.111	3.029	20.153	123.607
1945	Milk from BYCow Regime 3	0.471	6.062	43.702	0.047	0.481	6.309
1945	Milk from BYCow Regime 4	0.046	1.375	29.080	0.005	0.110	2.216
1945	Commercial Milk (Rural)	3.091	18.571	144.203	0.244	1.449	12.883
1945	Commercial Milk (Urban)	4.234	25.530	214.052	0.221	1.327	9.877
1945	Fruit and Vegetables*	16.345	66.668	271.969	12.191	44.116	189.410
1946	External	0.006	0.013	0.029	0.006	0.013	0.030
1946	Inhalation	0.149	0.407	1.472	0.123	0.320	0.971
1946	Milk from BYCow Regime 1	9.572	45.894	249.715	0.641	3.646	22.179
1946	Milk from BYCow Regime 2	7.522	40.327	258.398	0.477	3.211	16.929
1946	Milk from BYCow Regime 3	0.125	1.300	9.963	0.009	0.086	0.863
1946	Milk from BYCow Regime 4	0.003	0.131	2.649	0.001	0.014	0.251
1946	Commercial Milk (Rural)	0.378	2.675	20.518	0.040	0.224	1.445
1946	Commercial Milk (Urban)	0.467	3.116	23.933	0.030	0.188	1.269
1946	Fruit and Vegetables*	2.297	9.249	45.558	1.846	6.722	29.014
1947	External	0.002	0.004	0.011	0.002	0.004	0.010
1947	Inhalation	0.041	0.128	0.501	0.033	0.095	0.357
1947	Milk from BYCow Regime 1	2.232	12.110	53.403	0.152	0.809	4.731
1947	Milk from BYCow Regime 2	2.161	11.258	83.979	0.187	0.917	5.707
1947	Milk from BYCow Regime 3	0.034	0.336	2.830	0.002	0.028	0.440
1947	Milk from BYCow Regime 4	0.002	0.037	1.432	0.000	0.004	0.087
1947	Commercial Milk (Rural)	0.094	0.623	3.999	0.010	0.061	0.333
1947	Commercial Milk (Urban)	0.162	0.952	6.634	0.006	0.044	0.308
1947	Fruit and Vegetables*	0.401	1.535	6.524	0.309	1.166	6.057
1945-1947	External	0.039	0.071	0.162	0.040	0.072	0.160
1945-1947	Inhalation	1.100	2.446	7.196	0.925	1.918	5.678
1945-1947	Milk from BYCow Regime 1	104.553	351.325	1644.674	7.640	32.213	119.260
1945-1947	Milk from BYCow Regime 2	102.946	394.415	1736.697	8.035	27.229	118.270
1945-1947	Milk from BYCow Regime 3	1.700	9.381	53.725	0.147	0.890	6.395
1945-1947	Milk from BYCow Regime 4	0.235	2.093	29.064	0.020	0.165	2.711
1945-1947	Commercial Milk (Rural)	6.661	27.837	153.569	0.489	1.933	11.035
1945-1947	Commercial Milk (Urban)	8.832	34.978	207.718	0.505	1.829	9.811
1945-1947	Fruit and Vegetables*	28.255	87.078	291.353	20.751	59.809	208.838

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Benton County Census Division 08

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.008	0.056	0.002	0.007	0.051
1945	Inhalation	0.041	0.199	2.349	0.036	0.155	1.703
1945	Milk from BYCow Regime 1	4.953	29.450	267.620	0.359	2.494	24.562
1945	Milk from BYCow Regime 2	3.500	35.725	247.072	0.302	2.145	17.678
1945	Milk from BYCow Regime 3	0.086	0.821	7.350	0.018	0.106	1.150
1945	Milk from BYCow Regime 4	0.021	0.204	2.508	0.006	0.046	0.352
1945	Commercial Milk (Rural)	27.700	113.484	425.294	2.356	8.927	33.606
1945	Fruit and Vegetables*	1.743	8.936	63.115	1.353	6.007	42.032
1946	External	0.001	0.002	0.039	0.001	0.002	0.040
1946	Inhalation	0.010	0.052	0.881	0.008	0.041	0.853
1946	Milk from BYCow Regime 1	0.664	4.556	38.117	0.053	0.363	3.100
1946	Milk from BYCow Regime 2	0.645	4.697	30.920	0.040	0.340	4.053
1946	Milk from BYCow Regime 3	0.018	0.102	1.566	0.003	0.016	0.101
1946	Milk from BYCow Regime 4	0.002	0.023	0.330	0.001	0.006	0.047
1946	Commercial Milk (Rural)	3.498	15.798	58.670	0.281	1.261	5.352
1946	Fruit and Vegetables*	0.239	1.201	8.921	0.202	0.848	6.341
1947	External	0.000	0.001	0.009	0.000	0.001	0.009
1947	Inhalation	0.003	0.014	0.345	0.002	0.011	0.260
1947	Milk from BYCow Regime 1	0.205	1.416	14.924	0.015	0.103	0.687
1947	Milk from BYCow Regime 2	0.222	1.613	11.422	0.016	0.101	0.757
1947	Milk from BYCow Regime 3	0.005	0.043	0.435	0.001	0.005	0.041
1947	Milk from BYCow Regime 4	0.001	0.008	0.216	0.000	0.002	0.018
1947	Commercial Milk (Rural)	1.010	3.964	14.307	0.098	0.386	1.456
1947	Fruit and Vegetables*	0.047	0.235	1.614	0.037	0.158	0.840
1945-1947	External	0.005	0.014	0.121	0.005	0.014	0.104
1945-1947	Inhalation	0.104	0.385	4.219	0.083	0.290	3.339
1945-1947	Milk from BYCow Regime 1	9.702	44.688	272.649	0.860	3.716	28.949
1945-1947	Milk from BYCow Regime 2	10.438	49.242	309.909	0.722	3.549	23.983
1945-1947	Milk from BYCow Regime 3	0.257	1.208	8.074	0.039	0.151	1.062
1945-1947	Milk from BYCow Regime 4	0.050	0.313	3.484	0.015	0.068	0.488
1945-1947	Commercial Milk (Rural)	47.322	151.999	448.543	3.411	12.017	38.380
1945-1947	Fruit and Vegetables*	3.378	11.838	70.449	2.372	7.859	41.852

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources.

---------- Benton County Census Division 09 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.011	0.026	0.074	0.011	0.027	0.078
1945	Inhalation	0.250	0.767	3.051	0.216	0.613	2.065
1945	Milk from BYCow Regime 1	23.050	135.586	764.820	1.783	10.459	66.468
1945	Milk from BYCow Regime 2	16.875	117.308	897.344	1.669	11.040	64.134
1945	Milk from BYCow Regime 3	0.388	3.769	44.207	0.040	0.311	4.799
1945	Milk from BYCow Regime 4	0.032	0.475	8.816	0.009	0.096	1.597
1945	Commercial Milk (Rural)	24.314	105.245	353.268	1.835	8.421	27.601
1945	Fruit and Vegetables*	8.176	31.164	145.561	6.064	20.958	108.301
1946	External	0.003	0.007	0.018	0.003	0.007	0.017
1946	Inhalation	0.070	0.206	0.769	0.057	0.156	0.571
1946	Milk from BYCow Regime 1	3.398	19.124	86.741	0.249	1.538	10.852
1946	Milk from BYCow Regime 2	2.509	15.652	91.264	0.228	1.222	6.401
1946	Milk from BYCow Regime 3	0.069	0.587	3.633	0.009	0.060	0.389
1946	Milk from BYCow Regime 4	0.004	0.072	1.637	0.001	0.008	0.144
1946	Commercial Milk (Rural)	3.390	13.980	65.364	0.296	1.164	5.126
1946	Fruit and Vegetables*	1.054	4.318	24.687	0.779	2.868	13.745
1947	External	0.001	0.002	0.006	0.001	0.002	0.006
1947	Inhalation	0.019	0.062	0.275	0.016	0.048	0.224
1947	Milk from BYCow Regime 1	0.866	5.497	30.918	0.073	0.425	2.583
1947	Milk from BYCow Regime 2	1.154	5.888	26.838	0.076	0.463	3.005
1947	Milk from BYCow Regime 3	0.021	0.183	2.347	0.002	0.013	0.114
1947	Milk from BYCow Regime 4	0.002	0.021	0.393	0.000	0.003	0.025
1947	Commercial Milk (Rural)	0.976	3.779	16.494	0.082	0.311	1.271
1947	Fruit and Vegetables*	0.195	0.791	4.182	0.153	0.599	2.945
1945-1947	External	0.020	0.037	0.088	0.020	0.037	0.088
1945-1947	Inhalation	0.520	1.172	3.680	0.430	0.921	2.400
1945-1947	Milk from BYCow Regime 1	52.895	177.231	799.446	3.908	14.764	74.948
1945-1947	Milk from BYCow Regime 2	39.879	155.621	855.390	3.516	13.922	65.614
1945-1947	Milk from BYCow Regime 3	1.047	5.575	46.314	0.102	0.504	5.658
1945-1947	Milk from BYCow Regime 4	0.125	0.932	10.642	0.024	0.133	1.780
1945-1947	Commercial Milk (Rural)	44.487	128.426	402.016	3.339	9.970	29.298
1945-1947	Fruit and Vegetables*	13.694	41.529	165.356	9.552	27.762	113.728

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Franklin County Census Division 01

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.007	0.017	0.065	0.007	0.018	0.077
1945	Inhalation	0.173	0.609	2.690	0.153	0.469	2.168
1945	Milk from BYCow Regime 1	23.853	128.773	839.428	1.381	8.588	60.387
1945	Milk from BYCow Regime 2	20.105	135.794	1345.038	1.515	9.753	64.399
1945	Milk from BYCow Regime 3	0.253	2.624	26.866	0.044	0.370	4.563
1945	Milk from BYCow Regime 4	0.037	0.610	15.987	0.010	0.081	1.450
1945	Commercial Milk (Rural)	33.650	143.702	614.072	2.196	10.246	37.712
1945	Fruit and Vegetables*	5.945	26.154	156.054	4.748	19.380	95.810
1946	External	0.002	0.004	0.012	0.002	0.004	0.013
1946	Inhalation	0.040	0.131	0.546	0.034	0.105	0.432
1946	Milk from BYCow Regime 1	2.883	19.866	113.619	0.216	1.305	9.891
1946	Milk from BYCow Regime 2	3.019	15.965	105.023	0.256	1.628	10.064
1946	Milk from BYCow Regime 3	0.097	0.811	8.992	0.006	0.050	0.627
1946	Milk from BYCow Regime 4	0.006	0.107	2.885	0.001	0.014	0.130
1946	Commercial Milk (Rural)	4.946	19.389	79.231	0.388	2.000	7.946
1946	Fruit and Vegetables*	0.843	3.727	18.550	0.632	2.720	14.891
1947	External	0.000	0.001	0.004	0.000	0.001	0.004
1947	Inhalation	0.011	0.036	0.149	0.009	0.030	0.136
1947	Milk from BYCow Regime 1	1.097	5.995	46.817	0.065	0.499	3.854
1947	Milk from BYCow Regime 2	0.804	5.407	42.348	0.086	0.463	3.055
1947	Milk from BYCow Regime 3	0.014	0.156	1.626	0.002	0.020	0.198
1947	Milk from BYCow Regime 4	0.001	0.024	0.687	0.000	0.004	0.043
1947	Commercial Milk (Rural)	0.986	3.878	16.794	0.077	0.306	1.428
1947	Fruit and Vegetables*	0.146	0.587	3.065	0.119	0.513	3.123
1945-1947	External	0.012	0.024	0.068	0.012	0.025	0.081
1945-1947	Inhalation	0.337	0.848	2.922	0.280	0.677	2.463
1945-1947	Milk from BYCow Regime 1	46.362	165.192	876.968	2.856	12.948	64.661
1945-1947	Milk from BYCow Regime 2	45.290	199.758	1273.091	3.503	13.817	75.442
1945-1947	Milk from BYCow Regime 3	1.084	5.792	30.559	0.116	0.563	4.347
1945-1947	Milk from BYCow Regime 4	0.146	1.310	20.443	0.027	0.134	1.562
1945-1947	Commercial Milk (Rural)	58.363	188.820	673.472	4.561	14.016	42.183
1945-1947	Fruit and Vegetables*	11.172	34.620	158.591	8.480	24.522	101.622

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Franklin County Census Division 02 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.004	0.010	0.040	0.004	0.010	0.035
1945	Inhalation	0.093	0.325	1.590	0.081	0.263	1.128
1945	Milk from BYCow Regime 3	0.197	2.026	21.237	0.019	0.222	3.468
1945	Milk from BYCow Regime 4	0.018	0.298	4.923	0.006	0.056	1.057
1945	Commercial Milk (Rural)	9.906	45.510	184.056	0.880	4.115	21.481
1945	Fruit and Vegetables*	3.754	16.422	78.970	2.926	12.080	67.357
1946	External	0.001	0.002	0.007	0.001	0.002	0.008
1946	Inhalation	0.020	0.066	0.324	0.018	0.055	0.222
1946	Milk from BYCow Regime 3	0.037	0.434	3.762	0.004	0.030	0.240
1946	Milk from BYCow Regime 4	0.002	0.038	0.855	0.001	0.006	0.089
1946	Commercial Milk (Rural)	1.626	6.928	28.314	0.133	0.545	2.256
1946	Fruit and Vegetables*	0.531	2.415	13.332	0.440	1.685	8.043
1947	External	0.000	0.001	0.002	0.000	0.001	0.002
1947	Inhalation	0.005	0.020	0.101	0.005	0.015	0.068
1947	Milk from BYCow Regime 3	0.012	0.116	1.313	0.001	0.008	0.099
1947	Milk from BYCow Regime 4	0.001	0.015	0.409	0.000	0.002	0.030
1947	Commercial Milk (Rural)	0.483	1.827	7.229	0.041	0.178	0.568
1947	Fruit and Vegetables*	0.098	0.444	2.761	0.077	0.349	2.072
1945-1947	External	0.006	0.013	0.046	0.007	0.014	0.040
1945-1947	Inhalation	0.178	0.470	1.772	0.144	0.364	1.309
1945-1947	Milk from BYCow Regime 3	0.573	3.382	25.509	0.061	0.352	3.991
1945-1947	Milk from BYCow Regime 4	0.066	0.573	5.979	0.016	0.083	1.232
1945-1947	Commercial Milk (Rural)	20.056	61.141	196.976	1.760	5.129	21.712
1945-1947	Fruit and Vegetables*	6.605	21.450	84.197	4.863	16.009	79.858

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Franklin County Census Division 03

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.015	0.032	0.088	0.015	0.033	0.090
1945	Inhalation	0.374	1.081	4.230	0.301	0.813	2.838
1945	Milk from BYCow Regime 1	39.156	182.593	1217.709	2.423	13.672	62.261
1945	Milk from BYCow Regime 2	27.879	157.105	1124.925	2.338	14.088	76.111
1945	Milk from BYCow Regime 3	0.393	4.255	54.666	0.040	0.393	4.310
1945	Milk from BYCow Regime 4	0.025	0.814	23.656	0.002	0.056	0.950
1945	Commercial Milk (Urban)	56.500	212.253	730.926	2.478	10.254	48.438
1945	Fruit and Vegetables*	12.165	46.837	224.091	8.484	30.558	126.382
1946	External	0.004	0.008	0.020	0.004	0.008	0.020
1946	Inhalation	0.098	0.266	1.034	0.082	0.208	0.584
1946	Milk from BYCow Regime 1	5.512	34.069	229.638	0.399	2.422	16.837
1946	Milk from BYCow Regime 2	4.618	25.165	154.045	0.381	2.132	12.535
1946	Milk from BYCow Regime 3	0.084	0.729	6.330	0.007	0.060	0.503
1946	Milk from BYCow Regime 4	0.002	0.111	2.437	0.000	0.008	0.173
1946	Commercial Milk (Urban)	7.430	28.855	117.648	0.353	1.646	8.554
1946	Fruit and Vegetables*	1.518	5.990	24.728	1.147	4.217	19.557
1947	External	0.001	0.002	0.006	0.001	0.002	0.007
1947	Inhalation	0.026	0.078	0.314	0.021	0.058	0.217
1947	Milk from BYCow Regime 1	1.674	8.572	43.299	0.106	0.634	3.855
1947	Milk from BYCow Regime 2	1.588	8.346	38.561	0.125	0.579	3.443
1947	Milk from BYCow Regime 3	0.028	0.267	3.133	0.003	0.022	0.184
1947	Milk from BYCow Regime 4	0.002	0.039	0.988	0.000	0.004	0.063
1947	Commercial Milk (Rural)	0.657	2.659	12.310	0.051	0.220	0.715
1947	Commercial Milk (Urban)	1.134	4.145	13.744	0.056	0.255	0.837
1947	Fruit and Vegetables*	0.286	1.151	5.948	0.227	0.871	4.283
1945-1947	External	0.026	0.045	0.096	0.026	0.046	0.098
1945-1947	Inhalation	0.727	1.581	5.212	0.562	1.148	3.176
1945-1947	Milk from BYCow Regime 1	77.675	263.617	1277.392	5.805	20.979	67.161
1945-1947	Milk from BYCow Regime 2	65.547	218.268	1347.190	5.392	20.411	87.008
1945-1947	Milk from BYCow Regime 3	1.424	7.440	52.244	0.114	0.588	4.291
1945-1947	Milk from BYCow Regime 4	0.153	1.656	26.942	0.015	0.114	1.215
1945-1947	Commercial Milk (Rural)	0.672	2.660	11.335	0.045	0.219	0.871
1945-1947	Commercial Milk (Urban)	75.320	269.119	811.781	4.757	13.320	48.518
1945-1947	Fruit and Vegetables*	20.272	58.196	226.816	14.039	38.670	135.084

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Franklin County Census Division 04 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.017	0.041	0.124	0.017	0.041	0.124
1945	Inhalation	0.448	1.443	6.205	0.345	1.025	4.133
1945	Milk from BYCow Regime 1	53.667	374.062	2333.612	4.228	24.537	158.372
1945	Milk from BYCow Regime 2	44.880	331.324	2422.336	3.748	25.599	184.824
1945	Milk from BYCow Regime 3	1.022	11.383	96.287	0.065	0.626	5.527
1945	Milk from BYCow Regime 4	0.032	1.245	46.328	0.009	0.123	1.631
1945	Commercial Milk (Rural)	11.220	57.517	271.159	1.019	5.062	24.984
1945	Fruit and Vegetables*	16.127	68.403	376.078	12.065	45.992	225.894
1946	External	0.004	0.009	0.022	0.004	0.009	0.022
1946	Inhalation	0.092	0.281	1.039	0.080	0.222	0.773
1946	Milk from BYCow Regime 1	7.633	47.328	330.601	0.540	3.507	22.859
1946	Milk from BYCow Regime 2	6.614	42.366	263.523	0.447	3.494	24.484
1946	Milk from BYCow Regime 3	0.173	1.643	12.614	0.014	0.127	1.403
1946	Milk from BYCow Regime 4	0.005	0.149	5.372	0.001	0.017	0.361
1946	Commercial Milk (Rural)	1.655	7.502	37.542	0.156	0.702	2.904
1946	Fruit and Vegetables*	2.089	9.310	55.574	1.626	6.717	39.140
1947	External	0.001	0.003	0.008	0.001	0.003	0.007
1947	Inhalation	0.025	0.079	0.364	0.022	0.061	0.236
1947	Milk from BYCow Regime 1	2.184	12.616	77.950	0.149	0.996	6.078
1947	Milk from BYCow Regime 2	2.627	13.387	103.772	0.182	1.208	6.921
1947	Milk from BYCow Regime 3	0.035	0.359	4.146	0.003	0.031	0.368
1947	Milk from BYCow Regime 4	0.003	0.054	1.149	0.001	0.006	0.112
1947	Commercial Milk (Rural)	0.599	2.472	10.913	0.048	0.183	0.638
1947	Fruit and Vegetables*	0.380	1.604	9.495	0.322	1.291	7.443
1945-1947	External	0.029	0.055	0.137	0.028	0.054	0.139
1945-1947	Inhalation	0.809	1.967	6.746	0.628	1.432	4.500
1945-1947	Milk from BYCow Regime 1	119.807	537.761	2947.060	8.591	34.404	185.385
1945-1947	Milk from BYCow Regime 2	124.682	464.733	2746.339	9.219	34.859	179.974
1945-1947	Milk from BYCow Regime 3	2.834	14.662	100.953	0.201	1.126	8.415
1945-1947	Milk from BYCow Regime 4	0.239	2.542	25.229	0.036	0.221	1.709
1945-1947	Commercial Milk (Rural)	21.683	74.580	258.258	1.950	5.865	26.162
1945-1947	Fruit and Vegetables*	28.345	90.045	423.116	20.686	61.266	242.647

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Franklin County Census Division 05

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.026	0.056	0.144	0.026	0.057	0.149
1945	Inhalation	0.638	1.943	7.163	0.544	1.457	5.011
1945	Milk from BYCow Regime 1	65.276	310.059	1868.696	4.553	33.424	220.642
1945	Milk from BYCow Regime 2	63.081	364.338	1838.439	3.776	25.794	192.846
1945	Milk from BYCow Regime 3	1.182	10.664	101.203	0.089	0.931	8.386
1945	Milk from BYCow Regime 4	0.073	2.126	38.254	0.009	0.169	2.674
1945	Commercial Milk (Rural)	15.122	61.327	229.403	1.116	4.632	18.827
1945	Fruit and Vegetables*	22.199	92.155	454.014	16.708	58.348	240.638
1946	External	0.006	0.013	0.029	0.006	0.013	0.032
1946	Inhalation	0.146	0.389	1.361	0.127	0.317	1.001
1946	Milk from BYCow Regime 1	10.379	57.979	400.299	0.764	3.892	24.505
1946	Milk from BYCow Regime 2	8.793	60.526	284.780	0.756	4.517	27.974
1946	Milk from BYCow Regime 3	0.199	1.577	12.136	0.016	0.141	1.397
1946	Milk from BYCow Regime 4	0.014	0.307	5.720	0.002	0.021	0.388
1946	Commercial Milk (Rural)	2.071	8.570	35.549	0.170	0.685	2.811
1946	Fruit and Vegetables*	3.266	12.867	66.262	2.365	8.706	40.089
1947	External	0.002	0.004	0.010	0.002	0.004	0.010
1947	Inhalation	0.039	0.118	0.479	0.036	0.090	0.331
1947	Milk from BYCow Regime 1	2.614	16.322	81.725	0.233	1.431	8.715
1947	Milk from BYCow Regime 2	2.852	15.118	72.671	0.185	1.100	8.371
1947	Milk from BYCow Regime 3	0.054	0.479	4.288	0.005	0.045	0.443
1947	Milk from BYCow Regime 4	0.003	0.054	0.921	0.000	0.007	0.142
1947	Commercial Milk (Rural)	0.511	2.176	6.229	0.051	0.193	0.629
1947	Fruit and Vegetables*	0.505	2.120	12.000	0.416	1.511	6.796
1945-1947	External	0.043	0.077	0.163	0.043	0.077	0.173
1945-1947	Inhalation	1.168	2.631	8.287	0.929	2.023	5.704
1945-1947	Milk from BYCow Regime 1	124.362	461.842	2038.864	9.956	44.946	229.134
1945-1947	Milk from BYCow Regime 2	140.578	507.568	1817.477	10.102	38.215	205.350
1945-1947	Milk from BYCow Regime 3	3.948	16.069	102.952	0.255	1.322	10.294
1945-1947	Milk from BYCow Regime 4	0.390	4.067	41.989	0.035	0.272	3.030
1945-1947	Commercial Milk (Rural)	25.755	84.905	245.912	1.823	5.381	19.237
1945-1947	Fruit and Vegetables*	37.188	118.455	487.382	27.761	73.975	251.070

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Grant County Census Division 01 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.011	0.000	0.001	0.013
1945	Inhalation	0.004	0.018	0.432	0.004	0.015	0.203
1945	Milk from BYCow Regime 3	0.006	0.082	0.760	0.000	0.005	0.087
1945	Milk from BYCow Regime 4	0.000	0.015	0.281	0.000	0.001	0.020
1945	Commercial Milk (Rural)	0.000	0.005	0.071	0.000	0.000	0.006
1945	Fruit and Vegetables*	0.136	0.697	9.384	0.097	0.491	4.511
1946	External	0.000	0.000	0.002	0.000	0.000	0.002
1946	Inhalation	0.001	0.004	0.045	0.001	0.003	0.034
1946	Milk from BYCow Regime 3	0.001	0.010	0.200	0.000	0.001	0.008
1946	Milk from BYCow Regime 4	0.000	0.001	0.026	0.000	0.000	0.002
1946	Commercial Milk (Rural)	0.000	0.001	0.009	0.000	0.000	0.001
1946	Fruit and Vegetables*	0.018	0.102	0.944	0.014	0.067	0.743
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.001	0.008	0.000	0.001	0.007
1947	Milk from BYCow Regime 3	0.000	0.004	0.045	0.000	0.000	0.007
1947	Milk from BYCow Regime 4	0.000	0.000	0.012	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.000	0.000	0.006	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.003	0.019	0.211	0.003	0.013	0.151
1945-1947	External	0.000	0.001	0.017	0.000	0.001	0.020
1945-1947	Inhalation	0.009	0.029	0.426	0.008	0.024	0.239
1945-1947	Milk from BYCow Regime 3	0.021	0.122	0.760	0.002	0.009	0.085
1945-1947	Milk from BYCow Regime 4	0.002	0.025	0.359	0.000	0.002	0.022
1945-1947	Commercial Milk (Rural)	0.001	0.010	0.093	0.000	0.001	0.006
1945-1947	Fruit and Vegetables*	0.258	0.996	10.762	0.190	0.687	5.208

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Grant County Census Division 02

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.011	0.000	0.001	0.010
1945	Inhalation	0.004	0.017	0.275	0.003	0.014	0.380
1945	Milk from BYCow Regime 3	0.006	0.072	0.985	0.000	0.005	0.061
1945	Milk from BYCow Regime 4	0.000	0.006	0.132	0.000	0.001	0.018
1945	Commercial Milk (Rural)	0.001	0.006	0.093	0.000	0.000	0.006
1945	Fruit and Vegetables*	0.139	0.715	7.414	0.097	0.504	6.548
1946	External	0.000	0.000	0.002	0.000	0.000	0.004
1946	Inhalation	0.001	0.004	0.053	0.001	0.003	0.033
1946	Milk from BYCow Regime 3	0.001	0.009	0.141	0.000	0.001	0.009
1946	Milk from BYCow Regime 4	0.000	0.001	0.017	0.000	0.000	0.002
1946	Commercial Milk (Rural)	0.000	0.001	0.015	0.000	0.000	0.001
1946	Fruit and Vegetables*	0.018	0.106	1.674	0.013	0.071	1.086
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.001	0.010	0.000	0.001	0.006
1947	Milk from BYCow Regime 3	0.000	0.002	0.023	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.008	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.000	0.000	0.002	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.003	0.017	0.197	0.003	0.013	0.110
1945-1947	External	0.000	0.001	0.019	0.000	0.001	0.013
1945-1947	Inhalation	0.009	0.030	0.366	0.007	0.023	0.390
1945-1947	Milk from BYCow Regime 3	0.019	0.106	1.103	0.001	0.007	0.068
1945-1947	Milk from BYCow Regime 4	0.001	0.014	0.135	0.000	0.001	0.024
1945-1947	Commercial Milk (Rural)	0.002	0.010	0.095	0.000	0.001	0.008
1945-1947	Fruit and Vegetables*	0.269	1.041	10.869	0.189	0.708	8.198

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Grant County Census Division 03 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.010	0.000	0.001	0.009
1945	Inhalation	0.008	0.030	0.248	0.006	0.022	0.165
1945	Milk from BYCow Regime 3	0.020	0.162	1.492	0.001	0.008	0.098
1945	Milk from BYCow Regime 4	0.000	0.016	0.484	0.000	0.002	0.035
1945	Commercial Milk (Rural)	0.004	0.039	0.558	0.000	0.004	0.071
1945	Fruit and Vegetables*	0.255	1.294	10.966	0.186	0.784	5.348
1946	External	0.000	0.000	0.002	0.000	0.000	0.002
1946	Inhalation	0.002	0.007	0.047	0.002	0.005	0.040
1946	Milk from BYCow Regime 3	0.002	0.019	0.162	0.000	0.001	0.010
1946	Milk from BYCow Regime 4	0.000	0.003	0.054	0.000	0.000	0.005
1946	Commercial Milk (Rural)	0.001	0.006	0.059	0.000	0.000	0.008
1946	Fruit and Vegetables*	0.034	0.161	1.203	0.026	0.106	0.642
1947	External	0.000	0.000	0.000	0.000	0.000	0.001
1947	Inhalation	0.001	0.002	0.028	0.000	0.002	0.017
1947	Milk from BYCow Regime 3	0.000	0.004	0.036	0.000	0.000	0.002
1947	Milk from BYCow Regime 4	0.000	0.001	0.009	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.000	0.003	0.024	0.000	0.000	0.002
1947	Fruit and Vegetables*	0.006	0.027	0.144	0.005	0.019	0.100
1945-1947	External	0.001	0.002	0.013	0.001	0.002	0.015
1945-1947	Inhalation	0.017	0.048	0.316	0.014	0.037	0.266
1945-1947	Milk from BYCow Regime 3	0.039	0.212	1.713	0.002	0.012	0.095
1945-1947	Milk from BYCow Regime 4	0.003	0.029	0.434	0.000	0.003	0.040
1945-1947	Commercial Milk (Rural)	0.013	0.065	0.756	0.001	0.006	0.083
1945-1947	Fruit and Vegetables*	0.443	1.689	11.907	0.333	1.056	5.890

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Grant County Census Division 04

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.007	0.001	0.002	0.007
1945	Inhalation	0.017	0.058	0.333	0.014	0.045	0.224
1945	Milk from BYCow Regime 3	0.031	0.274	1.712	0.003	0.027	0.214
1945	Milk from BYCow Regime 4	0.002	0.041	0.578	0.000	0.006	0.086
1945	Commercial Milk (Rural)	0.413	3.337	51.820	0.027	0.201	3.155
1945	Fruit and Vegetables*	0.520	2.331	13.461	0.387	1.681	9.100
1946	External	0.000	0.000	0.003	0.000	0.000	0.004
1946	Inhalation	0.004	0.014	0.105	0.003	0.011	0.093
1946	Milk from BYCow Regime 3	0.004	0.033	0.315	0.000	0.003	0.025
1946	Milk from BYCow Regime 4	0.000	0.006	0.096	0.000	0.001	0.011
1946	Commercial Milk (Rural)	0.070	0.485	3.597	0.008	0.046	0.324
1946	Fruit and Vegetables*	0.077	0.332	1.770	0.053	0.219	1.235
1947	External	0.000	0.000	0.002	0.000	0.000	0.002
1947	Inhalation	0.001	0.004	0.042	0.001	0.003	0.034
1947	Milk from BYCow Regime 3	0.001	0.007	0.067	0.000	0.001	0.006
1947	Milk from BYCow Regime 4	0.000	0.003	0.043	0.000	0.000	0.004
1947	Commercial Milk (Rural)	0.029	0.224	4.637	0.002	0.016	0.211
1947	Fruit and Vegetables*	0.012	0.054	0.275	0.010	0.042	0.247
1945-1947	External	0.001	0.003	0.012	0.001	0.003	0.013
1945-1947	Inhalation	0.034	0.094	0.572	0.028	0.073	0.505
1945-1947	Milk from BYCow Regime 3	0.083	0.383	1.938	0.007	0.034	0.240
1945-1947	Milk from BYCow Regime 4	0.009	0.075	0.726	0.001	0.009	0.082
1945-1947	Commercial Milk (Rural)	1.181	5.184	58.745	0.082	0.374	3.677
1945-1947	Fruit and Vegetables*	0.903	2.990	14.677	0.685	2.074	9.633

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Grant County Census Division 05 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.007	0.001	0.002	0.007
1945	Inhalation	0.018	0.060	0.269	0.014	0.045	0.218
1945	Milk from BYCow Regime 3	0.028	0.260	2.901	0.002	0.019	0.281
1945	Milk from BYCow Regime 4	0.002	0.032	0.721	0.000	0.005	0.097
1945	Commercial Milk (Rural)	0.211	1.408	16.194	0.016	0.135	1.146
1945	Fruit and Vegetables*	0.519	2.249	12.451	0.393	1.676	8.952
1946	External	0.000	0.000	0.003	0.000	0.000	0.003
1946	Inhalation	0.004	0.012	0.068	0.003	0.010	0.046
1946	Milk from BYCow Regime 3	0.003	0.037	0.542	0.000	0.003	0.036
1946	Milk from BYCow Regime 4	0.000	0.005	0.136	0.000	0.001	0.009
1946	Commercial Milk (Rural)	0.045	0.306	3.507	0.003	0.024	0.295
1946	Fruit and Vegetables*	0.072	0.325	2.004	0.060	0.256	1.514
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.001	0.003	0.028	0.001	0.003	0.016
1947	Milk from BYCow Regime 3	0.001	0.017	0.137	0.000	0.001	0.017
1947	Milk from BYCow Regime 4	0.000	0.002	0.025	0.000	0.000	0.004
1947	Commercial Milk (Rural)	0.015	0.122	1.191	0.001	0.008	0.092
1947	Fruit and Vegetables*	0.013	0.053	0.289	0.010	0.044	0.276
1945-1947	External	0.001	0.003	0.016	0.001	0.003	0.012
1945-1947	Inhalation	0.032	0.088	0.398	0.026	0.067	0.306
1945-1947	Milk from BYCow Regime 3	0.074	0.350	2.899	0.007	0.031	0.311
1945-1947	Milk from BYCow Regime 4	0.006	0.063	0.777	0.001	0.009	0.106
1945-1947	Commercial Milk (Rural)	0.623	2.340	22.711	0.046	0.211	1.435
1945-1947	Fruit and Vegetables*	0.888	3.028	13.779	0.709	2.244	9.822

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Grant County Census Division 06

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.032	0.001	0.002	0.034
1945	Inhalation	0.012	0.058	0.848	0.009	0.045	0.535
1945	Milk from BYCow Regime 3	0.020	0.219	2.075	0.002	0.018	0.221
1945	Milk from BYCow Regime 4	0.001	0.026	0.984	0.000	0.003	0.064
1945	Commercial Milk (Rural)	0.191	1.630	24.615	0.013	0.112	1.232
1945	Fruit and Vegetables*	0.393	1.902	11.925	0.309	1.363	8.568
1946	External	0.000	0.001	0.010	0.000	0.001	0.010
1946	Inhalation	0.003	0.012	0.264	0.002	0.010	0.180
1946	Milk from BYCow Regime 3	0.003	0.039	0.445	0.000	0.004	0.050
1946	Milk from BYCow Regime 4	0.000	0.004	0.152	0.000	0.001	0.014
1946	Commercial Milk (Rural)	0.049	0.399	4.597	0.005	0.030	0.609
1946	Fruit and Vegetables*	0.055	0.293	2.112	0.042	0.211	1.468
1947	External	0.000	0.000	0.002	0.000	0.000	0.002
1947	Inhalation	0.001	0.004	0.072	0.001	0.003	0.049
1947	Milk from BYCow Regime 3	0.001	0.011	0.117	0.000	0.001	0.015
1947	Milk from BYCow Regime 4	0.000	0.001	0.023	0.000	0.000	0.003
1947	Commercial Milk (Rural)	0.018	0.119	1.358	0.001	0.008	0.082
1947	Fruit and Vegetables*	0.011	0.054	0.343	0.009	0.040	0.247
1945-1947	External	0.001	0.004	0.056	0.001	0.004	0.053
1945-1947	Inhalation	0.026	0.102	1.202	0.022	0.080	0.946
1945-1947	Milk from BYCow Regime 3	0.078	0.388	2.268	0.006	0.034	0.267
1945-1947	Milk from BYCow Regime 4	0.006	0.050	1.200	0.001	0.006	0.062
1945-1947	Commercial Milk (Rural)	0.609	3.076	24.058	0.048	0.219	2.007
1945-1947	Fruit and Vegetables*	0.770	2.627	12.572	0.574	1.953	9.885

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Grant County Census Division 07 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.003	0.010	0.001	0.003	0.010
1945	Inhalation	0.037	0.119	0.512	0.031	0.090	0.327
1945	Milk from BYCow Regime 3	0.064	0.507	3.053	0.005	0.037	0.349
1945	Milk from BYCow Regime 4	0.003	0.091	1.653	0.001	0.010	0.145
1945	Commercial Milk (Rural)	0.383	2.796	65.906	0.029	0.244	4.317
1945	Fruit and Vegetables*	1.119	4.616	21.965	0.821	3.126	14.215
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.008	0.025	0.101	0.007	0.019	0.069
1946	Milk from BYCow Regime 3	0.008	0.078	1.026	0.001	0.006	0.048
1946	Milk from BYCow Regime 4	0.000	0.014	0.232	0.000	0.002	0.033
1946	Commercial Milk (Rural)	0.102	0.669	4.711	0.008	0.055	0.755
1946	Fruit and Vegetables*	0.163	0.613	3.111	0.117	0.455	2.311
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.002	0.007	0.032	0.002	0.006	0.025
1947	Milk from BYCow Regime 3	0.002	0.018	0.175	0.000	0.001	0.009
1947	Milk from BYCow Regime 4	0.000	0.004	0.072	0.000	0.000	0.009
1947	Commercial Milk (Rural)	0.029	0.199	3.128	0.002	0.016	0.226
1947	Fruit and Vegetables*	0.028	0.113	0.542	0.021	0.081	0.409
1945-1947	External	0.002	0.005	0.012	0.003	0.005	0.012
1945-1947	Inhalation	0.069	0.166	0.578	0.058	0.126	0.346
1945-1947	Milk from BYCow Regime 3	0.157	0.834	3.415	0.014	0.057	0.405
1945-1947	Milk from BYCow Regime 4	0.021	0.150	1.715	0.002	0.016	0.180
1945-1947	Commercial Milk (Rural)	1.321	5.502	86.814	0.087	0.432	4.832
1945-1947	Fruit and Vegetables*	1.899	5.887	24.432	1.335	4.123	14.867

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Grant County Census Division 08

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.008	0.001	0.002	0.008
1945	Inhalation	0.020	0.064	0.296	0.017	0.052	0.256
1945	Milk from BYCow Regime 3	0.038	0.349	2.933	0.004	0.030	0.306
1945	Milk from BYCow Regime 4	0.004	0.054	0.947	0.000	0.005	0.094
1945	Commercial Milk (Rural)	0.425	2.958	35.517	0.031	0.322	3.661
1945	Fruit and Vegetables*	0.636	2.514	12.588	0.465	1.811	10.178
1946	External	0.000	0.001	0.005	0.000	0.001	0.006
1946	Inhalation	0.004	0.015	0.096	0.004	0.012	0.064
1946	Milk from BYCow Regime 3	0.005	0.043	0.316	0.000	0.003	0.032
1946	Milk from BYCow Regime 4	0.000	0.007	0.241	0.000	0.001	0.016
1946	Commercial Milk (Rural)	0.101	0.669	5.994	0.006	0.051	0.695
1946	Fruit and Vegetables*	0.073	0.350	1.942	0.063	0.238	1.455
1947	External	0.000	0.000	0.002	0.000	0.000	0.001
1947	Inhalation	0.001	0.005	0.054	0.001	0.003	0.029
1947	Milk from BYCow Regime 3	0.001	0.010	0.089	0.000	0.001	0.008
1947	Milk from BYCow Regime 4	0.000	0.002	0.037	0.000	0.000	0.006
1947	Commercial Milk (Rural)	0.032	0.211	2.586	0.003	0.018	0.118
1947	Fruit and Vegetables*	0.014	0.061	0.332	0.012	0.047	0.261
1945-1947	External	0.001	0.003	0.016	0.001	0.003	0.016
1945-1947	Inhalation	0.038	0.099	0.472	0.033	0.079	0.485
1945-1947	Milk from BYCow Regime 3	0.090	0.452	3.118	0.008	0.038	0.285
1945-1947	Milk from BYCow Regime 4	0.011	0.083	0.942	0.001	0.009	0.084
1945-1947	Commercial Milk (Rural)	1.160	5.833	36.823	0.105	0.516	3.647
1945-1947	Fruit and Vegetables*	1.070	3.275	14.151	0.779	2.358	11.693

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Grant County Census Division 09 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.013	0.002	0.004	0.013
1945	Inhalation	0.045	0.138	0.509	0.038	0.109	0.370
1945	Milk from BYCow Regime 3	0.084	0.622	5.619	0.006	0.057	0.514
1945	Milk from BYCow Regime 4	0.005	0.112	1.916	0.001	0.015	0.377
1945	Commercial Milk (Rural)	0.442	2.675	43.515	0.034	0.278	2.283
1945	Fruit and Vegetables*	1.427	6.006	30.233	1.004	3.857	16.758
1946	External	0.000	0.001	0.002	0.000	0.001	0.003
1946	Inhalation	0.011	0.031	0.120	0.009	0.025	0.083
1946	Milk from BYCow Regime 3	0.011	0.105	0.899	0.001	0.008	0.081
1946	Milk from BYCow Regime 4	0.001	0.018	0.483	0.000	0.002	0.030
1946	Commercial Milk (Rural)	0.104	0.720	8.238	0.007	0.046	0.447
1946	Fruit and Vegetables*	0.179	0.764	4.022	0.144	0.574	3.052
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.010	0.039	0.003	0.008	0.028
1947	Milk from BYCow Regime 3	0.003	0.026	0.294	0.000	0.002	0.019
1947	Milk from BYCow Regime 4	0.000	0.008	0.114	0.000	0.001	0.011
1947	Commercial Milk (Rural)	0.033	0.216	1.597	0.002	0.015	0.240
1947	Fruit and Vegetables*	0.032	0.145	0.715	0.026	0.104	0.511
1945-1947	External	0.003	0.006	0.015	0.003	0.006	0.016
1945-1947	Inhalation	0.084	0.194	0.621	0.071	0.156	0.442
1945-1947	Milk from BYCow Regime 3	0.216	0.944	5.585	0.016	0.083	0.523
1945-1947	Milk from BYCow Regime 4	0.026	0.222	2.235	0.003	0.023	0.326
1945-1947	Commercial Milk (Rural)	1.315	5.901	62.769	0.089	0.402	3.239
1945-1947	Fruit and Vegetables*	2.429	7.658	33.417	1.747	4.966	18.862

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Grant County Census Division 10

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.013	0.002	0.004	0.013
1945	Inhalation	0.050	0.152	0.573	0.043	0.127	0.459
1945	Milk from BYCow Regime 3	0.092	0.810	7.646	0.008	0.088	0.874
1945	Milk from BYCow Regime 4	0.007	0.147	2.759	0.001	0.011	0.341
1945	Commercial Milk (Rural)	0.312	2.691	33.174	0.033	0.295	3.762
1945	Fruit and Vegetables*	1.521	6.608	31.873	1.175	4.661	22.520
1946	External	0.000	0.001	0.003	0.000	0.001	0.003
1946	Inhalation	0.011	0.033	0.121	0.010	0.026	0.086
1946	Milk from BYCow Regime 3	0.010	0.095	0.858	0.001	0.009	0.068
1946	Milk from BYCow Regime 4	0.002	0.027	0.395	0.000	0.002	0.032
1946	Commercial Milk (Rural)	0.096	0.649	6.398	0.009	0.050	0.823
1946	Fruit and Vegetables*	0.211	0.941	5.019	0.171	0.661	3.410
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.010	0.048	0.003	0.008	0.031
1947	Milk from BYCow Regime 3	0.002	0.024	0.182	0.000	0.002	0.020
1947	Milk from BYCow Regime 4	0.000	0.007	0.212	0.000	0.001	0.010
1947	Commercial Milk (Rural)	0.033	0.226	3.334	0.002	0.021	0.319
1947	Fruit and Vegetables*	0.039	0.148	0.784	0.030	0.117	0.572
1945-1947	External	0.003	0.006	0.015	0.003	0.006	0.015
1945-1947	Inhalation	0.095	0.216	0.617	0.076	0.176	0.502
1945-1947	Milk from BYCow Regime 3	0.196	1.041	7.493	0.020	0.113	0.811
1945-1947	Milk from BYCow Regime 4	0.030	0.264	3.172	0.003	0.023	0.350
1945-1947	Commercial Milk (Rural)	1.248	5.413	38.784	0.092	0.463	5.282
1945-1947	Fruit and Vegetables*	2.608	8.567	35.592	1.993	6.066	24.910

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Grant County Census Division 11 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.041	0.002	0.005	0.060
1945	Inhalation	0.039	0.172	2.022	0.034	0.139	1.528
1945	Milk from BYCow Regime 3	0.065	0.691	10.404	0.005	0.053	0.544
1945	Milk from BYCow Regime 4	0.005	0.101	1.739	0.001	0.008	0.191
1945	Commercial Milk (Rural)	0.381	3.260	85.456	0.035	0.231	2.106
1945	Fruit and Vegetables*	1.323	6.118	40.527	0.965	3.956	21.990
1946	External	0.000	0.001	0.014	0.000	0.001	0.011
1946	Inhalation	0.009	0.037	0.492	0.008	0.028	0.330
1946	Milk from BYCow Regime 3	0.010	0.083	0.711	0.001	0.008	0.085
1946	Milk from BYCow Regime 4	0.000	0.016	0.655	0.000	0.001	0.025
1946	Commercial Milk (Rural)	0.109	0.709	6.952	0.007	0.052	0.396
1946	Fruit and Vegetables*	0.199	0.841	4.642	0.145	0.608	3.261
1947	External	0.000	0.000	0.003	0.000	0.000	0.003
1947	Inhalation	0.002	0.010	0.095	0.002	0.008	0.067
1947	Milk from BYCow Regime 3	0.002	0.023	0.294	0.000	0.002	0.018
1947	Milk from BYCow Regime 4	0.000	0.006	0.164	0.000	0.001	0.016
1947	Commercial Milk (Rural)	0.031	0.216	2.144	0.002	0.016	0.238
1947	Fruit and Vegetables*	0.034	0.132	0.740	0.026	0.112	0.586
1945-1947	External	0.003	0.009	0.061	0.003	0.009	0.091
1945-1947	Inhalation	0.086	0.279	3.187	0.071	0.214	1.722
1945-1947	Milk from BYCow Regime 3	0.180	1.045	7.210	0.014	0.075	0.513
1945-1947	Milk from BYCow Regime 4	0.022	0.207	2.847	0.003	0.018	0.214
1945-1947	Commercial Milk (Rural)	1.189	5.888	55.505	0.101	0.388	2.295
1945-1947	Fruit and Vegetables*	2.562	8.247	44.048	1.724	5.311	22.643

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Grant County Census Division 12

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.004	0.013	0.124	0.004	0.013	0.133
1945	Inhalation	0.099	0.404	4.833	0.079	0.313	2.724
1945	Milk from BYCow Regime 3	0.125	1.143	13.638	0.012	0.122	1.222
1945	Milk from BYCow Regime 4	0.006	0.165	6.362	0.001	0.021	0.505
1945	Commercial Milk (Rural)	0.360	2.717	41.997	0.032	0.237	3.949
1945	Fruit and Vegetables*	3.471	14.994	85.626	2.286	9.656	57.857
1946	External	0.001	0.004	0.039	0.001	0.004	0.065
1946	Inhalation	0.021	0.098	1.091	0.017	0.067	0.654
1946	Milk from BYCow Regime 3	0.022	0.191	2.032	0.002	0.018	0.190
1946	Milk from BYCow Regime 4	0.001	0.035	1.074	0.000	0.004	0.110
1946	Commercial Milk (Rural)	0.083	0.602	11.518	0.007	0.044	0.898
1946	Fruit and Vegetables*	0.436	2.004	12.494	0.359	1.454	7.879
1947	External	0.000	0.001	0.011	0.000	0.001	0.009
1947	Inhalation	0.006	0.027	0.267	0.005	0.020	0.215
1947	Milk from BYCow Regime 3	0.005	0.050	0.723	0.000	0.005	0.074
1947	Milk from BYCow Regime 4	0.000	0.011	0.283	0.000	0.001	0.032
1947	Commercial Milk (Rural)	0.031	0.243	3.230	0.002	0.018	0.255
1947	Fruit and Vegetables*	0.082	0.335	1.751	0.067	0.267	1.708
1945-1947	External	0.008	0.022	0.197	0.008	0.023	0.219
1945-1947	Inhalation	0.211	0.683	6.693	0.166	0.520	4.297
1945-1947	Milk from BYCow Regime 3	0.349	1.911	15.039	0.036	0.192	1.148
1945-1947	Milk from BYCow Regime 4	0.047	0.378	7.392	0.006	0.046	0.638
1945-1947	Commercial Milk (Rural)	1.158	6.140	54.325	0.086	0.415	5.200
1945-1947	Fruit and Vegetables*	6.046	19.098	91.842	4.190	12.784	63.472

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Grant County Census Division 13 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.009	0.029	0.261	0.009	0.031	0.349
1945	Inhalation	0.190	0.902	7.717	0.167	0.681	5.296
1945	Milk from BYCow Regime 3	0.318	3.387	50.021	0.020	0.240	3.071
1945	Milk from BYCow Regime 4	0.024	0.529	15.050	0.002	0.047	1.369
1945	Commercial Milk (Rural)	0.405	3.287	30.255	0.033	0.244	3.282
1945	Fruit and Vegetables*	7.580	33.758	205.059	5.160	22.095	126.201
1946	External	0.002	0.009	0.093	0.002	0.008	0.118
1946	Inhalation	0.048	0.212	1.791	0.041	0.161	1.175
1946	Milk from BYCow Regime 3	0.046	0.456	3.914	0.003	0.037	0.316
1946	Milk from BYCow Regime 4	0.003	0.064	1.668	0.000	0.006	0.180
1946	Commercial Milk (Rural)	0.089	0.660	6.875	0.008	0.053	0.378
1946	Fruit and Vegetables*	0.996	4.446	28.894	0.751	3.120	15.736
1947	External	0.001	0.002	0.023	0.001	0.002	0.023
1947	Inhalation	0.013	0.056	0.446	0.011	0.048	0.425
1947	Milk from BYCow Regime 3	0.013	0.127	1.952	0.001	0.010	0.189
1947	Milk from BYCow Regime 4	0.001	0.026	0.678	0.000	0.002	0.040
1947	Commercial Milk (Rural)	0.027	0.204	3.254	0.002	0.018	0.200
1947	Fruit and Vegetables*	0.171	0.728	3.550	0.140	0.547	3.090
1945-1947	External	0.019	0.052	0.441	0.019	0.053	0.643
1945-1947	Inhalation	0.457	1.448	10.711	0.353	1.092	7.270
1945-1947	Milk from BYCow Regime 3	0.897	4.833	42.150	0.068	0.411	3.248
1945-1947	Milk from BYCow Regime 4	0.090	1.039	15.251	0.009	0.077	1.007
1945-1947	Commercial Milk (Rural)	1.204	5.538	34.260	0.097	0.405	3.103
1945-1947	Fruit and Vegetables*	13.208	44.630	209.932	9.299	29.815	131.675

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Grant County Census Division 14

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.001	0.006	0.001	0.002	0.006
1945	Inhalation	0.015	0.051	0.252	0.012	0.041	0.171
1945	Milk from BYCow Regime 3	0.013	0.236	4.329	0.002	0.020	0.392
1945	Milk from BYCow Regime 4	0.001	0.031	0.619	0.000	0.002	0.080
1945	Commercial Milk (Urban)	0.348	1.987	20.417	0.014	0.117	1.389
1945	Fruit and Vegetables*	0.488	2.009	11.679	0.368	1.596	9.341
1946	External	0.000	0.000	0.003	0.000	0.000	0.003
1946	Inhalation	0.003	0.011	0.074	0.003	0.009	0.045
1946	Milk from BYCow Regime 3	0.004	0.051	0.391	0.000	0.003	0.046
1946	Milk from BYCow Regime 4	0.000	0.005	0.091	0.000	0.000	0.008
1946	Commercial Milk (Urban)	0.090	0.541	6.021	0.003	0.025	0.194
1946	Fruit and Vegetables*	0.067	0.292	1.719	0.050	0.211	1.003
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.001	0.003	0.022	0.001	0.003	0.018
1947	Milk from BYCow Regime 3	0.002	0.014	0.173	0.000	0.001	0.013
1947	Milk from BYCow Regime 4	0.000	0.002	0.060	0.000	0.000	0.004
1947	Commercial Milk (Urban)	0.019	0.163	2.242	0.001	0.010	0.142
1947	Fruit and Vegetables*	0.012	0.049	0.248	0.009	0.037	0.193
1945-1947	External	0.001	0.002	0.012	0.001	0.002	0.014
1945-1947	Inhalation	0.029	0.077	0.365	0.024	0.060	0.251
1945-1947	Milk from BYCow Regime 3	0.070	0.446	4.195	0.006	0.038	0.324
1945-1947	Milk from BYCow Regime 4	0.007	0.070	0.789	0.000	0.004	0.071
1945-1947	Commercial Milk (Urban)	0.888	3.729	21.803	0.049	0.213	1.469
1945-1947	Fruit and Vegetables*	0.840	2.635	12.278	0.660	1.987	9.336

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Kittitas County Census Division 01

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.003	0.063	0.000	0.003	0.048
1945	Inhalation	0.005	0.065	1.561	0.004	0.055	1.499
1945	Milk from BYCow Regime 1	0.393	6.121	176.947	0.023	0.509	12.337
1945	Milk from BYCow Regime 2	0.263	4.708	141.827	0.020	0.397	11.003
1945	Milk from BYCow Regime 3	0.012	0.320	23.972	0.001	0.022	1.063
1945	Milk from BYCow Regime 4	0.001	0.060	6.509	0.000	0.006	0.339
1945	Commercial Milk (Rural)	0.384	5.806	230.324	0.028	0.453	10.291
1945	Fruit and Vegetables*	0.239	2.261	44.772	0.175	1.671	45.310
1946	External	0.000	0.001	0.023	0.000	0.001	0.024
1946	Inhalation	0.001	0.017	0.700	0.001	0.014	0.475
1946	Milk from BYCow Regime 1	0.066	1.023	36.425	0.005	0.084	2.574
1946	Milk from BYCow Regime 2	0.063	0.740	38.198	0.004	0.096	3.046
1946	Milk from BYCow Regime 3	0.002	0.031	0.624	0.000	0.003	0.114
1946	Milk from BYCow Regime 4	0.000	0.008	0.203	0.000	0.001	0.023
1946	Commercial Milk (Rural)	0.067	0.787	11.189	0.005	0.056	3.077
1946	Fruit and Vegetables*	0.036	0.332	6.594	0.028	0.262	4.929
1947	External	0.000	0.000	0.005	0.000	0.000	0.006
1947	Inhalation	0.000	0.005	0.178	0.000	0.004	0.156
1947	Milk from BYCow Regime 1	0.017	0.272	7.387	0.002	0.027	0.550
1947	Milk from BYCow Regime 2	0.022	0.440	8.971	0.001	0.023	0.516
1947	Milk from BYCow Regime 3	0.000	0.005	0.101	0.000	0.001	0.012
1947	Milk from BYCow Regime 4	0.000	0.002	0.076	0.000	0.000	0.005
1947	Commercial Milk (Rural)	0.016	0.210	5.222	0.001	0.017	0.334
1947	Fruit and Vegetables*	0.006	0.068	1.055	0.005	0.057	1.237
1945-1947	External	0.001	0.007	0.099	0.001	0.007	0.092
1945-1947	Inhalation	0.021	0.172	2.709	0.019	0.133	2.960
1945-1947	Milk from BYCow Regime 1	1.522	12.937	259.068	0.124	1.151	17.635
1945-1947	Milk from BYCow Regime 2	1.464	11.791	154.393	0.095	0.844	26.830
1945-1947	Milk from BYCow Regime 3	0.044	0.511	32.895	0.005	0.048	1.150
1945-1947	Milk from BYCow Regime 4	0.009	0.104	3.503	0.001	0.011	0.247
1945-1947	Commercial Milk (Rural)	1.252	9.693	238.984	0.113	0.724	10.109
1945-1947	Fruit and Vegetables*	0.677	4.029	55.936	0.487	2.940	51.341

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Kittitas County Census Division 02

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.010	0.000	0.000	0.019
1945	Inhalation	0.001	0.006	1.021	0.000	0.005	2.220
1945	Milk from BYCow Regime 3	0.000	0.008	0.252	0.000	0.001	0.024
1945	Milk from BYCow Regime 4	0.000	0.002	0.165	0.000	0.000	0.017
1945	Commercial Milk (Rural)	0.016	0.261	13.186	0.001	0.033	1.803
1945	Fruit and Vegetables*	0.012	0.149	11.913	0.010	0.106	5.777
1946	External	0.000	0.000	0.006	0.000	0.000	0.006
1946	Inhalation	0.000	0.002	0.614	0.000	0.001	0.421
1946	Milk from BYCow Regime 3	0.000	0.002	0.186	0.000	0.000	0.010
1946	Milk from BYCow Regime 4	0.000	0.000	0.017	0.000	0.000	0.003
1946	Commercial Milk (Rural)	0.003	0.063	1.571	0.000	0.005	0.344
1946	Fruit and Vegetables*	0.002	0.016	0.549	0.002	0.017	1.064
1947	External	0.000	0.000	0.003	0.000	0.000	0.004
1947	Inhalation	0.000	0.001	0.228	0.000	0.001	0.146
1947	Milk from BYCow Regime 3	0.000	0.000	0.102	0.000	0.000	0.012
1947	Milk from BYCow Regime 4	0.000	0.000	0.011	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.001	0.014	1.598	0.000	0.001	0.256
1947	Fruit and Vegetables*	0.000	0.005	0.447	0.000	0.004	0.356
1945-1947	External	0.000	0.001	0.042	0.000	0.001	0.041
1945-1947	Inhalation	0.002	0.029	8.973	0.002	0.024	7.363
1945-1947	Milk from BYCow Regime 3	0.002	0.024	0.603	0.000	0.003	0.055
1945-1947	Milk from BYCow Regime 4	0.000	0.005	0.196	0.000	0.001	0.020
1945-1947	Commercial Milk (Rural)	0.078	0.793	18.024	0.007	0.085	2.589
1945-1947	Fruit and Vegetables*	0.037	0.287	15.439	0.029	0.244	9.713

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Kittitas County Census Division 03 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.007	0.000	0.000	0.014
1945	Inhalation	0.001	0.007	0.585	0.000	0.006	0.732
1945	Milk from BYCow Regime 3	0.000	0.010	0.388	0.000	0.001	0.040
1945	Milk from BYCow Regime 4	0.000	0.002	0.064	0.000	0.000	0.015
1945	Commercial Milk (Rural)	0.013	0.297	25.249	0.001	0.024	4.425
1945	Fruit and Vegetables*	0.011	0.134	8.906	0.010	0.117	8.457
1946	External	0.000	0.000	0.008	0.000	0.000	0.006
1946	Inhalation	0.000	0.002	0.580	0.000	0.002	0.570
1946	Milk from BYCow Regime 3	0.000	0.002	0.100	0.000	0.000	0.017
1946	Milk from BYCow Regime 4	0.000	0.000	0.016	0.000	0.000	0.002
1946	Commercial Milk (Rural)	0.004	0.053	1.931	0.000	0.004	0.204
1946	Fruit and Vegetables*	0.002	0.019	1.051	0.001	0.016	1.057
1947	External	0.000	0.000	0.003	0.000	0.000	0.003
1947	Inhalation	0.000	0.001	0.672	0.000	0.001	0.178
1947	Milk from BYCow Regime 3	0.000	0.000	0.034	0.000	0.000	0.008
1947	Milk from BYCow Regime 4	0.000	0.000	0.004	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.001	0.014	6.985	0.000	0.001	0.095
1947	Fruit and Vegetables*	0.000	0.005	0.182	0.000	0.004	0.294
1945-1947	External	0.000	0.001	0.025	0.000	0.001	0.030
1945-1947	Inhalation	0.003	0.030	4.361	0.002	0.023	4.120
1945-1947	Milk from BYCow Regime 3	0.002	0.032	0.511	0.000	0.003	0.079
1945-1947	Milk from BYCow Regime 4	0.000	0.004	0.125	0.000	0.001	0.020
1945-1947	Commercial Milk (Rural)	0.089	0.793	41.945	0.006	0.068	5.510
1945-1947	Fruit and Vegetables*	0.034	0.257	11.868	0.029	0.257	13.112

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Kittitas County Census Division 04

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.011	0.000	0.001	0.012
1945	Inhalation	0.001	0.012	0.482	0.001	0.009	0.331
1945	Milk from BYCow Regime 3	0.001	0.023	1.452	0.000	0.003	0.128
1945	Milk from BYCow Regime 4	0.000	0.010	1.570	0.000	0.001	0.050
1945	Commercial Milk (Rural)	0.015	0.426	12.894	0.001	0.020	1.528
1945	Fruit and Vegetables*	0.064	0.714	18.791	0.056	0.571	21.140
1946	External	0.000	0.000	0.003	0.000	0.000	0.003
1946	Inhalation	0.000	0.002	0.116	0.000	0.003	0.130
1946	Milk from BYCow Regime 3	0.000	0.007	0.753	0.000	0.000	0.020
1946	Milk from BYCow Regime 4	0.000	0.001	0.226	0.000	0.000	0.008
1946	Commercial Milk (Rural)	0.003	0.051	1.593	0.000	0.004	0.217
1946	Fruit and Vegetables*	0.010	0.088	1.968	0.007	0.069	1.638
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.047	0.000	0.001	0.034
1947	Milk from BYCow Regime 3	0.000	0.002	0.115	0.000	0.000	0.009
1947	Milk from BYCow Regime 4	0.000	0.000	0.019	0.000	0.000	0.003
1947	Commercial Milk (Rural)	0.001	0.021	1.287	0.000	0.001	0.101
1947	Fruit and Vegetables*	0.002	0.019	0.504	0.002	0.017	0.433
1945-1947	External	0.000	0.001	0.016	0.000	0.001	0.019
1945-1947	Inhalation	0.004	0.031	0.731	0.003	0.025	0.567
1945-1947	Milk from BYCow Regime 3	0.007	0.086	2.321	0.001	0.007	0.214
1945-1947	Milk from BYCow Regime 4	0.002	0.030	1.058	0.000	0.003	0.048
1945-1947	Commercial Milk (Rural)	0.097	0.955	16.737	0.006	0.055	1.561
1945-1947	Fruit and Vegetables*	0.178	1.137	20.902	0.151	0.998	23.438

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Kittitas County Census Division 05 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.014	0.000	0.000	0.022
1945	Inhalation	0.000	0.007	0.557	0.000	0.005	0.764
1945	Milk from BYCow Regime 3	0.001	0.036	2.118	0.000	0.003	0.554
1945	Milk from BYCow Regime 4	0.000	0.006	0.159	0.000	0.001	0.038
1945	Commercial Milk (Rural)	0.017	0.299	13.850	0.002	0.022	1.993
1945	Fruit and Vegetables*	0.024	0.293	12.457	0.021	0.222	14.974
1946	External	0.000	0.000	0.012	0.000	0.000	0.014
1946	Inhalation	0.000	0.002	0.629	0.000	0.002	0.199
1946	Milk from BYCow Regime 3	0.000	0.005	0.568	0.000	0.000	0.030
1946	Milk from BYCow Regime 4	0.000	0.001	0.035	0.000	0.000	0.005
1946	Commercial Milk (Rural)	0.004	0.064	2.282	0.000	0.004	0.227
1946	Fruit and Vegetables*	0.003	0.036	2.194	0.003	0.030	1.683
1947	External	0.000	0.000	0.002	0.000	0.000	0.002
1947	Inhalation	0.000	0.001	0.138	0.000	0.001	0.126
1947	Milk from BYCow Regime 3	0.000	0.001	0.062	0.000	0.000	0.016
1947	Milk from BYCow Regime 4	0.000	0.000	0.008	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.001	0.012	4.517	0.000	0.001	0.437
1947	Fruit and Vegetables*	0.001	0.008	0.232	0.001	0.007	0.364
1945-1947	External	0.000	0.001	0.044	0.000	0.001	0.063
1945-1947	Inhalation	0.002	0.026	3.874	0.002	0.021	5.117
1945-1947	Milk from BYCow Regime 3	0.005	0.083	3.446	0.001	0.014	1.267
1945-1947	Milk from BYCow Regime 4	0.001	0.012	0.228	0.000	0.002	0.050
1945-1947	Commercial Milk (Rural)	0.082	0.837	26.473	0.006	0.064	2.021
1945-1947	Fruit and Vegetables*	0.066	0.585	18.368	0.058	0.458	18.811

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Kittitas County Census Division 06

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.025	0.000	0.000	0.017
1945	Inhalation	0.000	0.007	1.077	0.000	0.005	0.550
1945	Milk from BYCow Regime 1	0.029	0.967	175.513	0.002	0.086	11.553
1945	Milk from BYCow Regime 2	0.022	0.826	80.051	0.002	0.048	3.306
1945	Milk from BYCow Regime 3	0.001	0.017	0.739	0.000	0.002	0.063
1945	Milk from BYCow Regime 4	0.000	0.003	0.199	0.000	0.001	0.022
1945	Commercial Milk (Rural)	0.035	0.641	28.395	0.003	0.066	2.086
1945	Fruit and Vegetables*	0.023	0.261	10.883	0.020	0.218	19.804
1946	External	0.000	0.000	0.013	0.000	0.000	0.009
1946	Inhalation	0.000	0.002	0.217	0.000	0.001	0.195
1946	Milk from BYCow Regime 1	0.006	0.148	15.469	0.000	0.011	0.399
1946	Milk from BYCow Regime 2	0.004	0.122	6.591	0.000	0.009	0.207
1946	Milk from BYCow Regime 3	0.000	0.003	0.199	0.000	0.000	0.017
1946	Milk from BYCow Regime 4	0.000	0.001	0.067	0.000	0.000	0.004
1946	Commercial Milk (Rural)	0.006	0.097	3.056	0.000	0.006	0.365
1946	Fruit and Vegetables*	0.003	0.035	1.660	0.002	0.027	1.712
1947	External	0.000	0.000	0.002	0.000	0.000	0.003
1947	Inhalation	0.000	0.001	0.154	0.000	0.001	0.164
1947	Milk from BYCow Regime 1	0.001	0.049	6.260	0.000	0.003	0.391
1947	Milk from BYCow Regime 2	0.001	0.033	6.436	0.000	0.003	0.541
1947	Milk from BYCow Regime 3	0.000	0.001	0.194	0.000	0.000	0.012
1947	Milk from BYCow Regime 4	0.000	0.000	0.025	0.000	0.000	0.002
1947	Commercial Milk (Rural)	0.001	0.023	11.743	0.000	0.003	0.283
1947	Fruit and Vegetables*	0.001	0.010	0.454	0.001	0.008	0.843
1945-1947	External	0.000	0.001	0.078	0.000	0.001	0.072
1945-1947	Inhalation	0.002	0.029	6.235	0.002	0.020	2.134
1945-1947	Milk from BYCow Regime 1	0.166	2.883	200.071	0.013	0.206	11.046
1945-1947	Milk from BYCow Regime 2	0.153	2.125	159.720	0.011	0.161	5.458
1945-1947	Milk from BYCow Regime 3	0.004	0.050	1.221	0.001	0.004	0.072
1945-1947	Milk from BYCow Regime 4	0.001	0.010	0.263	0.000	0.001	0.032
1945-1947	Commercial Milk (Rural)	0.155	1.750	55.180	0.014	0.141	2.113
1945-1947	Fruit and Vegetables*	0.069	0.574	19.765	0.056	0.497	25.678

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Kittitas County Census Division 07 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.014	0.000	0.000	0.011
1945	Inhalation	0.000	0.006	1.264	0.000	0.006	1.404
1945	Milk from BYCow Regime 1	0.030	0.858	134.019	0.003	0.076	5.247
1945	Milk from BYCow Regime 2	0.026	0.880	77.151	0.002	0.086	7.041
1945	Milk from BYCow Regime 3	0.001	0.044	8.097	0.000	0.007	0.918
1945	Milk from BYCow Regime 4	0.000	0.011	0.413	0.000	0.002	0.055
1945	Commercial Milk (Rural)	0.349	5.191	160.808	0.029	0.367	19.071
1945	Fruit and Vegetables*	0.023	0.269	17.451	0.019	0.218	16.119
1946	External	0.000	0.000	0.007	0.000	0.000	0.010
1946	Inhalation	0.000	0.002	0.575	0.000	0.002	0.557
1946	Milk from BYCow Regime 1	0.006	0.173	15.906	0.001	0.012	1.172
1946	Milk from BYCow Regime 2	0.006	0.136	24.714	0.001	0.011	0.777
1946	Milk from BYCow Regime 3	0.000	0.008	0.968	0.000	0.001	0.044
1946	Milk from BYCow Regime 4	0.000	0.001	0.028	0.000	0.000	0.008
1946	Commercial Milk (Rural)	0.052	0.631	16.899	0.004	0.055	1.188
1946	Fruit and Vegetables*	0.003	0.038	1.546	0.003	0.034	2.221
1947	External	0.000	0.000	0.004	0.000	0.000	0.005
1947	Inhalation	0.000	0.001	0.114	0.000	0.000	0.112
1947	Milk from BYCow Regime 1	0.002	0.049	2.380	0.000	0.003	0.200
1947	Milk from BYCow Regime 2	0.002	0.039	4.991	0.000	0.004	0.497
1947	Milk from BYCow Regime 3	0.000	0.001	0.087	0.000	0.000	0.007
1947	Milk from BYCow Regime 4	0.000	0.000	0.015	0.000	0.000	0.002
1947	Commercial Milk (Rural)	0.019	0.189	4.295	0.001	0.013	0.293
1947	Fruit and Vegetables*	0.001	0.008	0.294	0.001	0.008	0.591
1945-1947	External	0.000	0.001	0.039	0.000	0.001	0.049
1945-1947	Inhalation	0.002	0.032	4.427	0.002	0.028	6.046
1945-1947	Milk from BYCow Regime 1	0.215	2.314	138.123	0.016	0.205	8.640
1945-1947	Milk from BYCow Regime 2	0.170	2.388	138.637	0.013	0.197	7.679
1945-1947	Milk from BYCow Regime 3	0.007	0.116	13.220	0.001	0.014	0.803
1945-1947	Milk from BYCow Regime 4	0.002	0.018	0.291	0.000	0.004	0.063
1945-1947	Commercial Milk (Rural)	0.926	8.415	126.357	0.088	0.689	25.902
1945-1947	Fruit and Vegetables*	0.065	0.543	25.591	0.058	0.482	24.010

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Kittitas County Census Division 08

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.006	0.131	0.001	0.006	0.112
1945	Inhalation	0.010	0.116	4.718	0.008	0.097	3.291
1945	Milk from BYCow Regime 1	0.715	13.875	369.249	0.060	0.933	26.025
1945	Milk from BYCow Regime 2	0.710	10.295	186.163	0.066	1.030	23.029
1945	Milk from BYCow Regime 3	0.042	0.824	17.241	0.003	0.044	1.627
1945	Milk from BYCow Regime 4	0.003	0.099	4.542	0.000	0.012	0.492
1945	Commercial Milk (Rural)	0.371	4.878	129.458	0.030	0.373	8.037
1945	Fruit and Vegetables*	0.727	5.668	111.064	0.531	4.243	66.887
1946	External	0.000	0.001	0.026	0.000	0.002	0.046
1946	Inhalation	0.003	0.031	0.942	0.002	0.024	0.711
1946	Milk from BYCow Regime 1	0.108	1.436	29.678	0.012	0.150	2.656
1946	Milk from BYCow Regime 2	0.123	2.383	52.240	0.008	0.137	3.161
1946	Milk from BYCow Regime 3	0.004	0.076	2.631	0.000	0.007	0.119
1946	Milk from BYCow Regime 4	0.000	0.013	0.702	0.000	0.002	0.028
1946	Commercial Milk (Rural)	0.040	0.667	25.019	0.004	0.042	0.876
1946	Fruit and Vegetables*	0.097	0.784	12.358	0.076	0.545	7.292
1947	External	0.000	0.000	0.014	0.000	0.000	0.014
1947	Inhalation	0.001	0.007	0.237	0.001	0.006	0.221
1947	Milk from BYCow Regime 1	0.032	0.516	9.655	0.002	0.046	1.644
1947	Milk from BYCow Regime 2	0.039	0.477	14.193	0.003	0.036	0.511
1947	Milk from BYCow Regime 3	0.001	0.015	0.285	0.000	0.001	0.036
1947	Milk from BYCow Regime 4	0.000	0.003	0.144	0.000	0.000	0.011
1947	Commercial Milk (Rural)	0.013	0.164	5.753	0.001	0.015	0.352
1947	Fruit and Vegetables*	0.018	0.167	2.144	0.015	0.127	2.376
1945-1947	External	0.002	0.012	0.182	0.002	0.012	0.181
1945-1947	Inhalation	0.041	0.284	5.313	0.035	0.234	4.406
1945-1947	Milk from BYCow Regime 1	2.865	24.269	464.113	0.284	1.891	26.062
1945-1947	Milk from BYCow Regime 2	2.612	23.014	257.489	0.213	1.590	22.198
1945-1947	Milk from BYCow Regime 3	0.158	1.440	23.410	0.010	0.082	1.688
1945-1947	Milk from BYCow Regime 4	0.013	0.223	5.800	0.002	0.023	0.430
1945-1947	Commercial Milk (Rural)	1.145	8.863	151.610	0.101	0.765	9.752
1945-1947	Fruit and Vegetables*	1.674	8.900	140.317	1.309	6.747	71.077

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Kittitas County Census Division 09 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.020	0.000	0.001	0.026
1945	Inhalation	0.001	0.012	0.311	0.001	0.011	0.409
1945	Milk from BYCow Regime 1	0.079	1.419	76.289	0.007	0.108	3.387
1945	Milk from BYCow Regime 2	0.093	1.774	43.229	0.006	0.126	8.640
1945	Milk from BYCow Regime 3	0.004	0.084	4.697	0.001	0.010	1.100
1945	Milk from BYCow Regime 4	0.001	0.021	1.359	0.000	0.004	0.105
1945	Commercial Milk (Rural)	0.270	4.388	245.295	0.025	0.353	6.508
1945	Fruit and Vegetables*	0.066	0.687	13.294	0.062	0.593	17.092
1946	External	0.000	0.000	0.002	0.000	0.000	0.004
1946	Inhalation	0.000	0.003	0.127	0.000	0.002	0.067
1946	Milk from BYCow Regime 1	0.013	0.225	14.580	0.001	0.014	0.562
1946	Milk from BYCow Regime 2	0.014	0.197	18.335	0.001	0.021	1.027
1946	Milk from BYCow Regime 3	0.001	0.012	1.065	0.000	0.001	0.037
1946	Milk from BYCow Regime 4	0.000	0.003	0.135	0.000	0.001	0.012
1946	Commercial Milk (Rural)	0.054	0.952	44.806	0.004	0.048	1.677
1946	Fruit and Vegetables*	0.009	0.093	1.655	0.008	0.079	3.030
1947	External	0.000	0.000	0.001	0.000	0.000	0.002
1947	Inhalation	0.000	0.001	0.063	0.000	0.001	0.053
1947	Milk from BYCow Regime 1	0.005	0.115	1.885	0.000	0.009	0.382
1947	Milk from BYCow Regime 2	0.005	0.090	4.009	0.000	0.006	0.283
1947	Milk from BYCow Regime 3	0.000	0.002	0.230	0.000	0.000	0.020
1947	Milk from BYCow Regime 4	0.000	0.001	0.043	0.000	0.000	0.004
1947	Commercial Milk (Rural)	0.017	0.156	3.566	0.001	0.016	0.324
1947	Fruit and Vegetables*	0.002	0.019	0.686	0.002	0.019	0.496
1945-1947	External	0.000	0.001	0.036	0.000	0.001	0.035
1945-1947	Inhalation	0.004	0.033	0.636	0.004	0.029	0.683
1945-1947	Milk from BYCow Regime 1	0.396	3.947	128.743	0.033	0.300	6.134
1945-1947	Milk from BYCow Regime 2	0.353	3.586	86.422	0.036	0.316	11.038
1945-1947	Milk from BYCow Regime 3	0.016	0.194	5.679	0.002	0.024	1.189
1945-1947	Milk from BYCow Regime 4	0.004	0.055	1.989	0.001	0.008	0.120
1945-1947	Commercial Milk (Rural)	1.243	9.744	337.011	0.080	0.750	8.214
1945-1947	Fruit and Vegetables*	0.185	1.222	17.400	0.158	0.994	26.392

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Kittitas County Census Division 10

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.010	0.000	0.001	0.013
1945	Inhalation	0.001	0.013	0.484	0.001	0.010	0.540
1945	Milk from BYCow Regime 1	0.081	1.690	44.607	0.007	0.109	5.477
1945	Milk from BYCow Regime 2	0.100	1.871	114.118	0.006	0.097	3.524
1945	Milk from BYCow Regime 3	0.005	0.097	4.957	0.001	0.010	0.232
1945	Milk from BYCow Regime 4	0.001	0.015	0.632	0.000	0.002	0.059
1945	Commercial Milk (Rural)	0.303	4.556	127.786	0.027	0.453	11.418
1945	Fruit and Vegetables*	0.070	0.669	16.623	0.057	0.513	12.585
1946	External	0.000	0.000	0.003	0.000	0.000	0.004
1946	Inhalation	0.000	0.003	0.162	0.000	0.002	0.080
1946	Milk from BYCow Regime 1	0.016	0.288	16.249	0.001	0.020	1.524
1946	Milk from BYCow Regime 2	0.013	0.233	6.532	0.001	0.023	0.662
1946	Milk from BYCow Regime 3	0.001	0.011	0.356	0.000	0.001	0.043
1946	Milk from BYCow Regime 4	0.000	0.003	0.112	0.000	0.000	0.014
1946	Commercial Milk (Rural)	0.045	0.527	12.599	0.004	0.046	1.141
1946	Fruit and Vegetables*	0.008	0.078	1.567	0.008	0.074	1.840
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.032	0.000	0.001	0.034
1947	Milk from BYCow Regime 1	0.004	0.072	5.131	0.000	0.006	0.160
1947	Milk from BYCow Regime 2	0.004	0.061	2.195	0.000	0.007	0.331
1947	Milk from BYCow Regime 3	0.000	0.003	0.137	0.000	0.000	0.011
1947	Milk from BYCow Regime 4	0.000	0.001	0.018	0.000	0.000	0.003
1947	Commercial Milk (Rural)	0.014	0.197	4.125	0.001	0.012	0.304
1947	Fruit and Vegetables*	0.002	0.019	0.445	0.002	0.019	0.563
1945-1947	External	0.000	0.001	0.014	0.000	0.001	0.023
1945-1947	Inhalation	0.004	0.033	0.847	0.003	0.026	0.801
1945-1947	Milk from BYCow Regime 1	0.424	3.955	57.371	0.027	0.229	6.130
1945-1947	Milk from BYCow Regime 2	0.333	4.038	119.592	0.032	0.234	3.926
1945-1947	Milk from BYCow Regime 3	0.020	0.187	7.938	0.002	0.020	0.389
1945-1947	Milk from BYCow Regime 4	0.004	0.031	0.758	0.001	0.005	0.092
1945-1947	Commercial Milk (Rural)	1.256	8.954	124.663	0.075	0.597	10.373
1945-1947	Fruit and Vegetables*	0.187	1.161	21.080	0.153	0.939	17.404

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Kittitas County Census Division 11 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.010	0.000	0.001	0.010
1945	Inhalation	0.001	0.012	0.506	0.001	0.011	0.304
1945	Milk from BYCow Regime 1	0.119	2.259	134.451	0.007	0.142	3.261
1945	Milk from BYCow Regime 2	0.042	1.885	154.504	0.005	0.093	4.394
1945	Milk from BYCow Regime 3	0.002	0.062	2.496	0.000	0.004	0.525
1945	Milk from BYCow Regime 4	0.000	0.012	1.184	0.000	0.001	0.090
1945	Commercial Milk (Urban)	0.865	6.892	156.185	0.046	0.490	9.223
1945	Fruit and Vegetables*	0.074	0.661	17.232	0.061	0.537	18.228
1946	External	0.000	0.000	0.003	0.000	0.000	0.004
1946	Inhalation	0.000	0.003	0.120	0.000	0.003	0.095
1946	Milk from BYCow Regime 1	0.016	0.255	7.786	0.001	0.024	1.307
1946	Milk from BYCow Regime 2	0.011	0.221	15.918	0.001	0.027	1.474
1946	Milk from BYCow Regime 3	0.000	0.010	0.614	0.000	0.001	0.032
1946	Milk from BYCow Regime 4	0.000	0.002	0.247	0.000	0.000	0.011
1946	Commercial Milk (Urban)	0.139	1.185	20.251	0.007	0.083	1.028
1946	Fruit and Vegetables*	0.010	0.098	1.763	0.010	0.089	2.564
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.041	0.000	0.001	0.038
1947	Milk from BYCow Regime 1	0.005	0.086	2.135	0.000	0.008	0.353
1947	Milk from BYCow Regime 2	0.003	0.094	4.573	0.000	0.006	0.730
1947	Milk from BYCow Regime 3	0.000	0.002	0.133	0.000	0.000	0.014
1947	Milk from BYCow Regime 4	0.000	0.001	0.036	0.000	0.000	0.003
1947	Commercial Milk (Urban)	0.046	0.333	3.957	0.002	0.025	0.332
1947	Fruit and Vegetables*	0.002	0.023	0.535	0.002	0.017	0.557
1945-1947	External	0.000	0.001	0.018	0.000	0.001	0.021
1945-1947	Inhalation	0.004	0.033	0.752	0.004	0.031	1.014
1945-1947	Milk from BYCow Regime 1	0.500	4.268	83.113	0.033	0.291	6.717
1945-1947	Milk from BYCow Regime 2	0.409	4.885	112.074	0.025	0.260	5.962
1945-1947	Milk from BYCow Regime 3	0.014	0.153	7.909	0.001	0.012	0.493
1945-1947	Milk from BYCow Regime 4	0.002	0.039	1.984	0.000	0.002	0.090
1945-1947	Commercial Milk (Urban)	2.396	10.977	112.349	0.135	0.779	10.220
1945-1947	Fruit and Vegetables*	0.196	1.170	19.249	0.166	1.019	23.518

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Klickitat County Census Division 01

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.018	0.000	0.001	0.018
1945	Inhalation	0.001	0.015	0.431	0.001	0.011	0.323
1945	Milk from BYCow Regime 3	0.003	0.057	1.484	0.000	0.005	0.193
1945	Milk from BYCow Regime 4	0.000	0.014	1.529	0.000	0.002	0.074
1945	Commercial Milk (Rural)	0.001	0.011	0.280	0.000	0.001	0.022
1945	Fruit and Vegetables*	0.126	1.092	15.583	0.077	0.554	9.002
1946	External	0.000	0.000	0.004	0.000	0.000	0.004
1946	Inhalation	0.000	0.004	0.112	0.000	0.003	0.099
1946	Milk from BYCow Regime 3	0.000	0.008	0.321	0.000	0.000	0.015
1946	Milk from BYCow Regime 4	0.000	0.003	0.187	0.000	0.000	0.008
1946	Commercial Milk (Rural)	0.000	0.002	0.029	0.000	0.000	0.003
1946	Fruit and Vegetables*	0.018	0.136	1.800	0.012	0.086	1.465
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.030	0.000	0.001	0.023
1947	Milk from BYCow Regime 3	0.000	0.001	0.063	0.000	0.000	0.003
1947	Milk from BYCow Regime 4	0.000	0.001	0.037	0.000	0.000	0.004
1947	Commercial Milk (Rural)	0.000	0.001	0.042	0.000	0.000	0.002
1947	Fruit and Vegetables*	0.003	0.027	0.440	0.003	0.019	0.297
1945-1947	External	0.000	0.002	0.024	0.000	0.002	0.023
1945-1947	Inhalation	0.005	0.032	0.578	0.004	0.027	0.577
1945-1947	Milk from BYCow Regime 3	0.011	0.126	1.950	0.001	0.008	0.237
1945-1947	Milk from BYCow Regime 4	0.003	0.045	1.759	0.000	0.004	0.061
1945-1947	Commercial Milk (Rural)	0.003	0.022	0.591	0.000	0.002	0.025
1945-1947	Fruit and Vegetables*	0.304	1.650	16.131	0.192	0.973	10.873

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Klickitat County Census Division 02 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.015	0.000	0.001	0.017
1945	Inhalation	0.002	0.017	0.511	0.001	0.012	0.391
1945	Milk from BYCow Regime 3	0.004	0.075	2.396	0.000	0.006	0.135
1945	Milk from BYCow Regime 4	0.001	0.015	0.886	0.000	0.002	0.076
1945	Commercial Milk (Rural)	0.001	0.015	0.336	0.000	0.001	0.025
1945	Fruit and Vegetables*	0.132	1.066	13.710	0.098	0.714	9.753
1946	External	0.000	0.000	0.007	0.000	0.000	0.008
1946	Inhalation	0.000	0.004	0.146	0.000	0.004	0.130
1946	Milk from BYCow Regime 3	0.001	0.007	0.195	0.000	0.001	0.015
1946	Milk from BYCow Regime 4	0.000	0.003	0.106	0.000	0.000	0.005
1946	Commercial Milk (Rural)	0.000	0.002	0.035	0.000	0.000	0.004
1946	Fruit and Vegetables*	0.021	0.183	2.900	0.016	0.123	1.503
1947	External	0.000	0.000	0.001	0.000	0.000	0.002
1947	Inhalation	0.000	0.001	0.042	0.000	0.001	0.036
1947	Milk from BYCow Regime 3	0.000	0.003	0.125	0.000	0.000	0.004
1947	Milk from BYCow Regime 4	0.000	0.001	0.027	0.000	0.000	0.003
1947	Commercial Milk (Rural)	0.000	0.000	0.016	0.000	0.000	0.001
1947	Fruit and Vegetables*	0.004	0.035	0.441	0.003	0.022	0.346
1945-1947	External	0.000	0.002	0.029	0.000	0.002	0.031
1945-1947	Inhalation	0.006	0.041	0.977	0.005	0.031	0.749
1945-1947	Milk from BYCow Regime 3	0.016	0.146	2.028	0.001	0.011	0.143
1945-1947	Milk from BYCow Regime 4	0.004	0.041	0.718	0.000	0.004	0.185
1945-1947	Commercial Milk (Rural)	0.003	0.027	0.356	0.000	0.002	0.030
1945-1947	Fruit and Vegetables*	0.345	1.736	13.705	0.244	1.152	11.887

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Klickitat County Census Division 03

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.003	0.000	0.000	0.002
1945	Inhalation	0.000	0.003	0.083	0.000	0.002	0.070
1945	Milk from BYCow Regime 3	0.001	0.011	0.378	0.000	0.001	0.024
1945	Milk from BYCow Regime 4	0.000	0.003	0.172	0.000	0.000	0.016
1945	Commercial Milk (Rural)	0.000	0.001	0.051	0.000	0.000	0.004
1945	Fruit and Vegetables*	0.028	0.223	5.977	0.018	0.131	2.562
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.000	0.001	0.023	0.000	0.000	0.016
1946	Milk from BYCow Regime 3	0.000	0.002	0.037	0.000	0.000	0.004
1946	Milk from BYCow Regime 4	0.000	0.000	0.009	0.000	0.000	0.001
1946	Commercial Milk (Rural)	0.000	0.000	0.007	0.000	0.000	0.001
1946	Fruit and Vegetables*	0.004	0.037	0.832	0.003	0.022	0.474
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.005	0.000	0.000	0.004
1947	Milk from BYCow Regime 3	0.000	0.000	0.010	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.007	0.000	0.000	0.000
1947	Commercial Milk (Rural)	0.000	0.000	0.002	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.001	0.006	0.105	0.000	0.004	0.065
1945-1947	External	0.000	0.000	0.005	0.000	0.000	0.004
1945-1947	Inhalation	0.001	0.006	0.128	0.001	0.005	0.090
1945-1947	Milk from BYCow Regime 3	0.003	0.025	0.355	0.000	0.002	0.024
1945-1947	Milk from BYCow Regime 4	0.001	0.005	0.151	0.000	0.000	0.019
1945-1947	Commercial Milk (Rural)	0.000	0.003	0.056	0.000	0.000	0.004
1945-1947	Fruit and Vegetables*	0.069	0.383	6.486	0.041	0.215	3.239

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Klickitat County Census Division 04 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.002	0.000	0.000	0.002
1945	Inhalation	0.000	0.003	0.044	0.000	0.002	0.043
1945	Milk from BYCow Regime 3	0.001	0.016	0.216	0.000	0.001	0.020
1945	Milk from BYCow Regime 4	0.000	0.003	0.118	0.000	0.000	0.020
1945	Commercial Milk (Rural)	0.000	0.002	0.044	0.000	0.000	0.005
1945	Fruit and Vegetables*	0.029	0.187	1.921	0.019	0.119	1.179
1946	External	0.000	0.000	0.000	0.000	0.000	0.000
1946	Inhalation	0.000	0.000	0.011	0.000	0.000	0.005
1946	Milk from BYCow Regime 3	0.000	0.002	0.039	0.000	0.000	0.004
1946	Milk from BYCow Regime 4	0.000	0.001	0.015	0.000	0.000	0.001
1946	Commercial Milk (Rural)	0.000	0.000	0.006	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.004	0.025	0.249	0.003	0.016	0.169
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.002	0.000	0.000	0.002
1947	Milk from BYCow Regime 3	0.000	0.000	0.010	0.000	0.000	0.000
1947	Milk from BYCow Regime 4	0.000	0.000	0.002	0.000	0.000	0.000
1947	Commercial Milk (Rural)	0.000	0.000	0.003	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.001	0.005	0.056	0.000	0.003	0.031
1945-1947	External	0.000	0.000	0.003	0.000	0.000	0.003
1945-1947	Inhalation	0.001	0.005	0.066	0.001	0.004	0.063
1945-1947	Milk from BYCow Regime 3	0.003	0.023	0.231	0.000	0.002	0.016
1945-1947	Milk from BYCow Regime 4	0.000	0.007	0.135	0.000	0.000	0.013
1945-1947	Commercial Milk (Rural)	0.000	0.004	0.065	0.000	0.000	0.006
1945-1947	Fruit and Vegetables*	0.062	0.267	1.945	0.038	0.171	1.363

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Klickitat County Census Division 05

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.005	0.000	0.000	0.004
1945	Inhalation	0.000	0.003	0.142	0.000	0.002	0.069
1945	Milk from BYCow Regime 1	0.036	0.569	18.231	0.003	0.032	0.660
1945	Milk from BYCow Regime 2	0.024	0.324	6.381	0.002	0.030	0.553
1945	Milk from BYCow Regime 3	0.001	0.015	0.420	0.000	0.001	0.053
1945	Milk from BYCow Regime 4	0.000	0.004	0.177	0.000	0.000	0.022
1945	Commercial Milk (Rural)	0.008	0.160	2.694	0.001	0.010	0.168
1945	Fruit and Vegetables*	0.027	0.235	6.009	0.019	0.149	2.485
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.000	0.001	0.012	0.000	0.000	0.010
1946	Milk from BYCow Regime 1	0.005	0.077	1.561	0.000	0.005	0.173
1946	Milk from BYCow Regime 2	0.004	0.065	2.870	0.000	0.004	0.111
1946	Milk from BYCow Regime 3	0.000	0.002	0.092	0.000	0.000	0.008
1946	Milk from BYCow Regime 4	0.000	0.000	0.032	0.000	0.000	0.003
1946	Commercial Milk (Rural)	0.002	0.019	0.394	0.000	0.002	0.053
1946	Fruit and Vegetables*	0.004	0.034	0.823	0.003	0.018	0.340
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.003	0.000	0.000	0.004
1947	Milk from BYCow Regime 1	0.001	0.020	0.682	0.000	0.001	0.035
1947	Milk from BYCow Regime 2	0.001	0.019	0.378	0.000	0.002	0.031
1947	Milk from BYCow Regime 3	0.000	0.000	0.015	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.007	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.000	0.005	0.121	0.000	0.000	0.014
1947	Fruit and Vegetables*	0.001	0.006	0.089	0.000	0.004	0.067
1945-1947	External	0.000	0.000	0.007	0.000	0.000	0.005
1945-1947	Inhalation	0.001	0.006	0.184	0.001	0.004	0.084
1945-1947	Milk from BYCow Regime 1	0.101	0.971	15.089	0.008	0.065	1.092
1945-1947	Milk from BYCow Regime 2	0.095	0.659	7.799	0.007	0.056	0.707
1945-1947	Milk from BYCow Regime 3	0.003	0.031	0.476	0.000	0.003	0.053
1945-1947	Milk from BYCow Regime 4	0.001	0.008	0.286	0.000	0.001	0.024
1945-1947	Commercial Milk (Rural)	0.034	0.282	3.296	0.002	0.017	0.214
1945-1947	Fruit and Vegetables*	0.068	0.395	8.541	0.044	0.233	2.710

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Klickitat County Census Division 06 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.005	0.000	0.000	0.004
1945	Inhalation	0.000	0.003	0.097	0.000	0.002	0.074
1945	Milk from BYCow Regime 1	0.026	0.395	7.273	0.002	0.033	0.868
1945	Milk from BYCow Regime 2	0.023	0.454	19.261	0.002	0.027	0.790
1945	Milk from BYCow Regime 3	0.001	0.016	0.445	0.000	0.001	0.062
1945	Milk from BYCow Regime 4	0.000	0.003	0.264	0.000	0.000	0.018
1945	Commercial Milk (Rural)	0.011	0.180	5.086	0.001	0.011	0.680
1945	Fruit and Vegetables*	0.027	0.237	4.435	0.019	0.153	2.697
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.000	0.001	0.021	0.000	0.000	0.010
1946	Milk from BYCow Regime 1	0.005	0.077	1.324	0.000	0.004	0.130
1946	Milk from BYCow Regime 2	0.004	0.052	1.235	0.000	0.003	0.060
1946	Milk from BYCow Regime 3	0.000	0.002	0.043	0.000	0.000	0.006
1946	Milk from BYCow Regime 4	0.000	0.001	0.035	0.000	0.000	0.002
1946	Commercial Milk (Rural)	0.001	0.015	0.244	0.000	0.002	0.034
1946	Fruit and Vegetables*	0.004	0.033	0.652	0.003	0.022	0.362
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.003	0.000	0.000	0.002
1947	Milk from BYCow Regime 1	0.001	0.014	0.306	0.000	0.001	0.019
1947	Milk from BYCow Regime 2	0.001	0.018	0.326	0.000	0.001	0.027
1947	Milk from BYCow Regime 3	0.000	0.000	0.011	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.014	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.000	0.005	0.149	0.000	0.000	0.012
1947	Fruit and Vegetables*	0.001	0.005	0.070	0.000	0.004	0.071
1945-1947	External	0.000	0.000	0.008	0.000	0.000	0.005
1945-1947	Inhalation	0.001	0.006	0.152	0.001	0.004	0.090
1945-1947	Milk from BYCow Regime 1	0.095	0.666	7.805	0.007	0.054	1.159
1945-1947	Milk from BYCow Regime 2	0.087	0.727	20.511	0.007	0.049	0.707
1945-1947	Milk from BYCow Regime 3	0.003	0.027	0.637	0.000	0.003	0.062
1945-1947	Milk from BYCow Regime 4	0.001	0.009	0.225	0.000	0.001	0.021
1945-1947	Commercial Milk (Rural)	0.026	0.247	4.564	0.003	0.022	0.729
1945-1947	Fruit and Vegetables*	0.064	0.375	5.673	0.043	0.249	2.735

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Klickitat County Census Division 07

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.004	0.000	0.000	0.006
1945	Inhalation	0.000	0.002	0.083	0.000	0.002	0.073
1945	Milk from BYCow Regime 3	0.001	0.011	0.243	0.000	0.001	0.039
1945	Milk from BYCow Regime 4	0.000	0.003	0.093	0.000	0.000	0.023
1945	Commercial Milk (Rural)	0.000	0.002	0.045	0.000	0.000	0.004
1945	Fruit and Vegetables*	0.026	0.233	4.765	0.018	0.142	2.915
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.000	0.001	0.020	0.000	0.000	0.012
1946	Milk from BYCow Regime 3	0.000	0.002	0.072	0.000	0.000	0.002
1946	Milk from BYCow Regime 4	0.000	0.000	0.032	0.000	0.000	0.002
1946	Commercial Milk (Rural)	0.000	0.000	0.008	0.000	0.000	0.001
1946	Fruit and Vegetables*	0.004	0.032	0.640	0.003	0.018	0.334
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.004	0.000	0.000	0.003
1947	Milk from BYCow Regime 3	0.000	0.000	0.005	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.006	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.000	0.000	0.005	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.001	0.005	0.126	0.001	0.004	0.056
1945-1947	External	0.000	0.000	0.005	0.000	0.000	0.009
1945-1947	Inhalation	0.001	0.006	0.115	0.001	0.004	0.083
1945-1947	Milk from BYCow Regime 3	0.003	0.020	0.294	0.000	0.002	0.043
1945-1947	Milk from BYCow Regime 4	0.000	0.008	0.156	0.000	0.001	0.020
1945-1947	Commercial Milk (Rural)	0.000	0.003	0.048	0.000	0.000	0.004
1945-1947	Fruit and Vegetables*	0.069	0.410	6.169	0.042	0.217	3.101

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Klickitat County Census Division 08 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.005	0.000	0.000	0.006
1945	Inhalation	0.000	0.003	0.095	0.000	0.002	0.078
1945	Milk from BYCow Regime 3	0.001	0.013	0.485	0.000	0.001	0.022
1945	Milk from BYCow Regime 4	0.000	0.002	0.133	0.000	0.000	0.008
1945	Commercial Milk (Rural)	0.000	0.002	0.045	0.000	0.000	0.004
1945	Fruit and Vegetables*	0.026	0.227	3.576	0.018	0.132	2.250
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.000	0.000	0.012	0.000	0.000	0.010
1946	Milk from BYCow Regime 3	0.000	0.002	0.063	0.000	0.000	0.003
1946	Milk from BYCow Regime 4	0.000	0.000	0.026	0.000	0.000	0.001
1946	Commercial Milk (Rural)	0.000	0.000	0.006	0.000	0.000	0.001
1946	Fruit and Vegetables*	0.003	0.030	0.597	0.003	0.019	0.287
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.003	0.000	0.000	0.002
1947	Milk from BYCow Regime 3	0.000	0.000	0.004	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.007	0.000	0.000	0.000
1947	Commercial Milk (Rural)	0.000	0.000	0.003	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.001	0.006	0.077	0.001	0.004	0.054
1945-1947	External	0.000	0.000	0.005	0.000	0.000	0.006
1945-1947	Inhalation	0.001	0.005	0.126	0.001	0.004	0.104
1945-1947	Milk from BYCow Regime 3	0.003	0.021	0.564	0.000	0.002	0.026
1945-1947	Milk from BYCow Regime 4	0.000	0.006	0.164	0.000	0.000	0.012
1945-1947	Commercial Milk (Rural)	0.000	0.004	0.059	0.000	0.000	0.005
1945-1947	Fruit and Vegetables*	0.060	0.353	4.329	0.040	0.213	2.408

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Klickitat County Census Division 09

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.003	0.000	0.000	0.003
1945	Inhalation	0.000	0.003	0.102	0.000	0.002	0.096
1945	Milk from BYCow Regime 3	0.001	0.011	0.170	0.000	0.001	0.024
1945	Milk from BYCow Regime 4	0.000	0.003	0.196	0.000	0.000	0.012
1945	Commercial Milk (Rural)	0.000	0.002	0.041	0.000	0.000	0.005
1945	Fruit and Vegetables*	0.025	0.220	3.659	0.016	0.124	2.307
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.000	0.001	0.016	0.000	0.000	0.013
1946	Milk from BYCow Regime 3	0.000	0.001	0.038	0.000	0.000	0.003
1946	Milk from BYCow Regime 4	0.000	0.000	0.018	0.000	0.000	0.003
1946	Commercial Milk (Rural)	0.000	0.000	0.009	0.000	0.000	0.000
1946	Fruit and Vegetables*	0.004	0.035	1.451	0.002	0.021	0.713
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.006	0.000	0.000	0.002
1947	Milk from BYCow Regime 3	0.000	0.001	0.009	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.013	0.000	0.000	0.001
1947	Commercial Milk (Rural)	0.000	0.000	0.002	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.001	0.006	0.092	0.000	0.004	0.067
1945-1947	External	0.000	0.000	0.004	0.000	0.000	0.003
1945-1947	Inhalation	0.001	0.005	0.131	0.001	0.004	0.102
1945-1947	Milk from BYCow Regime 3	0.003	0.019	0.184	0.000	0.002	0.026
1945-1947	Milk from BYCow Regime 4	0.000	0.007	0.204	0.000	0.000	0.016
1945-1947	Commercial Milk (Rural)	0.000	0.003	0.047	0.000	0.000	0.005
1945-1947	Fruit and Vegetables*	0.065	0.401	6.255	0.040	0.212	3.525

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Klickitat County Census Division 10 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.003	0.000	0.000	0.003
1945	Inhalation	0.000	0.002	0.089	0.000	0.002	0.081
1945	Milk from BYCow Regime 3	0.001	0.012	0.171	0.000	0.001	0.020
1945	Milk from BYCow Regime 4	0.000	0.002	0.093	0.000	0.000	0.015
1945	Commercial Milk (Rural)	0.000	0.001	0.068	0.000	0.000	0.003
1945	Fruit and Vegetables*	0.025	0.222	5.056	0.017	0.127	1.860
1946	External	0.000	0.000	0.001	0.000	0.000	0.001
1946	Inhalation	0.000	0.001	0.017	0.000	0.000	0.012
1946	Milk from BYCow Regime 3	0.000	0.002	0.031	0.000	0.000	0.003
1946	Milk from BYCow Regime 4	0.000	0.000	0.019	0.000	0.000	0.002
1946	Commercial Milk (Rural)	0.000	0.000	0.008	0.000	0.000	0.001
1946	Fruit and Vegetables*	0.004	0.037	0.670	0.003	0.020	0.421
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.004	0.000	0.000	0.003
1947	Milk from BYCow Regime 3	0.000	0.000	0.007	0.000	0.000	0.001
1947	Milk from BYCow Regime 4	0.000	0.000	0.007	0.000	0.000	0.000
1947	Commercial Milk (Rural)	0.000	0.000	0.003	0.000	0.000	0.000
1947	Fruit and Vegetables*	0.001	0.006	0.101	0.000	0.004	0.069
1945-1947	External	0.000	0.000	0.005	0.000	0.000	0.004
1945-1947	Inhalation	0.001	0.005	0.126	0.001	0.004	0.108
1945-1947	Milk from BYCow Regime 3	0.003	0.020	0.240	0.000	0.002	0.021
1945-1947	Milk from BYCow Regime 4	0.000	0.006	0.130	0.000	0.001	0.013
1945-1947	Commercial Milk (Rural)	0.000	0.004	0.129	0.000	0.000	0.005
1945-1947	Fruit and Vegetables*	0.060	0.383	5.312	0.040	0.215	2.132

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Morrow County Census Division 01

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.002	0.019	0.000	0.002	0.017
1945	Inhalation	0.009	0.044	0.680	0.008	0.040	0.469
1945	Milk from BYCow Regime 1	1.104	10.292	129.015	0.082	0.687	9.386
1945	Milk from BYCow Regime 2	0.926	9.335	91.555	0.085	0.845	12.468
1945	Milk from BYCow Regime 3	0.020	0.269	3.644	0.003	0.029	0.420
1945	Milk from BYCow Regime 4	0.003	0.054	1.582	0.001	0.011	0.133
1945	Commercial Milk (Rural)	1.010	7.045	86.334	0.073	0.548	6.630
1945	Fruit and Vegetables*	0.587	3.440	37.597	0.431	2.095	21.366
1946	External	0.000	0.000	0.005	0.000	0.001	0.007
1946	Inhalation	0.002	0.011	0.166	0.002	0.009	0.148
1946	Milk from BYCow Regime 1	0.158	1.337	10.902	0.014	0.117	0.948
1946	Milk from BYCow Regime 2	0.155	1.449	14.093	0.014	0.106	1.353
1946	Milk from BYCow Regime 3	0.005	0.055	0.663	0.001	0.005	0.045
1946	Milk from BYCow Regime 4	0.000	0.006	0.160	0.000	0.001	0.013
1946	Commercial Milk (Rural)	0.141	0.933	6.992	0.013	0.083	0.665
1946	Fruit and Vegetables*	0.075	0.455	4.649	0.063	0.308	4.667
1947	External	0.000	0.000	0.002	0.000	0.000	0.002
1947	Inhalation	0.001	0.003	0.098	0.000	0.002	0.042
1947	Milk from BYCow Regime 1	0.055	0.359	2.920	0.004	0.034	0.574
1947	Milk from BYCow Regime 2	0.046	0.397	2.612	0.004	0.035	0.385
1947	Milk from BYCow Regime 3	0.001	0.016	0.236	0.000	0.001	0.013
1947	Milk from BYCow Regime 4	0.000	0.001	0.035	0.000	0.000	0.006
1947	Commercial Milk (Rural)	0.039	0.256	1.945	0.004	0.022	0.144
1947	Fruit and Vegetables*	0.015	0.084	0.694	0.013	0.061	0.485
1945-1947	External	0.001	0.004	0.028	0.001	0.003	0.033
1945-1947	Inhalation	0.022	0.088	1.194	0.018	0.071	0.786
1945-1947	Milk from BYCow Regime 1	3.148	16.305	223.673	0.248	1.107	8.441
1945-1947	Milk from BYCow Regime 2	2.647	11.710	72.632	0.261	1.398	11.306
1945-1947	Milk from BYCow Regime 3	0.089	0.509	4.442	0.008	0.043	0.444
1945-1947	Milk from BYCow Regime 4	0.010	0.110	2.290	0.002	0.015	0.149
1945-1947	Commercial Milk (Rural)	1.977	9.200	76.954	0.175	0.767	10.914
1945-1947	Fruit and Vegetables*	1.173	4.889	43.552	0.837	3.097	33.766

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Morrow County Census Division 02

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.008	0.001	0.002	0.008
1945	Inhalation	0.011	0.042	0.337	0.009	0.032	0.182
1945	Milk from BYCow Regime 1	1.130	7.225	66.275	0.082	0.561	4.571
1945	Milk from BYCow Regime 2	1.052	6.991	43.385	0.063	0.554	3.895
1945	Milk from BYCow Regime 3	0.030	0.187	1.352	0.003	0.018	0.162
1945	Milk from BYCow Regime 4	0.003	0.059	1.190	0.001	0.007	0.075
1945	Commercial Milk (Rural)	0.377	2.704	19.109	0.026	0.177	1.490
1945	Fruit and Vegetables*	0.542	2.320	14.029	0.382	1.548	7.859
1946	External	0.000	0.000	0.002	0.000	0.000	0.003
1946	Inhalation	0.002	0.008	0.059	0.002	0.007	0.048
1946	Milk from BYCow Regime 1	0.168	1.269	10.500	0.017	0.094	0.738
1946	Milk from BYCow Regime 2	0.166	0.969	6.526	0.014	0.097	0.695
1946	Milk from BYCow Regime 3	0.004	0.030	0.251	0.000	0.003	0.019
1946	Milk from BYCow Regime 4	0.001	0.011	0.188	0.000	0.001	0.009
1946	Commercial Milk (Rural)	0.059	0.425	3.230	0.004	0.031	0.266
1946	Fruit and Vegetables*	0.078	0.361	2.647	0.056	0.250	1.723
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.001	0.002	0.025	0.001	0.002	0.017
1947	Milk from BYCow Regime 1	0.044	0.324	2.263	0.005	0.029	0.215
1947	Milk from BYCow Regime 2	0.048	0.327	2.121	0.004	0.027	0.159
1947	Milk from BYCow Regime 3	0.001	0.009	0.100	0.000	0.001	0.008
1947	Milk from BYCow Regime 4	0.000	0.003	0.054	0.000	0.000	0.005
1947	Commercial Milk (Rural)	0.016	0.110	1.029	0.001	0.010	0.080
1947	Fruit and Vegetables*	0.013	0.069	0.407	0.012	0.048	0.270
1945-1947	External	0.001	0.002	0.012	0.001	0.002	0.013
1945-1947	Inhalation	0.022	0.064	0.405	0.018	0.048	0.318
1945-1947	Milk from BYCow Regime 1	2.605	10.842	61.320	0.211	0.872	3.877
1945-1947	Milk from BYCow Regime 2	2.570	10.089	51.385	0.198	0.847	4.788
1945-1947	Milk from BYCow Regime 3	0.076	0.296	1.681	0.006	0.029	0.179
1945-1947	Milk from BYCow Regime 4	0.014	0.112	1.039	0.002	0.011	0.077
1945-1947	Commercial Milk (Rural)	0.958	3.771	20.136	0.071	0.304	1.974
1945-1947	Fruit and Vegetables*	0.979	3.233	15.725	0.692	2.164	9.025

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Morrow County Census Division 03

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.002	0.031	0.000	0.002	0.022
1945	Inhalation	0.006	0.033	0.609	0.005	0.028	0.456
1945	Milk from BYCow Regime 1	0.724	5.582	56.107	0.059	0.486	7.516
1945	Milk from BYCow Regime 2	0.587	5.749	76.852	0.044	0.434	5.201
1945	Milk from BYCow Regime 3	0.021	0.203	2.107	0.002	0.016	0.167
1945	Milk from BYCow Regime 4	0.003	0.045	1.437	0.000	0.006	0.082
1945	Commercial Milk (Rural)	0.270	2.384	26.744	0.020	0.173	2.154
1945	Fruit and Vegetables*	0.402	2.113	28.995	0.298	1.406	13.231
1946	External	0.000	0.000	0.010	0.000	0.000	0.010
1946	Inhalation	0.001	0.007	0.322	0.001	0.006	0.180
1946	Milk from BYCow Regime 1	0.103	0.767	19.728	0.008	0.056	0.632
1946	Milk from BYCow Regime 2	0.099	0.813	10.294	0.008	0.069	0.798
1946	Milk from BYCow Regime 3	0.003	0.021	0.253	0.000	0.002	0.019
1946	Milk from BYCow Regime 4	0.000	0.008	0.100	0.000	0.001	0.011
1946	Commercial Milk (Rural)	0.032	0.253	2.446	0.003	0.022	0.311
1946	Fruit and Vegetables*	0.056	0.307	3.929	0.036	0.200	2.510
1947	External	0.000	0.000	0.005	0.000	0.000	0.005
1947	Inhalation	0.000	0.002	0.083	0.000	0.002	0.047
1947	Milk from BYCow Regime 1	0.028	0.234	2.461	0.003	0.021	0.202
1947	Milk from BYCow Regime 2	0.029	0.249	2.311	0.003	0.025	0.279
1947	Milk from BYCow Regime 3	0.001	0.005	0.055	0.000	0.000	0.006
1947	Milk from BYCow Regime 4	0.000	0.003	0.044	0.000	0.000	0.008
1947	Commercial Milk (Rural)	0.011	0.077	1.109	0.001	0.006	0.052
1947	Fruit and Vegetables*	0.010	0.059	0.523	0.008	0.046	0.440
1945-1947	External	0.001	0.003	0.085	0.001	0.003	0.059
1945-1947	Inhalation	0.016	0.065	1.644	0.013	0.055	1.319
1945-1947	Milk from BYCow Regime 1	1.917	7.984	69.349	0.131	0.680	7.698
1945-1947	Milk from BYCow Regime 2	1.493	7.405	60.981	0.135	0.767	8.684
1945-1947	Milk from BYCow Regime 3	0.050	0.293	2.814	0.005	0.024	0.177
1945-1947	Milk from BYCow Regime 4	0.013	0.093	1.018	0.001	0.009	0.078
1945-1947	Commercial Milk (Rural)	0.608	3.068	27.403	0.054	0.240	2.438
1945-1947	Fruit and Vegetables*	0.784	3.185	38.608	0.562	2.066	16.537

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Umatilla County Census Division 01 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.003	0.005	0.014	0.003	0.006	0.015
1945	Inhalation	0.062	0.185	0.665	0.054	0.148	0.503
1945	Milk from BYCow Regime 1	7.364	45.923	230.356	0.483	3.159	12.987
1945	Milk from BYCow Regime 2	7.661	41.733	226.333	0.461	2.817	14.446
1945	Milk from BYCow Regime 3	0.148	1.473	14.175	0.015	0.103	1.418
1945	Milk from BYCow Regime 4	0.015	0.211	4.262	0.003	0.025	0.298
1945	Commercial Milk (Rural)	9.271	37.338	114.822	0.715	2.572	9.223
1945	Fruit and Vegetables*	2.382	9.344	44.364	1.614	5.832	25.861
1946	External	0.001	0.001	0.003	0.001	0.001	0.003
1946	Inhalation	0.014	0.041	0.156	0.013	0.031	0.100
1946	Milk from BYCow Regime 1	1.065	5.961	38.543	0.095	0.512	2.607
1946	Milk from BYCow Regime 2	1.100	6.193	33.303	0.079	0.458	2.305
1946	Milk from BYCow Regime 3	0.026	0.217	2.280	0.002	0.016	0.097
1946	Milk from BYCow Regime 4	0.002	0.040	0.542	0.001	0.005	0.048
1946	Commercial Milk (Rural)	1.356	6.286	16.171	0.116	0.420	1.267
1946	Fruit and Vegetables*	0.321	1.158	5.342	0.240	0.860	3.870
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.004	0.012	0.054	0.003	0.009	0.037
1947	Milk from BYCow Regime 1	0.333	1.828	10.276	0.025	0.134	0.996
1947	Milk from BYCow Regime 2	0.330	1.866	16.517	0.028	0.161	0.755
1947	Milk from BYCow Regime 3	0.007	0.049	0.438	0.001	0.005	0.031
1947	Milk from BYCow Regime 4	0.001	0.008	0.169	0.000	0.001	0.013
1947	Commercial Milk (Rural)	0.451	1.646	5.796	0.034	0.120	0.482
1947	Fruit and Vegetables*	0.056	0.213	0.914	0.042	0.171	0.746
1945-1947	External	0.004	0.008	0.017	0.004	0.008	0.017
1945-1947	Inhalation	0.115	0.260	0.758	0.097	0.206	0.561
1945-1947	Milk from BYCow Regime 1	15.845	61.603	244.861	1.185	4.578	15.263
1945-1947	Milk from BYCow Regime 2	17.000	56.686	277.984	1.100	3.563	15.974
1945-1947	Milk from BYCow Regime 3	0.415	2.243	19.620	0.036	0.152	1.566
1945-1947	Milk from BYCow Regime 4	0.047	0.380	6.886	0.009	0.043	0.341
1945-1947	Commercial Milk (Rural)	16.734	46.171	131.171	1.246	3.398	9.709
1945-1947	Fruit and Vegetables*	3.768	11.723	48.666	2.739	7.557	26.450

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Umatilla County Census Division 02

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.014	0.002	0.005	0.014
1945	Inhalation	0.064	0.182	0.688	0.051	0.139	0.460
1945	Milk from BYCow Regime 1	7.179	42.235	215.978	0.612	3.627	23.602
1945	Milk from BYCow Regime 2	7.499	41.770	188.629	0.732	4.303	19.473
1945	Milk from BYCow Regime 3	0.165	1.360	12.566	0.019	0.135	1.478
1945	Milk from BYCow Regime 4	0.014	0.207	6.283	0.004	0.034	0.463
1945	Commercial Milk (Rural)	11.632	55.640	177.815	1.002	4.274	12.946
1945	Fruit and Vegetables*	2.348	8.902	42.593	1.628	6.129	26.174
1946	External	0.001	0.001	0.003	0.001	0.001	0.003
1946	Inhalation	0.013	0.035	0.113	0.012	0.030	0.090
1946	Milk from BYCow Regime 1	1.310	6.187	29.018	0.115	0.649	3.625
1946	Milk from BYCow Regime 2	1.373	7.360	53.208	0.095	0.590	3.661
1946	Milk from BYCow Regime 3	0.022	0.221	2.730	0.003	0.018	0.147
1946	Milk from BYCow Regime 4	0.003	0.029	0.834	0.001	0.006	0.068
1946	Commercial Milk (Rural)	2.123	8.838	31.051	0.164	0.652	2.301
1946	Fruit and Vegetables*	0.340	1.246	5.489	0.263	0.940	3.965
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.004	0.011	0.042	0.003	0.008	0.030
1947	Milk from BYCow Regime 1	0.364	2.100	12.987	0.028	0.157	1.005
1947	Milk from BYCow Regime 2	0.350	1.980	11.121	0.023	0.137	0.912
1947	Milk from BYCow Regime 3	0.006	0.061	0.713	0.001	0.005	0.041
1947	Milk from BYCow Regime 4	0.001	0.009	0.227	0.000	0.001	0.010
1947	Commercial Milk (Rural)	0.571	2.274	6.665	0.051	0.184	0.627
1947	Fruit and Vegetables*	0.059	0.233	1.103	0.050	0.190	1.014
1945-1947	External	0.004	0.007	0.016	0.004	0.007	0.017
1945-1947	Inhalation	0.112	0.249	0.737	0.088	0.190	0.534
1945-1947	Milk from BYCow Regime 1	17.107	58.340	228.244	1.322	5.046	26.377
1945-1947	Milk from BYCow Regime 2	17.093	59.225	234.636	1.304	5.214	17.724
1945-1947	Milk from BYCow Regime 3	0.462	2.263	14.583	0.044	0.206	1.564
1945-1947	Milk from BYCow Regime 4	0.052	0.364	8.297	0.012	0.052	0.638
1945-1947	Commercial Milk (Rural)	23.649	67.738	195.368	1.776	5.482	13.294
1945-1947	Fruit and Vegetables*	3.840	11.375	44.117	2.802	8.037	29.798

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Umatilla County Census Division 03 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.014	0.002	0.004	0.015
1945	Inhalation	0.040	0.129	0.583	0.034	0.101	0.415
1945	Milk from BYCow Regime 1	3.761	21.291	142.917	0.288	2.154	14.498
1945	Milk from BYCow Regime 2	3.261	23.897	185.316	0.247	1.899	12.548
1945	Milk from BYCow Regime 3	0.094	0.870	6.813	0.008	0.061	0.474
1945	Milk from BYCow Regime 4	0.010	0.170	3.436	0.002	0.017	0.217
1945	Commercial Milk (Rural)	2.508	13.242	90.469	0.201	1.133	6.578
1945	Fruit and Vegetables*	1.454	6.221	29.803	1.072	4.126	21.272
1946	External	0.000	0.001	0.003	0.000	0.001	0.003
1946	Inhalation	0.009	0.027	0.100	0.008	0.021	0.076
1946	Milk from BYCow Regime 1	0.547	2.946	15.940	0.037	0.240	1.745
1946	Milk from BYCow Regime 2	0.538	3.274	17.961	0.035	0.257	1.567
1946	Milk from BYCow Regime 3	0.009	0.082	0.791	0.001	0.007	0.054
1946	Milk from BYCow Regime 4	0.002	0.023	0.500	0.000	0.003	0.035
1946	Commercial Milk (Rural)	0.405	2.037	11.781	0.033	0.159	1.504
1946	Fruit and Vegetables*	0.213	0.824	4.220	0.157	0.572	2.646
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.008	0.033	0.002	0.006	0.026
1947	Milk from BYCow Regime 1	0.136	1.017	8.274	0.012	0.075	0.391
1947	Milk from BYCow Regime 2	0.155	0.867	5.693	0.010	0.062	0.397
1947	Milk from BYCow Regime 3	0.003	0.022	0.284	0.000	0.002	0.019
1947	Milk from BYCow Regime 4	0.000	0.006	0.096	0.000	0.001	0.009
1947	Commercial Milk (Rural)	0.107	0.584	3.100	0.008	0.046	0.256
1947	Fruit and Vegetables*	0.038	0.139	0.706	0.030	0.114	0.521
1945-1947	External	0.003	0.006	0.017	0.003	0.006	0.017
1945-1947	Inhalation	0.074	0.176	0.643	0.064	0.141	0.461
1945-1947	Milk from BYCow Regime 1	8.111	29.995	169.071	0.622	2.800	15.389
1945-1947	Milk from BYCow Regime 2	7.949	31.020	132.663	0.653	2.563	13.196
1945-1947	Milk from BYCow Regime 3	0.230	1.072	5.668	0.019	0.082	0.457
1945-1947	Milk from BYCow Regime 4	0.042	0.288	3.965	0.005	0.027	0.226
1945-1947	Commercial Milk (Rural)	5.868	20.671	113.480	0.389	1.521	6.447
1945-1947	Fruit and Vegetables*	2.572	7.925	30.309	1.817	5.225	22.787

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Umatilla County Census Division 04

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.003	0.007	0.019	0.003	0.007	0.019
1945	Inhalation	0.074	0.220	0.742	0.065	0.181	0.586
1945	Milk from BYCow Regime 3	0.108	1.114	12.250	0.007	0.076	0.637
1945	Milk from BYCow Regime 4	0.008	0.260	5.977	0.001	0.016	0.367
1945	Commercial Milk (Rural)	0.704	3.973	36.053	0.045	0.295	3.398
1945	Fruit and Vegetables*	2.425	10.173	45.079	1.716	6.500	32.661
1946	External	0.001	0.002	0.004	0.001	0.002	0.004
1946	Inhalation	0.019	0.054	0.174	0.017	0.043	0.134
1946	Milk from BYCow Regime 3	0.016	0.189	1.531	0.001	0.012	0.078
1946	Milk from BYCow Regime 4	0.001	0.028	0.623	0.000	0.002	0.041
1946	Commercial Milk (Rural)	0.105	0.580	4.002	0.008	0.038	0.230
1946	Fruit and Vegetables*	0.343	1.337	6.733	0.268	0.987	4.195
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.005	0.016	0.065	0.005	0.013	0.046
1947	Milk from BYCow Regime 3	0.005	0.053	0.335	0.000	0.004	0.041
1947	Milk from BYCow Regime 4	0.000	0.009	0.163	0.000	0.001	0.022
1947	Commercial Milk (Rural)	0.031	0.169	1.037	0.002	0.013	0.065
1947	Fruit and Vegetables*	0.059	0.230	1.027	0.047	0.166	0.699
1945-1947	External	0.005	0.009	0.023	0.005	0.010	0.021
1945-1947	Inhalation	0.144	0.315	0.871	0.120	0.257	0.686
1945-1947	Milk from BYCow Regime 3	0.298	1.735	12.652	0.022	0.106	0.700
1945-1947	Milk from BYCow Regime 4	0.038	0.420	6.325	0.004	0.033	0.387
1945-1947	Commercial Milk (Rural)	1.350	5.366	35.371	0.105	0.404	3.525
1945-1947	Fruit and Vegetables*	4.034	12.559	48.504	3.075	8.447	35.884

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Umatilla County Census Division 05 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.012	0.002	0.004	0.012
1945	Inhalation	0.055	0.164	0.605	0.046	0.126	0.409
1945	Milk from BYCow Regime 3	0.133	1.117	9.926	0.009	0.091	1.025
1945	Milk from BYCow Regime 4	0.005	0.160	4.246	0.000	0.012	0.567
1945	Commercial Milk (Urban)	17.306	65.692	212.094	0.823	3.616	11.185
1945	Fruit and Vegetables*	2.101	7.535	35.827	1.508	5.273	22.369
1946	External	0.000	0.001	0.003	0.000	0.001	0.003
1946	Inhalation	0.012	0.033	0.109	0.010	0.026	0.087
1946	Milk from BYCow Regime 3	0.025	0.180	1.879	0.001	0.014	0.153
1946	Milk from BYCow Regime 4	0.001	0.026	0.414	0.000	0.002	0.048
1946	Commercial Milk (Urban)	2.610	10.270	28.271	0.158	0.577	1.865
1946	Fruit and Vegetables*	0.298	1.105	4.836	0.210	0.825	3.561
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.010	0.049	0.003	0.008	0.030
1947	Milk from BYCow Regime 3	0.004	0.042	0.475	0.001	0.004	0.039
1947	Milk from BYCow Regime 4	0.000	0.007	0.220	0.000	0.001	0.015
1947	Commercial Milk (Urban)	0.756	2.579	8.564	0.040	0.165	0.687
1947	Fruit and Vegetables*	0.052	0.207	1.088	0.041	0.152	0.745
1945-1947	External	0.003	0.006	0.014	0.003	0.006	0.014
1945-1947	Inhalation	0.098	0.226	0.706	0.082	0.175	0.466
1945-1947	Milk from BYCow Regime 3	0.320	1.660	11.615	0.030	0.134	0.953
1945-1947	Milk from BYCow Regime 4	0.031	0.284	3.647	0.002	0.021	0.529
1945-1947	Commercial Milk (Urban)	30.267	78.022	236.069	1.626	4.640	11.931
1945-1947	Fruit and Vegetables*	3.547	9.866	39.367	2.465	6.772	23.296

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Umatilla County Census Division 06

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.012	0.002	0.005	0.014
1945	Inhalation	0.052	0.152	0.600	0.043	0.117	0.419
1945	Milk from BYCow Regime 3	0.105	0.806	5.378	0.009	0.074	0.547
1945	Milk from BYCow Regime 4	0.004	0.146	3.544	0.000	0.014	0.279
1945	Commercial Milk (Urban)	6.230	24.725	91.725	0.303	1.309	5.259
1945	Fruit and Vegetables*	1.753	6.891	30.679	1.318	4.610	21.682
1946	External	0.001	0.001	0.003	0.001	0.001	0.003
1946	Inhalation	0.013	0.037	0.123	0.011	0.028	0.079
1946	Milk from BYCow Regime 3	0.014	0.104	1.016	0.001	0.009	0.065
1946	Milk from BYCow Regime 4	0.001	0.021	0.610	0.000	0.002	0.038
1946	Commercial Milk (Urban)	0.918	3.666	14.189	0.044	0.203	0.730
1946	Fruit and Vegetables*	0.239	0.891	4.693	0.185	0.656	2.690
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.004	0.011	0.047	0.003	0.009	0.031
1947	Milk from BYCow Regime 3	0.003	0.024	0.172	0.000	0.002	0.016
1947	Milk from BYCow Regime 4	0.000	0.006	0.121	0.000	0.001	0.011
1947	Commercial Milk (Urban)	0.269	0.990	3.937	0.015	0.057	0.258
1947	Fruit and Vegetables*	0.043	0.171	0.884	0.034	0.128	0.652
1945-1947	External	0.004	0.007	0.014	0.004	0.007	0.015
1945-1947	Inhalation	0.096	0.215	0.652	0.081	0.168	0.470
1945-1947	Milk from BYCow Regime 3	0.215	1.168	5.565	0.020	0.098	0.653
1945-1947	Milk from BYCow Regime 4	0.032	0.289	3.439	0.003	0.025	0.296
1945-1947	Commercial Milk (Urban)	12.298	31.356	87.524	0.629	1.729	9.096
1945-1947	Fruit and Vegetables*	2.970	8.786	32.489	2.175	5.784	22.969

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Umatilla County Census Division 07 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.002	0.007	0.001	0.002	0.009
1945	Inhalation	0.021	0.067	0.290	0.018	0.054	0.190
1945	Milk from BYCow Regime 1	1.534	10.016	64.882	0.141	0.914	7.084
1945	Milk from BYCow Regime 2	1.712	11.278	72.251	0.122	0.878	5.754
1945	Milk from BYCow Regime 3	0.051	0.411	3.458	0.005	0.037	0.298
1945	Milk from BYCow Regime 4	0.006	0.090	2.293	0.001	0.012	0.193
1945	Commercial Milk (Rural)	1.874	10.403	51.673	0.126	0.658	3.754
1945	Fruit and Vegetables*	0.857	3.432	17.623	0.629	2.365	9.636
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.005	0.016	0.069	0.004	0.012	0.046
1946	Milk from BYCow Regime 1	0.306	1.652	11.160	0.024	0.152	0.985
1946	Milk from BYCow Regime 2	0.253	1.537	7.787	0.018	0.121	0.859
1946	Milk from BYCow Regime 3	0.007	0.047	0.361	0.001	0.004	0.034
1946	Milk from BYCow Regime 4	0.001	0.014	0.331	0.000	0.002	0.032
1946	Commercial Milk (Rural)	0.302	1.261	5.457	0.021	0.107	0.564
1946	Fruit and Vegetables*	0.123	0.481	2.414	0.087	0.345	1.624
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.001	0.004	0.023	0.001	0.003	0.017
1947	Milk from BYCow Regime 1	0.077	0.451	2.842	0.005	0.040	0.239
1947	Milk from BYCow Regime 2	0.098	0.543	2.965	0.007	0.043	0.280
1947	Milk from BYCow Regime 3	0.002	0.011	0.085	0.000	0.001	0.009
1947	Milk from BYCow Regime 4	0.000	0.004	0.108	0.000	0.000	0.010
1947	Commercial Milk (Rural)	0.079	0.402	1.921	0.006	0.031	0.128
1947	Fruit and Vegetables*	0.021	0.087	0.461	0.017	0.066	0.307
1945-1947	External	0.002	0.003	0.009	0.002	0.003	0.010
1945-1947	Inhalation	0.041	0.098	0.358	0.033	0.077	0.227
1945-1947	Milk from BYCow Regime 1	4.045	14.287	75.597	0.356	1.307	7.975
1945-1947	Milk from BYCow Regime 2	3.727	16.147	99.204	0.319	1.246	6.568
1945-1947	Milk from BYCow Regime 3	0.117	0.580	3.645	0.012	0.051	0.290
1945-1947	Milk from BYCow Regime 4	0.024	0.178	2.206	0.003	0.019	0.183
1945-1947	Commercial Milk (Rural)	3.580	12.627	62.043	0.277	0.934	4.821
1945-1947	Fruit and Vegetables*	1.487	4.520	18.736	1.142	2.993	10.470

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Umatilla County Census Division 08

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.009	0.002	0.004	0.010
1945	Inhalation	0.041	0.123	0.460	0.037	0.098	0.299
1945	Milk from BYCow Regime 3	0.078	0.715	5.909	0.006	0.060	0.550
1945	Milk from BYCow Regime 4	0.005	0.157	3.030	0.001	0.014	0.198
1945	Commercial Milk (Rural)	0.541	3.033	17.087	0.034	0.202	1.292
1945	Fruit and Vegetables*	1.504	5.511	25.049	1.065	3.918	18.312
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.010	0.029	0.097	0.009	0.023	0.065
1946	Milk from BYCow Regime 3	0.014	0.082	0.505	0.001	0.007	0.066
1946	Milk from BYCow Regime 4	0.001	0.018	0.396	0.000	0.002	0.028
1946	Commercial Milk (Rural)	0.072	0.451	2.681	0.006	0.030	0.163
1946	Fruit and Vegetables*	0.202	0.761	3.716	0.163	0.560	2.757
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.009	0.032	0.002	0.007	0.027
1947	Milk from BYCow Regime 3	0.002	0.023	0.154	0.000	0.002	0.013
1947	Milk from BYCow Regime 4	0.000	0.007	0.127	0.000	0.001	0.010
1947	Commercial Milk (Rural)	0.019	0.117	0.699	0.002	0.009	0.054
1947	Fruit and Vegetables*	0.039	0.145	0.664	0.031	0.115	0.495
1945-1947	External	0.003	0.005	0.010	0.003	0.005	0.012
1945-1947	Inhalation	0.078	0.177	0.537	0.066	0.137	0.358
1945-1947	Milk from BYCow Regime 3	0.201	0.920	6.441	0.016	0.083	0.578
1945-1947	Milk from BYCow Regime 4	0.028	0.234	2.368	0.003	0.021	0.260
1945-1947	Commercial Milk (Rural)	1.010	3.790	18.157	0.084	0.281	1.389
1945-1947	Fruit and Vegetables*	2.411	7.178	27.948	1.794	5.084	19.675

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Umatilla County Census Division 09 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.003	0.010	0.001	0.003	0.009
1945	Inhalation	0.026	0.086	0.400	0.022	0.064	0.314
1945	Milk from BYCow Regime 1	2.988	16.981	88.182	0.185	1.323	9.373
1945	Milk from BYCow Regime 2	2.343	14.380	91.610	0.224	1.282	10.600
1945	Milk from BYCow Regime 3	0.055	0.576	5.462	0.007	0.049	0.452
1945	Milk from BYCow Regime 4	0.011	0.138	2.559	0.002	0.019	0.239
1945	Commercial Milk (Rural)	1.945	9.973	60.287	0.163	1.029	7.504
1945	Fruit and Vegetables*	1.025	4.323	23.013	0.796	3.022	15.839
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.006	0.018	0.075	0.005	0.014	0.048
1946	Milk from BYCow Regime 1	0.444	2.435	17.573	0.028	0.177	1.089
1946	Milk from BYCow Regime 2	0.363	2.413	16.241	0.024	0.172	1.148
1946	Milk from BYCow Regime 3	0.008	0.057	0.398	0.001	0.006	0.046
1946	Milk from BYCow Regime 4	0.001	0.017	0.658	0.000	0.002	0.030
1946	Commercial Milk (Rural)	0.278	1.729	11.965	0.022	0.122	0.788
1946	Fruit and Vegetables*	0.150	0.617	3.379	0.124	0.451	2.236
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.002	0.005	0.026	0.001	0.004	0.018
1947	Milk from BYCow Regime 1	0.109	0.691	4.998	0.007	0.049	0.365
1947	Milk from BYCow Regime 2	0.094	0.638	4.698	0.007	0.040	0.216
1947	Milk from BYCow Regime 3	0.002	0.016	0.157	0.000	0.002	0.011
1947	Milk from BYCow Regime 4	0.000	0.008	0.173	0.000	0.001	0.015
1947	Commercial Milk (Rural)	0.080	0.391	2.126	0.006	0.037	0.227
1947	Fruit and Vegetables*	0.026	0.111	0.587	0.022	0.080	0.358
1945-1947	External	0.002	0.004	0.011	0.002	0.004	0.011
1945-1947	Inhalation	0.049	0.126	0.469	0.039	0.090	0.351
1945-1947	Milk from BYCow Regime 1	5.274	24.947	104.916	0.434	1.764	8.321
1945-1947	Milk from BYCow Regime 2	5.500	22.214	95.209	0.478	1.708	10.342
1945-1947	Milk from BYCow Regime 3	0.137	0.731	5.759	0.014	0.067	0.450
1945-1947	Milk from BYCow Regime 4	0.037	0.265	2.728	0.005	0.025	0.348
1945-1947	Commercial Milk (Rural)	4.192	15.431	69.460	0.359	1.356	10.701
1945-1947	Fruit and Vegetables*	1.737	5.489	24.726	1.350	3.942	16.895

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Umatilla County Census Division 10

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.003	0.007	0.001	0.002	0.006
1945	Inhalation	0.027	0.082	0.349	0.024	0.063	0.211
1945	Milk from BYCow Regime 3	0.064	0.504	4.749	0.005	0.046	0.561
1945	Milk from BYCow Regime 4	0.004	0.096	1.255	0.001	0.006	0.110
1945	Commercial Milk (Rural)	0.591	3.292	27.371	0.039	0.245	1.759
1945	Fruit and Vegetables*	1.097	3.961	18.434	0.735	2.785	12.444
1946	External	0.000	0.001	0.001	0.000	0.001	0.002
1946	Inhalation	0.006	0.017	0.058	0.005	0.014	0.045
1946	Milk from BYCow Regime 3	0.009	0.059	0.497	0.001	0.004	0.035
1946	Milk from BYCow Regime 4	0.001	0.015	0.379	0.000	0.001	0.033
1946	Commercial Milk (Rural)	0.072	0.489	3.534	0.008	0.045	0.229
1946	Fruit and Vegetables*	0.141	0.570	2.736	0.106	0.399	1.921
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.002	0.005	0.024	0.001	0.004	0.015
1947	Milk from BYCow Regime 3	0.002	0.016	0.138	0.000	0.002	0.018
1947	Milk from BYCow Regime 4	0.000	0.005	0.077	0.000	0.000	0.008
1947	Commercial Milk (Rural)	0.027	0.155	1.129	0.002	0.012	0.072
1947	Fruit and Vegetables*	0.024	0.094	0.421	0.020	0.077	0.327
1945-1947	External	0.002	0.003	0.008	0.002	0.003	0.007
1945-1947	Inhalation	0.050	0.111	0.391	0.042	0.090	0.260
1945-1947	Milk from BYCow Regime 3	0.148	0.708	4.665	0.012	0.056	0.458
1945-1947	Milk from BYCow Regime 4	0.020	0.170	1.693	0.002	0.013	0.145
1945-1947	Commercial Milk (Rural)	1.214	5.372	38.428	0.094	0.330	1.945
1945-1947	Fruit and Vegetables*	1.768	5.159	19.948	1.261	3.467	12.998

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Umatilla County Census Division 11 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.003	0.006	0.015	0.003	0.006	0.015
1945	Inhalation	0.070	0.208	0.703	0.058	0.160	0.565
1945	Milk from BYCow Regime 1	8.631	47.430	266.519	0.552	3.631	19.963
1945	Milk from BYCow Regime 2	8.553	40.012	255.990	0.542	3.219	22.083
1945	Milk from BYCow Regime 3	0.219	1.635	15.334	0.023	0.157	1.517
1945	Milk from BYCow Regime 4	0.015	0.222	4.760	0.004	0.034	0.542
1945	Commercial Milk (Rural)	12.710	41.894	172.762	0.929	4.324	13.453
1945	Fruit and Vegetables*	2.420	10.092	45.108	1.863	6.366	28.967
1946	External	0.001	0.001	0.003	0.001	0.001	0.003
1946	Inhalation	0.016	0.044	0.151	0.013	0.033	0.105
1946	Milk from BYCow Regime 1	1.478	8.393	59.013	0.100	0.553	3.068
1946	Milk from BYCow Regime 2	1.421	7.635	40.673	0.103	0.592	2.964
1946	Milk from BYCow Regime 3	0.029	0.259	2.467	0.003	0.022	0.224
1946	Milk from BYCow Regime 4	0.003	0.035	0.564	0.001	0.005	0.052
1946	Commercial Milk (Rural)	2.266	8.165	31.894	0.181	0.622	2.375
1946	Fruit and Vegetables*	0.354	1.419	7.356	0.268	0.979	4.129
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.004	0.013	0.050	0.003	0.010	0.033
1947	Milk from BYCow Regime 1	0.443	1.939	8.665	0.041	0.240	1.644
1947	Milk from BYCow Regime 2	0.437	2.201	12.188	0.028	0.191	1.960
1947	Milk from BYCow Regime 3	0.010	0.086	1.176	0.001	0.006	0.055
1947	Milk from BYCow Regime 4	0.001	0.010	0.177	0.000	0.002	0.018
1947	Commercial Milk (Rural)	0.585	2.601	7.261	0.043	0.188	0.788
1947	Fruit and Vegetables*	0.065	0.253	1.290	0.052	0.191	0.876
1945-1947	External	0.004	0.008	0.018	0.005	0.008	0.017
1945-1947	Inhalation	0.128	0.292	0.811	0.100	0.216	0.631
1945-1947	Milk from BYCow Regime 1	19.225	68.349	290.392	1.608	5.100	19.842
1945-1947	Milk from BYCow Regime 2	19.309	62.038	286.945	1.289	4.713	22.995
1945-1947	Milk from BYCow Regime 3	0.494	2.440	17.311	0.051	0.221	1.639
1945-1947	Milk from BYCow Regime 4	0.046	0.398	5.400	0.011	0.052	0.640
1945-1947	Commercial Milk (Rural)	24.458	59.174	191.765	1.791	5.411	14.814
1945-1947	Fruit and Vegetables*	4.251	12.889	47.980	3.141	8.188	29.854

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Umatilla County Census Division 12

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.014	0.002	0.004	0.015
1945	Inhalation	0.040	0.132	0.563	0.034	0.097	0.401
1945	Milk from BYCow Regime 1	3.607	22.836	142.605	0.364	1.964	15.395
1945	Milk from BYCow Regime 2	3.404	21.936	101.051	0.260	1.771	12.092
1945	Milk from BYCow Regime 3	0.067	0.665	6.905	0.008	0.077	0.606
1945	Milk from BYCow Regime 4	0.009	0.189	4.945	0.001	0.013	0.220
1945	Commercial Milk (Rural)	2.596	13.983	98.428	0.257	1.376	14.752
1945	Fruit and Vegetables*	1.414	5.924	28.802	1.130	4.174	21.056
1946	External	0.000	0.001	0.003	0.000	0.001	0.003
1946	Inhalation	0.009	0.028	0.116	0.008	0.022	0.080
1946	Milk from BYCow Regime 1	0.737	3.935	21.739	0.043	0.251	1.286
1946	Milk from BYCow Regime 2	0.479	3.437	26.648	0.039	0.264	1.895
1946	Milk from BYCow Regime 3	0.013	0.119	1.050	0.001	0.012	0.129
1946	Milk from BYCow Regime 4	0.001	0.013	0.417	0.000	0.002	0.030
1946	Commercial Milk (Rural)	0.423	2.296	15.568	0.030	0.171	1.055
1946	Fruit and Vegetables*	0.206	0.842	4.500	0.158	0.584	2.500
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.008	0.034	0.002	0.006	0.028
1947	Milk from BYCow Regime 1	0.194	1.062	6.315	0.012	0.086	0.535
1947	Milk from BYCow Regime 2	0.188	1.024	6.495	0.015	0.070	0.525
1947	Milk from BYCow Regime 3	0.005	0.034	0.202	0.000	0.003	0.029
1947	Milk from BYCow Regime 4	0.000	0.006	0.144	0.000	0.001	0.007
1947	Commercial Milk (Rural)	0.127	0.607	3.659	0.008	0.040	0.206
1947	Fruit and Vegetables*	0.039	0.161	0.748	0.031	0.117	0.510
1945-1947	External	0.003	0.006	0.016	0.003	0.006	0.017
1945-1947	Inhalation	0.078	0.188	0.659	0.061	0.142	0.456
1945-1947	Milk from BYCow Regime 1	8.522	34.283	173.025	0.724	2.498	14.966
1945-1947	Milk from BYCow Regime 2	8.230	31.528	99.941	0.639	2.543	13.248
1945-1947	Milk from BYCow Regime 3	0.203	1.042	8.175	0.020	0.110	0.635
1945-1947	Milk from BYCow Regime 4	0.029	0.312	5.334	0.004	0.021	0.260
1945-1947	Commercial Milk (Rural)	5.539	19.180	99.044	0.466	1.886	13.488
1945-1947	Fruit and Vegetables*	2.358	7.385	28.907	1.899	5.254	21.209

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Umatilla County Census Division 13 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.010	0.002	0.004	0.010
1945	Inhalation	0.049	0.145	0.600	0.042	0.114	0.379
1945	Milk from BYCow Regime 3	0.135	1.025	8.645	0.014	0.083	0.703
1945	Milk from BYCow Regime 4	0.018	0.218	4.414	0.003	0.031	0.346
1945	Commercial Milk (Rural)	8.172	34.387	96.769	0.595	2.774	8.529
1945	Fruit and Vegetables*	1.922	7.318	33.573	1.400	5.087	22.180
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.011	0.029	0.107	0.008	0.022	0.072
1946	Milk from BYCow Regime 3	0.016	0.125	1.202	0.002	0.012	0.053
1946	Milk from BYCow Regime 4	0.002	0.040	0.778	0.001	0.005	0.026
1946	Commercial Milk (Rural)	1.561	5.453	16.750	0.108	0.390	1.623
1946	Fruit and Vegetables*	0.273	1.051	4.830	0.218	0.753	3.193
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.007	0.030	0.002	0.006	0.023
1947	Milk from BYCow Regime 3	0.004	0.029	0.274	0.000	0.003	0.028
1947	Milk from BYCow Regime 4	0.001	0.011	0.136	0.000	0.001	0.019
1947	Commercial Milk (Rural)	0.371	1.527	4.813	0.032	0.133	0.441
1947	Fruit and Vegetables*	0.047	0.183	0.854	0.038	0.147	0.735
1945-1947	External	0.003	0.005	0.012	0.003	0.005	0.012
1945-1947	Inhalation	0.087	0.202	0.678	0.069	0.152	0.421
1945-1947	Milk from BYCow Regime 3	0.286	1.380	9.392	0.028	0.109	0.748
1945-1947	Milk from BYCow Regime 4	0.066	0.401	3.540	0.011	0.046	0.357
1945-1947	Commercial Milk (Rural)	15.001	44.166	110.111	1.202	3.464	9.080
1945-1947	Fruit and Vegetables*	3.214	9.541	37.553	2.352	6.678	25.034

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Umatilla County Census Division 14

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.003	0.009	0.001	0.003	0.009
1945	Inhalation	0.038	0.115	0.449	0.033	0.094	0.322
1945	Milk from BYCow Regime 3	0.088	0.745	7.321	0.011	0.064	0.562
1945	Milk from BYCow Regime 4	0.013	0.177	3.399	0.004	0.025	0.221
1945	Commercial Milk (Rural)	7.684	34.177	93.559	0.564	2.505	8.175
1945	Fruit and Vegetables*	1.398	5.132	23.153	1.095	4.029	16.561
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.008	0.023	0.090	0.007	0.018	0.057
1946	Milk from BYCow Regime 3	0.011	0.075	0.665	0.001	0.008	0.049
1946	Milk from BYCow Regime 4	0.001	0.019	0.469	0.000	0.004	0.044
1946	Commercial Milk (Rural)	1.423	5.594	21.161	0.107	0.422	1.294
1946	Fruit and Vegetables*	0.207	0.786	3.287	0.151	0.513	2.496
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.002	0.007	0.029	0.002	0.005	0.022
1947	Milk from BYCow Regime 3	0.003	0.021	0.155	0.000	0.002	0.014
1947	Milk from BYCow Regime 4	0.000	0.008	0.129	0.000	0.001	0.012
1947	Commercial Milk (Rural)	0.439	1.623	5.265	0.031	0.129	0.421
1947	Fruit and Vegetables*	0.034	0.134	0.614	0.028	0.105	0.463
1945-1947	External	0.002	0.004	0.010	0.002	0.004	0.010
1945-1947	Inhalation	0.070	0.158	0.489	0.058	0.124	0.347
1945-1947	Milk from BYCow Regime 3	0.180	0.945	7.107	0.023	0.091	0.547
1945-1947	Milk from BYCow Regime 4	0.050	0.327	4.881	0.008	0.039	0.373
1945-1947	Commercial Milk (Rural)	15.579	45.966	108.179	1.145	3.261	8.222
1945-1947	Fruit and Vegetables*	2.350	6.689	24.969	1.749	4.966	17.627

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Walla Walla County Census Division 01 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.013	0.002	0.005	0.014
1945	Inhalation	0.048	0.150	0.663	0.043	0.120	0.452
1945	Milk from BYCow Regime 3	0.106	1.018	10.098	0.012	0.076	0.939
1945	Milk from BYCow Regime 4	0.006	0.189	3.602	0.002	0.017	0.359
1945	Commercial Milk (Rural)	2.522	10.657	38.925	0.221	0.837	3.328
1945	Fruit and Vegetables*	1.891	7.724	35.967	1.486	5.435	26.753
1946	External	0.000	0.001	0.003	0.000	0.001	0.002
1946	Inhalation	0.010	0.029	0.102	0.009	0.024	0.079
1946	Milk from BYCow Regime 3	0.016	0.152	1.528	0.002	0.014	0.138
1946	Milk from BYCow Regime 4	0.002	0.037	0.515	0.000	0.003	0.077
1946	Commercial Milk (Rural)	0.469	1.862	7.253	0.040	0.172	0.459
1946	Fruit and Vegetables*	0.266	1.102	5.427	0.200	0.807	3.712
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.009	0.040	0.003	0.007	0.027
1947	Milk from BYCow Regime 3	0.003	0.044	0.534	0.000	0.003	0.032
1947	Milk from BYCow Regime 4	0.000	0.009	0.142	0.000	0.001	0.015
1947	Commercial Milk (Rural)	0.138	0.519	2.143	0.010	0.041	0.164
1947	Fruit and Vegetables*	0.050	0.198	1.042	0.042	0.164	0.840
1945-1947	External	0.003	0.006	0.015	0.003	0.006	0.016
1945-1947	Inhalation	0.089	0.205	0.741	0.074	0.165	0.485
1945-1947	Milk from BYCow Regime 3	0.299	1.429	10.098	0.028	0.122	0.941
1945-1947	Milk from BYCow Regime 4	0.045	0.382	3.995	0.005	0.031	0.319
1945-1947	Commercial Milk (Rural)	5.350	14.744	43.970	0.421	1.138	3.570
1945-1947	Fruit and Vegetables*	3.185	9.538	36.579	2.484	7.086	29.463

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Walla Walla County Census Division 02

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.005	0.011	0.028	0.005	0.011	0.031
1945	Inhalation	0.133	0.380	1.479	0.107	0.290	1.048
1945	Milk from BYCow Regime 3	0.317	2.004	15.936	0.036	0.213	1.558
1945	Milk from BYCow Regime 4	0.041	0.481	11.103	0.008	0.069	0.793
1945	Commercial Milk (Rural)	16.946	78.401	281.513	1.547	6.297	22.497
1945	Fruit and Vegetables*	4.845	19.076	80.523	3.576	13.094	56.854
1946	External	0.001	0.002	0.006	0.001	0.002	0.006
1946	Inhalation	0.028	0.080	0.281	0.023	0.058	0.194
1946	Milk from BYCow Regime 3	0.038	0.302	3.089	0.004	0.028	0.235
1946	Milk from BYCow Regime 4	0.006	0.095	1.834	0.001	0.012	0.140
1946	Commercial Milk (Rural)	3.222	11.415	47.384	0.239	0.910	3.238
1946	Fruit and Vegetables*	0.677	2.656	11.385	0.569	2.067	8.234
1947	External	0.000	0.001	0.002	0.000	0.001	0.002
1947	Inhalation	0.007	0.022	0.090	0.006	0.017	0.067
1947	Milk from BYCow Regime 3	0.008	0.095	0.887	0.001	0.007	0.065
1947	Milk from BYCow Regime 4	0.001	0.022	0.526	0.000	0.003	0.034
1947	Commercial Milk (Rural)	0.910	3.329	15.136	0.079	0.292	1.398
1947	Fruit and Vegetables*	0.124	0.466	1.883	0.099	0.353	1.611
1945-1947	External	0.008	0.014	0.032	0.008	0.015	0.035
1945-1947	Inhalation	0.238	0.533	1.695	0.181	0.390	1.043
1945-1947	Milk from BYCow Regime 3	0.643	3.043	16.165	0.071	0.295	1.673
1945-1947	Milk from BYCow Regime 4	0.128	1.006	12.412	0.023	0.121	0.940
1945-1947	Commercial Milk (Rural)	37.566	101.897	306.174	2.632	8.090	24.086
1945-1947	Fruit and Vegetables*	8.084	23.180	85.392	6.137	16.805	63.259

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Walla Walla County Census Division 03 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.007	0.016	0.044	0.007	0.016	0.043
1945	Inhalation	0.194	0.564	2.002	0.160	0.433	1.474
1945	Milk from BYCow Regime 3	0.302	2.889	22.469	0.042	0.307	2.931
1945	Milk from BYCow Regime 4	0.064	0.596	6.379	0.011	0.098	1.251
1945	Commercial Milk (Rural)	27.870	135.803	441.484	2.320	10.805	40.833
1945	Fruit and Vegetables*	6.833	25.484	113.132	4.504	16.972	83.557
1946	External	0.002	0.004	0.009	0.002	0.004	0.009
1946	Inhalation	0.044	0.125	0.408	0.037	0.095	0.285
1946	Milk from BYCow Regime 3	0.037	0.371	3.094	0.006	0.043	0.488
1946	Milk from BYCow Regime 4	0.007	0.103	1.709	0.002	0.014	0.168
1946	Commercial Milk (Rural)	4.590	19.514	81.440	0.362	1.435	5.994
1946	Fruit and Vegetables*	0.851	3.253	16.048	0.650	2.380	10.703
1947	External	0.001	0.001	0.003	0.001	0.001	0.003
1947	Inhalation	0.012	0.034	0.156	0.010	0.028	0.103
1947	Milk from BYCow Regime 3	0.017	0.156	1.240	0.002	0.013	0.107
1947	Milk from BYCow Regime 4	0.002	0.024	0.858	0.001	0.005	0.069
1947	Commercial Milk (Rural)	1.270	5.355	17.420	0.111	0.474	2.337
1947	Fruit and Vegetables*	0.164	0.654	3.473	0.128	0.477	2.044
1945-1947	External	0.012	0.022	0.050	0.012	0.022	0.051
1945-1947	Inhalation	0.351	0.777	2.298	0.280	0.603	1.763
1945-1947	Milk from BYCow Regime 3	0.881	4.341	30.509	0.102	0.421	3.004
1945-1947	Milk from BYCow Regime 4	0.197	1.158	6.716	0.032	0.154	1.120
1945-1947	Commercial Milk (Rural)	55.105	168.669	445.292	4.052	12.676	42.776
1945-1947	Fruit and Vegetables*	11.348	33.381	120.556	7.694	21.347	87.577

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Walla Walla County Census Division 04

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.004	0.010	0.025	0.004	0.009	0.023
1945	Inhalation	0.109	0.326	1.185	0.093	0.250	0.791
1945	Milk from BYCow Regime 1	11.653	60.342	311.884	0.975	5.585	29.638
1945	Milk from BYCow Regime 2	12.339	62.493	406.724	0.841	5.689	25.542
1945	Milk from BYCow Regime 3	0.195	1.577	11.011	0.022	0.166	0.976
1945	Milk from BYCow Regime 4	0.034	0.530	6.530	0.008	0.057	0.841
1945	Commercial Milk (Rural)	14.174	54.173	165.491	1.204	4.611	18.717
1945	Fruit and Vegetables*	4.167	15.352	73.492	2.979	10.665	41.638
1946	External	0.001	0.002	0.005	0.001	0.002	0.005
1946	Inhalation	0.025	0.070	0.237	0.021	0.054	0.171
1946	Milk from BYCow Regime 1	2.026	10.298	61.717	0.149	0.918	5.464
1946	Milk from BYCow Regime 2	1.866	9.120	48.241	0.130	0.716	3.802
1946	Milk from BYCow Regime 3	0.037	0.313	2.390	0.004	0.029	0.176
1946	Milk from BYCow Regime 4	0.003	0.053	1.190	0.001	0.007	0.104
1946	Commercial Milk (Rural)	2.455	10.559	32.023	0.205	0.842	2.169
1946	Fruit and Vegetables*	0.559	2.308	11.664	0.395	1.499	6.696
1947	External	0.000	0.001	0.002	0.000	0.001	0.002
1947	Inhalation	0.007	0.021	0.090	0.006	0.015	0.062
1947	Milk from BYCow Regime 1	0.575	2.846	17.207	0.047	0.262	1.643
1947	Milk from BYCow Regime 2	0.542	2.666	17.212	0.046	0.219	1.230
1947	Milk from BYCow Regime 3	0.008	0.070	0.750	0.001	0.007	0.087
1947	Milk from BYCow Regime 4	0.001	0.020	0.524	0.000	0.002	0.067
1947	Commercial Milk (Rural)	0.720	2.782	11.028	0.047	0.218	0.608
1947	Fruit and Vegetables*	0.107	0.420	2.050	0.084	0.307	1.413
1945-1947	External	0.007	0.013	0.029	0.007	0.013	0.028
1945-1947	Inhalation	0.202	0.455	1.396	0.159	0.341	0.876
1945-1947	Milk from BYCow Regime 1	23.623	87.910	399.690	2.311	8.424	35.215
1945-1947	Milk from BYCow Regime 2	26.698	89.500	417.777	2.026	7.330	26.448
1945-1947	Milk from BYCow Regime 3	0.625	2.797	13.471	0.052	0.241	1.551
1945-1947	Milk from BYCow Regime 4	0.109	0.817	6.959	0.017	0.098	1.302
1945-1947	Commercial Milk (Rural)	26.989	73.040	189.459	2.219	5.571	19.152
1945-1947	Fruit and Vegetables*	6.889	19.406	75.225	4.881	13.516	44.272

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Walla Walla County Census Division 05 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.003	0.006	0.017	0.003	0.007	0.018
1945	Inhalation	0.072	0.221	0.800	0.060	0.171	0.536
1945	Milk from BYCow Regime 3	0.148	1.280	10.078	0.015	0.102	0.780
1945	Milk from BYCow Regime 4	0.023	0.293	8.976	0.005	0.050	0.598
1945	Commercial Milk (Rural)	14.500	58.614	158.803	1.148	4.569	12.841
1945	Fruit and Vegetables*	2.838	11.224	41.839	2.191	7.992	39.502
1946	External	0.001	0.001	0.003	0.001	0.001	0.003
1946	Inhalation	0.015	0.043	0.141	0.013	0.034	0.103
1946	Milk from BYCow Regime 3	0.021	0.182	1.754	0.003	0.022	0.167
1946	Milk from BYCow Regime 4	0.003	0.042	0.585	0.001	0.007	0.069
1946	Commercial Milk (Rural)	2.382	9.499	31.373	0.173	0.733	2.674
1946	Fruit and Vegetables*	0.393	1.626	7.085	0.290	1.123	5.082
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.004	0.012	0.047	0.004	0.010	0.032
1947	Milk from BYCow Regime 3	0.008	0.074	0.599	0.001	0.006	0.054
1947	Milk from BYCow Regime 4	0.001	0.014	0.236	0.000	0.002	0.017
1947	Commercial Milk (Rural)	0.692	2.705	8.970	0.057	0.203	0.603
1947	Fruit and Vegetables*	0.072	0.309	1.440	0.061	0.230	1.003
1945-1947	External	0.005	0.008	0.020	0.005	0.009	0.020
1945-1947	Inhalation	0.128	0.295	0.923	0.103	0.226	0.605
1945-1947	Milk from BYCow Regime 3	0.426	1.914	10.679	0.053	0.180	0.785
1945-1947	Milk from BYCow Regime 4	0.081	0.563	9.439	0.014	0.075	0.640
1945-1947	Commercial Milk (Rural)	25.415	77.314	178.712	2.030	5.822	13.956
1945-1947	Fruit and Vegetables*	4.830	14.414	46.512	3.582	10.388	42.584

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Walla Walla County Census Division 06

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.013	0.002	0.005	0.015
1945	Inhalation	0.050	0.160	0.656	0.046	0.134	0.576
1945	Milk from BYCow Regime 3	0.096	0.817	16.404	0.015	0.096	0.604
1945	Milk from BYCow Regime 4	0.019	0.264	5.115	0.004	0.033	0.459
1945	Commercial Milk (Rural)	14.428	61.193	163.992	1.100	4.206	14.116
1945	Fruit and Vegetables*	2.092	7.684	34.194	1.546	5.759	24.265
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.010	0.030	0.126	0.009	0.024	0.092
1946	Milk from BYCow Regime 3	0.019	0.188	1.904	0.003	0.016	0.133
1946	Milk from BYCow Regime 4	0.003	0.036	0.845	0.001	0.005	0.047
1946	Commercial Milk (Rural)	2.737	10.974	28.538	0.195	0.761	2.578
1946	Fruit and Vegetables*	0.285	1.092	5.135	0.217	0.796	3.615
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.009	0.033	0.002	0.007	0.024
1947	Milk from BYCow Regime 3	0.006	0.054	0.676	0.001	0.006	0.039
1947	Milk from BYCow Regime 4	0.001	0.009	0.193	0.000	0.002	0.017
1947	Commercial Milk (Rural)	0.797	2.869	7.507	0.054	0.204	0.736
1947	Fruit and Vegetables*	0.056	0.215	1.001	0.045	0.167	0.749
1945-1947	External	0.003	0.006	0.015	0.003	0.006	0.017
1945-1947	Inhalation	0.090	0.220	0.739	0.078	0.178	0.707
1945-1947	Milk from BYCow Regime 3	0.313	1.455	15.000	0.036	0.134	0.662
1945-1947	Milk from BYCow Regime 4	0.054	0.414	5.420	0.011	0.054	0.483
1945-1947	Commercial Milk (Rural)	27.030	75.522	189.009	2.024	5.358	15.982
1945-1947	Fruit and Vegetables*	3.414	10.025	36.957	2.584	7.208	25.126

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Walla Walla County Census Division 07 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.004	0.011	0.002	0.004	0.012
1945	Inhalation	0.044	0.146	0.691	0.036	0.107	0.450
1945	Milk from BYCow Regime 3	0.111	0.806	5.494	0.015	0.082	0.604
1945	Milk from BYCow Regime 4	0.018	0.253	6.742	0.005	0.028	0.222
1945	Commercial Milk (Rural)	15.598	59.592	214.812	1.234	4.088	15.486
1945	Fruit and Vegetables*	1.849	6.599	30.094	1.378	5.034	22.451
1946	External	0.000	0.001	0.002	0.000	0.001	0.002
1946	Inhalation	0.009	0.026	0.106	0.007	0.019	0.073
1946	Milk from BYCow Regime 3	0.016	0.106	0.857	0.002	0.014	0.094
1946	Milk from BYCow Regime 4	0.003	0.046	0.643	0.001	0.005	0.046
1946	Commercial Milk (Rural)	2.305	9.948	29.589	0.191	0.760	2.317
1946	Fruit and Vegetables*	0.258	1.057	5.097	0.209	0.751	3.248
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.002	0.007	0.028	0.002	0.005	0.019
1947	Milk from BYCow Regime 3	0.004	0.039	0.470	0.001	0.003	0.019
1947	Milk from BYCow Regime 4	0.001	0.010	0.211	0.000	0.002	0.009
1947	Commercial Milk (Rural)	0.734	2.566	10.264	0.045	0.200	0.582
1947	Fruit and Vegetables*	0.046	0.179	0.906	0.037	0.146	0.677
1945-1947	External	0.003	0.005	0.013	0.003	0.005	0.014
1945-1947	Inhalation	0.078	0.197	0.737	0.064	0.143	0.531
1945-1947	Milk from BYCow Regime 3	0.305	1.182	6.903	0.033	0.110	0.644
1945-1947	Milk from BYCow Regime 4	0.069	0.496	7.402	0.011	0.042	0.258
1945-1947	Commercial Milk (Rural)	29.254	75.857	214.087	2.221	5.799	16.359
1945-1947	Fruit and Vegetables*	3.026	8.734	31.543	2.291	6.529	24.008

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Walla Walla County Census Division 08

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.012	0.002	0.005	0.013
1945	Inhalation	0.060	0.171	0.633	0.049	0.138	0.448
1945	Milk from BYCow Regime 1	7.663	48.833	254.161	0.549	3.300	19.960
1945	Milk from BYCow Regime 2	8.292	41.152	273.290	0.466	3.210	22.346
1945	Milk from BYCow Regime 3	0.138	1.435	15.508	0.020	0.111	0.690
1945	Milk from BYCow Regime 4	0.018	0.259	3.453	0.006	0.043	0.476
1945	Commercial Milk (Rural)	11.534	45.871	162.513	0.968	3.828	14.260
1945	Fruit and Vegetables*	2.355	8.553	34.463	1.721	6.274	28.833
1946	External	0.000	0.001	0.003	0.000	0.001	0.003
1946	Inhalation	0.012	0.034	0.124	0.010	0.027	0.086
1946	Milk from BYCow Regime 1	1.034	6.628	49.989	0.088	0.504	2.314
1946	Milk from BYCow Regime 2	1.121	6.280	40.443	0.094	0.656	3.654
1946	Milk from BYCow Regime 3	0.035	0.224	1.816	0.003	0.020	0.132
1946	Milk from BYCow Regime 4	0.001	0.024	0.545	0.001	0.005	0.102
1946	Commercial Milk (Rural)	2.007	8.652	25.190	0.162	0.672	2.598
1946	Fruit and Vegetables*	0.330	1.278	6.113	0.253	0.902	3.969
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.010	0.037	0.003	0.008	0.029
1947	Milk from BYCow Regime 1	0.319	1.981	12.798	0.026	0.157	0.779
1947	Milk from BYCow Regime 2	0.365	2.168	15.206	0.024	0.152	1.049
1947	Milk from BYCow Regime 3	0.008	0.078	0.587	0.001	0.006	0.045
1947	Milk from BYCow Regime 4	0.001	0.011	0.236	0.000	0.002	0.017
1947	Commercial Milk (Rural)	0.586	2.177	8.304	0.046	0.169	0.656
1947	Fruit and Vegetables*	0.062	0.245	1.141	0.049	0.192	0.792
1945-1947	External	0.004	0.007	0.015	0.004	0.007	0.015
1945-1947	Inhalation	0.106	0.230	0.695	0.082	0.181	0.478
1945-1947	Milk from BYCow Regime 1	15.771	63.168	293.903	1.384	4.455	22.168
1945-1947	Milk from BYCow Regime 2	15.671	58.837	307.992	1.193	5.010	22.447
1945-1947	Milk from BYCow Regime 3	0.410	2.140	14.560	0.045	0.166	0.648
1945-1947	Milk from BYCow Regime 4	0.052	0.390	3.852	0.011	0.061	0.551
1945-1947	Commercial Milk (Rural)	24.640	64.487	175.394	1.794	4.819	13.996
1945-1947	Fruit and Vegetables*	3.918	11.006	38.081	2.823	8.067	31.144

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Walla Walla County Census Division 09 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.003	0.006	0.017	0.003	0.006	0.016
1945	Inhalation	0.076	0.228	0.827	0.062	0.166	0.537
1945	Milk from BYCow Regime 1	9.245	47.565	248.857	0.754	3.836	22.576
1945	Milk from BYCow Regime 2	9.813	58.405	319.694	0.558	3.373	14.983
1945	Milk from BYCow Regime 3	0.153	1.318	19.496	0.018	0.127	0.784
1945	Milk from BYCow Regime 4	0.017	0.264	7.843	0.005	0.037	0.502
1945	Commercial Milk (Rural)	14.211	55.398	196.899	1.129	4.841	17.292
1945	Fruit and Vegetables*	2.861	10.667	52.550	2.157	7.660	34.328
1946	External	0.001	0.001	0.004	0.001	0.001	0.003
1946	Inhalation	0.017	0.046	0.144	0.013	0.035	0.106
1946	Milk from BYCow Regime 1	1.462	7.745	49.437	0.106	0.625	3.382
1946	Milk from BYCow Regime 2	1.330	8.305	48.366	0.100	0.618	3.418
1946	Milk from BYCow Regime 3	0.034	0.284	2.835	0.004	0.025	0.239
1946	Milk from BYCow Regime 4	0.002	0.029	0.542	0.001	0.005	0.055
1946	Commercial Milk (Rural)	2.157	8.641	29.936	0.189	0.670	2.652
1946	Fruit and Vegetables*	0.386	1.424	6.601	0.290	1.045	4.951
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.004	0.013	0.058	0.004	0.010	0.035
1947	Milk from BYCow Regime 1	0.488	2.273	14.643	0.029	0.185	0.977
1947	Milk from BYCow Regime 2	0.468	2.167	14.509	0.032	0.179	0.956
1947	Milk from BYCow Regime 3	0.009	0.071	0.677	0.001	0.007	0.058
1947	Milk from BYCow Regime 4	0.001	0.011	0.240	0.000	0.001	0.017
1947	Commercial Milk (Rural)	0.680	2.453	8.817	0.047	0.195	0.791
1947	Fruit and Vegetables*	0.067	0.292	1.399	0.058	0.219	1.079
1945-1947	External	0.005	0.009	0.020	0.005	0.008	0.019
1945-1947	Inhalation	0.139	0.311	0.956	0.109	0.228	0.600
1945-1947	Milk from BYCow Regime 1	18.391	69.346	241.773	1.683	5.486	25.008
1945-1947	Milk from BYCow Regime 2	19.424	71.453	308.233	1.383	4.867	17.686
1945-1947	Milk from BYCow Regime 3	0.515	2.205	24.557	0.043	0.201	0.980
1945-1947	Milk from BYCow Regime 4	0.056	0.464	8.273	0.012	0.057	0.442
1945-1947	Commercial Milk (Rural)	24.164	72.179	222.889	2.071	6.326	17.454
1945-1947	Fruit and Vegetables*	4.826	13.489	57.671	3.621	9.735	35.380

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Walla Walla County Census Division 10

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.014	0.002	0.005	0.014
1945	Inhalation	0.063	0.185	0.650	0.051	0.140	0.440
1945	Milk from BYCow Regime 1	7.314	41.593	284.734	0.554	3.308	21.877
1945	Milk from BYCow Regime 2	7.347	41.989	223.377	0.640	3.274	18.659
1945	Milk from BYCow Regime 3	0.148	1.244	14.404	0.008	0.098	1.105
1945	Milk from BYCow Regime 4	0.009	0.209	6.216	0.001	0.020	0.780
1945	Commercial Milk (Urban)	22.188	69.049	198.440	1.021	3.920	12.813
1945	Fruit and Vegetables*	2.432	9.198	39.161	1.831	6.584	29.834
1946	External	0.001	0.001	0.002	0.001	0.001	0.003
1946	Inhalation	0.013	0.036	0.113	0.011	0.028	0.094
1946	Milk from BYCow Regime 1	1.496	6.632	28.305	0.088	0.502	3.154
1946	Milk from BYCow Regime 2	1.170	6.389	38.025	0.084	0.546	2.789
1946	Milk from BYCow Regime 3	0.022	0.185	1.823	0.002	0.016	0.142
1946	Milk from BYCow Regime 4	0.000	0.028	0.764	0.000	0.002	0.042
1946	Commercial Milk (Urban)	3.442	11.700	31.399	0.152	0.757	2.062
1946	Fruit and Vegetables*	0.348	1.418	7.774	0.280	1.018	4.205
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.003	0.011	0.045	0.003	0.009	0.032
1947	Milk from BYCow Regime 1	0.355	2.140	10.819	0.025	0.176	1.086
1947	Milk from BYCow Regime 2	0.377	2.208	14.446	0.026	0.144	0.783
1947	Milk from BYCow Regime 3	0.009	0.068	0.619	0.001	0.005	0.064
1947	Milk from BYCow Regime 4	0.000	0.008	0.099	0.000	0.001	0.010
1947	Commercial Milk (Urban)	0.889	3.186	8.902	0.052	0.196	0.773
1947	Fruit and Vegetables*	0.057	0.232	1.296	0.046	0.176	0.868
1945-1947	External	0.004	0.007	0.016	0.004	0.007	0.016
1945-1947	Inhalation	0.111	0.251	0.718	0.091	0.188	0.487
1945-1947	Milk from BYCow Regime 1	16.957	55.369	272.129	1.146	4.728	26.343
1945-1947	Milk from BYCow Regime 2	16.816	64.072	231.542	1.254	4.597	19.785
1945-1947	Milk from BYCow Regime 3	0.431	2.002	13.263	0.033	0.174	1.235
1945-1947	Milk from BYCow Regime 4	0.036	0.409	6.923	0.003	0.033	0.705
1945-1947	Commercial Milk (Urban)	35.523	84.725	216.080	1.707	5.404	14.950
1945-1947	Fruit and Vegetables*	4.036	11.840	43.457	3.168	8.988	33.331

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Walla Walla County Census Division 11 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.005	0.013	0.002	0.005	0.014
1945	Inhalation	0.061	0.190	0.733	0.052	0.137	0.446
1945	Milk from BYCow Regime 1	7.720	44.814	225.865	0.517	3.398	22.556
1945	Milk from BYCow Regime 2	7.849	42.807	236.336	0.515	3.006	17.640
1945	Milk from BYCow Regime 3	0.124	1.371	11.701	0.009	0.094	0.768
1945	Milk from BYCow Regime 4	0.008	0.379	8.334	0.001	0.024	0.418
1945	Commercial Milk (Urban)	19.644	73.411	177.311	0.819	3.823	12.585
1945	Fruit and Vegetables*	2.414	9.595	42.553	1.884	6.568	27.923
1946	External	0.001	0.001	0.003	0.001	0.001	0.003
1946	Inhalation	0.013	0.036	0.117	0.011	0.028	0.083
1946	Milk from BYCow Regime 1	1.214	6.675	36.505	0.081	0.470	2.505
1946	Milk from BYCow Regime 2	0.977	5.802	32.023	0.089	0.485	2.624
1946	Milk from BYCow Regime 3	0.026	0.244	1.989	0.001	0.013	0.194
1946	Milk from BYCow Regime 4	0.001	0.030	0.588	0.000	0.001	0.040
1946	Commercial Milk (Urban)	3.390	13.166	33.669	0.173	0.786	2.410
1946	Fruit and Vegetables*	0.347	1.385	6.331	0.257	0.954	4.309
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.004	0.010	0.039	0.003	0.008	0.029
1947	Milk from BYCow Regime 1	0.362	1.905	10.091	0.022	0.141	0.965
1947	Milk from BYCow Regime 2	0.382	2.221	14.045	0.026	0.163	0.810
1947	Milk from BYCow Regime 3	0.008	0.072	0.845	0.001	0.006	0.049
1947	Milk from BYCow Regime 4	0.000	0.008	0.146	0.000	0.001	0.012
1947	Commercial Milk (Urban)	0.850	3.039	8.268	0.049	0.183	0.635
1947	Fruit and Vegetables*	0.068	0.250	1.214	0.050	0.187	0.895
1945-1947	External	0.004	0.007	0.015	0.004	0.007	0.016
1945-1947	Inhalation	0.110	0.253	0.811	0.088	0.191	0.504
1945-1947	Milk from BYCow Regime 1	16.676	57.844	283.012	1.152	4.485	23.806
1945-1947	Milk from BYCow Regime 2	16.633	57.782	249.045	1.307	4.501	19.847
1945-1947	Milk from BYCow Regime 3	0.407	2.116	12.987	0.027	0.149	0.780
1945-1947	Milk from BYCow Regime 4	0.041	0.508	7.025	0.003	0.036	0.411
1945-1947	Commercial Milk (Urban)	34.124	87.023	202.229	1.719	5.045	14.008
1945-1947	Fruit and Vegetables*	4.126	12.399	44.592	3.060	8.551	31.003

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Yakima County Census Division 01

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.006	0.144	0.001	0.006	0.097
1945	Inhalation	0.008	0.104	3.112	0.007	0.099	5.164
1945	Milk from BYCow Regime 3	0.024	0.312	7.539	0.003	0.045	1.732
1945	Milk from BYCow Regime 4	0.005	0.070	4.274	0.001	0.008	0.164
1945	Commercial Milk (Rural)	2.155	11.464	93.758	0.156	0.990	8.996
1945	Fruit and Vegetables*	0.574	5.724	178.704	0.419	4.021	126.297
1946	External	0.000	0.002	0.060	0.000	0.002	0.065
1946	Inhalation	0.002	0.031	1.669	0.002	0.023	2.044
1946	Milk from BYCow Regime 3	0.003	0.051	2.102	0.000	0.005	0.351
1946	Milk from BYCow Regime 4	0.000	0.008	0.375	0.000	0.001	0.053
1946	Commercial Milk (Rural)	0.260	1.366	9.510	0.022	0.120	0.607
1946	Fruit and Vegetables*	0.071	0.596	11.171	0.058	0.489	9.956
1947	External	0.000	0.000	0.015	0.000	0.000	0.011
1947	Inhalation	0.001	0.007	0.174	0.000	0.006	0.162
1947	Milk from BYCow Regime 3	0.001	0.014	0.260	0.000	0.001	0.034
1947	Milk from BYCow Regime 4	0.000	0.003	0.102	0.000	0.000	0.017
1947	Commercial Milk (Rural)	0.108	0.431	2.276	0.008	0.041	0.228
1947	Fruit and Vegetables*	0.012	0.122	1.980	0.011	0.101	2.223
1945-1947	External	0.002	0.015	0.273	0.002	0.014	0.238
1945-1947	Inhalation	0.035	0.268	6.881	0.031	0.247	7.789
1945-1947	Milk from BYCow Regime 3	0.096	0.712	10.605	0.009	0.090	1.968
1945-1947	Milk from BYCow Regime 4	0.016	0.174	4.487	0.003	0.016	0.251
1945-1947	Commercial Milk (Rural)	4.081	14.884	85.227	0.345	1.343	9.285
1945-1947	Fruit and Vegetables*	1.382	8.620	181.683	1.009	6.490	137.064

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Yakima County Census Division 02 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.020	0.000	0.001	0.016
1945	Inhalation	0.001	0.014	0.517	0.001	0.011	0.420
1945	Milk from BYCow Regime 3	0.007	0.112	3.680	0.001	0.012	0.300
1945	Milk from BYCow Regime 4	0.001	0.010	0.576	0.000	0.003	0.047
1945	Commercial Milk (Rural)	1.391	8.006	80.669	0.117	0.588	4.667
1945	Fruit and Vegetables*	0.079	0.731	17.531	0.063	0.643	12.331
1946	External	0.000	0.000	0.005	0.000	0.000	0.005
1946	Inhalation	0.000	0.003	0.136	0.000	0.002	0.109
1946	Milk from BYCow Regime 3	0.001	0.014	0.244	0.000	0.001	0.016
1946	Milk from BYCow Regime 4	0.000	0.001	0.145	0.000	0.000	0.006
1946	Commercial Milk (Rural)	0.207	0.969	5.245	0.016	0.079	0.665
1946	Fruit and Vegetables*	0.010	0.098	2.975	0.009	0.085	1.747
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.033	0.000	0.000	0.020
1947	Milk from BYCow Regime 3	0.000	0.003	0.063	0.000	0.000	0.006
1947	Milk from BYCow Regime 4	0.000	0.001	0.023	0.000	0.000	0.004
1947	Commercial Milk (Rural)	0.049	0.254	1.805	0.004	0.023	0.110
1947	Fruit and Vegetables*	0.002	0.024	0.611	0.002	0.020	0.436
1945-1947	External	0.000	0.001	0.031	0.000	0.001	0.023
1945-1947	Inhalation	0.004	0.032	0.846	0.003	0.024	0.640
1945-1947	Milk from BYCow Regime 3	0.027	0.204	3.841	0.003	0.019	0.412
1945-1947	Milk from BYCow Regime 4	0.003	0.023	0.729	0.001	0.005	0.058
1945-1947	Commercial Milk (Rural)	2.764	10.413	80.266	0.198	0.805	4.883
1945-1947	Fruit and Vegetables*	0.216	1.313	21.413	0.165	1.063	14.791

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Yakima County Census Division 04 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.020	0.000	0.000	0.015
1945	Inhalation	0.001	0.007	0.222	0.001	0.006	0.223
1945	Milk from BYCow Regime 1	0.114	1.489	68.153	0.010	0.118	4.080
1945	Milk from BYCow Regime 2	0.082	1.540	63.370	0.007	0.101	2.371
1945	Milk from BYCow Regime 3	0.006	0.070	2.792	0.001	0.010	0.137
1945	Milk from BYCow Regime 4	0.001	0.013	0.477	0.000	0.003	0.050
1945	Commercial Milk (Rural)	1.814	9.257	88.295	0.157	0.827	9.015
1945	Fruit and Vegetables*	0.058	0.662	29.611	0.054	0.542	24.554
1946	External	0.000	0.000	0.003	0.000	0.000	0.005
1946	Inhalation	0.000	0.001	0.035	0.000	0.001	0.025
1946	Milk from BYCow Regime 1	0.014	0.199	8.731	0.002	0.014	0.562
1946	Milk from BYCow Regime 2	0.015	0.255	10.771	0.001	0.018	0.472
1946	Milk from BYCow Regime 3	0.001	0.009	0.177	0.000	0.001	0.030
1946	Milk from BYCow Regime 4	0.000	0.002	0.057	0.000	0.001	0.005
1946	Commercial Milk (Rural)	0.271	1.392	8.302	0.018	0.106	0.623
1946	Fruit and Vegetables*	0.008	0.097	4.166	0.007	0.069	2.557
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.000	0.010	0.000	0.000	0.005
1947	Milk from BYCow Regime 1	0.004	0.046	1.460	0.000	0.005	0.134
1947	Milk from BYCow Regime 2	0.004	0.063	4.946	0.000	0.005	0.125
1947	Milk from BYCow Regime 3	0.000	0.002	0.054	0.000	0.000	0.006
1947	Milk from BYCow Regime 4	0.000	0.000	0.014	0.000	0.000	0.002
1947	Commercial Milk (Rural)	0.089	0.393	3.051	0.006	0.035	0.226
1947	Fruit and Vegetables*	0.002	0.022	0.686	0.001	0.016	0.683
1945-1947	External	0.000	0.001	0.032	0.000	0.001	0.042
1945-1947	Inhalation	0.002	0.014	0.484	0.002	0.011	0.332
1945-1947	Milk from BYCow Regime 1	0.353	3.116	87.966	0.034	0.240	4.806
1945-1947	Milk from BYCow Regime 2	0.310	2.973	71.312	0.028	0.213	3.072
1945-1947	Milk from BYCow Regime 3	0.015	0.107	2.705	0.003	0.017	0.136
1945-1947	Milk from BYCow Regime 4	0.003	0.022	0.882	0.001	0.005	0.057
1945-1947	Commercial Milk (Rural)	3.750	13.791	69.113	0.296	1.065	7.780
1945-1947	Fruit and Vegetables*	0.170	1.312	46.521	0.142	1.007	32.532

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Yakima County Census Division 05

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.000	0.020	0.000	0.000	0.013
1945	Inhalation	0.001	0.006	0.209	0.001	0.006	0.186
1945	Milk from BYCow Regime 1	0.125	1.301	31.943	0.009	0.096	1.875
1945	Milk from BYCow Regime 2	0.087	1.127	25.306	0.007	0.103	3.203
1945	Milk from BYCow Regime 3	0.006	0.065	1.325	0.001	0.009	0.156
1945	Milk from BYCow Regime 4	0.001	0.013	0.833	0.000	0.004	0.136
1945	Commercial Milk (Rural)	2.052	9.331	61.562	0.162	1.051	7.933
1945	Fruit and Vegetables*	0.062	0.649	22.711	0.055	0.552	15.859
1946	External	0.000	0.000	0.003	0.000	0.000	0.002
1946	Inhalation	0.000	0.001	0.037	0.000	0.001	0.039
1946	Milk from BYCow Regime 1	0.015	0.284	10.464	0.001	0.016	0.380
1946	Milk from BYCow Regime 2	0.011	0.209	6.853	0.001	0.017	0.692
1946	Milk from BYCow Regime 3	0.001	0.008	0.190	0.000	0.001	0.020
1946	Milk from BYCow Regime 4	0.000	0.002	0.088	0.000	0.000	0.012
1946	Commercial Milk (Rural)	0.329	1.653	11.704	0.025	0.131	0.640
1946	Fruit and Vegetables*	0.009	0.109	3.699	0.008	0.091	3.871
1947	External	0.000	0.000	0.000	0.000	0.000	0.000
1947	Inhalation	0.000	0.000	0.012	0.000	0.000	0.006
1947	Milk from BYCow Regime 1	0.005	0.061	1.699	0.000	0.006	0.277
1947	Milk from BYCow Regime 2	0.004	0.058	2.549	0.000	0.006	0.189
1947	Milk from BYCow Regime 3	0.000	0.002	0.046	0.000	0.000	0.004
1947	Milk from BYCow Regime 4	0.000	0.000	0.017	0.000	0.000	0.005
1947	Commercial Milk (Rural)	0.094	0.407	2.109	0.007	0.030	0.153
1947	Fruit and Vegetables*	0.002	0.021	1.053	0.002	0.018	0.700
1945-1947	External	0.000	0.001	0.028	0.000	0.001	0.022
1945-1947	Inhalation	0.002	0.012	0.410	0.002	0.011	0.312
1945-1947	Milk from BYCow Regime 1	0.425	3.094	39.029	0.027	0.198	2.483
1945-1947	Milk from BYCow Regime 2	0.297	2.616	41.705	0.026	0.190	4.537
1945-1947	Milk from BYCow Regime 3	0.016	0.123	1.402	0.002	0.015	0.149
1945-1947	Milk from BYCow Regime 4	0.003	0.022	0.797	0.001	0.006	0.107
1945-1947	Commercial Milk (Rural)	4.309	13.810	76.077	0.380	1.404	9.232
1945-1947	Fruit and Vegetables*	0.169	1.278	32.520	0.145	1.100	27.133

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Yakima County Census Division 06 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.001	0.010	0.218	0.001	0.010	0.318
1945	Inhalation	0.017	0.199	9.423	0.016	0.154	4.558
1945	Milk from BYCow Regime 1	2.127	28.541	569.757	0.127	1.639	32.771
1945	Milk from BYCow Regime 2	1.369	19.018	469.741	0.096	1.781	41.096
1945	Milk from BYCow Regime 3	0.041	0.626	20.028	0.005	0.068	8.504
1945	Milk from BYCow Regime 4	0.006	0.109	3.760	0.001	0.016	0.570
1945	Commercial Milk (Rural)	2.628	20.067	234.385	0.224	1.673	25.920
1945	Fruit and Vegetables*	1.100	10.800	284.426	0.895	6.990	117.825
1946	External	0.000	0.004	0.149	0.000	0.003	0.237
1946	Inhalation	0.004	0.053	3.115	0.003	0.039	1.972
1946	Milk from BYCow Regime 1	0.280	3.463	73.171	0.020	0.300	4.202
1946	Milk from BYCow Regime 2	0.231	3.482	108.189	0.019	0.243	4.858
1946	Milk from BYCow Regime 3	0.005	0.081	1.682	0.001	0.009	0.191
1946	Milk from BYCow Regime 4	0.001	0.018	0.640	0.000	0.002	0.059
1946	Commercial Milk (Rural)	0.462	2.755	26.281	0.034	0.248	2.801
1946	Fruit and Vegetables*	0.157	1.334	28.721	0.118	0.912	18.473
1947	External	0.000	0.001	0.033	0.000	0.001	0.043
1947	Inhalation	0.001	0.012	0.622	0.001	0.010	0.402
1947	Milk from BYCow Regime 1	0.093	1.074	21.332	0.006	0.088	1.499
1947	Milk from BYCow Regime 2	0.061	0.919	15.520	0.005	0.079	1.201
1947	Milk from BYCow Regime 3	0.001	0.019	0.480	0.000	0.002	0.058
1947	Milk from BYCow Regime 4	0.000	0.005	0.389	0.000	0.001	0.043
1947	Commercial Milk (Rural)	0.120	0.813	5.045	0.011	0.072	0.601
1947	Fruit and Vegetables*	0.032	0.276	5.081	0.024	0.184	3.680
1945-1947	External	0.004	0.028	0.791	0.004	0.026	0.993
1945-1947	Inhalation	0.069	0.533	23.125	0.053	0.379	8.931
1945-1947	Milk from BYCow Regime 1	6.823	50.339	976.336	0.520	3.481	57.923
1945-1947	Milk from BYCow Regime 2	5.906	41.210	716.339	0.350	2.815	50.051
1945-1947	Milk from BYCow Regime 3	0.120	1.043	21.157	0.017	0.129	5.197
1945-1947	Milk from BYCow Regime 4	0.028	0.288	5.830	0.004	0.033	0.614
1945-1947	Commercial Milk (Rural)	6.314	30.110	280.143	0.598	2.581	18.175
1945-1947	Fruit and Vegetables*	2.887	18.124	289.400	2.048	11.488	139.040

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Yakima County Census Division 07

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.030	0.000	0.001	0.026
1945	Inhalation	0.001	0.023	0.814	0.001	0.017	0.470
1945	Milk from BYCow Regime 1	0.244	3.506	56.852	0.018	0.291	8.176
1945	Milk from BYCow Regime 2	0.192	3.651	67.360	0.020	0.232	7.595
1945	Milk from BYCow Regime 3	0.007	0.110	2.838	0.001	0.013	0.203
1945	Milk from BYCow Regime 4	0.002	0.029	1.141	0.001	0.006	0.072
1945	Commercial Milk (Rural)	2.484	14.048	155.390	0.184	0.921	7.508
1945	Fruit and Vegetables*	0.167	1.530	47.420	0.107	0.949	25.661
1946	External	0.000	0.000	0.006	0.000	0.000	0.008
1946	Inhalation	0.000	0.004	0.191	0.000	0.003	0.123
1946	Milk from BYCow Regime 1	0.037	0.592	17.500	0.003	0.044	1.657
1946	Milk from BYCow Regime 2	0.027	0.459	13.429	0.002	0.027	0.722
1946	Milk from BYCow Regime 3	0.001	0.015	0.378	0.000	0.002	0.055
1946	Milk from BYCow Regime 4	0.000	0.003	0.087	0.000	0.001	0.021
1946	Commercial Milk (Rural)	0.286	1.549	9.270	0.023	0.135	0.729
1946	Fruit and Vegetables*	0.024	0.241	4.749	0.016	0.154	4.212
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.026	0.000	0.001	0.023
1947	Milk from BYCow Regime 1	0.010	0.133	3.479	0.001	0.011	0.287
1947	Milk from BYCow Regime 2	0.009	0.137	3.185	0.001	0.008	0.308
1947	Milk from BYCow Regime 3	0.000	0.005	0.132	0.000	0.000	0.013
1947	Milk from BYCow Regime 4	0.000	0.001	0.045	0.000	0.000	0.003
1947	Commercial Milk (Rural)	0.101	0.539	2.782	0.006	0.042	0.349
1947	Fruit and Vegetables*	0.005	0.046	1.027	0.003	0.030	0.602
1945-1947	External	0.000	0.002	0.042	0.000	0.002	0.052
1945-1947	Inhalation	0.006	0.048	1.088	0.005	0.034	0.963
1945-1947	Milk from BYCow Regime 1	0.885	7.500	109.139	0.067	0.626	10.486
1945-1947	Milk from BYCow Regime 2	0.699	5.974	84.472	0.055	0.464	5.775
1945-1947	Milk from BYCow Regime 3	0.027	0.198	4.116	0.004	0.021	0.276
1945-1947	Milk from BYCow Regime 4	0.006	0.053	0.855	0.002	0.011	0.099
1945-1947	Commercial Milk (Rural)	4.459	17.747	165.678	0.383	1.251	7.843
1945-1947	Fruit and Vegetables*	0.443	2.881	63.278	0.280	1.733	32.337

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Yakima County Census Division 08 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.002	0.058	0.000	0.002	0.063
1945	Inhalation	0.002	0.029	2.383	0.002	0.026	1.385
1945	Milk from BYCow Regime 3	0.010	0.171	7.579	0.002	0.018	0.478
1945	Milk from BYCow Regime 4	0.002	0.030	0.796	0.001	0.007	0.150
1945	Commercial Milk (Rural)	2.284	10.658	92.128	0.173	0.946	13.141
1945	Fruit and Vegetables*	0.252	3.018	83.171	0.191	1.815	55.736
1946	External	0.000	0.000	0.010	0.000	0.000	0.011
1946	Inhalation	0.001	0.008	0.398	0.000	0.006	0.319
1946	Milk from BYCow Regime 3	0.001	0.021	0.867	0.000	0.003	0.086
1946	Milk from BYCow Regime 4	0.000	0.005	0.132	0.000	0.001	0.013
1946	Commercial Milk (Rural)	0.300	1.459	8.948	0.022	0.105	0.580
1946	Fruit and Vegetables*	0.039	0.379	11.449	0.026	0.259	7.356
1947	External	0.000	0.000	0.002	0.000	0.000	0.002
1947	Inhalation	0.000	0.002	0.058	0.000	0.002	0.053
1947	Milk from BYCow Regime 3	0.000	0.006	0.145	0.000	0.001	0.017
1947	Milk from BYCow Regime 4	0.000	0.002	0.065	0.000	0.000	0.005
1947	Commercial Milk (Rural)	0.101	0.432	1.876	0.007	0.035	0.198
1947	Fruit and Vegetables*	0.007	0.071	1.388	0.005	0.048	1.098
1945-1947	External	0.001	0.004	0.084	0.001	0.004	0.079
1945-1947	Inhalation	0.009	0.085	3.842	0.008	0.068	1.920
1945-1947	Milk from BYCow Regime 3	0.032	0.313	7.910	0.005	0.038	0.482
1945-1947	Milk from BYCow Regime 4	0.009	0.064	0.993	0.002	0.011	0.160
1945-1947	Commercial Milk (Rural)	4.318	14.652	77.740	0.350	1.159	12.894
1945-1947	Fruit and Vegetables*	0.714	5.072	89.645	0.490	3.261	58.337

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Yakima County Census Division 09

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.002	0.006	0.070	0.001	0.006	0.077
1945	Inhalation	0.026	0.142	1.969	0.023	0.105	2.421
1945	Milk from BYCow Regime 1	3.192	28.597	261.965	0.226	1.593	12.864
1945	Milk from BYCow Regime 2	3.218	21.990	169.718	0.258	1.940	15.152
1945	Milk from BYCow Regime 3	0.065	0.731	9.045	0.009	0.062	0.696
1945	Milk from BYCow Regime 4	0.016	0.329	4.623	0.003	0.028	0.445
1945	Commercial Milk (Rural)	4.182	22.118	147.722	0.317	1.633	12.111
1945	Fruit and Vegetables*	1.513	7.019	42.482	1.081	4.821	28.109
1946	External	0.000	0.002	0.021	0.000	0.002	0.030
1946	Inhalation	0.007	0.034	0.583	0.006	0.029	0.490
1946	Milk from BYCow Regime 1	0.467	3.650	34.281	0.029	0.232	1.812
1946	Milk from BYCow Regime 2	0.399	2.854	22.185	0.039	0.314	2.312
1946	Milk from BYCow Regime 3	0.009	0.111	1.171	0.001	0.009	0.077
1946	Milk from BYCow Regime 4	0.001	0.032	0.587	0.000	0.004	0.040
1946	Commercial Milk (Rural)	0.624	3.533	22.419	0.049	0.273	1.680
1946	Fruit and Vegetables*	0.210	1.002	6.686	0.153	0.683	4.075
1947	External	0.000	0.000	0.004	0.000	0.000	0.004
1947	Inhalation	0.002	0.011	0.143	0.002	0.008	0.091
1947	Milk from BYCow Regime 1	0.123	0.702	5.089	0.012	0.108	0.911
1947	Milk from BYCow Regime 2	0.144	1.207	13.067	0.009	0.086	0.792
1947	Milk from BYCow Regime 3	0.002	0.032	0.252	0.000	0.003	0.028
1947	Milk from BYCow Regime 4	0.000	0.009	0.198	0.000	0.001	0.022
1947	Commercial Milk (Rural)	0.197	1.002	5.893	0.014	0.079	0.458
1947	Fruit and Vegetables*	0.039	0.197	1.246	0.030	0.147	0.913
1945-1947	External	0.003	0.011	0.115	0.003	0.011	0.143
1945-1947	Inhalation	0.067	0.253	3.660	0.054	0.205	3.472
1945-1947	Milk from BYCow Regime 1	7.160	40.983	282.023	0.630	2.535	17.673
1945-1947	Milk from BYCow Regime 2	7.471	32.111	196.112	0.644	2.931	15.765
1945-1947	Milk from BYCow Regime 3	0.194	1.167	9.209	0.022	0.101	0.957
1945-1947	Milk from BYCow Regime 4	0.054	0.502	7.772	0.009	0.044	0.440
1945-1947	Commercial Milk (Rural)	8.694	31.150	155.666	0.765	2.500	12.959
1945-1947	Fruit and Vegetables*	2.712	9.517	48.542	2.023	6.490	29.632

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

---------- Yakima County Census Division 10 ----------

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.002	0.022	0.000	0.002	0.026
1945	Inhalation	0.008	0.052	1.228	0.007	0.040	1.206
1945	Milk from BYCow Regime 1	0.923	7.922	83.687	0.080	0.639	7.012
1945	Milk from BYCow Regime 2	0.810	8.572	85.756	0.080	0.683	9.160
1945	Milk from BYCow Regime 3	0.027	0.277	5.028	0.003	0.027	0.290
1945	Milk from BYCow Regime 4	0.005	0.111	2.819	0.001	0.014	0.278
1945	Commercial Milk (Rural)	4.126	25.874	204.520	0.348	1.891	11.425
1945	Fruit and Vegetables*	0.478	3.025	32.775	0.358	1.861	19.339
1946	External	0.000	0.001	0.008	0.000	0.001	0.011
1946	Inhalation	0.002	0.012	0.237	0.002	0.010	0.188
1946	Milk from BYCow Regime 1	0.149	1.291	12.494	0.014	0.118	1.377
1946	Milk from BYCow Regime 2	0.143	1.240	15.306	0.012	0.111	1.329
1946	Milk from BYCow Regime 3	0.005	0.048	0.669	0.000	0.005	0.059
1946	Milk from BYCow Regime 4	0.001	0.017	0.408	0.000	0.002	0.051
1946	Commercial Milk (Rural)	0.737	3.369	23.613	0.046	0.232	1.437
1946	Fruit and Vegetables*	0.071	0.434	6.046	0.053	0.280	3.337
1947	External	0.000	0.000	0.002	0.000	0.000	0.003
1947	Inhalation	0.001	0.004	0.128	0.000	0.003	0.102
1947	Milk from BYCow Regime 1	0.037	0.346	3.444	0.003	0.028	0.353
1947	Milk from BYCow Regime 2	0.050	0.481	5.511	0.003	0.028	0.279
1947	Milk from BYCow Regime 3	0.001	0.015	0.220	0.000	0.001	0.012
1947	Milk from BYCow Regime 4	0.000	0.003	0.085	0.000	0.001	0.006
1947	Commercial Milk (Rural)	0.191	0.862	4.660	0.015	0.071	0.519
1947	Fruit and Vegetables*	0.014	0.079	0.719	0.011	0.061	0.503
1945-1947	External	0.001	0.004	0.032	0.001	0.004	0.038
1945-1947	Inhalation	0.022	0.108	2.262	0.018	0.080	1.720
1945-1947	Milk from BYCow Regime 1	2.460	12.620	105.711	0.174	0.953	8.498
1945-1947	Milk from BYCow Regime 2	2.685	13.241	113.189	0.204	1.150	9.838
1945-1947	Milk from BYCow Regime 3	0.080	0.493	3.946	0.010	0.045	0.296
1945-1947	Milk from BYCow Regime 4	0.021	0.215	3.652	0.005	0.026	0.185
1945-1947	Commercial Milk (Rural)	9.483	37.232	184.967	0.730	2.393	11.160
1945-1947	Fruit and Vegetables*	1.006	4.459	41.332	0.712	2.696	20.956

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Yakima County Census Division 11

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.001	0.037	0.000	0.001	0.046
1945	Inhalation	0.001	0.017	0.676	0.001	0.014	0.455
1945	Milk from BYCow Regime 3	0.006	0.098	2.229	0.001	0.011	0.284
1945	Milk from BYCow Regime 4	0.001	0.026	0.625	0.001	0.006	0.078
1945	Commercial Milk (Rural)	2.437	13.944	145.393	0.204	0.993	6.043
1945	Fruit and Vegetables*	0.162	1.550	46.272	0.115	0.954	14.717
1946	External	0.000	0.000	0.004	0.000	0.000	0.007
1946	Inhalation	0.000	0.004	0.092	0.000	0.003	0.098
1946	Milk from BYCow Regime 3	0.001	0.012	0.366	0.000	0.002	0.031
1946	Milk from BYCow Regime 4	0.000	0.003	0.128	0.000	0.001	0.009
1946	Commercial Milk (Rural)	0.311	1.581	8.453	0.026	0.139	0.961
1946	Fruit and Vegetables*	0.024	0.197	3.193	0.016	0.121	2.989
1947	External	0.000	0.000	0.001	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.033	0.000	0.001	0.020
1947	Milk from BYCow Regime 3	0.000	0.004	0.072	0.000	0.000	0.007
1947	Milk from BYCow Regime 4	0.000	0.001	0.033	0.000	0.000	0.003
1947	Commercial Milk (Rural)	0.083	0.405	2.408	0.007	0.035	0.216
1947	Fruit and Vegetables*	0.005	0.041	0.593	0.003	0.028	0.516
1945-1947	External	0.000	0.002	0.042	0.000	0.002	0.064
1945-1947	Inhalation	0.005	0.040	0.874	0.005	0.031	0.663
1945-1947	Milk from BYCow Regime 3	0.022	0.167	2.608	0.003	0.019	0.258
1945-1947	Milk from BYCow Regime 4	0.006	0.061	0.829	0.001	0.008	0.097
1945-1947	Commercial Milk (Rural)	4.562	16.648	148.327	0.358	1.318	5.833
1945-1947	Fruit and Vegetables*	0.413	2.423	45.497	0.255	1.554	19.604

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

Yakima County Census Division 12

Year	Dose Pathway	Infant Dose Percentiles 5th	50th	95th	Adult Dose Percentiles 5th	50th	95th
1945	External	0.000	0.002	0.068	0.000	0.002	0.049
1945	Inhalation	0.002	0.027	1.805	0.001	0.022	1.337
1945	Milk from BYCow Regime 3	0.006	0.094	2.991	0.001	0.013	0.501
1945	Milk from BYCow Regime 4	0.001	0.028	2.008	0.001	0.007	0.098
1945	Commercial Milk (Rural)	2.069	10.914	77.368	0.174	0.997	11.657
1945	Fruit and Vegetables*	0.200	2.386	52.324	0.129	1.181	28.836
1946	External	0.000	0.000	0.010	0.000	0.000	0.013
1946	Inhalation	0.000	0.006	0.300	0.000	0.005	0.297
1946	Milk from BYCow Regime 3	0.001	0.014	0.422	0.000	0.002	0.033
1946	Milk from BYCow Regime 4	0.000	0.005	0.253	0.000	0.001	0.019
1946	Commercial Milk (Rural)	0.337	1.599	8.386	0.027	0.136	0.824
1946	Fruit and Vegetables*	0.029	0.273	6.421	0.019	0.172	3.775
1947	External	0.000	0.000	0.002	0.000	0.000	0.001
1947	Inhalation	0.000	0.001	0.056	0.000	0.001	0.030
1947	Milk from BYCow Regime 3	0.000	0.002	0.094	0.000	0.000	0.006
1947	Milk from BYCow Regime 4	0.000	0.001	0.041	0.000	0.000	0.005
1947	Commercial Milk (Rural)	0.104	0.479	2.651	0.006	0.033	0.194
1947	Fruit and Vegetables*	0.005	0.043	0.810	0.003	0.027	0.443
1945-1947	External	0.001	0.004	0.095	0.001	0.003	0.079
1945-1947	Inhalation	0.008	0.072	3.235	0.006	0.052	1.984
1945-1947	Milk from BYCow Regime 3	0.019	0.162	2.928	0.003	0.021	0.341
1945-1947	Milk from BYCow Regime 4	0.006	0.060	2.012	0.002	0.010	0.101
1945-1947	Commercial Milk (Rural)	4.668	15.318	96.954	0.356	1.365	15.410
1945-1947	Fruit and Vegetables*	0.550	3.611	66.036	0.307	1.993	38.815

* Dose from the fruit and vegetables pathway assumes that 100% of diet comes from local sources

DISCLAIMER

This report was prepared under the direction of the HANFORD ENVIRONMENTAL DOSE RECONSTRUCTION PROJECT Technical Steering Panel by Battelle Memorial Institute's Pacific Northwest Laboratories operating the Pacific Northwest Laboratory for the U.S. Department of Energy (DOE). While funding for the work was provided by DOE, the work is not under DOE direction or control. The views and opinions of the authors expressed in this document do not necessarily reflect those of the United States Government or any agency thereof. Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer or otherwise does not necessarily constitute or imply its endorsement, recommendation or favoring by the U.S. Government or any agency thereof, nor by Battelle Memorial Institute. Results in this report, including preliminary dose estimates, are based on the use of unverified software. No assurance is expressed or implied as to the accuracy, completeness, or usefulness of this information.

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