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OAK RIDGE HEALTH STUDIES

Oak Ridge Health Agreement Steering Panel

PHASE 1 REPORT

VOLUME II - PART C
DOSE RECONSTRUCTION FEASIBLITY STUDY

TASK 5

A Summary of Information Concerning
Historical Locations and Activities of Populations Potentially
Affected by Releases from the Oak Ridge Reservation

Prepared by
ChemRisk®
A Division of Mclaren/Hart

for the
Tennessee Department of Health and the
Oak Ridge Health Agreement Steering Panel

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Volume II - Part C - Dose Reconstruction Feasibility Study

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CONTENTS OF THE OAK RIDGE HEALTH STUDIES PHASE I REPORT

Volume I summarizes the activities of the Oak Ridge Health Agreement Steering Panel, other than the Dose Reconstruction Feasibility Study, during Phase I of the Oak Ridge Health Studies. It includes four major topics:

- **Executive Summary of the Oak Ridge Health Studies Phase I Report**
- **Health Studies Background and Overview**
- **Phase I Goals**
- **Conclusions and Recommendations for Phase I**

Volume II documents the study (referred to as the Dose Reconstruction Feasibility Study) to find out if enough data exist to estimate historical doses of chemicals and radionuclides to the public living around the Reservation. It is comprised of four parts:

- **Part A** addressing project Tasks 1 and 2 to identify the historical operations and emissions at each of the complexes and characterize the availability of environmental sampling and research data

- **Part B** addressing Tasks 3 and 4 to identify important environmental exposure pathways and contaminants released from the Reservation

- **Part C** addressing Task 5 to identify information regarding historical locations and activities of off-site populations that could potentially be affected by releases from the Reservation

- **Part D** addressing Task 6 to identify the hazards associated with substances used at the reservation

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ACRONYMS, INITIALISMS, AND ABBREVIATIONS USED IN THIS REPORT

AEC	Atomic Energy Commission
AVLIS	Atomic Vapor Laser Isotope Separation
DOE	United States Department of Energy
EFPC	East Fork Poplar Creek
ETWWC	East Tennessee White Water Club
GIS	Geographic Information System
K-25	Code name for the site of the Oak Ridge Gaseous Diffusion Plant
ORAU	Oak Ridge Associated Universities
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OTA	Office of Technology Assessment, U.S. Congress
TDWM	Tennessee Department of Water Management
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UT	University of Tennessee
UT-AEC	University of Tennessee- Atomic Energy Commission cooperative
UTK	University of Tennessee at Knoxville
WMA	Wildlife Management Area
X-10	Code name for the site of the Clinton Engineer Works plutonium project; now the site of Oak Ridge National Laboratory
Y-12	Code name for the site of the Oak Ridge electromagnetic enrichment plant and the later nuclear weapons plant

VOLUME SUMMARY

The Phase I feasibility study has focused on determining the availability of information for estimating exposures of the public to chemicals and radionuclides released as a result of historical operation of the facilities at the Oak Ridge Reservation. The estimation of such past exposures is frequently called dose reconstruction. The work of Phase I has examined both the feasibility of performing dose reconstruction and also attempted, in a limited way, to examine a portion of the enormous volume of historical data to identify the releases from the facilities in the past having the highest potential to have caused harm to the health of the public.

The project work was composed of a number of individual tasks designed to meet the overall objectives of the Phase I Studies. The study tasks are numbered 1 through 7. The initial project tasks, **Tasks 1 and 2** were designed to identify and collect information that documents the history of activities at the Reservation that resulted in the release of contamination and to characterize the availability of data that could be used to estimate the magnitude of the contaminant releases or public exposures. **Task 7** was designed to support the collection of many of the documents and data identified in Tasks 1 and 2 in a library that could then be used in any future health studies. These three tasks represent the information collection portion of the project and included qualitative evaluations of the potential for activities to have produced significant contaminant releases.

In structuring the Phase I studies, there was a desire to attempt to use the quantitative data on releases from the facilities and contamination present in the environment as another means of identifying those plant activities that should receive the highest priority in any further health studies. Project **Tasks 3 through 6** support a more quantitative evaluation of the potential impacts of facility releases. This quantitative evaluation represents a very rough and preliminary evaluation of the large quantity of information and data identified in Tasks 1 and 2 to identify those activities and contaminants having the greatest potential to cause harm to the public's health.

In **Task 3**, complete exposure pathways were identified based on environmental conditions, potential for a contaminant to move from one medium to another, and by the life-styles, activities, and locations of the exposed population. The **Task 5** work described in this report was performed to support the analysis of complete exposure pathways by evaluating the likelihood of human contact with contaminated media and the existence of human activities leading to contaminant intake or exposure. Task 5 efforts began the process of identifying available historical information on local populations and land uses near the Oak Ridge facilities, as well as addressing other specific concerns of dose reconstruction. These specific concerns included the potential for: consumption of locally produced crops, beef, dairy products, fish, and game; the use of surface water for drinking, irrigation, and recreation; groundwater use for drinking and irrigation; and river dredging and sediment spreading.

1.0 INTRODUCTION AND SUMMARY OF RESULTS

A key factor in determining the feasibility of dose reconstruction involves characterizing historical locations and activities of potentially exposed populations in the area surrounding the Oak Ridge Reservation (ORR). The locations of residents relative to the site and the nature of nearby land use must be characterized in order to determine if individuals were likely exposed to contaminants released from the facility.

All of the following elements must have been present for off-site exposures to have occurred:

- A chemical or radionuclide release,
- An environmental transport medium (e.g., air, water, soil),
- Human contact with the medium, and
- A route of human exposure (e.g., inhalation, ingestion, dermal contact or physical proximity to radioactive materials).

These four elements comprise what is known as a "complete exposure pathway."

The purpose of Project Task 5 is to support the evaluation of two of the requirements of a complete exposure pathway: the opportunity for human contact with contaminated media, and the existence of human activities leading to possible contaminant intake or exposure. Project Tasks 1, 2, and 3 address material uses and emissions along with identifying and evaluating environmental exposure pathways.

1.1 The Task 5 Scope of Work

Task 5 of Oak Ridge Phase I Health Studies involves identifying available information on historical populations and land use near the ORR, and beginning the process of generally characterizing historical populations and land use for the fifty-year period from 1942 to 1992. In addition to generally describing the location of historical populations and land uses, an investigation was conducted to address specific concerns related to dose reconstruction. These concerns include the consumption of locally produced crops, beef, dairy products, fish, and game; the use of surface water for drinking, irrigation, and recreation; groundwater use for drinking and irrigation; and river dredging and sediment spreading.

1.2 Definition of Study Areas of Phase I Emphasis

Geographical areas of focus for the Phase I feasibility study were selected to include areas most likely to have been impacted by releases from the sites. The potential for impacts to an area from contaminant releases is dependent on the distance from the source of release, availability

of pathways, and on the amount, mobility, and toxicity of the material in question. Exposures would most likely have occurred in the vicinity of the site and/or along pathways for transporting materials off-site (streams, rivers, etc.), with the probability and impact of exposure generally decreasing as distance from the site increased.

For purposes of this feasibility study, the study area for investigation of airborne emissions is defined as the area within 10 miles from the center of each of the three plants at the ORR: K-25 (the Oak Ridge Gaseous Diffusion Plant), the Y-12 Plant, and the X-10 Site (now Oak Ridge National Laboratory). The area presently within the boundary of ORR was excluded from the study area, since this study is focused on off-site rather than worker exposures. However, residential areas of the City of Oak Ridge which were, until 1959, part of the ORR were included. As will be discussed later, on-site farming and use of an on-site recreation area have also been identified for their potential significance for exposures to members of the public.

The study area of emphasis for airborne emissions includes portions of five counties: Anderson, Knox, Loudon, Morgan, and Roane. Because population and land use information that is relevant to assessment of exposures from airborne contaminants is generally available on a county basis, much of the associated discussion of data availability during the feasibility study centers on these five counties. The study area for airborne emissions is shown in Figure 1-1.

The study area of emphasis for contaminants in surface waters includes the Clinch River and its tributaries above the Tennessee River, the Emory River, and the Tennessee River from Fort Loudoun Dam to Watts Bar Dam. The locations of these rivers in relation to the ORR are shown in Figure 1-2. In addition to the counties that lie within the study area for airborne emissions, surface waters of interest pass by the shores of Rhea and Meigs Counties. Because population and land use information that is relevant to assessment of exposures to contaminants in surface waters generally pertains to specific water bodies, most of the associated discussion of data availability during the feasibility study phase is organized around the water bodies of interest rather than the counties that surround them. This is a result of the method of organization of the available information, and in no way reflects a lower level of importance assigned to historical locations and activities of populations in Rhea and Meigs Counties.

There is no simple method for defining an appropriate study area for characterization of population and land use prior to actually modeling or measuring concentrations of contaminants in the environment at various distances from the site. However, information obtained from Project Tasks 1 and 2, as well as Task 5, will assist in determining an appropriate study area for any future dose reconstruction efforts.

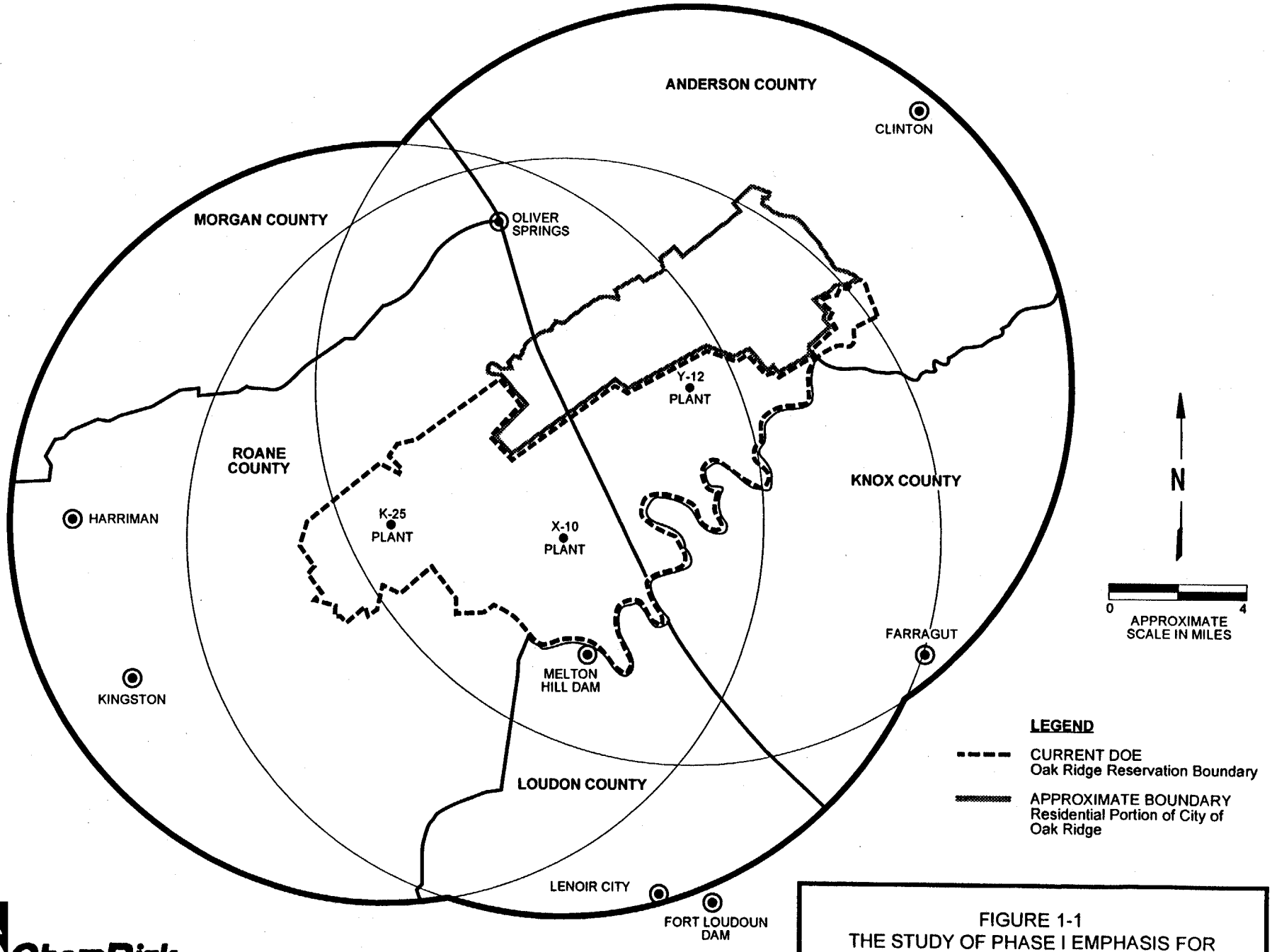

FIGURE 1-1
THE STUDY OF PHASE I EMPHASIS FOR AIRBORNE EMISSIONS

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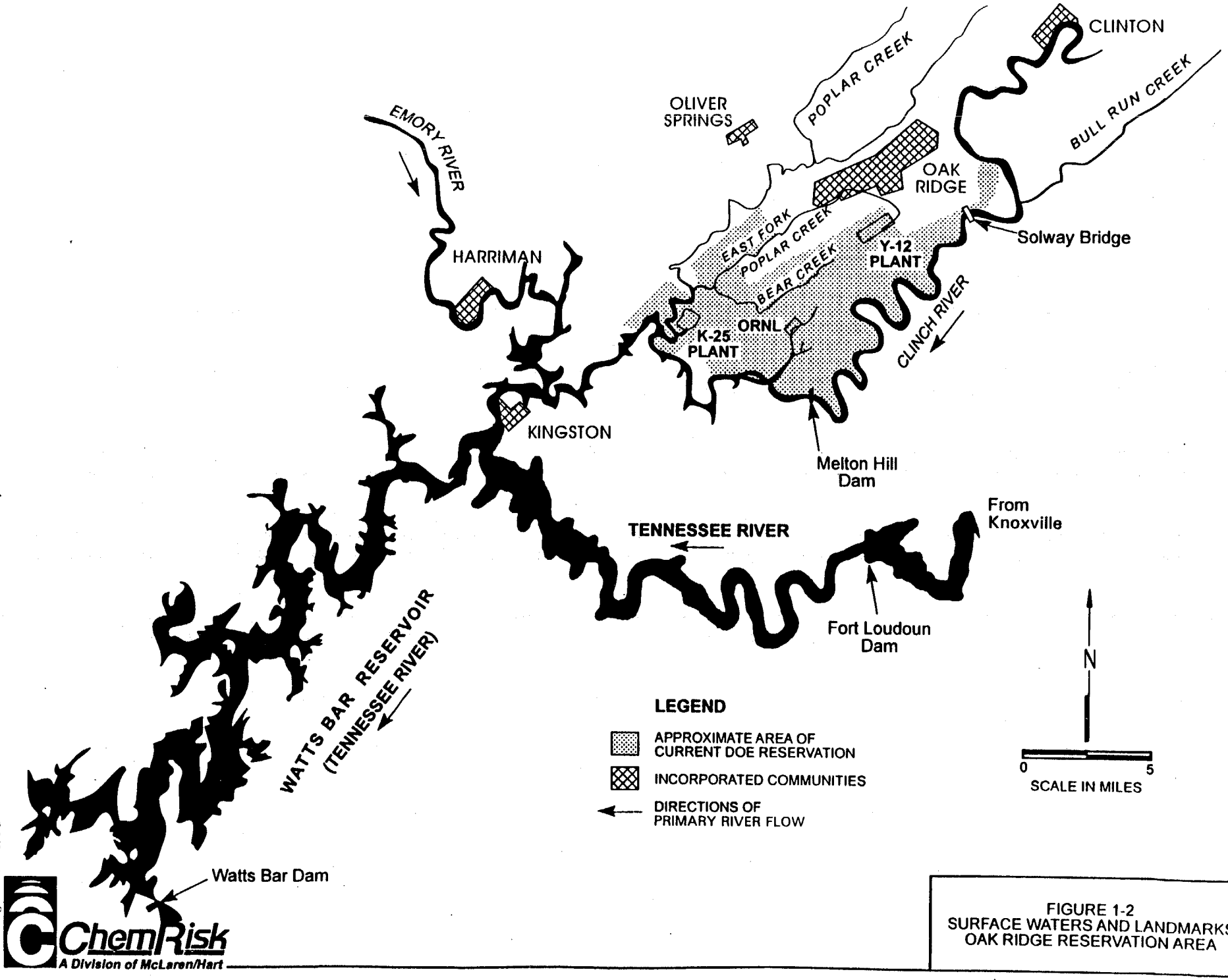


FIGURE 1-2
SURFACE WATERS AND LANDMARKS
OAK RIDGE RESERVATION AREA

1.3 Methodology

The first step in this study was review of the most recently issued or revised United States Geological Survey (USGS) 7.5-minute quadrangle maps for the study area and of U.S. Census population data for study area cities and counties. Next federal, state, and local agencies were contacted to determine the existence of historical population and land use data for the area. Research on other available data sources was conducted at local libraries including the University of Tennessee Library at Knoxville, the Oak Ridge Public Library, and the Technical Library at Oak Ridge National Laboratories. Finally, telephone interviews were conducted with agency representatives to verify interpretation of data collected, and for their knowledge of geographically-specific information not available in agency records and reports.

Relevant data that were easily obtainable within the time frame and budget of the feasibility study were collected. The existence of data less relevant or not readily obtainable during Phase I was noted. Descriptions of data sources used in this report, as well as data sources identified for further research related to future dose reconstruction, are included in Section 2.

For purposes of the ongoing feasibility study, emphasis was placed on qualitative rather than on quantitative information. In other words, efforts were concentrated on determining if particular land uses and activities occurred in the area. If they did, the focus was on approximately when and where, rather than on how many individuals may have potentially been affected.

Methods outlined in the Task 5 Plan (ChemRisk, 1992) for collecting population and land use information included review of aerial photography and historical maps. Although availability of aerial photographs and historical maps has been documented, due to the size of the study area (approximately 450 square miles) and the magnitude of the time period being considered (50 years), detailed analysis of the information contained in these records was not possible during the Phase I investigation. Once specific geographic areas and time periods of concern are identified, aerial photographs and historical maps can be collected and analyzed to determine detailed land use and population information.

As mentioned in the Task 5 Plan, records on information specific to a particular geographical area are often not kept. Most land use and population data are in the form of regional summaries, such as county level summaries or agency management area summaries. For this reason, interviews with long-time residents are often a good source of geographically specific data. Extensive personal interviews were beyond the scope of this task, but will no doubt be of value if a dose reconstruction is conducted.

The most valuable sources of information for this study were conversations with federal, state, and local government agency personnel and Phase I project team reviews of government agency

reports, books on local history, reports done for past projects in the area, and current and historical maps. These sources provided an overview of historical population and land use patterns in the study area and specific data related to activities of particular concern.

This report does not present a complete record of all information or of all possible data sources on historical demography and land use in the study area. It is intended to provide enough information to address the likelihood of human contact and potential routes of exposure; when reviewed with the results of Project Tasks 1, 2, and 3, the focus of any future dose reconstruction efforts can be better defined.

1.4 Summary of Results

Section 3.0 presents available information concerning historical population patterns near the ORR. Section 4.0 presents available information concerning land uses in the area. This section provides a brief summary of the key points presented in Sections 3.0 and 4.0 dealing with historical locations and activities of potentially exposed populations.

1.4.1 Summary of Historical Population

The City of Oak Ridge has been the largest population center in the study area almost since its establishment in the early 1940s. Other population centers in the study area include Clinton in Anderson County; Harriman and Kingston in Roane County; Lenoir City in Loudon County; Farragut in Knox County; and Oliver Springs in Morgan, Roane and Anderson counties. Several small communities are also located throughout the study area. The population of study area counties has increased at varying rates during the 50-year period; the population of Anderson County has been particularly influenced by the presence of the city of Oak Ridge. People have lived throughout the study area; development has generally been concentrated in valleys which were originally cleared for agricultural use.

1.4.2 Summary of Historical Land Use

The two predominant land uses over the years in study area counties have been agriculture and forestry. Both land uses are decreasing. Beef cattle have been raised throughout the study area over the 50-year period; cattle sold commercially have been slaughtered at feed lots in the midwest and distributed nationwide. Dairy cattle have been raised in some parts of the study area. For many years, milk produced locally was bottled and distributed locally. Major crops grown in the area over the 50-year period include corn, tobacco, wheat, and soybeans.

Deer hunting has occurred during particular periods of time in study area counties; small game and waterfowl hunting has occurred continuously throughout the area. Surface water has been

used for municipal water supply and recreation, and groundwater has been used for municipal water supply and private use through wells. Use of surface or groundwater for irrigation of farmland has been minimal.

Records have been kept on recreational use of Tennessee Valley Authority (TVA) reservoirs in the area; use has been extensive and has included boating, swimming, and fishing. Recreational fishing has occurred on streams as well as lakes in the area, and extensive commercial fishing has occurred on Watts Bar Reservoir. Mercury-contaminated stream sediment was used during reclamation activities associated with installing a sewer line in the City of Oak Ridge; in several areas contaminated fill material was removed and replaced.

2.0 SOURCES OF INFORMATION

Information sources used to determine historical population patterns and land uses are described below; sources of information not used in this study, but potentially of value in any future dose reconstruction efforts, are also discussed.

2.1 Information Sources Used in This Investigation

Population statistics for study area cities and counties were obtained from U.S. Census reports, and information on agricultural production for counties was obtained from U.S. Census of Agriculture reports. The location of population centers and small communities, and general population patterns of rural areas were determined by reviewing USGS 7.5-minute quadrangle maps. Additional sources of information included federal, state, and local government agencies and books written about regional and local history.

2.1.1 U.S. Census Data

Population data for the study area cities and counties were obtained from decennial U.S. Bureau of Census population reports (Bureau of Census, 1940 to 1990). Census data were used in this study to indicate population trends in study area counties and major population centers since 1940. The population of rural areas for each county was also collected. Review of census block data, which can provide more detailed information on the locations of populations in rural areas, was not deemed practical for this feasibility study, because of the large size of the study area and the length of the time period of interest. Once specific geographic areas and time periods of concern are identified, further review of census data may be useful in estimating the locations of populations in rural areas, when reviewed with historical USGS quadrangle maps, discussed below.

U.S. Census of Agriculture data (Bureau of Census, 1950 to 1987) were used to determine the nature and extent of agricultural production in study area counties. Between 1942 and 1992, Census of Agriculture data were published in 1945, 1950, 1954, 1959, 1964, 1969, 1974, 1978, 1982, and 1987. In order to determine trends in agricultural production, data were collected for the years 1950, 1959, 1969, 1978, and 1987. Census of Agriculture reports are an excellent information source, representing the only set of uniform agricultural data at the county level in the United States. However, since the most detailed agricultural census reporting consists of county level summaries, census data are not useful in determining the locations of agricultural activities beyond that level.

2.1.2 United States Geological Survey 7.5-Minute Quadrangle Maps

United States Geological Survey (USGS) 7.5-minute quadrangle maps were reviewed to determine the location of population centers and to generally determine population patterns in rural areas. The study area is covered by all or part of 16 quadrangle maps. The most recently issued or updated USGS quadrangle maps for the study area were reviewed. In Section 2.2.1, the names and the years of issue or significant update of the 16 quadrangle maps that cover the study area are discussed.

2.1.3 Information Supplied by Federal, State and Local Government Agencies

Information obtained from government agencies was a primary source of data for this study. Some of the information used in this report was obtained through conversations with agency representatives. Several agency reports were also reviewed. The following agencies were contacted:

<u>National</u>
National Archives Cartography
United States Army Corps of Engineers
United States Department of Agriculture
United States Department of Energy
United States Geological Survey

State/Regional
Local Planning Assistance Office, East Tennessee Region
Tennessee Agriculture Department
Tennessee Agricultural Stabilization and Conservation Service
Tennessee Department of Environment and Conservation
Tennessee Department of Health
Tennessee Valley Authority
Tennessee Wildlife Resources Agency
University of Tennessee Library

Local
County Agricultural Extension Offices
County Tax Assessor's Offices
City of Oak Ridge Planning Department
City of Oak Ridge Public Works Department
Harriman Public Library
Kingston Public Library
Knox County Library, McClung Historical Collection
Knox County Metropolitan Planning Commission

Agency reports used in this study are cited in the text and included in the references list. Additional reports that may be of value in future research are discussed in Section 2.2.5.

2.1.4 Information from Public Documents for Projects Within the Study Area

Other sources of land use and population data were reports prepared for projects in the area, such as Environmental Assessments or Environmental Impact Statements. These generally represented site-specific data for particular time periods. The following three reports are examples that contain data pertinent to the study area:

"Data Package for the Atomic Vapor Laser Isotope Separation (AVLIS) Plant Environmental Impact Statement." ORNL/TM-14482. Prepared by the Oak Ridge National Laboratory for U.S. Department of Energy. February 1990.

"Environmental Analysis of the Oak Ridge Gaseous Diffusion Plant Site." DOE/EA-0106. Prepared for the Department of Energy. December 1979.

"Environmental Analysis of the Operation of Oak Ridge National Laboratory (X-10 Site)." ORNL-5870. Prepared by the Oak Ridge National Laboratory for the U.S. Department of Energy. November 1982.

"Environmental Assessment Y-12 Plant Site. Oak Ridge Tennessee." DOE/EA-0182. U.S. Department of Energy Office of Military Application. December 1982.

"Land-Use Changes on the Proposed Clinch River Breeder Reactor Demonstration Project Site: 1924 to 1972." ORNL/TM-4838. R. K. McConathy, Oak Ridge National Laboratory for the Energy Research and Development Administration. February 1976.

2.1.5 Books on Regional and Local History

The history of the City of Oak Ridge is well documented, particularly for the period from 1942 to 1945. Several books and articles have been written on activities during that time period, and government reports document the many details of the city from its construction to the move to self-government in 1959. Books consulted for this study included the following:

These Are Our Voices, The Story of Oak Ridge, 1942-1970. James Overholt, Editor. Children's Museum of Oak Ridge, Tennessee. 1987.

City Behind a Fence, Oak Ridge, Tennessee 1942-1946. Charles W. Johnson and Charles O. Jackson. University of Tennessee Press, Knoxville. 1981.

Oak Ridge - From Secret City to Science City. Dot DeCamp. Publisher Unknown. 1988.

Anderson County, Tennessee. A Pictorial History. James Overholt. The Donning Company Publishers. 1989

Oak Ridge 1942 - 1992. A Commemorative Portrait. Dick Smyser. Oak Ridge Community Foundation, Inc. 1992.

2.2 Sources of Information Available for Further Research

Many resources are available for research related to dose reconstruction. Future research can include further use of the above mentioned resources. Some other data sources for further research are discussed below.

2.2.1 Historical Maps

The types of maps described in this section, which are available from a variety of agencies, have been identified as useful resources in characterizing historical population locations or activities.

As noted, samples of some of the maps have been obtained and added to the project information repository.

USGS 7.5-Minute Quadrangle Maps

Table 2-1 lists the 16 quadrangle maps that cover the study area, and presents the years of issue or significant update for each map. Figure 2-1 shows quadrangle map coverage of the study area.

Because of the size of the study area, and the period of time being considered, it was not practical or efficient to obtain and review historical copies of the 16 quadrangle maps that cover the study area. Once locations and time periods of concern are determined, applicable historical quadrangle maps can be reviewed. USGS maps show the locations of detailed features including residences, barns, schools, churches, industrial facilities and water bodies. Along with aerial photographs, these will probably be the best source of data for determining the location of populations.

Other Historical Maps of the Area

Some of the historical maps available for the area include the following:

"Town of Oak Ridge, Tennessee, Manhattan District - Corps of Engineers." Skidmore, Owings and Merrill. 1945.

This map was reproduced to commemorate the 50th anniversary of the founding of the City of Oak Ridge. The scale is 9 inches = 1 mile. The map includes the residential portions of ORR, now the self-governing City of Oak Ridge.

"Land Use and Land Cover, 1980, Chattanooga, Tennessee; North Carolina."

"Land Use and Land Cover,1980-1981, Corbin, Kentucky, Tennessee."

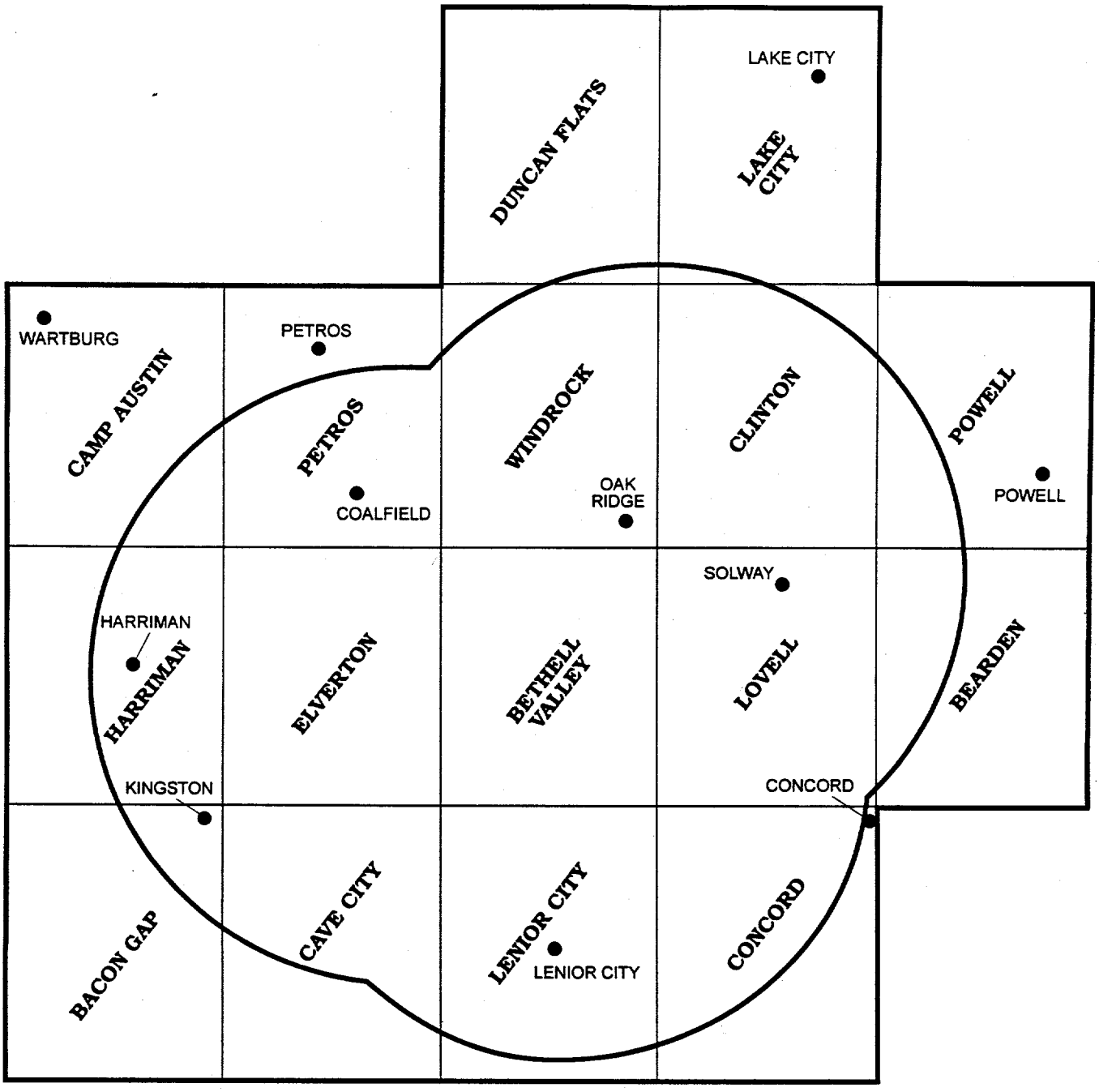
The USGS offers a series of land use and land cover information maps at a scale of 1:250,000. These maps were compiled from land use source materials dated 1980-1981; this is the only time frame for which maps in this series are available for the study area; these two maps include the entire study area and surrounding region. There are 92 categories of land use and land cover designated in the series; approximately 60 of these categories are applicable to the vicinity of Oak Ridge. The 60 categories include types of urban or built up land, agricultural land, rangeland, forestland, water, and wetlands. The maps are available in

TABLE 2-1

HISTORICAL USGS
7.5-MINUTE QUADRANGLE MAPS OF THE STUDY AREA

Quadrangle Map	Issue Date of Revised* or New Quadrangle Map
Bacon Gap	1936, 1940, 1952, 1968, 1980
Bearden	1935, 1940, 1953, 1966, 1977, 1990
Bethel Valley	1935, 1941, 1953, 1968, 1989
Camp Austin	1935, 1943, 1946, 1952, 1976, 1979
Cave Creek	1936, 1940, 1953, 1968, 1989
Clinton	1936, 1943, 1952, 1968, 1975, 1990
Concord	1936, 1940, 1953, 1968, 1984
Duncan Flats	1936, 1947, 1954, 1968, 1979
Elverton	1935, 1941, 1953, 1968, 1990
Harriman	1935, 1941, 1953, 1968, 1976, 1980
Lake City	1946, 1952, 1973
Lenoir City	1935, 1940, 1953, 1968, 1986, 1990
Lovell	1935, 1940, 1953, 1968, 1980, 1990
Petros	1936, 1943, 1952, 1967, 1976, 1979
Powell	1952, 1968, 1976
Windrock	1936, 1943, 1952, 1968, 1970, 1975

* Major revisions only



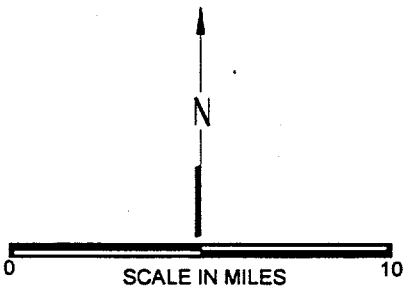


FIGURE 2-1
USGS QUADRANGLE MAP
COVERAGE OF THE STUDY AREA
FOR AIRBORNE EMISSIONS

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TDH-Okrdg/8-93/2-1

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several forms, including as clear overlays, from the Earth Science Information Center in Rolla, Missouri (See Repository Document #1140).

"Land Cover, Clinton, Tennessee Quadrangle," 1972

Compiled from information obtained from aerial photographs dated 1972, this map shows 14 categories of land cover, including types of urban and built up, agricultural, forestland, and water. The Clinton Quadrangle Map includes a portion of the City of Oak Ridge. According to TVA personnel, this map was produced as a trial; no others exist for the area. (Repository Document #1141).

"Transportation Map of the Clinch-Powell Rivers Watershed, Tennessee," August, 1961.

This map indicates the location of residences in the region, including within the study area. With a scale of 3 inches = 4 miles, this map was published by the TVA Division of Water Control Planning. (Repository Document #1142).

"Existing Land Use, Anderson County, Tennessee," March 1982.

Indicated on these maps are the locations of residential, commercial, public and semi-public, industrial, transportation, communication and utility, and extractive (e.g. mining) uses, at a scale of 1 inch = 300 feet. It is the only planning department land use map for the county; an updated version will be available later this year.

"Existing Land Use, Loudon County, Tennessee," January 1975.

"Existing Land Use, Lenoir City, Tennessee," April 1986.

Residential, public and semi-public, commercial, industrial, extractive, transportation, communication, and utility uses are indicated. These are the only dates for which planning department land use maps exist for Loudon County and Lenoir City.

2.2.2 Aerial Photography

Along with quadrangle maps, aerial photographs provide an excellent source of information for determining the locations of populations. Several sources of aerial photography for the area in the vicinity of Oak Ridge were discovered.

USGS Index of Aerial Photography

An index of aerial photographs taken by both public agencies and private parties was obtained from USGS for the area covered by the 16 quadrangle maps that include the study area (Repository Document #1149). The index is from the Aerial Photography Summary Record System, which is an information system for determining the availability of aerial photography projects that met specified criteria over a given geographic area. Holders of the photography include government agencies, universities, and commercial companies.

Aerial photography used as the basis of update and reissue of the USGS quadrangle maps is included in the index. The index includes, among other information, the name of the agency or company that holds the photographs, the date of coverage, the scale, and the percent coverage of the quadrangle. The index includes photographs dating from the 1930s to the 1980s. It is likely that photographs with the most complete coverage of an area, flown at the lowest altitude, will be most useful for collecting population and land use information. Review of the index indicates that TVA photographs exist for many areas at a scale of 1:12,000. It appears that these might be a consistent and useful source of land use data due to the relatively large scale. The index is periodically updated, and is not considered by USGS to be an exhaustive listing of aerial photographs for the United States.

U.S. Department of Agriculture Aerial Photographs

The U.S. Department of Agriculture (USDA) Aerial Photography Field Office in Salt Lake City, Utah, maintains an index of aerial photographs taken as part of the National Aerial Photography Program. A printout of the index for study area counties was obtained and is available (Repository Document #1147). Coverage for the study area dates from 1953 to 1992, with updates every 5 to 7 years. The scale of the photographs is 1:20,000. The photographs were not reviewed; because of their scale, detailed land use features will probably not be discernible, however, these photographs may be of value in determining general land use categories for specific time periods.

According to personnel at the State Agricultural Stabilization and Conservation Office, photographs are periodically taken of farmland in the state at a scale of 1:1,000. The most recent photographs for Tennessee were generally taken from 1985 to 1987. These recent photographs are on file and available for review at the Agricultural Stabilization and Conservation offices in each county. Photographs taken since about 1950 can be obtained from the USDA in Denver; those taken prior to about 1950 are available from the National Archives in Washington D.C. Because of the large scale, these photographs may be of particular value in determining land use activities in agricultural areas.

Photographs Maintained by the Department of Energy

The Department of Energy (DOE) at ORR maintains an extensive collection of photographs of the ORR and vicinity dating from the early 1940s. The photographs have not been taken at regular intervals, except of particular facilities during certain time periods, for instance, during periods of construction to document progress. Most of the aerial photographs show specific facilities at ORR; however, there are also photographs of the surrounding areas, including nearby communities. Interior shots, and shots of people working are also included in the collection. A private company, Analysas, currently maintains the photograph collection under contract to DOE.

There have also been photographs taken by the prime contractors at the ORR, mainly Union Carbide and Martin Marietta. Some of these are included in the DOE collection, but many more are maintained by the past and present ORR prime contractors. These photographs may be of value in determining historical land use activities in the immediate area of ORR. A collection of aerial photographs is also available in the Oak Ridge National Laboratory (ORNL) Environmental Sciences Division Library; a description of this collection has been published (Repository Document #93).

2.2.3 Personnel Interviews

Since consistent sources of detailed land use information for the 50-year period are not available for the study area, interviews with long time residents will be a valuable source of site and time specific land use information. Interviews can help to determine the location of land use activities, including agricultural and recreational activities. Interviews may be of particular value in researching the consumption patterns of locally produced crops, meat, dairy products, and fish.

2.2.4 Historical Telephone Directories

Historical telephone directories provide a detailed source of specific information on where people have lived. Oak Ridge Public Library has a nearly complete collection of Southern Bell Telephone Directories for the City of Oak Ridge from 1946 to the present. The directories for 1946 through 1955 are for the City of Oak Ridge only; beginning in 1955, the books include the towns of Clinton (within the study area) and Norris (outside the study area). For 1962, a directory is available for Oliver Springs (within the study area).

There were also telephone directories published by private companies. One such directory was published by Management Services, Inc., for the years 1954, 1955, and 1956. It includes the

names of streets listed by area of the city; and the names of residents on each street listed by address.

Another directory, "City Directory," was published by Mullin-Kille for the years 1958, 1960, 1966, 1970, and 1974 for Oak Ridge and vicinity. It includes a directory of names of streets and avenues with the names of residents, an alphabetical resident directory including persons over 18 years of age living in the community, the number of children under 18 years of age by household, the occupation and place of employment of the head of household, a rural route directory containing the names of persons living outside the city limits, and a buyers' guide and classified section listing businesses in the community. The accuracy and completeness of these directories was not determined.

An attempt was made to locate collections of phone books for other communities in the study area. The McClung Historical Collection at the Knox County Library has a fairly complete collection of historical phone books for Knox County dating from 1930. These collections were not reviewed. The Pioneer Museum in Knoxville also has some historical directories for the area; the collection is not cataloged and was not reviewed.

The Harriman City Library has a few phone books from the 1950s, and some from the 1970s and 1980s. The librarian did not know of a complete collection in the county. Historical phone books were not located for other cities or counties in the study area.

2.2.5 Information Supplied by Government Agencies and Private Organizations

Annual estimates of livestock and crop production are tabulated by the Tennessee Agricultural Statistics Service for counties in the State. Historical county level summaries were collected for study area counties for corn, cattle, and tobacco. Historical data are available from the 1950s and 1960s to 1990. Annual production estimates for corn, tobacco, beef and dairy cattle were obtained for study area counties (Repository Document #1148). The names of two resident experts on agricultural history in Tennessee were also obtained, and are available in the same document.

Some reports were received from state government agencies that are available to support a more detailed demography and land use investigation. Examples are listed below:

> Waterfowl Technical Report 1991-92. Department of Tennessee Wildlife Resources. 1992.
>
> Wildlife Research Report, Activities on Wildlife Management Areas and Refuges, 1990-1991. Tennessee Wildlife Resources Agency. TWRA Technical Report No. 91-13.

Wildlife Research Report, Small Game Harvest Report Field Bag Check Data 1991-1992. Tennessee Wildlife Resources Agency. TWRA Technical Report No. 92-2.

Map generated from "Computerized Master Files of Tennessee's Water Wells," Tennessee Department of Environment and Conservation, Division of Water Resources. 1993.

A few local government agency data sources were noted, but have not been acquired. A master plan for the City of Oak Ridge was done in 1948 by Skidmore, Owings, and Merrill, for the Atomic Energy Commission. It is available at the Oak Ridge Public Library. A Land Use Map for the City of Oak Ridge was completed in about 1968; according to the Oak Ridge Planning Department, it is available at the Oak Ridge Public Library; it was not reviewed. Other potential sources of information noted, but not investigated, include the Tennessee State Archives and the Oak Ridge Childrens' Library, which maintains a collection of materials on local history. Private organizations which might prove of value include local historical societies.

Other local government information that may be of value for determining the locations of young persons and seniors include school district records on the historical locations of schools and numbers and names of school age children; and county licensing records, to research the locations and population of senior care facilities.

Tax assessor records and maps may be a good source of very detailed land use information. Tax maps are generally at a scale of 1 inch = 100 feet or 1 inch = 400 feet. They are generally accurate, particularly for the last 20 years. Some counties keep their own archives of tax maps; historical tax data for other counties are kept by the State.

2.2.6 Commercial Sources of Information

There are several commercial sources of census and economic data throughout the country that can be used to provide detailed demographic information on specified areas. One such source in the Oak Ridge area is the Geographic Information System (GIS) database available at ORNL. Current population data for all of East Tennessee are available; historical population data are currently being collected. The main GIS data source is U.S. Census reports. Population density maps can be provided for specified areas. Land use data are not available. GIS services are sold to parties outside ORNL.

3.0 HISTORICAL POPULATION

This section presents an overview of historical population patterns in the city of Oak Ridge, and in the study area. Reference is made to sources of information used during this feasibility study,

and to sources of information which might be used to further define the specific locations of populations as part of any dose reconstruction effort.

3.1 Historical Locations of Populations

Scattered residences and small farms exist in many areas just beyond the ORR boundary. Populated areas nearest each ORR plant are shown in Figure 3-1. Populated areas nearest the three plants include a portion of the urban part of Oak Ridge located about one-quarter mile north of the Y-12 Plant in Gamble Valley. That area is separated from the Y-12 Plant by Pine Ridge and is contiguous with the post-1959 ORR boundary in that area. This area was inhabited in the 1940s as the Gamble Valley Trailer Camp (Skidmore, Owings and Merrill, 1945) and is now known as the Scarboro community.

Residences nearest the K-25 Plant are located three-quarters of a mile to the north, just beyond the ORR boundary. Other residences near K-25 are located about two miles to the northwest and to the south. Review of USGS quadrangle maps indicates that many of these residences existed in the 1960s.

Residences nearest the X-10 Plant are approximately two and one-half to three miles to the southwest of the central plant area, south of Watts Bar Reservoir near Jones Island.

Population levels within areas defined by incremental distances in each of 16 directional sectors are shown out to 10 miles in Figure 3-2 and out to 50 miles in Figure 3-3. These figures were presented in the USDOE annual environmental report for 1991 (USDOE, 1992), and are based on 1990 census data.

Table 3-1 and Figure 3-4 presents U.S. Census figures for the total population of the five counties, portions of which make up the study area, from 1940 to 1990. Table 3-1 also includes data for major population centers within the study area. The total rural population for each county is also shown.

With a 1990 population of 27,300, the city of Oak Ridge in Anderson and Roane counties is presently the largest population center within the study area, and has been almost since its establishment in 1942. Other population centers within the study area include Clinton in Anderson County; Harriman and Kingston in Roane County; Lenoir City in Loudon County; Farragut in Knox County; and Oliver Springs, located in Anderson, Roane and Morgan Counties. The location of major population centers within the study area is shown in Figure 1-1. Several unincorporated communities are also located throughout the area.

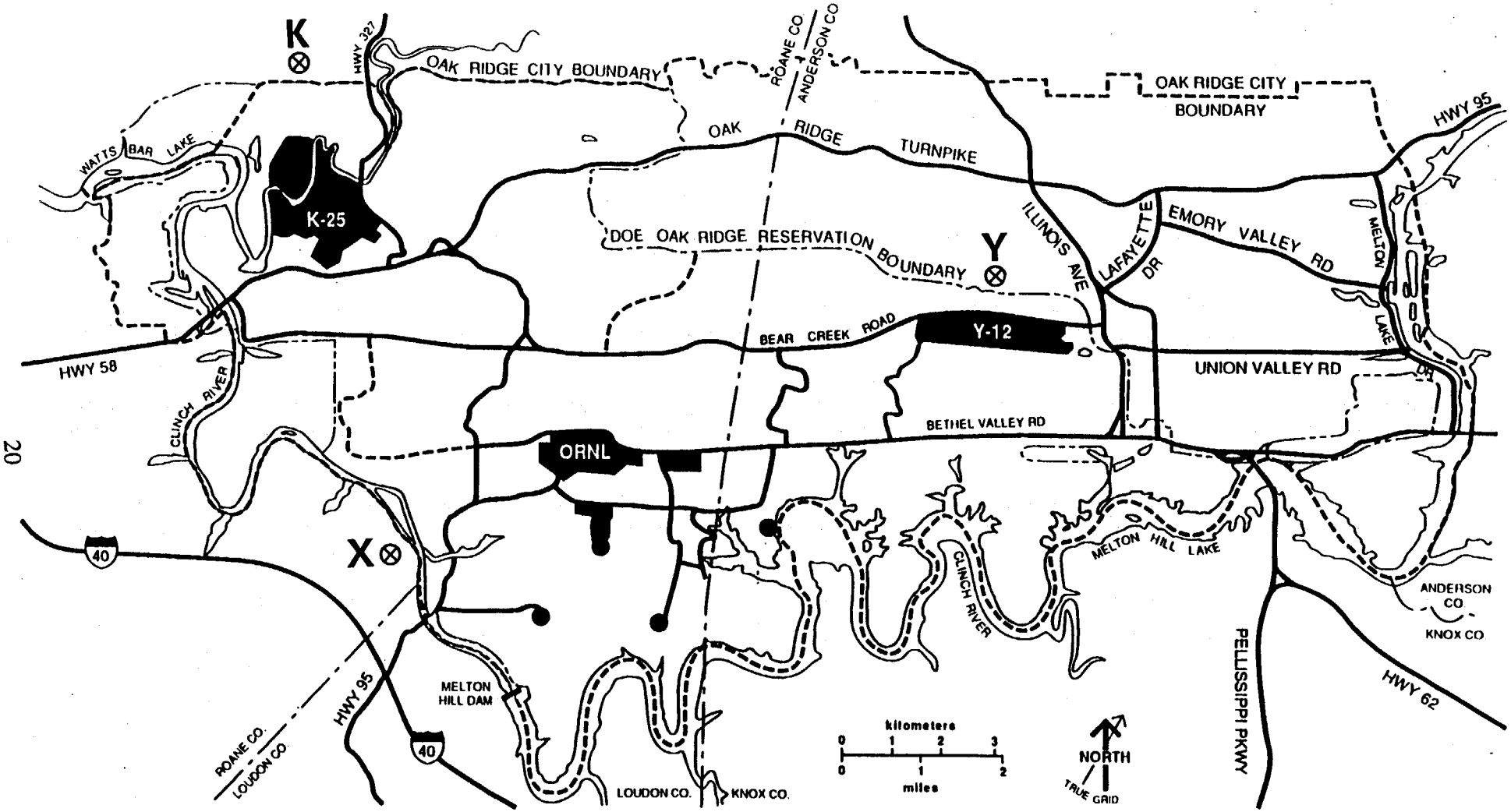

FIGURE 3-1
POPULATED AREAS NEAREST THE
THREE OAK RIDGE PLANTS

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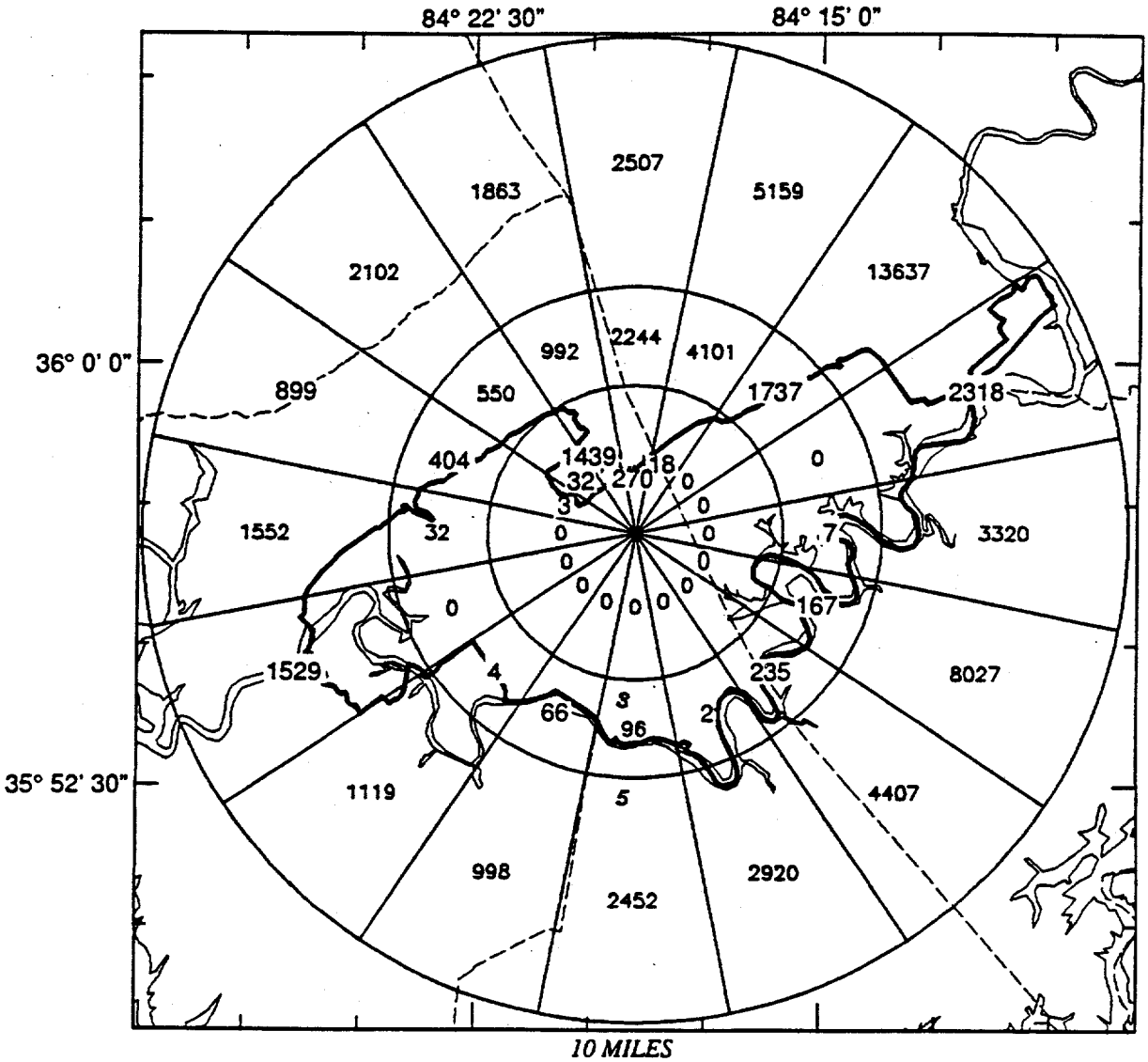

FIGURE 3-2
POPULATION LEVELS WITHIN
10 MILES OF THE CENTER OF
THE OAK RIDGE RESERVATION

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ORNL-DWG 92-6991R

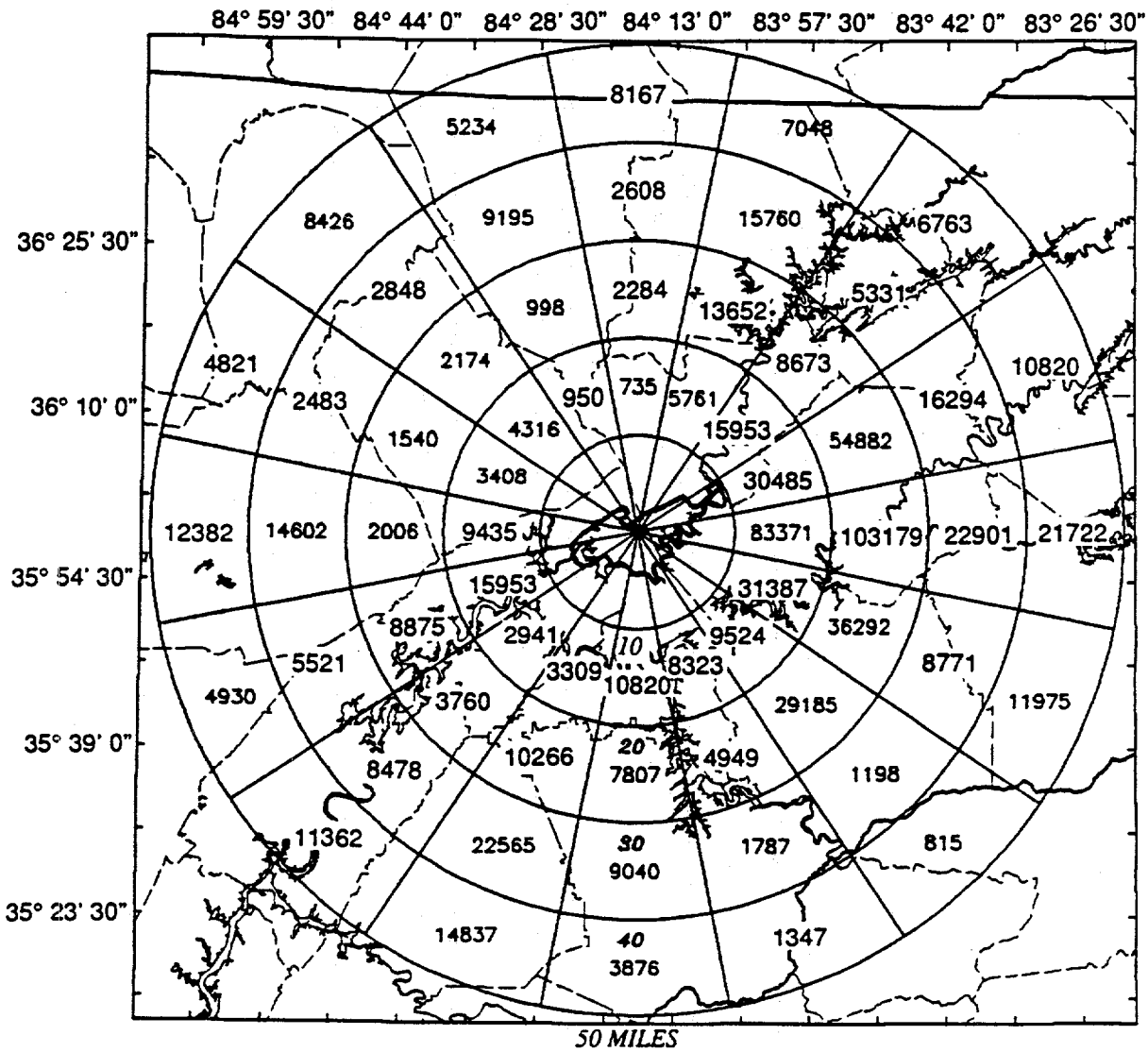

FIGURE 3-3
POPULATION LEVELS WITHIN
50 MILES OF THE CENTER OF
THE OAK RIDGE RESERVATION

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TABLE 3-1

POPULATION OF COUNTIES, RURAL AREAS, AND MAJOR POPULATION CENTERS

Location	Population					
	1940	1950	1960	1970	1980	1990
Anderson Country	26,504	59,407	60,032	60,300	67,346	68,250
Clinton	2,761	3,712	4,943	4,794	7,790[a]	8,972
Oak Ridge[b]	*	30,229	27,169	28,319	27,662	27,310
Rural Areas	23,743	25,497	27,629	26,469	34,208	32,228
Knox County**	178,468	223,007	250,523	276,293	319,694	335,749
Farragut	*	*	*	*	6,279	12,804
Rural Areas	66,888	74,841	138,702	101,706	74,160	74,029
Loudon County	19,838	23,182	23,757	24,266	28,553	31,255
Lenoir City	4,373	5,159	4,979	5,324[a]	5,505[a]	6,147
Rural Areas	12,448	14,456	14,966	15,214	19,164	20,184
Morgan County	15,242	15,727	14,304	13,619	16,604	17,300
Rural Areas	15,242	15,727	14,304	13,619	16,545	17,249
Roane County	27,795	31,665	39,133	38,188	48,425	47,227
Harriman	5,520	6,389	5,931	8,734[a]	8,303	7,119
Kingston	880	1,627	2,101	4,142[a]	4,441	4,552
Oliver Springs[c]	855	1,089	1,163	3,405	3,659	3,275
Rural Areas	18,194	18,212	27,812	18,093	26,477	27,018

* Not yet incorporated.

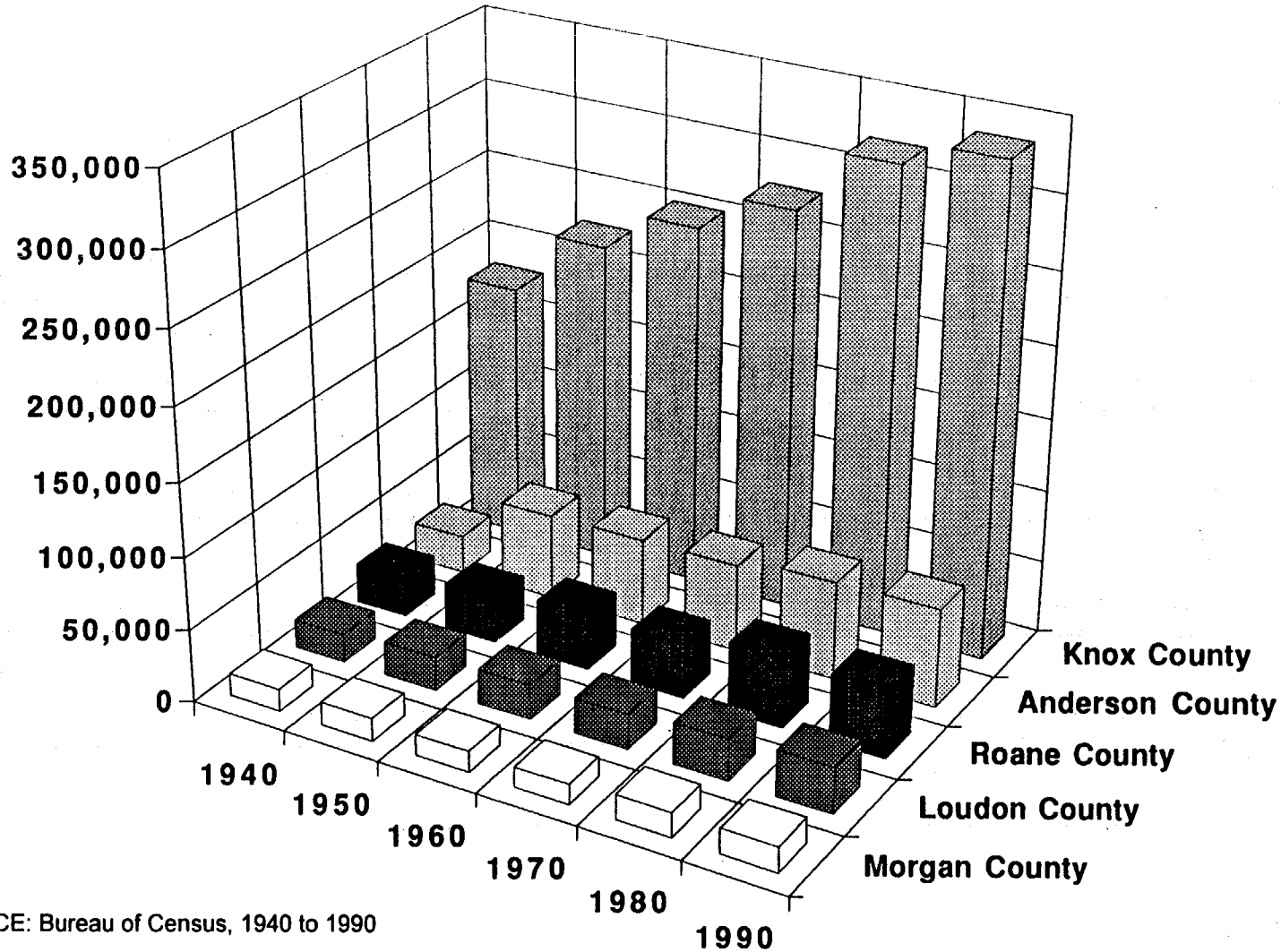
** Many of the residents of Knox County reside in Knoxville, which lies outside the study area of Phase I emphasis for airborne releases.

[a] Changes in base population figures are the result of census corrections or annexations.

[b] Portions of Oak Ridge located in Anderson and Roane counties.

[c] Portions of Oliver Springs located in Anderson, Roane and Morgan counties.

Source: U.S. Dept. of Commerce Bureau of Census Reports.



REFERENCE: Bureau of Census, 1940 to 1990

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FIGURE 3-4
POPULATIONS OF COUNTIES WITHIN THE STUDY AREA FOR AIRBORNE EMISSIONS

The historical population of the city of Oak Ridge is of particular interest because of its proximity to the three plants at ORR, its rapid and significant changes in population in the 1940s, and its influence on the population of the surrounding area. A brief history of the city of Oak Ridge is presented in Section 4.1.1. Population patterns for the city are discussed below and are depicted in Figure 3-5.

Before development of the ORR, the area consisted of farms and the small communities of Scarboro, Wheat, Robertsville and Elza, which were absorbed by the new city of Oak Ridge. A few months after its establishment in 1942, the community of Oak Ridge had a population of approximately 20,000. By the middle of 1944, the population had increased to 50,000. Population peaked at 75,000 in 1945; employment at ORR at that time was nearly 82,000. At the end of World War II, the population decreased dramatically. By January of 1946, the population had fallen to 48,000, and by June, to 43,000. In 1950, the population was about 30,000, and decreased slightly through the decade to about 27,000 in 1960. During the 1960 to 1990 period, the population of Oak Ridge fluctuated slightly, averaging about 28,000.

In Anderson County, the population has been influenced over the years by the City of Oak Ridge, much more so than in Roane County. In 1945, at the peak of the population boom in Oak Ridge, the population of Anderson County reached approximately 100,000 (Johnson and Jackson, 1981), a 275 percent increase from the 1940 population of about 27,000. In 1950, the population had dropped to about 59,000. It has slowly risen since then to a 1990 population of about 68,000. In Roane County, the population increased 70 percent between 1940 and 1990, compared with 158 percent in Anderson County for the same time period. The population of Knox County grew steadily from 1940 to 1990 by about 88 percent. Of particular note is recent growth in the western portion of the county between Knoxville and the City of Oak Ridge, within the study area. In particular, the new community of Farragut appears in the 1980 census as an incorporated community for the first time; and the Cedar Bluffs portion of Knoxville has undergone increased development in recent years.

The population of Loudon County has increased six percent since 1940. Morgan County, with the largest land area of the five study area counties, has experienced about 14 percent growth since 1940.

More specific information on the locations of historical populations can be obtained through the review of historical USGS 7.5-minute topographical maps and other historical maps of the area, and of historical telephone directories; these and other resources are discussed in Section 2.2.

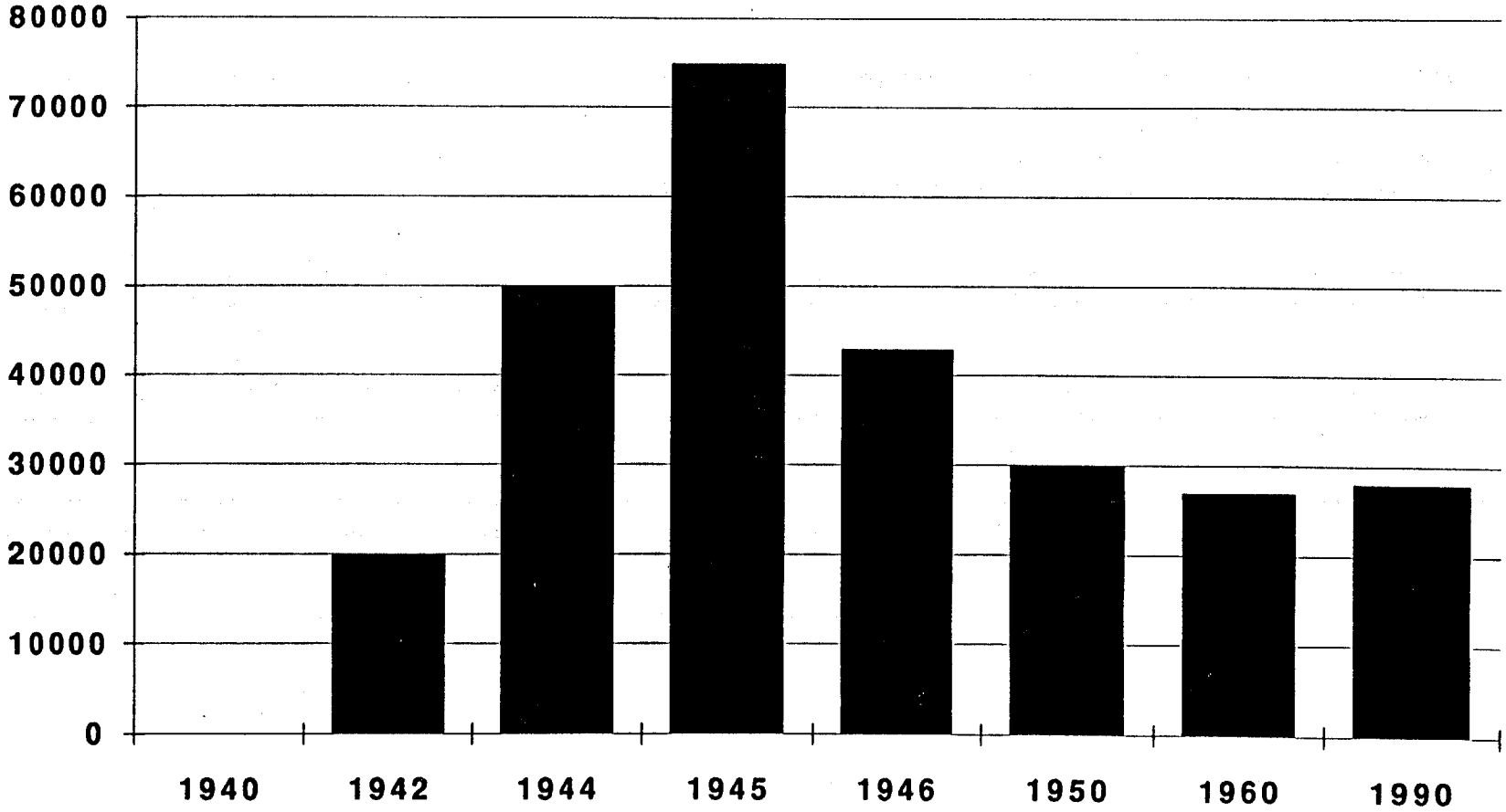

FIGURE 3-5
OAK RIDGE CITY
POPULATION, 1940-1990

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3.2 Population Age Distribution

An additional concern related to dose reconstruction is the age distribution of populations. Exposures to chemical toxicants and radioactive materials are commonly characterized for various age groups because physiological differences between persons of different ages may affect the degree of exposure, and because some age groups may be more sensitive than others to certain chemical toxicants or radioactive materials. Population age distribution data are available from U.S. Census Bureau reports for study area cities and counties.

Of particular interest is the population age distribution for the City of Oak Ridge. For the years 1940 to 1960, Oak Ridge had a higher proportion of working age people than the rest of the state, and fewer seniors. Since 1960, the number of residents over age 35, and in particular, over age 55, has increased, while the population under age 16 has declined (City of Oak Ridge, 1988).

Sources of information for further research on the locations of specific age groups include researching the historical locations of schools and senior care facilities in the study area. These sources of information are discussed in Section 2.2.

4.0 HISTORICAL LAND USE

This section presents an overview of historical land use patterns in the vicinity of Oak Ridge Reservation and a discussion of specific land and water uses that are of concern related to dose reconstruction, as outlined in the Task 5 Plan (ChemRisk, 1992). These specific concerns include the consumption of locally produced crops, meat, and dairy products; use of surface water for drinking, irrigation, and recreation; use of ground water for drinking and irrigation; consumption of local fish and game; and river dredging and sediment spreading.

4.1 Overview of Historical Land Use Patterns

General land use information for the region is useful in gaining a sense of what has occurred historically in the study area. A historical overview of the city of Oak Ridge, and of study area counties, is presented below.

4.1.1 Historical Overview of the City of Oak Ridge

In 1942, the federal government acquired approximately 58,000 acres of land in Anderson and Roane counties for weapons development during World War II. This area of land became the Oak Ridge Reservation. At the time, ORR included an area of land set aside for residential, commercial and support services needed by Reservation employees. In 1959, this area of land became the self-governing city of Oak Ridge. Although the entire original ORR is designated

as the city of Oak Ridge, about 37,600 acres, within the present ORR boundary, are under control of the federal government through the Department of Energy (DOE).

From 1948 to 1981, the University of Tennessee controlled a portion of ORR land as part of the UT-AEC Agricultural Research Station. This program originated to support studies of effects of Alamogordo, New Mexico nuclear test fallout on cattle that had been grazing near the Alamogordo test site. In 1981 the UT-controlled land which had been associated with the UT-AEC Agricultural Research Station was turned over to Oak Ridge Associated Universities (Thomas, 1993).

The self-governing portion of Oak Ridge consists of about 14,000 acres, most of which are located in Anderson County (ORNL, 1982). Approximately 40 percent of the urban portion of Oak Ridge is undeveloped. When the town was developed in 1942, it was divided into two halves by a main east-west road that is today Oak Ridge Turnpike. To the north were housing, schools, parks and a few shops and offices. To the south were industrial areas supporting the main defense plants, which were removed from the urban area (City of Oak Ridge, 1988). Housing consisted of trailers, dormitories, "flat top" houses, and single family dwellings called cemestos because of cement/asbestos boards used in their construction.

The transition from a controlled city to a self-governing one was gradual. From its founding in 1942 until 1949, the entire ORR was closed to the public. In March 1949, the residential portion of ORR was first opened to the public. At that time, a fence was erected around the controlled access areas. In July 1953, the main roads through the controlled area were opened to the public. In 1955, the Atomic Energy Commission sold government owned housing and land to private individuals. Today, areas around the three plants remain controlled access areas.

The urban portion of Oak Ridge has grown to the west since the late 1950s, and has included the development of Oak Hills subdivision beginning in the late 1950s, and County Club Estates, beginning in the early 1970s. Many residences on the western side of the urban portion of Oak Ridge have the ORR boundary as a property line (Faust, 1993).

4.1.2 Historical Overview of Study Area Counties

The five study area counties, Anderson, Knox, Loudon, Morgan, and Roane, were rural in character in 1942 when Oak Ridge was developed, consisting of farms and small communities. Large portions of the study area, particularly in Anderson and Roane counties, are composed of ridges and hills separated by narrow valleys. Historically, valleys were cleared for agricultural use and ridges remained forested. Today, rural populations tend to be concentrated in valley bottoms more so than on ridges. With the exception of urban areas, the land use pattern of farms and small communities remains throughout the area today.

As discussed in Section 3, the major communities in the study area are Oak Ridge, Oliver Springs, Clinton, Lenoir City, Harriman, Kingston, and Farragut. In addition several small communities are scattered throughout the area. Many of these consist of a cluster of residences and small farms, and perhaps a small commercial area.

Currently the two predominant land uses within study area counties are, first, commercial forestry, and second, agriculture, with the exception of Loudon County, where agriculture predominates, and forestry is second (ORNL, 1990), Table 4-1 presents the acres of land devoted to these uses in each of the study area counties. As can be seen, both agricultural and forestry uses are declining.

4.2 Livestock and Crop Production

U.S. Census Bureau Census of Agriculture reports were reviewed to determine major types of livestock and crops raised within study area counties. Census of Agricultural data do not indicate the location of these activities within the study area; however, statistics can be reviewed to determine the possible extent of activities within the area for a particular time period.

Because Census of Agriculture data are not site-specific within each county, County Agricultural Extension Agents were contacted for their knowledge of the location of past and present agricultural activities.

It is interesting to note that in 1943, a private company (called the Roane-Anderson Company) was hired to manage the details of running the residential area of ORR. As part of the effort, they ran a substantial farming and cattle raising operation within the boundary of ORR to help supply food to the growing city of Oak Ridge, with 640 acres of cultivated land, 800 head of cattle, and 5,000 chickens. Cattle were slaughtered on-site (Johnson and Jackson, 1981).

4.2.1 Livestock

As mentioned above, beef cattle were raised and slaughtered on the Reservation during the 1940s to supplement food supplies for the people of Oak Ridge. While the exact location and duration of the cattle raising operation have not yet been determined, these and any other on-site farming practices could be important when estimating off-site exposures from ingestion of food products.

Table 4-2 presents Census of Agriculture statistics on livestock raised in the five study area counties for the years 1950, 1959, 1969, 1978, and 1987. With the exception of cattle and calves, livestock production is generally decreasing. Cattle production has generally increased over the period in all countries except Knox. The following information on the location of beef and dairy cattle farms was summarized from conversations with current and retired County Agricultural Extension Agents (Amonatt, 1993; Bryan, 1993; Goddard, 1993; Hall, 1993;

TABLE 4-1

LAND IN AGRICULTURAL AND FORESTRY USES IN STUDY AREA COUNTIES
(Thousands of Acres)

County	1950	1959	1961	1969	1971	1978	1980	1987
Anderson Country								
Forestry % of County			145.0 83%		140.3 64%		134.2 62%	
Agriculture % of County	75.2 35%	64.2 30%		57.2 27%		43.5 20%		40.5 19%
Knox County								
Forestry % of County			106.2 33%		106.2 31%		102.0 30%	
Agriculture % of County	217.8 67%	166.7 51%		127.5 39%		105.2 32%		94.5 29%
Loudon County								
Forestry % of County			53.2 39%		53.3 33%		55.2 25%	
Agriculture % of County	132.2 89%	114.8 75%		110.8 73%		80.2 53%		77.7 52%
Morgan County								
Forestry % of County			297.0 86%		291.6 85%		270.0 78%	
Agriculture % of County	104.9 30%	78.3 23%		65.5 19%		49.3 14%		44.0 13%
Roane County								
Forestry % of County			146.9 35%		131.25 53%		150.0 60%	
Agriculture % of County	130.9 58%	95.3 42%		85.1 38%		62.2 28%		50.7 26%

Source: Agricultural data from U.S. Census of Agriculture, 1950, 1959, 1969, 1978, 1987; forestry data from Tennessee Statistical Abstracts, 1969, 1977, 1991.

TABLE 4-2

LIVESTOCK PRODUCTION IN STUDY AREA COUNTIES

County	1950	1959	1969	1978	1987
Anderson					
Cattle & Calves*	6,211	7,783	10,996	9,805	10,197
Milk Cows	2,433	1,867	1,106	568	542
Hogs & Pigs	3,477	3,074	1,266	1,584	2,817
Sheep & Lambs	325	471	NA	84	67
Chickens	41,733	37,237	28,175	1,426	1,147
Knox					
Cattle & Calves*	29,161	29,861	28,495	27,668	24,789
Milk Cows	11,917	7,473	3,299	1,159	1,150
Hogs & Pigs	12,015	10,231	4,850	2,859	1,746
Sheep & Lambs	1,181	1,169	195	154	821
Chickens	137,957	171,880	132,107	230,931	1,615
Loudon					
Cattle & Calves*	16,945	16,670	26,546	22,200	24,640
Milk Cows	5,928	5,183	4,370	3,417	3,958
Hogs & Pigs	6,007	4,541	1,986	2,022	914
Sheep & Lambs	543	643	111	NA	218
Chickens	55,343	51,183	57,300	11,163	687
Morgan					
Cattle & Calves*	4,614	4,614	5,386	6,207	7,273
Milk Cows	2,063	1,464	834	494	477
Hogs & Pigs	8,311	4,233	2,833	1,694	1,563
Sheep & Lambs	4,944	505	105	NA	NA
Chickens	40,604	38,609	11,209	9,122	950
Roane					
Cattle & Calves*	8,100	9,218	11,828	11,914	11,612
Milk Cows	3,429	2,346	1,129	1,577	652
Hogs & Pigs	3,878	4,140	2,280	2,704	431
Sheep & Lambs	344	323	3	0	52
Chickens	52,626	45,396	48,088	0	927

* Cattle and Calves includes milk cows.

McCallie, 1993; Sutton, 1993) in the five study area counties. These conversations represented their best recollections or knowledge of historical activities.

Anderson County. There are presently no dairy farms in western Anderson County, within the study area, nor have there been any within the past 19 years. All dairy farms in the county are in the Andersonville/Norris area, outside the study area. The only dairy farm near the study area is about 1.5 miles north-northeast of Clinton, located on the Clinch River. About 20 cows are milked; the farm has been there for about five years.

Norris Creamery was located in the town of Norris, outside the study area, from about the early 1940s until sometime in the 1970s, bottling and distributing milk locally.

Beef cattle are presently and have been historically scattered throughout the county, including within the study area. There is one large herd of about 40 head near the Bull Run Steam Plant.

Knox County. There were many dairy farms in western Knox County, within the study area, during the 1940s and 1950s. Dairy farming has decreased throughout the county; there were approximately 130 dairy farms in the county until about 25 to 30 years ago, as compared with about ten now. Many were in the Hardin Valley area just south of Melton Hill Reservoir; in the area of Karns, (a small community in the western portion of the study area), and along State Highway 162 which runs between Interstate 40 and the city of Oak Ridge (all within the study area).

At present, only one dairy farm exists in western Knox County, within the study area; it is located near Karns, and is approximately 40 years old.

It may be assumed that milk produced locally was consumed locally until advances in refrigeration technology allowed for longer storage time and the long distance shipping of milk. Prior to that time, the shelf life of milk was only about three or four days. There were several bottling plants in Knoxville, typically making deliveries to homes and stores.

Beef cattle have been and are still raised throughout western Knox County, within the study area. Beef cattle sold commercially are exported out of state for slaughter, to feed lots in the midwest; meat is then distributed throughout the country. There are no feedlots in the state of Tennessee.

Loudon County. There are presently no dairy farms north of the Tennessee River, within the study area, in Loudon County, and probably have not been for the last 14

years. Beef cattle are raised in the area of Eaton Crossroads, a small community in the study area, north-northwest of Lenoir City, and have been probably as far back as the early 1940s.

Morgan County. There are currently some dairy farms within the Morgan County portion of the study area. One is four to five miles north of the town of Coalfield, within the study area, with about 65 cows milked; it has probably been in existence since the early 1950s.

Another is just west of Coalfield. It was in existence as a dairy farm in 1958, the date of establishment is unknown. About 35 cows were milked; it changed to beef cattle in 1974 or 1975, and is now beef cattle and sheep.

There are also other dairy farms four to five miles west of Coalfield on the road to Harriman. One has been in existence since 1950s; about 30 to 35 cows are milked.

There is one other farm about one mile beyond the study area, located in the town of Union, located northwest of Coalfield.

There was a farm four to five miles north of Coalfield where about 60 cows were milked; it was established between 1956 and 1958 and changed to beef cattle in about 1985 or 1986.

Beef cattle are raised throughout Morgan County, including within the study area, and have been for many years. Beef cattle sold commercially have always been exported to the midwest for slaughter.

Roane County. Most dairy farms in Roane County are in the southern part of the county, outside of the study area. Presently there is only one dairy farm in the northern part of the county, within the study area. It is located about one mile east of Kingston. It is an old family operation milking about 30 cows.

Historically, there was a dairy farm about one and one half to two miles south of Kingston, at the edge of the study area, where about 35 cows were milked. It was in existence in 1956, and closed in the early 1970s.

Two others were located about three fourths mile northwest of the Kingston Steam Plant, milking about 35 cows each. Both were in operation in the 1940s, and ceased operation about 15 to 20 years ago.

Two other farms were also located in the same area: one milked about 70 to 80 cows, operating from the early 1950s until about five or six years ago. The other milked about 50 to 60 cows, was in business in 1956, and ceased operation about 10 to 12 years ago.

Beef cattle have been and continue to be raised throughout Roane County. There are currently about 15,000 head of cattle in the county. There is significant beef cattle production in the area of Oliver Springs, within the study area.

4.2.2 Crops

Table 4-3 presents U.S. Census of Agriculture statistics on corn, hay, soybeans, wheat, and tobacco grown in study area counties for the years 1950, 1959, 1969, 1978, and 1987. Almost without exception, production of these crops has decreased in the period since 1950.

The following information pertaining to the location of crop production within each study area county was summarized from conversations with present and retired County Agricultural Extension Agents.

Anderson County. Historical crop production within Anderson County has consisted predominantly of hay.

Knox County. The best farm land in Knox County was in the western portion of the county, within the study area.

Loudon County. Crops currently grown within the Loudon County portion of the study area include corn and sorghum; in the past, soybeans and tobacco were also raised. There have been home gardens and pastures, and there are presently some peach and apple orchards.

Morgan County. Some corn is grown within the study area portion of Morgan County, but it is much more common outside of study area. Most of the corn and tobacco in the county is grown in the western portion of the county, also outside the study area.

Roane County. Crop production in Roane County includes corn, tobacco, and hay.

4.3 Hunting

Tennessee Wildlife Resources Agency (TWRA) statistics were reviewed to determine if deer had been hunted in the study area; and TWRA personnel were questioned regarding the history of deer, waterfowl and small game hunting in the vicinity of ORR.

TABLE 4-3

CROP PRODUCTION IN STUDY AREA COUNTIES
(Acres)

County	1950	1959	1969	1978	1987
Anderson					
Corn	5,462	3,271	391	NA	183
Hay	10,007	7,591	5,818	6,612	7,669
Soybeans	83	211	0	0	0
Tobacco	277	258	221	139	124
Wheat	388	38	6	NA	0
Knox					
Corn	15,727	6,998	1,425	1,574	1,614
Hay	38,428	27,557	18,880	19,387	20,068
Soybeans	954	1,034	164	642	410
Tobacco	715	664	575	553	419
Wheat	3,712	905	482	322	304
Loudon					
Corn	12,938	5,972	1,353	1,574	794
Hay	20,225	15,155	11,377	12,977	17,410
Soybeans	657	501	733	2,087	799
Tobacco	1,135	735	637	469	430
Wheat	5,075	1,803	525	671	996
Morgan					
Corn	5,104	3,282	1,612	1,658	1,474
Hay	8,917	6,634	4,880	6,257	7,177
Soybeans	743	576	117	320	574
Tobacco	52	46	85	41	64
Wheat	340	205	125	NA	34
Roane					
Corn	8,411	3,679	1,192	534	237
Hay	14,163	9,407	8,127	9,460	10,381
Soybeans	824	662	342	83	144
Tobacco	465	340	267	209	194
Wheat	1,489	460	40	95	65

NA = Not available.

The "Big Game Harvest Data and Range Surveys 1991-1992" (TWRA, 1992) were reviewed to determine the numbers of deer harvested in the study area. Statistics were available for Tennessee counties for the years 1952 and 1957, and then yearly from 1962 to 1991. A brief summary of these statistics is presented below for study area counties, as an indication of what might have occurred in the study area. For example, it is known that some counties were closed to deer hunting for periods of time due to depletion of the deer population or for other reasons. This provides an indication that few deer were killed and eaten in that portion of the study area during those periods of time.

In Anderson County, the numbers of deer harvested per year during the 1950s and 1960s were in the range of two to 15 per year. The county was closed to deer hunting from 1975 through 1983. From 1984 to 1991, the numbers of deer harvested increased steadily from 34 to 286 per year.

In Knox County, between 20 and 108 deer per year were harvested during the 1950s and 1960s; after 1967, the county was closed to deer hunting due to depletion in the population. Loudon County was closed to deer hunting until 1984; between 1984 and 1991 the number of deer harvested per year increased steadily from 22 to 108. Both Morgan and Roane counties have been open to deer hunting for almost the entire time period from 1951 to the present, with a few years excepted. In Morgan County, less than 100 deer per year were harvested in the 1950s and 1960s; the numbers increased steadily to a high of 876 per year in 1989. In Roane County, between one and 40 deer per year were harvested from 1957 until 1981. Numbers then rose steadily from 57 in 1982 to a high of 321 deer per year in 1991. Statistics on game harvested in the wildlife management areas are not included in county statistics.

According to a TWRA representative, there is currently a large deer herd within the Oak Ridge City limits. The Oak Ridge Wildlife Management Area (WMA) is located within ORR in Anderson and Roane Counties, and is open to hunting at certain times of the year. A map showing the boundaries of the Oak Ridge WMA and all other wildlife management areas in Tennessee has been placed in the project repository (Repository Document #1146). Approximately 25,000 acres of ORR are open for hunting during deer season. The area has been open to hunting since 1985; between 440 and 927 deer per year have been harvested during that time. During deer season, there is a TWRA check station in the area where tissue, blood, and liver samples are collected from deer carcasses. Carcasses are checked for sex, age, and weight, as well as for evidence of contamination. The radiological surveys, which take about 10 minutes per animal, include measurements of alpha, beta, and gamma radioactivity and strontium-90. About 10 carcasses per year are confiscated due to strontium-90 content. (Evans, 1993).

Small game and waterfowl have been hunted over the years throughout the study area, going back to the early 1940s and earlier. Species of small game hunted include dove, squirrel, quail,

rabbit, raccoon and grouse. Waterfowl species include ducks and Canada geese. According to TWRA personnel, there is no evidence that small game and waterfowl hunting ceased for any period of time in the last 50 years, with the possible exception of raccoon hunting; raccoon season has been closed occasionally due to depletion of the population. In particular, there has been significant waterfowl hunting on Melton Hill Reservoir and the Clinch River (Evans, 1993).

4.4 Surface Water Use For Drinking, Irrigation, Recreation, and Fishing

The Task 5 Plan (ChemRisk, 1992) proposed an investigation of activities of concern, related to dose reconstruction, on surface waters in the vicinity of the study area. Those surface waters were the Tennessee River, the Emory River, and the Clinch River and its tributaries above Watts Bar Dam. A brief description of the relationship of these bodies of water to ORR, and to each other, is presented below. Figure 1-2 shows the location of these water bodies.

The ORR is drained by several small streams which ultimately flow into the Clinch River. These include White Oak, Poplar, and East Fork Poplar Creeks. The Clinch River joins the Tennessee River at Kingston. Three dams control the Clinch River flow: Norris Dam, located upstream from ORR; Melton Hill Dam, located adjacent to the southern boundary of ORR; and Watts Bar Dam on the Tennessee River, 39 miles downstream from its junction with the Clinch River.

Watts Bar Dam is located in Rhea and Meigs counties, about 30 miles southwest of ORR. Construction of Watts Bar Dam began in January 1936 and was completed in January 1940. The dam creates backwaters on the Clinch River that extend to Melton Hill Dam, forming the southwestern and western boundaries of ORR. Melton Hill Reservoir forms the eastern and southern boundaries of ORR. Construction of Melton Hill Dam began in September 1960 and was completed in May 1963.

The flow of the Tennessee River is regulated by TVA using nine multipurpose dams on the Tennessee and 26 dams on tributaries. The two uppermost dams on the Tennessee are Fort Loudoun Dam, located at the southern edge of the study area at Lenoir City, and Watts Bar Dam, discussed above. The Emory River is one of the largest tributaries of the Clinch River. The Emory River drains an area northwest of ORR and joins the Clinch River near Kingston.

4.4.1 Surface Water Use for Drinking and Irrigation

Reports on the locations of surface water withdrawal for public water supply for 1980 and 1988 were reviewed (Alexander et al., 1984; Hutson and Morris, 1992). Excerpts from these documents have been retained in the project repository (Repository Document #1150). No site-specific data on surface water withdrawal before 1980 were identified (Hutson, 1993).

Surface water has been withdrawn at several locations on the Emory, Clinch, and Tennessee Rivers and on Watts Bar and Melton Hill Reservoirs. In Anderson County, Rust Engineering Company has withdrawn water from Melton Hill Reservoir at a point near the southern boundary of the ORR. In 1988, they directly served a population of about 3,300. Rust Engineering also sold water to the Oak Ridge Department of Public Works as their only source of water. Rust Engineering was at one time a contractor to the Atomic Energy Commission and the Department of Energy in that capacity. The Oak Ridge Department of Public Works served a population of about 29,000.

The Anderson County Utility Board has withdrawn water from the Clinch River at a point about one mile east of the residential portion of Oak Ridge. They directly served a population of about 2,100 in 1988, and sold water to the Clinton Utility Board as one of several sources of water. The Clinton Utility Board served a population of about 12,400.

In Knox County, the Hallsdale-Powell Utility District has withdrawn water from Melton Hill Reservoir, as one of several sources of water, serving a 1988 population of about 33,000. The West Knox County Utility District withdrew water from Melton Hill Reservoir at two points, both on the southern boundary of the ORR. This was the only source of water for the district, which served a 1988 population of about 33,000.

Surface water withdrawal for the Lenoir City Utility Board in Loudon County was from the Tennessee River near Fort Loudoun Dam. The Lenoir City Utility Board served a population of about 7,500, and sold water to the Dixie Lee Utility Board as one of three sources of water for a population of about 6,300 in northern Loudon County. The Dixie Lee Utility Board sold water to the Martel Utility Board, as their only source of water, serving a population of about 1,600. The Loudon County Utilities Board withdrew water from the Tennessee River at a point about one mile south of the city of Loudon, and served a population of about 6,000.

In Roane County, the Harriman Utility Board withdrew water from the Emory River west of Harriman, upstream from the point where the Emory River joins the Clinch River, and directly served a population of about 9,300. The Swan Point Utility District bought water from the Harriman Utility Board as its only source of water, and served a population of approximately 8,500.

The Wolf Branch Utility District in Morgan County also received water from the Harriman Utility Board as its only source of water. It served a population of about 2,000.

The Cumberland Utility District in Roane County has withdrawn water from the Little Emory River at a point about three miles north of Kingston, as one of several sources of water, and served a population of approximately 7,100. The Rockwood Water System, also in Roane County, has withdrawn water from Watts Bar Reservoir at a point about seven miles west of

Kingston. The Watts Bar Reservoir was its only source of water to supply a population of about 8,500.

The Spring City Water System in Rhea County withdrew water from Watts Bar Reservoir near Kingston, as one of several sources of water, and served a population of about 2,700. In Meigs County, the Spring City Water System also withdrew water from Watts Bar Reservoir near Kingston as one of three sources of water, and served a population of about 2,700.

Information on withdrawal of water by industrial users was also reviewed. According to TVA, such water has probably been used for process water, and not as a drinking water supply. The reports also contain information on withdrawal of water by private users, such as mobile home parks and property owners' associations; the locations of these users are available from TVA.

Water is reportedly withdrawn at the TVA-operated Kingston Steam Plant, in part to supply drinking water to plant workers. Unlike the complete treatment at the Kingston City water treatment plant, the potable water treatment at the power plant reportedly consists of chlorination alone (Cook, 1993). The K-25 plant currently withdraws water from the Clinch River at mile 14.5 (Leming, 1993). This water was used for domestic purposes in the past, but now is used solely for fire protection.

Collection of historical information on withdrawal of surface water will require contacting each public water supplier to determine past practices.

According to USGS personnel, almost no data, particularly historical data, exist on use of surface water for irrigation. Because the 40-year annual average precipitation in the Oak Ridge area is nearly 54 inches (USDOE, 1991), there has reportedly been little need for irrigation. There are no estimates on agricultural use of surface water beyond county estimates based on number of head of cattle per county and the number of gallons of water consumed per day per head.

Some U.S. Census of Agriculture reports contain information on the number of acres of irrigated farmland per county. The Census reports do not indicate whether the irrigation water is surface water or groundwater. Reports for 1950 and 1987 indicate that, in all five study area counties, the number of irrigated acres was quite low. In Anderson County, only three acres were irrigated in 1950; 60 acres were irrigated in 1987. In Knox, Loudon, Morgan, and Roane Counties, there was no irrigated farmland in 1950. In Knox County, 268 acres were irrigated in 1987; in Loudon County, 191 acres; in Morgan County, 4 acres; and Roane County, 66 acres. Further research would be required to determine the location of irrigated land in the study area and the sources of the water. This investigation would most likely center on interviews of long-time residents.

4.4.2 Surface Water Use for Recreation

As discussed above, there are two TVA lakes which ultimately receive drainage waters from ORR: Watts Bar Reservoir on the Tennessee River, and Melton Hill Reservoir on the Clinch River. Originally designed for the purposes of flood control, navigation, and generation of electricity, the lakes offer a wide range of recreational activities.

Melton Hill Reservoir. Melton Hill Reservoir extends 44 miles upriver from Melton Hill Dam and covers 5,690 acres of lake area within 173 miles of shoreline. The left (south) bank of the dam reservation has been improved for visitor use. The right (north) bank of the lake, from the dam to a point approximately 21 miles upstream where State Highway 162 crosses the Lake, is within the boundary of ORR, and use is restricted to authorized personnel only. Recreation facilities and activities available at Melton Hill Reservoir include the following:

4 county parks
2 municipal marinas
3 municipal parks
5 public access areas
2 clubs
2 commercial recreation areas (TVA, date unknown)

A recreation map of Melton Hill Reservoir showing the 1987 locations of these areas has been placed in the project repository (Repository Document #1145). Many of these areas were developed during the early to mid-1970s.

Visitation data were collected by TVA beginning in 1963, at the completion of dam construction, until 1978. Visitation increased steadily from 53,000 in 1963 to over 500,000 in 1978 (TVA, 1993). According to TVA personnel, recreational use of the Clinch River prior to dam construction (1960 to 1963) was probably light; recreational facilities probably consisted of boat ramps and picnic areas (Farrell, 1993). No records were discovered for recreational use of the River before dam construction.

Also important to acknowledge is the historical use of the Clark Center Recreational Park within the ORR boundary. Established in the late 1960s on the shores of the McCoy Branch embayment of Melton Hill Reservoir, the park has long been unofficially called Carbide Park (Thomas, 1993). Originally limited essentially to use by Union Carbide employees, the park has in subsequent years been open to the general public. The park has picnic facilities, a boat ramp, and a small sandy beach. Although the park is upriver from the major emission points on the Reservation, and residence times in the park

would likely be small compared to those of individuals at their homes, the potential has existed for exposures to members of the public from use of these on-site facilities.

Watts Bar Reservoir. Watts Bar Reservoir is 72 miles long and has a maximum width of 1.3 miles. It extends upriver to Melton Hill Dam where a 75 foot by 400 foot navigation lock allows commercial and recreation boats to travel back and forth between Melton Hill and Watts Bar Reservoirs. Watts Bar Reservoir has a surface area of 39,000 acres and a shoreline of 783 miles. Recreation facilities available at Watts Bar Reservoir include the following.

60 public access areas
2 county parks
5 municipal parks
2 state wildlife management areas
1 environmental study area
6 group camps and clubs
25 commercial recreation areas
2 natural areas
3 trails (TVA 1993a)

A recreation map of Watts Bar Reservoir showing the 1987 locations of these areas has been placed in the project repository (Repository Document #1144). Although dam construction was completed in 1940, many of these areas were not developed until the early to mid-1970s. Prior to development of recreation areas, recreational use of the lake was much lighter; facilities available probably consisted of boat ramps and picnic areas (Farrell, 1993). Visitation to Watts Bar Reservoir in 1947 was just under 200,000, and had risen to over 3 million in 1978 (TVA, 1993).

Emory River. Information was received from TVA on canoeing on the Obed-Emory Rivers System. The information indicates that there is currently one developed public access, and six undeveloped access points along the length of the Emory River. Approximately one mile of the Emory, extending upstream from its junction with the Obed, became part of the National Wild and Scenic River system in 1976. (ETWWC et al., undated). According to TVA personnel, canoeing is the main recreational use of the Emory River. Historically, recreational use of the River has probably been light (Farrell, 1993).

Further research to determine specific historical activities on TVA lakes could include contacting the TVA Property Administration Group which maintains all permits, and records of sales and leases, for TVA land.

4.4.3 Surface Water Use for Fishing

Information sources for recreational fishing included conversations with TWRA personnel, and review of TWRA reports for Melton Hill and Watts Bar Reservoirs. Sources of information for commercial fishing included conversations with TVA personnel and review of a TVA report on commercial fisheries.

Recreational Fishing

Conversations with TWRA personnel indicated that creeks within the City of Oak Ridge and in the immediate vicinity have been fished throughout the 50-year period. No statistics have been kept on specific fishing locations or numbers of fish caught. The best source of information will probably be conversations with long time residents (Evans, 1993).

Data on the estimated magnitude of recreational fishing in Melton Hill Reservoir between 1977 and 1983, and in Watts Bar Reservoir between 1977 and 1991 were obtained from a TWRA summary report (TWRA, undated). It is estimated that between 1977 to 1983, there were approximately 5,000 to 20,000 pounds of fish per year harvested by recreational fishermen in Melton Hill Reservoir. At Watts Bar Reservoir, it is estimated that between 83,000 and 395,000 pounds per year were harvested from 1977 to 1991. Fishing is permitted all year in TVA lakes.

Data for other years is available in annual TWRA reports. Data collected before 1977 is incomplete. On-site research of annual reports at TWRA offices will be required to access data for other years.

No information was available on numbers of fishermen or specific locations of recreational fishing in TVA lakes. However, TVA recreation maps for Watts Bar and Melton Hill Reservoirs showing the location of fish attractor sites are available (Repository Documents #1144 and #1145). Fish attractors are piles of brush and/or tires anchored to the bottom of a lake, which have proven effective in concentrating fish by serving as shelter and feeding sites. There are currently approximately 50 fish attractor sites in Melton Hill Reservoir, and about 30 in Watts Bar Reservoir. Fish attractors were first put in place in the late 1970s and early 1980s. They have proven effective and probably indicate areas of increased fishing concentration. In addition, areas in the tailwaters of the dams are also popular sites for recreational fishermen due to higher concentrations of fish.

State level summary data are available on the number of fishing licenses issued per year, however only the 1992 data include county level summaries. The number of fishing licenses sold is probably not a good indicator of the numbers of recreational fishermen since for many years, licenses were not required for persons fishing in their county of residence, or for persons

under 16 years of age. In addition, fishing licenses were given free of charge to senior citizens (Chesser, 1993).

One indication of the numbers and types of fish caught is creel data, which consists of interviews with fishermen in the field to determine numbers and types of fish being caught. Conversations with TVA personnel indicated that creel data have been collected for reservoirs only; none have been collected for rivers or streams in the study area. Typically creel data have been collected related to specific projects for which environmental baseline data was required (Wathern, 1993). Such reports can be reviewed to obtain more detailed information on recreational fishing.

Commercial Fishing

Commercial fishing has been a traditional source of income in Tennessee since the first settlements were established in the State. Prior to reservoir construction throughout the state, which greatly expanded the resource, the Tennessee River was one of the principal waters fished commercially.

A TWRA survey was conducted in 1989 on the number of commercial fishermen, and the amount of fish harvested, in TVA lakes. Results indicated that there were 37 commercial fishermen on Watts Bar Reservoir; four were full-time and 33 were part-time. A total of 44,000 pounds of fish were harvested. These figures were based on estimates from fishermen responding to a voluntary survey. Fish species caught commercially in Watts Bar Reservoir included catfish, paddlefish and drum (Todd, 1989).

None of the licensed commercial fishermen who responded to the survey fished the Emory River; however, TWRA personnel report that the Emory is fished commercially, and has been in the past. There are no more than three commercial fishermen there at present; catch is low. Melton Hill Reservoir is closed to commercial fishing, and has been for many years, probably since the construction of Melton Hill Dam in 1963 (Todd, 1993).

Only statewide information was available on the disposition of fish caught. In 1989, statewide, commercial fishermen disposed of their catch in a variety of methods. Most of the fish, 79 percent by weight, were sold to wholesale fish markets. According to conversations with TWRA personnel, these wholesale markets are located in Chicago and New York City. Consumers bought about 10 percent directly from fishermen; 7 percent were kept for personal use; 3 percent went to grocery stores and restaurants, and fewer than 1 percent were given to friends (Todd, 1989).

Personal interviews with local commercial fishermen will be required to determine how fish caught locally are disposed of. Information on how catch has been disposed of in the past will require research, including personal interviews and review of historical reports.

4.5 Groundwater Use for Drinking and Irrigation

Records of water wells are maintained by the Tennessee Department of Environment and Conservation in their "Computerized Master File of Tennessee Water Wells." Records include: name of owner, date of drilling, date reported, and location. The location may be indicated as being on a named access road somewhere within a 2.5-minute grid, or may be specific to latitude and longitude. Sources of information include drillers' reports and USGS ground survey records. The accuracy of the data is not considered to be 100 percent because the source of the data, drillers' logs, may not have always been accurate or complete. Information as to whether wells are active or inactive is not always dependable, since notification of well closings is voluntary. The database contains well data from 1963 to the present. A map of water wells located within the study area, generated from the computerized master file, has been placed in the project repository (Repository Document #1143).

The Tennessee Division of Geology Bulletin #58, Part 1, "Ground-Water Resources of East Tennessee" (DeBuchananne and Richardson, 1956), contains information on wells dating back to the 1940s (Repository Document #1139). General information on the geology and groundwater of each study area county except Morgan County is included, as well as maps showing location of wells at the time.

According to the Bulletin, drilled wells supplied most of the drinking water to the rural population of Anderson County at the time of publication in 1956. Four cities in Anderson County had municipal water supplies, including Clinton and Oak Ridge within the study area. Clinton obtained its water supply from springs, and Oak Ridge from the Clinch River.

In Knox County, it was estimated that the amount of groundwater used in the Knoxville area in 1956 exceeded 10 million gallons per day. The city of Knoxville obtained its water supply from Fort Loudon Reservoir on the Tennessee River at the southern edge of the study area. No other information specific to the Knox County portion of the study area is given.

Lenoir City, within the Loudon County portion of the study area, obtained its water supply from the Tennessee River. The Dixie Lee Utility District, also within the study area, obtained some of its water supply from springs.

In Roane County, wells and springs were supplying most of the rural population. Of the study area communities in the county, Kingston and Oliver Springs had public water supplies developed from groundwater; Harriman obtained its water from the Emory River. The water supply for Kingston was from a spring three miles northwest of town; and for Oliver Springs from a well in Morgan County one and one half miles northwest of town, augmented by a well located in the city of Oliver Springs.

According to USGS personnel, the statewide trend over the years has been toward an increase in the use of public water supply, and decreased use of private wells (Hutson, 1993).

4.6 River Dredging and Sediment Spreading

Reference to use of mercury contaminated sediment used in construction fill for the Oak Ridge Civic Center was noted in a report published by the United State Congress (OTA, 1991). Conversations with City of Oak Ridge Public Works Department personnel revealed that East Fork Poplar Creek (EFPC) was dredged in about 1974 or 1975 to remove silt that had accumulated upstream from culverts at points where roadways cross the creek. At that time, dredged material was placed along the banks of the creek. During subsequent sewer line installation in the city, dredged material was removed from the creek banks and used as topsoil in reclamation. Later testing revealed elevated levels of mercury in the dredged material. The creek originates on the Y-12 property and passes through residential areas of western Oak Ridge. Sampling was done along the sewer line right-of-way, and the top 12 to 18 inches of soil was replaced in some of the areas near the Civic Center. No subsequent dredging of East Fork Poplar Creek has occurred, although dredging is planned for later this year (Calvert, 1993). The course of the EFPC stream channel was altered (relocated) in the early to mid-1980s in the Oak Ridge commercial district (McCoy, 1993).

TVA personnel were contacted to determine the extent of river dredging in the ORR area. With a few exceptions, rivers in the region do not require maintenance dredging. The closest maintenance dredging is on the Tennessee River above Fort Loudoun Dam, upstream from ORR.

The Corps of Engineers and the TVA regulate bottom-disturbing activities in surface water bodies near the ORR. The Corps of Engineers is given this authority under the Clean Water Act and the Rivers and Harbors Act. The TVA Act of 1933 gives TVA responsibility for regulating dredging. TVA owns land around the Watts Bar Reservoir. Landowners who live near the reservoir are allowed to use the land, with certain restrictions. TVA and the Corps of Engineers have for some time issued permits for bottom-disturbing activities, such as installation of boat docks or piers, installation of rip-rap, or dredging of channels for boats. The water level of Watts Bar reservoir is lowered approximately ten feet in the winter, from about 745 feet above sea level to about 735 feet above sea level. With a permit, landowners are allowed to dredge provided removed material is placed above the 750-foot contour. The material is sometimes put in low spots in yards, on gardens, etc.

When the Clinch River environmental restoration program started around 1990, scoping study reports raised concerns about Cs-137 levels in sediments of the Clinch and in Watts Bar reservoir. TVA and the Corps of Engineers halted all dredging activity. In January of 1991 TVA and the Corps of Engineers met with the DOE and the State of Tennessee and the U.S. EPA. A Watts Bar Interagency Working Group was formed to review permit applications for

bottom-disturbing activities in Watts Bar Reservoir. Upon receipt of an application, sampling is performed in the area in question. If Cs-137 levels are above an action level of 15 picocuries per gram dry weight, more samples are taken. If levels are below this limit, the Interagency Working Group passes the application along to the Corps of Engineers for processing as was done previously. Since formation of the Interagency Working Group, over a hundred applications have been reviewed, and none have been denied due to Cs-137 contamination levels (Cook, 1993).

Excerpts from a technical report were obtained from TVA which describe dredging activities related to the construction of Melton Hill and Watts Bar Dams (Repository Document #1151). General information on disposal of dredge spoils is included in the report.

5.0 SUMMARY AND CONCLUSIONS

A significant number of information sources have been identified that are relevant to historical locations and activities of populations potentially affected by releases from the Oak Ridge Reservation. The information that has been reviewed as part of this Task 5 investigation has shown that numerous residences and farms have historically been present near the ORR boundary and that a variety of land uses and recreational activities have been practiced. Based on this information alone, it would appear that many routes of off-site exposure could have been plausible. Coupled with the toxic material use and emission information that is being compiled in Task 1 and the environmental monitoring and research data that are being assembled in Task 2, the Task 5 demography and land use information will play an important part in Task 3 efforts to identify which of the possible exposure pathways have been complete and Task 4 activities to determine which of the complete pathways may have been most significant. Throughout this Phase I process, one of the primary objectives is to focus on those activities, materials, and exposure pathways that warrant detailed evaluation in the form of dose reconstruction or health study efforts.

Most of the available published information addresses demographic and land use data on a regional or county-wide basis over fairly broad time periods. The information sources that are most readily available do not support direct evaluation of potential exposure pathways at specific geographic locations near the Oak Ridge facilities at specific points in time. A number of information sources have been identified that can provide demography and land use information more specific to locations and time periods that are identified to be of interest. Examples of data sources in this category include individual USGS topographic maps, aerial photographs, lowest-level census tract data, and interviews with long-time local residents. However, specific release events and periods of interest should be identified prior to attempts to collect more specific demographic or land use information for actual dose reconstruction.

A primary purpose of Phase I is to focus attention on those activities, materials, and exposure pathways warranting detailed evaluation. Once historical activities that have been most significant in terms of off-site emissions have been identified, it will be possible to narrow the focus of the investigations onto the time periods, contaminants, and emission sources associated with these key activities. Once those determinations have been made, the information sources identified in this report can be visited in greater detail to collect demography and land use information addressing the time periods and locations of interest.

6.0 REFERENCES

Alexander et al., 1984. Alexander, Frank M., and Lee A. Keck, TDWM; Lewis Conn, USGS; and Stanley J. Wentz, TVA. "Drought Related Impacts on Municipal and Major Self Supplied Industrial Water Withdrawal in Tennessee-- Part B." United States Geological Survey. Water-Resource Investigations Report 84-4074.

Amonatt, 1993. Personal Communication with D. Kelly Amonatt. Morgan County Agricultural Extension Office. February 9, 1993.

Bryan, 1993. Personal Communication with Harry Bryan, Knox County Agricultural Extension Office. February 8, 1993.

Bureau of Census, 1940. United States Department of Commerce, Bureau of Census. *Sixteenth Census of the United States: 1940.*

Bureau of Census, 1950. United States Department of Commerce, Bureau of Census. *Census of Population: 1950.*

Bureau of Census, 1950. United States Department of Commerce, Bureau of Census. *1950 United States Census of Agriculture.*

Bureau of Census, 1959. United States Department of Commerce, Bureau of Census. *United States Census of Agriculture 1959.*

Bureau of Census, 1959. United States Department of Commerce, Bureau of Census. *1959 Census of Agriculture.*

Bureau of Census, 1969. United States Department of Commerce, Bureau of Census. *1969 Census of Agriculture.*

Bureau of Census, 1970. United States Department of Commerce, Bureau of Census. *1970 Census of Population.*

Bureau of Census, 1978. United States Department of Commerce, Bureau of Census. *1978 United States Census of Agriculture.*

Bureau of Census, 1980. United States Department of Commerce, Bureau of Census. *1980 Census of Population and Housing.*

Bureau of Census, 1987. United States Department of Commerce, Bureau of Census. *1987 United States Census of Agriculture.*

Bureau of Census, 1990. United States Department of Commerce, Bureau of Census. *1990 Census of Population and Housing.*

Calvert, 1993. Personal Communication with John Calvert, City of Oak Ridge Public Works Department. March 15, 1993.

ChemRisk, 1992. ChemRisk Division of McLaren/Hart. "Task 5 Draft Plan, Identification of Potentially Affected Populations." Prepared for the Tennessee Department of Health. July. As amended.

Chesser, 1993. Personal Communication with Helen Chesser, Tennessee Wildlife Resources Agency. January 29, 1993.

City of Oak Ridge, 1988. "Comprehensive Plan Including 1988 Update." City of Oak Ridge, May 1988.

Cook, 1993. Personal Communication with Bob Cook, Oak Ridge National Laboratory. February 16, 1993.

DeBuchananne and Richardson, 1956. DeBuchananne, G.C., and R.M. Richardson. "Ground-Water Resources of East Tennessee." State of Tennessee Department of Environment and Conservation Division of Geology Bulletin 58 Part 1. Prepared in cooperation with the U. S. Geological Survey.

ETWWC et al., undated. East Tennessee White Water Club, the Tennessee Scenic River Association and the Tennessee Valley Authority. "Obed-Emory River Guide". TVA/ONRED/LER-86/11.

Evans, 1993. Personal Communication with Jim Evans, Tennessee Wildlife Resources Agency, Oak Ridge Tennessee. February 23, 1993.

Farrell, 1993. Personal Communication with Robert Farrell, TVA Land Resources Office, Norris, Tennessee. March 25, 1993.

Faust, 1993. Personal Communication with Lucian Faust, City Planner, City of Oak Ridge Planning Department. August 6, 1993.

Goddard, 1993. Personal Communication with John Goddard, Loudon County Agricultural Extension Office. February 10, 1993.

Hall, 1993. Personal Communication with Joe Hall, Anderson County Agricultural Extension Office. February 9, 1993.

Hill et al., 1984. Hill, C.C., L.S. Jones, and M.A. Manuel. "Removal of Topsoil from the Oak Ridge Civic Center Greenbelt Sewer Line, Health, Safety, Environment, and Accountability." Oak Ridge Y-12 Plant Operated by Martin Marietta Energy Systems, Inc. for the U.S. DOE. July 18.

Hutson, 1993. Personal Communication with Susan Hutson, United States Geological Survey, Memphis, Tennessee. January 27, 1993.

Hutson and Morris, 1992. Hutson, Susan S., and A. Janine Morris. "Public Water-Supply Systems and Water Use in Tennessee, 1988." USGS Water-Resources Investigations Report 91-4195.

Johnson and Jackson, 1981. Johnson, Charles W., and Charles O. Jackson. *City Behind a Fence, Oak Ridge, Tennessee 1942-1946*. University of Tennessee Press, Knoxville.

Leming, 1993. Personal Communication with Earl C. Leming, Tennessee Department of Environment and Conservation, DOE Oversight Division. April 1993.

McCallie, 1993. Personal Communication with Paul McCallie, Roane County Agricultural Extension Office. February 8, 1993.

McCoy, 1993. Personal Communication with Doug McCoy, Tennessee Department of Environment of Environment & Conservation, DOE Oversight Division. August 18, 1993.

ORNL, 1990. Oak Ridge National Laboratories. "Data Package for the Atomic Vapor Laser Isotope Separation (AVLIS) Plant Environmental Impact Statement." ORNL/TM-14482. Prepared by the Oak Ridge National Laboratory for U.S. Department of Energy. February 1990.

ORNL, 1982. Oak Ridge National Laboratories. "Environmental Analysis of the Operation of Oak Ridge National Laboratory (X-10 Site)." ORNL-5870. Prepared by the Oak Ridge National Laboratory for the U.S. Department of Energy. November.

OTA, 1991. United States Congress, Office of Technology Assessment. *Complex Cleanup, the Environmental Legacy of Nuclear Weapons Production.* February 1991.

Riddle, 1993. Personal Communication with John Riddle, Tennessee Wildlife Resources Agency, Nashville, Tennessee. January 28, 1993.

Skidmore, Owings, and Merrill, 1945. Skidmore, Owings and Merrill Construction Company. "Town of Oak Ridge, Tennessee, Manhattan District - Corps of Engineers." Historical map of Oak Ridge residences.

Sutton, 1993. Personal Communication with Kenneth Sutton, retired agent, Roane County Agricultural Extension Office. February 8, 1993.

Thomas, 1993. Personal Communication with William A. Thomas, Oak Ridge Associated Universities. February 19, 1993 and August 18, 1993.

Todd, 1989. Todd, Robert M.. "Fisheries Report, Commercial Fishing Survey." Tennessee Wildlife Resources Agency Report No. 91-1.

Todd, 1993. Personal Communication with Robert Todd, Tennessee Wildlife Resources Agency, Nashville, Tennessee. March 1, 1993.

TVA, Date Unknown. Tennessee Valley Authority. "Recreation Areas by Reservoirs on TVA Land, Former TVA Land, Tributary Area Association Land and Private Land." Excerpt from TVA Handbook. Collected January 1993.

TVA, 1993. Tennessee Valley Authority. Visitation data received from Ellen K. Bean, TVA Land Resources Office, Norris, Tennessee. February 1993.

TWRA, 1992. Tennessee Wildlife Resources Agency. "Wildlife Research Report, Big Game Harvest Data and Range Surveys 1991-92." TWRA Report No. 92-3.

TWRA, Undated. Tennessee Wildlife Resources Agency, Reports on Recreational Fishing at Watts Bar and Melton Hill Reservoirs received from John Riddle, TWRA, Nashville. Received February 1993.

USDOE, 1991. U.S. Department of Energy. "Oak Ridge Reservation Environmental Report for 1990." Prepared by Martin Marietta Energy Systems, Inc. Report ES/ESH-18/V1. September 1991.

USDOE, 1992. U.S. Department of Energy. "Oak Ridge Reservation Environmental Report for 1991." Martin Marietta Energy Systems for the USDOE. Report ES/ESH-22/V2.

UTK, 1990. University of Tennessee, Knoxville, *Tennessee Statistical Abstract 1990*. College of Business Administration, Center for Business and Economic Research.

UTK, 1977. University of Tennessee, Knoxville. *Tennessee Statistical Abstract 1977*. College of Business Administration, Center for Business and Economic Research.

UTK, 1969. University of Tennessee, Knoxville. *Tennessee Statistical Abstract 1969*. College of Business Administration, Center for Business and Economic Research.

Wathern, 1993. Personal Communication with Greg Wathern. Tennessee Wildlife Resources Agency, Nashville, Tennessee. February 23, 1993.

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