

**ENVIRONMENTAL MONITORING PLAN
FOR THE
OAK RIDGE RESERVATION**

**UNITED STATES DEPARTMENT OF ENERGY
OAK RIDGE OFFICE**



October 2007

**Environmental Monitoring Plan
for the
Oak Ridge Reservation**

**United States Department of Energy
Oak Ridge Office**

Prepared for the
U. S. Department of Energy
Oak Ridge Office

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for the U.S. Department of Energy under Contract No. DE-AC05-00OR22725

PREFACE

Controlled copies of the *Environmental Monitoring Plan for the Oak Ridge Reservation United States Department of Energy Oak Ridge Office*, DOE/OR-2227/R0, are available on the UT-Battelle external web site at: http://www.ornl.gov/sci/env_rpt/orrem_plan.shtml.

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Acronyms

| | |
|-----------|---|
| ACTS | Assessment and Commitment Tracking System |
| AMAD | activity median aerodynamic diameter |
| ASER | Annual Site Environmental Report |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BERA | Biological and Ecological Risk Assessment |
| BWXT | BWXT Y-12, LLC |
| CAP | Clean Air Act Assessment Package |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CRK | Clinch River kilometer |
| DCF | dose conversion factor |
| DOE | U.S. Department of Energy |
| DOE EM | DOE Office of Environmental Management |
| DOE ORO | DOE Oak Ridge Office |
| ED | effective dose |
| EDE | effective dose equivalent |
| EMP | Environmental Monitoring Plan |
| EPA | U.S. Environmental Protection Agency |
| EPWSD | Environmental Protection and Waste Services Division |
| ESS | Environmental Surveillance System |
| ETTP | East Tennessee Technology Park |
| FFA | Federal Facility Agreement |
| FGR | Federal Guidance Report |
| F&O/I&CTS | Facilities and Operations/Instrumentation and Control Technical Support |
| FTM | Functional Training Matrix |
| HQ | hazard quotient |
| ICPT | Integrated Contractor Procurement Team |
| IDMS | Integrated Document Management System |
| IT | Information Technology |
| mrem | millirem |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NNSA | National Nuclear Security Administration |
| OREIS | Oak Ridge Environmental Information System |
| ORNL | Oak Ridge National Laboratory |
| ORR | Oak Ridge Reservation |

Acronyms

(continued)

| | |
|------|-------------------------------------|
| QA | quality assurance |
| QC | quality control |
| SBMS | Standards-Based Management System |
| SWSA | Solid Waste Storage Area |
| SOP | standard operating procedure |
| SNS | Spallation Neutron Source |
| TOA | Tennessee Oversight Agreement |
| WRRP | Water Resources Restoration Program |
| Y-12 | Y-12 National Security Complex |

Units of Measure and Conversion Factors

Units of measure and their abbreviations

| | | | |
|--------------------|---------|------------------------------|------|
| acre | acre | millimeter | mm |
| Becquerel | Bq | million | M |
| centimeter | cm | millirad | mrad |
| curie | Ci | millirem | mrem |
| day | day | millisievert | mSv |
| degrees Celsius | °C | minute | min |
| degrees Fahrenheit | °F | nephelometric turbidity unit | NTU |
| foot | ft | parts per billion | ppb |
| gallon | gal | parts per million | ppm |
| gallons per minute | gal/min | parts per trillion | ppt |
| gram | g | picocurie | pCi |
| hectare | ha | pound | lb |
| hour | h | pounds per square inch | psi |
| kilogram | kg | quart | qt |
| kilometer | km | rad | rad |
| kilowatt | kW | roentgen | R |
| liter | L | roentgen equivalent man | rem |
| megawatt | MW | second | s |
| meter | m | sievert | Sv |
| microcurie | μCi | standard unit (pH) | SU |
| microgram | μg | ton, short (2000 lb) | ton |
| millicurie | mCi | yard | yd |
| milligram | mg | year | year |
| milliliter | mL | | |

Quantitative prefixes

| | | | |
|-------|------------------|-------|-------------------|
| tera | $\times 10^{12}$ | pico | $\times 10^{-12}$ |
| giga | $\times 10^9$ | nano | $\times 10^{-9}$ |
| mega | $\times 10^6$ | micro | $\times 10^{-6}$ |
| kilo | $\times 10^3$ | milli | $\times 10^{-3}$ |
| hecto | $\times 10^2$ | centi | $\times 10^{-2}$ |
| deka | $\times 10^1$ | deci | $\times 10^{-1}$ |

Unit conversions

| Unit | Conversion | Equivalent | Unit | Conversion | Equivalent |
|----------------------|---------------------------|---------------------|---------------------|--------------------------|---------------------|
| Length | | | | | |
| In. | × 2.54 | cm | cm | × 0.394 | in. |
| Ft | × 0.305 | m | m | × 3.28 | ft |
| mile | × 1.61 | km | km | × 0.621 | mile |
| Area | | | | | |
| acre | × 0.405 | ha | ha | × 2.47 | acre |
| Ft ² | × 0.093 | m ² | m ² | × 10.764 | ft ² |
| mile ² | × 2.59 | km ² | km ² | × 0.386 | mile ² |
| Volume | | | | | |
| Ft ³ | × 0.028 | m ³ | m ³ | × 35.31 | ft ³ |
| qt (U.S. liquid) | × 0.946 | L | L | × 1.057 | qt (U.S. liquid) |
| gal | × 3.7854118 | L | L | × 0.264172051 | gal |
| Concentration | | | | | |
| ppm | × 1 | mg/L | mg/L | × 1 | ppm |
| Weight | | | | | |
| Lb | × 0.4536 | kg | kg | × 2.205 | lb |
| ton | × 907.1847 | kg | kg | × 0.00110231131 | ton |
| Temperature | | | | | |
| °C | F = (9/5) C + 32 | °F | °F | C = (5/9) (F - 32) | °C |
| Activity | | | | | |
| Bq | × 2.7 × 10 ⁻¹¹ | Ci | Ci | × 3.7 × 10 ¹⁰ | Bq |
| Bq | × 27 | pCi | pCi | × 0.037 | Bq |
| mSv | × 100 | mrem | mrem | × 0.01 | mSv |
| Sv | × 100 | rem | rem | × 0.01 | Sv |
| nCi | × 1000 | pCi | pCi | × 0.001 | nCi |
| mCi/km ² | × 1 | nCi/m ² | nCi/m ² | × 1 | mCi/km ² |
| dpm/L | × 0.45 × 10 ⁹ | μCi/cm ³ | μCi/cm ³ | × 2.22 × 10 ⁹ | dpm/L |
| pCi/L | × 10 ⁻⁹ | μCi/mL | μCi/mL | × 10 ⁹ | pCi/L |
| pCi/m ³ | × 10 ⁻¹² | μCi/cm ³ | μCi/cm ³ | × 10 ¹² | pCi/m ³ |

CHEMICAL ELEMENTS

| Atomic Number | Name | Symbol | Atomic Number | Name | Symbol | Atomic Number | Name | Symbol |
|---------------|------------|--------|---------------|--------------|--------|---------------|---------------|--------|
| 1 | Hydrogen | H | 41 | Niobium | Nb | 81 | Thallium | Tl |
| 2 | Helium | He | 42 | Molybdenum | Mo | 82 | Lead | Pb |
| 3 | Lithium | Li | 43 | Technetium | Tc | 83 | Bismuth | Bi |
| 4 | Beryllium | Be | 44 | Ruthenium | Ru | 84 | Polonium | Po |
| 5 | Boron | B | 45 | Rhodium | Rh | 85 | Astatine | At |
| 6 | Carbon | C | 46 | Palladium | Pd | 86 | Radon | Rn |
| 7 | Nitrogen | N | 47 | Silver | Ag | 87 | Francium | Fr |
| 8 | Oxygen | O | 48 | Cadmium | Cd | 88 | Radium | Ra |
| 9 | Fluorine | F | 49 | Indium | In | 89 | Actinium | Ac |
| 10 | Neon | Ne | 50 | Tin | Sn | 90 | Thorium | Th |
| 11 | Sodium | Na | 51 | Antimony | Sb | 91 | Protactinium | Pa |
| 12 | Magnesium | Mg | 52 | Tellurium | Te | 92 | Uranium | U |
| 13 | Aluminium | Al | 53 | Iodine | I | 93 | Neptunium | Np |
| 14 | Silicon | Si | 54 | Xenon | Xe | 94 | Plutonium | Pu |
| 15 | Phosphorus | P | 55 | Cesium | Cs | 95 | Americium | Am |
| 16 | Sulphur | S | 56 | Barium | Ba | 96 | Curium | Cm |
| 17 | Chlorine | Cl | 57 | Lanthanum | La | 97 | Berkelium | Bk |
| 18 | Argon | Ar | 58 | Cerium | Ce | 98 | Californium | Cf |
| 19 | Potassium | K | 59 | Praseodymium | Pr | 99 | Einsteinium | Es |
| 20 | Calcium | Ca | 60 | Neodymium | Nd | 100 | Fermium | Fm |
| 21 | Scandium | Sc | 61 | Promethium | Pm | 101 | Mendelevium | Me |
| 22 | Titanium | Ti | 62 | Samarium | Sm | 102 | Nobelium | No |
| 23 | Vanadium | V | 63 | Europium | Eu | 103 | Lawrencium | Lr |
| 24 | Chromium | Cr | 64 | Gadolinium | Gd | 104 | Rutherfordium | Rf |
| 25 | Manganese | Mn | 65 | Terbium | Tb | 105 | Dubnium | Db |
| 26 | Iron | Fe | 66 | Dysprosium | Dy | 106 | Seaborgium | Sg |
| 27 | Cobalt | Co | 67 | Holmium | Ho | 107 | Bohrium | Bh |
| 28 | Nickel | Ni | 68 | Erbium | Er | 108 | Hassium | Hs |
| 29 | Copper | Cu | 69 | Thulium | Tm | 109 | Meitnerium | Mt |
| 30 | Zinc | Zn | 70 | Ytterbium | Yb | 110 | Ununnilium | Uun |
| 31 | Gallium | Ga | 71 | Lutetium | Lu | 111 | Unununium | Uuu |
| 32 | Germanium | Ge | 72 | Hafnium | Hf | 112 | Ununbium | Uub |
| 33 | Arsenic | As | 73 | Tantalum | Ta | | | |
| 34 | Selenium | Se | 74 | Tungsten | W | | | |
| 35 | Bromine | Br | 75 | Rhenium | Re | | | |
| 36 | Krypton | Kr | 76 | Osmium | Os | | | |
| 37 | Rubidium | Rb | 77 | Iridium | Ir | | | |
| 38 | Strontium | Sr | 78 | Platinum | Pt | | | |
| 39 | Yttrium | Y | 79 | Gold | Au | | | |
| 40 | Zirconium | Zr | 80 | Mercury | Hg | | | |

1. INTRODUCTION

1.1 PURPOSE

The purpose of Oak Ridge Reservation (ORR) environmental surveillance is to characterize radiological and non-radiological conditions of the offsite environs and estimate public doses related to these conditions, confirm estimations of public dose based on effluent monitoring data, and, where appropriate, to provide supplemental data to support compliance monitoring for applicable environmental regulations. This environmental monitoring plan (EMP) is intended to document the rationale, frequency, parameters and analytical methods for the environmental surveillance program. It also provides information on ORR site characteristics, environmental pathways, dose assessment methodologies, and quality management. Guidance for environmental monitoring is included in DOE Order 450.1, “Environmental Protection Program;” DOE Order 5400.5, “Radiation Protection of the Public and the Environment;” DOE/EH-0173T; “Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance” (the Regulatory Guide); and state and federal regulations that implement federal environmental laws.

1.2 OAK RIDGE RESERVATION BACKGROUND INFORMATION

The ORR is owned by the federal government and contains three major operating sites: East Tennessee Technology Park (ETTP), the Oak Ridge National Laboratory (ORNL), and the Y-12 National Security Complex (Y-12). Facilities at these sites were constructed as part of the Manhattan Project. Their primary missions have evolved over the years and continue to adapt to meet the changing research, defense, and environmental restoration needs of the United States.

BWXT Y-12, LLC (BWXT) is the U. S. Department of Energy (DOE) prime contractor responsible for operating Y-12, a manufacturing facility that continues to play an integral role in the nation’s nuclear weapons complex. The Y-12 site is undergoing significant modernization. Key considerations of the modernization strategy include incorporation of sustainable environmental stewardship in planning, design, and construction; maintaining compliance with regulatory requirements; and coordinating modernization activities with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. In addition to National Nuclear Security Administration (NNSA) work scope at the Y-12 site, the DOE Office of Environmental Management (DOE EM) is conducting environmental restoration activities at the site and manages the site landfills.

UT-Battelle, LLC is the DOE prime contractor responsible for operating ORNL, DOE’s largest science and energy research laboratory. ORNL is an international leader in a range of scientific areas that support the DOE mission. The six major mission roles include neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. In addition to the DOE Office of Science work at ORNL, the DOE EM program is conducting environmental restoration and waste management activities at the site.

Bechtel Jacobs, LLC is the DOE prime contractor responsible for operations at ETTP. The mission at ETTP is environmental cleanup and reindustrialization/reuse of the assets of the shutdown gaseous diffusion plant. The ETTP mission is accomplished through the DOE EM.

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The ORR is on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL), and environmental restoration is being addressed under a Federal Facility Agreement (FFA) with the EPA and the state of Tennessee.

1.3 ENVIRONMENTAL MONITORING PLAN HISTORY

The EMP for the ORR (DOE/OR-1066) was originally issued in September 1992 by the then DOE Oak Ridge Operations Office to provide a single point of reference for the effluent monitoring and environmental surveillance programs conducted by the DOE contractor at the major operating sites and at ORR areas outside specific facility boundaries. The ORR effluent monitoring and environmental surveillance programs have historically collected and analyzed data to assess the impacts of ORR activities on the environment and human health. Since 1992, DOE/OR-1066 has been revised six times; the last revision was completed in 2003.

As a result of a decision by the DOE Oak Ridge Office (ORO) to provide separate environmental monitoring plans for site and ORR-level activities, this document is being issued as DOE/ORO-2227, Rev. 0 and replaces DOE/OR-1066, Rev. 5, which has been archived.

Requirements for the original EMP were contained in “General Environmental Protection Program” (DOE Order 5400.1), Chap. IV. This order, which described environmental monitoring in terms of effluent and surveillance monitoring, was canceled and replaced by DOE Order 450.1, “Environmental Protection Program,” in 2003. The Tennessee Oversight Agreement (TOA) between the state of Tennessee and DOE commits DOE to maintaining the EMP and provides the State the opportunity to review EMP modifications prior to implementation. Additional data is available through the projects related to DOE EM environmental restoration and/or waste management efforts such as the Water Resources Restoration Program (WRRP), which evaluates remedial project effectiveness by comparing baseline information with post-remediation data and specified performance goals. This and other special studies carried out on the ORR in support of remediation projects provide data supplemental to the routine, historical environmental effluent and surveillance monitoring conducted by the individual site programs.

An Annual Site Environmental Report (ASER) which describes environmental monitoring activities on the DOE Oak Ridge Reservation has been prepared since 1971 to document results of radiological and non-radiological environmental sampling and analysis programs on the ORR. These reports are available on the web at http://www.ornl.gov/sci/env_rpt/. The ASER is required by DOE Order 231.1A, “Environment, Safety and Health Reporting,” and will continue to be issued to communicate the results of surveillance monitoring conducted under this EMP, as well as effluent monitoring and best management practice monitoring conducted by each site’s operating contractor.

Data collected by the ORR surveillance monitoring program are also provided to the Oak Ridge Environmental Information System (OREIS) for integration with sampling and analysis results from individual site effluent and surveillance monitoring activities and remedial investigations. The OREIS is the primary component of the data management program for restoration projects and fulfills requirements prescribed in both the FFA and the TOA.

2. SITE CHARACTERISTICS

The city of Oak Ridge lies within the Great Valley of Eastern Tennessee between the Cumberland and Great Smoky Mountains and is bordered on two sides by the Clinch River (Fig. 2.1). The Cumberland Mountains are 16 km to the northwest; the Great Smoky Mountains are 51 km to the southeast.

The ORR encompasses about 13,401 hectares of mostly contiguous land owned by DOE in the Oak Ridge area. Most of it lies within the corporate limits of the city of Oak Ridge; 243 hectares west of the ETPP are outside the city limits. The residential section of Oak Ridge forms the northern boundary of the reservation. The Tennessee Valley Authority's Melton Hill and Watts Bar reservoirs on the Clinch and Tennessee rivers form the southern and western boundaries of the city (Fig. 2.2). The population of the ten-county region surrounding the ORR is about 885,000, with about 4% of its labor force employed on the reservation. Other towns close to the reservation include Oliver Springs, Clinton, Karns, Lenoir City, Farragut, Kingston, and Harriman (Fig. 2.3).

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km to the east and has a population of about 177,000. Except for the city of Oak Ridge, the land within 8 km of the ORR is semi-rural and is used primarily for residences, small farms, and cattle pasture. Fishing, boating, water skiing, and swimming are popular recreational activities in the area.

The topography, geology, hydrology, vegetation and wildlife of the ORR provide a complex and intricate array of resources. Detailed information regarding the natural resources and physical characteristics of the ORR are available at <http://www.esd.ornl.gov/facilities/nerp/ORNL-TM2006-110.pdf>.

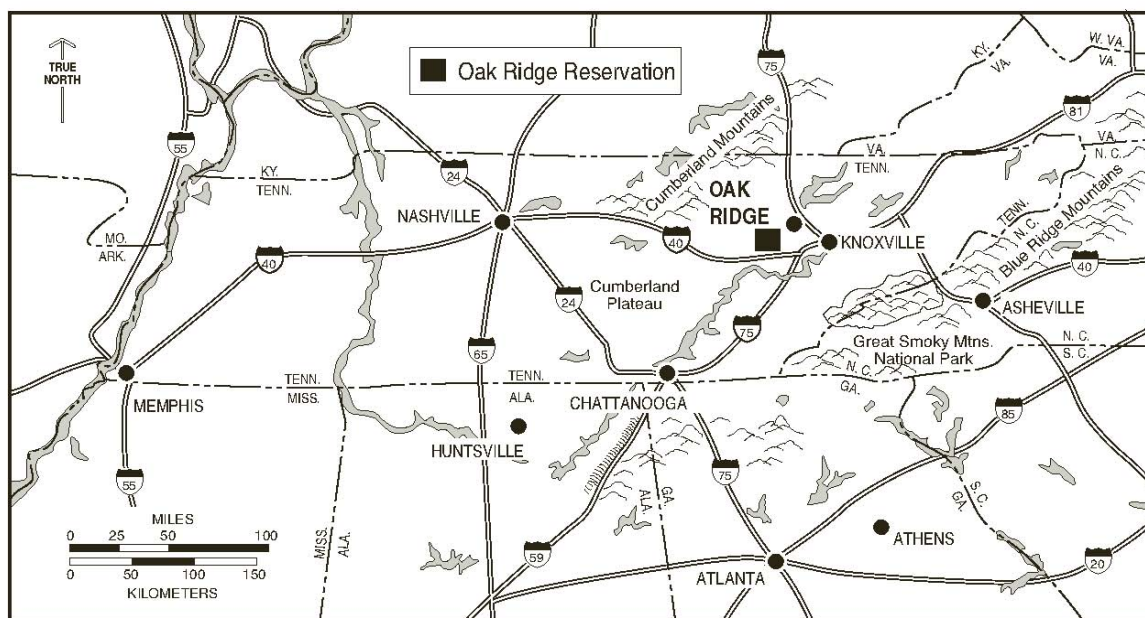


Fig. 2.1. Location of the city of Oak Ridge.

ENVIRONMENTAL MONITORING PLAN FOR THE OAK RIDGE RESERVATION

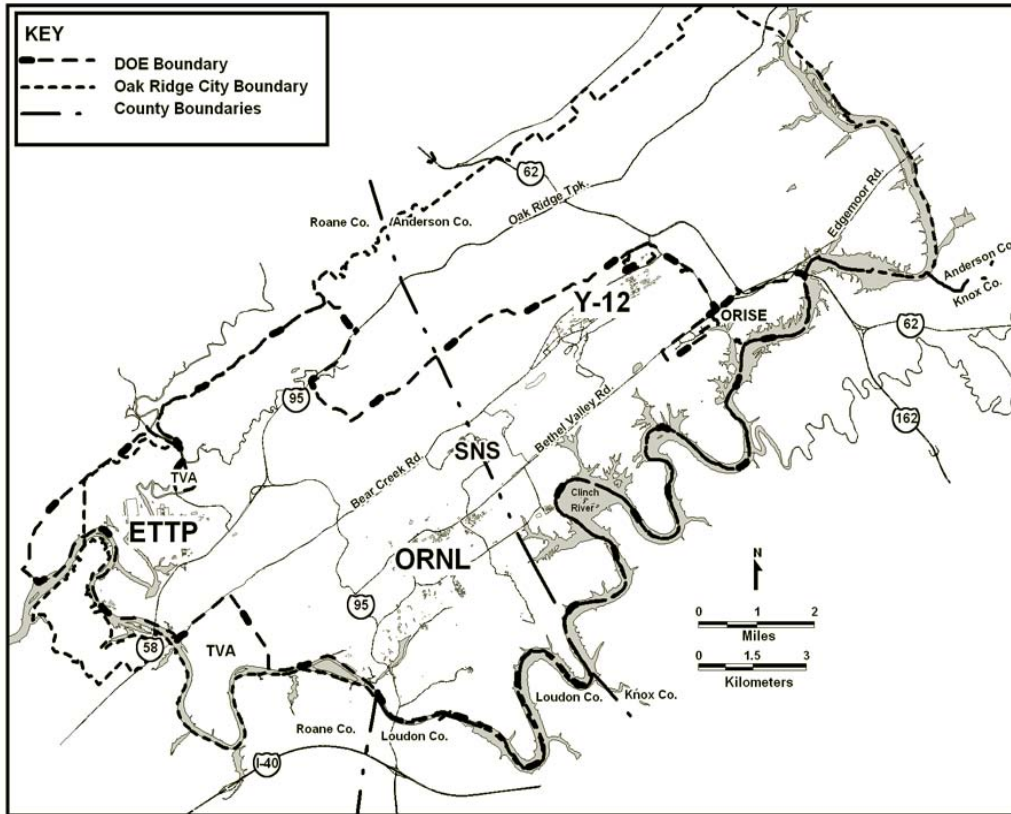


Fig. 2.2. Oak Ridge Reservation.

ENVIRONMENTAL MONITORING PLAN FOR THE OAK RIDGE RESERVATION

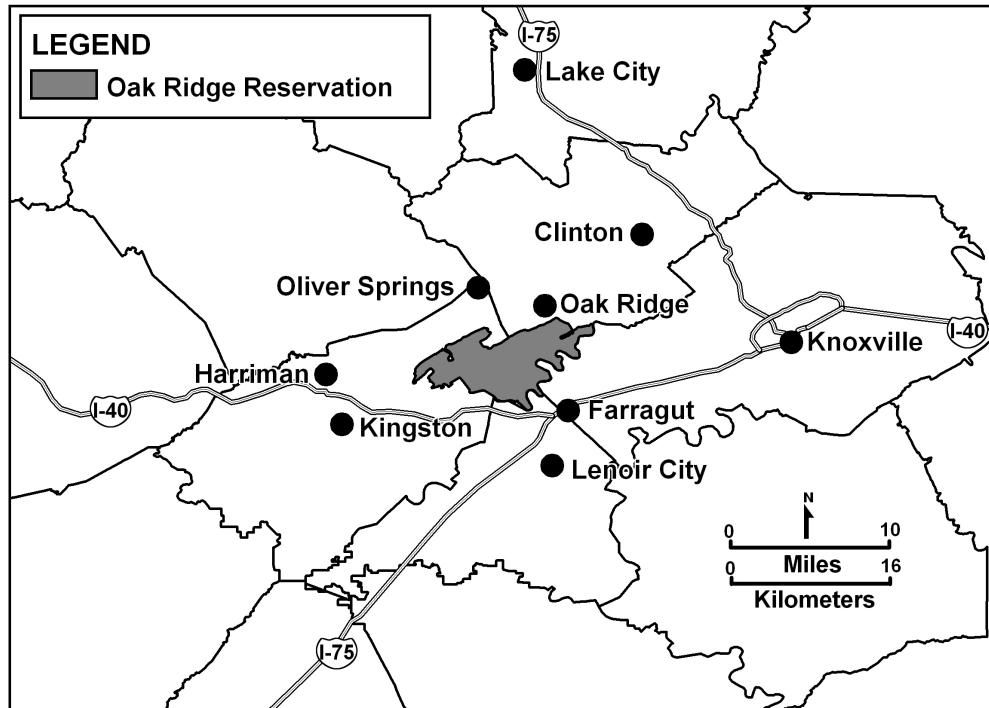


Fig. 2.3. Locations of towns nearest the Oak Ridge Reservation.

3. ENVIRONMENTAL PATHWAYS AND DOSE CALCULATIONS

3.1 INTRODUCTION

Operations at the three ORR facilities may emit airborne and waterborne radionuclides and chemicals. After release, these substances disperse throughout the environment by applicable transport mechanisms, where eventually some may reach and affect humans. This section describes the methodologies used to characterize dispersion of released radionuclides and to estimate human exposures to and intakes of the dispersed substances. Human exposures to radionuclides are quantified in terms of total effective dose equivalents (EDEs) to maximally exposed off-site individuals and to the entire population residing within 80 km of the ORR and each facility on the ORR. For chemical releases into the environment, regulatory standards and facility-specific permits typically specify release concentration criteria and limits and do not require dose or risk estimates. Therefore, only exposures from drinking water and consuming fish, characterized by hazard quotients (HQs) for noncarcinogenic chemicals and risk estimates for carcinogenic chemicals, are evaluated.

3.2 CONFORMANCE WITH STANDARDS FOR PUBLIC DOSE CALCULATIONS

Dose calculations are performed to demonstrate compliance with the EPA's "National Emission Standards for Hazardous Air Pollutants: Standards for Radionuclides" (40 CFR Part 61, Subpart H) (Rad NESHAP) and DOE Order 5400.5. Models selected to assess environmental transport of and human exposures to substances released from the ORR are appropriate for the physical and environmental situation encountered and for the data available to characterize the situation.

Potential human exposure pathways are considered in assessments of radiological and chemical (in drinking water and fish) exposures. Pathways that contribute significantly to exposures to the most exposed individual and the entire population residing within 80 km of the facilities on the ORR are evaluated. These pathways are discussed in Sects. 3.3 and 3.4.

3.3 MAJOR CONSIDERATIONS

The EPA Rad NESHAP standard limits the annual EDE to a member of the public from radionuclides released in the air to 10 millirem (mrem). DOE Order 5400.5 states that no member of the public shall receive an EDE greater than 100 mrem/year from DOE-related activities. Members of the public have the potential to receive radiation doses from internal and external exposures to materials released to the atmosphere, ground and surface waters, and soils and sediment. In addition, some members of the public may receive external radiation doses through direct external irradiation and by radiation emanating from buildings and other objects (e.g., drum storage and burial areas) located within facility and ORR boundaries.

Table 3.1 lists environmental release and transport mechanisms that apply to emissions from the ORR. Section 3.4 discusses the environmental transport, food chain, and dosimetric models used to evaluate human exposures due to operations on the ORR. Input data to the models will be either site specific (e.g., collected under the environmental monitoring and surveillance activities described in this EMP) or generic (default values). In the absence of nuclide-specific data only bounding dose calculations will be made.

Models and computer codes for evaluating public exposures to released radionuclides will be selected based on regulatory requirements, the applicability of the model to the situation being evaluated, the degree to which the model has been documented and verified, and the availability of the data needed to implement the model. Unless otherwise required by regulatory or legal mandates, the simplest model needed to characterize a situation will be used.

3.4 TRANSPORT MODELS

This section describes the methodologies that are used to characterize environmental concentrations of materials released from the ORR. In some cases, transport models are used to calculate concentrations; in other cases, measured concentrations are available. When both predicted and measured concentrations are available, measured concentrations are compared to modeling predictions.

3.4.1 Atmospheric Transport

Contaminants released into the atmosphere may remain suspended in air and may deposit on soil, vegetation, and water surfaces (Table 3.1). Atmospheric transport models are used to calculate annual-average ground-level airborne concentrations of contaminants and associated rates of deposition on the ground and vegetation. Deposition onto water surfaces is not evaluated since the potential consequences of such deposition are negligible relative to those of contaminants that remain airborne and those that deposit on soil and vegetation.

Calculations of airborne concentrations and deposition rates of radionuclides released to the atmosphere are estimated using the Clean Air Act Assessment Package – 1998 (CAP-88), which is specified by EPA for demonstrating compliance with the Rad NESHAP standard. The CAP-88 computer codes are used to calculate annual-average ground-level air concentrations and deposition rates at selected environmental locations. The locations are selected to (1) allow identification of the maximally exposed individual for each source, each facility, and the entire ORR and (2) characterize exposures of the entire population within 80 km of the ORR.

When possible, site-specific parameter values will be used to quantify radionuclide releases [e.g., release rates, particle size in terms of activity median aerodynamic diameter (AMAD), and chemical composition]; meteorological variables (e.g., wind speed and direction, atmospheric stability class, air temperature, rainfall rate, and mixing layer height); and source parameters (e.g., release height, stack diameter, exit gas velocity and temperature, and location with respect to exposed persons). These parameters are obtained from data collected under the environmental monitoring, sampling, and surveillance programs conducted on the ORR. If particle-size data are not available, an AMAD of 1.0 μm is assumed unless a facility operator specifically requests the use of a different size. If chemical-composition (solubility) data are not provided, the solubility class that gives the highest EDE via inhalation is used.

Doses calculated from ambient air monitoring data are compared to doses calculated by CAP-88 at air monitor locations to verify that the atmospheric dispersion codes are not significantly underestimating airborne concentrations of radionuclides around the ORR.

Table 3.1. Environmental Transport Mechanisms Applicable to Releases from the Oak Ridge Reservation

| | |
|-----------------------------|---|
| Releases to air | Remain suspended in air Deposit on ground Deposit on vegetation Deposit on water surfaces |
| Releases to surface water | Remain dissolved or suspended in water Deposit on ground via irrigation Deposit on vegetation via irrigation Deposit in sediments Infiltrate to groundwater |
| Releases to groundwater | Remain dissolved or suspended in water Deposit on ground via irrigation Deposit on vegetation via irrigation Flow into surface water |
| Radionuclides in objects | Remain in fixed sources |
| Releases to ground surfaces | Remain on ground Dissolve or suspend in surface water Infiltrate to groundwater Become suspended in air |

3.4.2 Surface Water Transport

Contaminants released to surface water may remain dissolved or suspended in water, be deposited in sediments, or be deposited on the ground or on vegetation by irrigation. Since opportunities for direct human exposure to sediments are limited and irrigation is not widely practiced along the Clinch River system, sedimentation and irrigation pathways are considered less significant in modeling human exposures than other more probable pathways, such as air inhalation or immersion.

Drinking water and creel survey data associated with the Clinch/Tennessee River system are collected each year; these data are used to quantify drinking water populations and fish harvests. Data on the population served from water treatment plants located on the Clinch River and down stream of the ORR is obtained annually from the TDEC Division of Water Supply (Regions III and IV). The creel data is obtained from Tennessee Reservoir Creel Report prepared annually by the TN Wildlife Resources Agency. The creel data provides information on the amount of fish harvested annually which is used to estimate the number of persons consuming fish from these water bodies.

Quantities of radionuclides released to surface waters are determined by sampling data collected at points of discharge. Concentrations of radionuclides in surface waters accessible to the public are also quantified by sampling results. A simple dilution model is used to calculate radiation doses at sampling and downstream locations.

3.4.3 Groundwater Transport

Contaminants released into groundwater may remain dissolved or suspended in the water and may be deposited by irrigation near the ORR on the ground surface and vegetation. Groundwater sampling programs are managed by the site specific compliance organizations and the WRRP. Since most of the groundwater from the ORR discharges to surface waters and irrigation is uncommon in the Clinch River system, these pathways are not evaluated.

Additionally, the Agency for Toxic Substances and Disease Registry (ATSDR) has completed a public health assessment to evaluate potential groundwater exposures from the ORR. ATSDR concluded that no human exposures to contaminated groundwater outside of the ORR boundary have occurred in the past, no exposures are currently occurring, and exposures are not likely to occur in the future. Since nearly all of the groundwater underneath the ORR ends up as surface water before leaving the site, community exposure to contamination from groundwater off site is unlikely. The only confirmed contaminated groundwater area that extends outside of the ORR boundary originates from the Y-12 Complex; however, there are no private wells pumping groundwater in this vicinity and administrative controls (i.e., deed restrictions) have been put in place to restrict groundwater usage.

3.5 ENVIRONMENTAL PATHWAY MODELS

This section describes the methodologies that will be used to characterize mechanisms for human uptake and exposure to the contaminant concentrations described in Sect. 3.4. Both modeling results and sampling data will be used, as available, to obtain contaminant concentrations in media and foods to which humans may be exposed. *Regulatory Guide* 1.109 models (Nuclear Regulatory Commission 1977) will be used unless better site-specific models and data are available.

3.5.1 Contaminants in Air

Potential direct pathways of human exposure to airborne contaminants include inhalation (breathing) and immersion. Indirect pathways, which are discussed in the following sections, involve deposition of contaminants on soil, crops, water, and uptake by terrestrial animals.

The CAP-88 computer code is used to calculate total EDEs from inhalation of and immersion in air containing radionuclides. CAP-88 uses air concentrations at each selected location (Sect. 3.4.1) and *Regulatory Guide* 1.109 pathway models to calculate quantities of radionuclides inhaled by a person remaining at a selected location for the entire year.

The inhaled quantities and air concentrations are combined with air inhalation and immersion dose conversion factors (DCFs) to calculate a total EDE to an individual at each selected location. DCFs are chosen based on particle size and solubility class. In the absence of actual data, a 1.0 μm particle size and the solubility class yielding the highest dose via inhalation are assumed. CAP-88 also calculates the collective EDE from inhalation and immersion to the population residing within 80 km of the ORR.

3.5.2 Contaminants in Surface Water

Potential direct pathways of human exposure to contaminants in surface waters include ingestion (drinking water), eating fish, immersion (swimming, wading, showering), direct irradiation (boating, skiing, shoreline use), and inhalation (breathing water vapor while showering). Indirect pathways involve deposition on soil and crops by irrigation, deposition in sediments, uptake by fish, and ingestion by terrestrial animals.

The direct pathways for human exposure to contaminants from surface waters on or near the ORR which are evaluated for dose estimates include drinking water, swimming, boating, and shoreline use. *Regulatory Guide* 1.109 models are used to estimate radiation doses due to immersion in and direct irradiation from surface water. Both measured and calculated nuclide concentrations are used in the calculations, which are performed using the LADTAP.XL computer code (Hamby 1991) or its equivalent.

For radionuclides, EDEs are calculated for drinking water at nearby drinking water plants. Data from water samples collected before entry into a drinking water plant is used; water plant outputs are not sampled. A population dose estimate is made for the entire population residing within 80 km of the ORR.

For chemicals, HQs for noncarcinogenic chemicals and risk estimates for carcinogenic chemicals are calculated. Both chemical and radiation dose estimates from drinking water will be performed using measured concentrations in drinking water when such concentrations are available.

3.5.3 Contaminants in Groundwater

Potential direct pathways of human exposure to contaminants in groundwater include ingestion (drinking water), immersion (showering), and inhalation (breathing water vapor while showering). Indirect pathways involve deposition on soil and crops by irrigation and ingestion by terrestrial animals. Since most of the groundwater from the ORR discharges to surface water or is use-controlled (i.e., deed restrictions), none of the above pathways are modeled.

3.5.4 Contaminants in Soil

Contaminants may reach soil by deposition of airborne materials, materials contained in irrigation water, and direct dumping. Potential direct pathways of human exposure to contaminants in soil include inhalation of resuspended soil, ingestion of soil, and direct exposure to (being near or in contact with) the soil. Indirect pathways involve uptake of contaminants from soil by crops.

The resuspension of soil and soil ingestion pathways are not evaluated because their potential consequences are insignificant relative to those from inhalation of newly emitted contaminants and ingestion of foodstuffs. The CAP-88 computer code is used to calculate EDEs due to direct irradiation by radionuclides on soil. CAP-88 calculates concentrations of radionuclides at each selected location as if deposition had occurred for 50 years. A person is assumed to remain unprotected at a location for the entire year. Ground concentrations and exposure times are combined with the DCFs for exposure to a contaminated ground surface to calculate EDEs to an individual at each selected location. CAP-88 is used also to calculate the collective EDE to the population residing within 80 km of the ORR from exposure to contaminated ground surfaces.

3.5.5 Contaminants in or on vegetation

Contaminants may reach vegetation (food and feed crops) by deposition of airborne materials, uptake from soil, and deposition of materials contained in irrigation water. The significant potential direct pathway for human exposure to contaminants in food crops is ingestion. Indirect pathways involve ingestion of feed crops by terrestrial animals.

The CAP-88 computer code uses *Regulatory Guide* 1.109 models and parameters to estimate concentrations of radionuclides in vegetables at selected locations due to deposition from the air and uptake from soil. Other *Regulatory Guide* 1.109 models and parameters are used to estimate human intakes of the vegetables and, thus, of the radionuclides. The code treats radionuclide deposition as if it had occurred for 50 years. The radionuclide intakes are combined with DCFs for ingestion to calculate total EDEs to an individual residing at each location and the entire population residing within 80 km of the ORR.

The ORR environmental surveillance program includes sampling of radionuclides in selected food crops. This sampling data and the intake models described above will be used to provide additional estimates of doses from ingestion of locally grown foods.

3.5.6 Contaminants in Terrestrial Animals and Fish¹

Contaminants may accumulate in terrestrial animals from eating contaminated feed, drinking contaminated water (not modeled), and breathing contaminated air (not modeled). Contaminants may accumulate in fish when they eat contaminated foods and reach equilibrium with contaminants in the aquatic environment. Potential direct pathways for human exposure to contaminants in terrestrial animals and fish are eating meat, fish, and drinking milk.

The CAP-88 computer code uses *Regulatory Guide* 1.109 models and parameters to estimate concentrations of radionuclides in beef and milk due to consumption of feed contaminated with radionuclides released to the atmosphere. Other *Regulatory Guide* 1.109 models and parameters are used to estimate human intake values of milk and beef and, thus, of the radionuclides. The radionuclide intake values are combined with the DCFs for ingestion to calculate EDEs to an individual residing at each location and to the entire population residing within 80 km of the ORR.

A second set of estimates of potential doses is based on measured contaminant concentrations in food products and aquatic or terrestrial organisms. Maximum individual doses are calculated for ingestion of milk containing measured quantities of radionuclides and of fish containing measured quantities of radionuclides. Potential doses from ingesting deer, turkey, and selected water fowl (e.g., geese) harvested legally from the reservation are also calculated.

3.6 RADIONUCLIDES IN OBJECTS

Currently identified sources of potential exposure to the public from radiation emanating from radionuclides contained in structures and other objects include scattered gamma radiation from the experimental cesium plots near the Clinch River. Based on measured exposure rates, theoretical EDEs are calculated to hypothetical, maximally exposed individuals. Calculated doses will be modified to reflect

¹ See Sect. 3.8 for discussion on estimating doses to aquatic and terrestrial organisms.

any changes in the measured dose rates. If other sources of direct radiation are identified, appropriate exposure scenarios will be devised and doses estimated.

3.7 INTERNAL DOSIMETRY MODELS

The dose calculation results are reported in terms of total EDE, the sum of EDEs received during the year from external exposures plus the 50-year committed EDEs from intake of radionuclides during the year. The DCFs used in the dose calculations are obtained from the following sources, and any revisions thereto. For calculations using CAP-88, the DCFs supplied with the package are used. Factors to be used in all other calculations are provided in DOE/EH-0070, "Internal Dose Conversion Factors for Calculation of Dose to the Public;" EPA-520/1-88-020, "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion;" and EPA 402-R-93-081, "External Exposure to Radionuclides in Air, Water, and Soil." Although not used in specific dose calculations, the derived concentration guides given in DOE Order 5400.5 may be used to infer the acceptability or magnitude of doses associated with measured concentrations of radionuclides in environmental media.

CAP-88 PC Version 3, which incorporates dose and risk factors from *Federal Guidance Report (FGR) 13, Cancer Risk Coefficients for Environmental Exposure to Radionuclides* is not used to conduct dose calculations for Rad NESHAPS compliance due to unresolved compliance issues associated with this code; however, when these issues are resolved, CAP-88 PC Version 3 is expected to replace the currently used version. When this replacement occurs, EDs will also be calculated for other exposure pathways.

3.8 RADIATION DOSE TO NATIVE AQUATIC AND TERRESTRIAL ORGANISMS

DOE Order 450.1 requires protection of terrestrial and aquatic biota from ionizing radiation at DOE facilities, and DOE Order 5400.5 establishes a limit of 1.0 rad/day to protect native aquatic biota from exposure to radiation or radioactive releases into the aquatic environment. To demonstrate compliance with this limit, the methodology described in the DOE Standard, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," DOE-STD-1153-2002, (DOE 2002) is used to estimate absorbed dose rates to aquatic organisms. The absorbed doses are generally calculated using the RESRAD-BIOTA computer code but other methods may also be used. The RESRAD-BIOTA code is also available as a screening tool to estimate whether doses to terrestrial organisms exceed the recommended absorbed dose rate of 0.1 rad/day.

4. OAK RIDGE RESERVATION ENVIRONMENTAL SURVEILLANCE

In addition to environmental monitoring conducted at the three major DOE installations, reservation-wide surveillance monitoring is performed to measure radiological and nonradiological parameters directly in environmental media adjacent to the facilities. Data from the reservation surveillance programs are analyzed to assess the environmental impact of DOE operations on the entire reservation and the surrounding area.

4.1 AMBIENT AIR

4.1.1 Purpose and Scope

Ambient air monitoring is performed to measure radiological parameters directly in the ambient air adjacent to the facilities and supplements data from exhaust stack monitoring conducted at the DOE and NNSA Oak Ridge facilities. Ambient air monitoring also provides a means to verify that fugitive and diffuse sources are insignificant, serves as a check on dose modeling calculations, and would allow determination of contaminant levels at monitoring locations in the event of an emergency.

4.1.2 Sampling Locations

The ORR ambient air monitoring network includes eight stations sited on or near the reservation, and one reference station in an area not affected by Oak Ridge operations (Fig. 4.1). Atmospheric dispersion modeling was used to select appropriate sampling locations. Due to changes in operations, land ownership, and accessibility of areas that once were not available to the public, the ambient air locations and parameters are to be reviewed as remediation projects are completed.

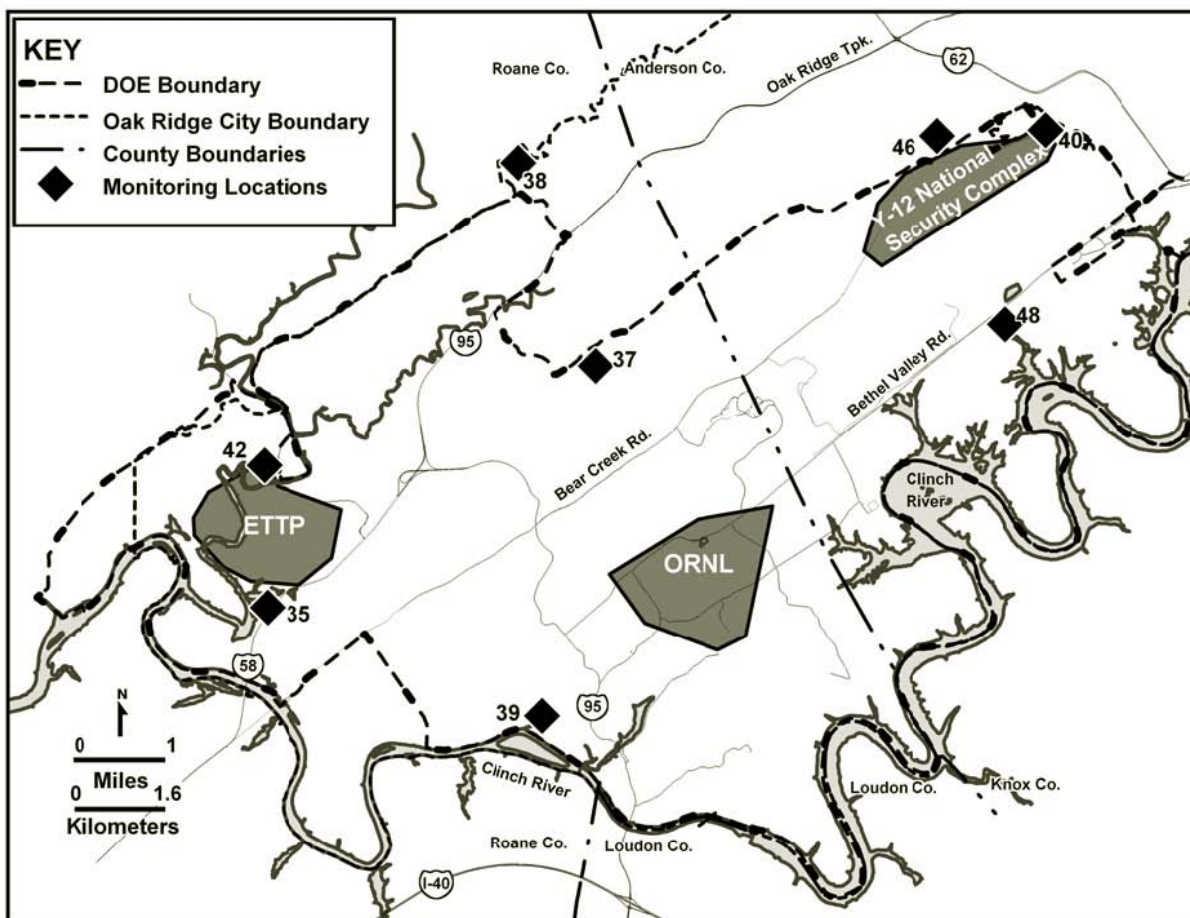


Fig. 4.1. Locations of ORR perimeter air monitoring stations.

4.1.3 Frequency

Continuous sampling is performed with weekly to biweekly collection of sampling media. Quarterly composites are submitted for laboratory analyses and analyzed as described in Table 4.1.

4.1.4 Parameters and Methods

The sampling system consists of two separate instruments. Particulates are captured on glass-fiber filters in a high-volume air sampler. The second system collects tritiated water vapor. The sampler consists of a prefilter, followed by an adsorbent trap consisting of indicating silica gel. The samples are collected weekly or biweekly, composited quarterly, then submitted to the laboratory for tritium analysis (Table 4.1).

Table 4.1. Ambient Air Parameters and Methods

| Parameter | Media | Method | MDA ¹ |
|-------------------------|--------------------|--------------|------------------|
| Gross alpha | Glass-fiber filter | EPA 900.0 | 4.7 pCi |
| Gross beta | Glass-fiber filter | EPA 900.0 | 7.5 pCi |
| Gamma Scan ² | Glass-fiber filter | EPA 901.1 | Lab Specific |
| Alpha Spec ³ | Glass-fiber filter | Lab Specific | Lab Specific |
| Tritium | Silica gel | EPA 906.0 | 100 pCi |

¹Minimum Detectable Activity

²Report ⁴⁰K and all detectable man-made isotopes.

³Report ²³⁴U, ²³⁵U, and ²³⁸U

4.2. EXTERNAL GAMMA RADIATION

4.2.1 Purpose and Scope

Members of the public could hypothetically be exposed directly to gamma radiation from radionuclides released into the environment; previously released radionuclides deposited on soil and vegetation or in sediments; radiation-generating facilities, especially high-energy accelerators; and the storage of radioactive materials.

4.2.2 Sampling Locations

Direct radiation levels will be monitored continuously at five ORR ambient air stations (39, 40, 42, 46, 48) and the Fort Loudoun reference location. (See Figure 4.2)

4.2.3 Frequency

Continuous monitoring will be conducted at all locations.

ENVIRONMENTAL MONITORING PLAN FOR THE OAK RIDGE RESERVATION

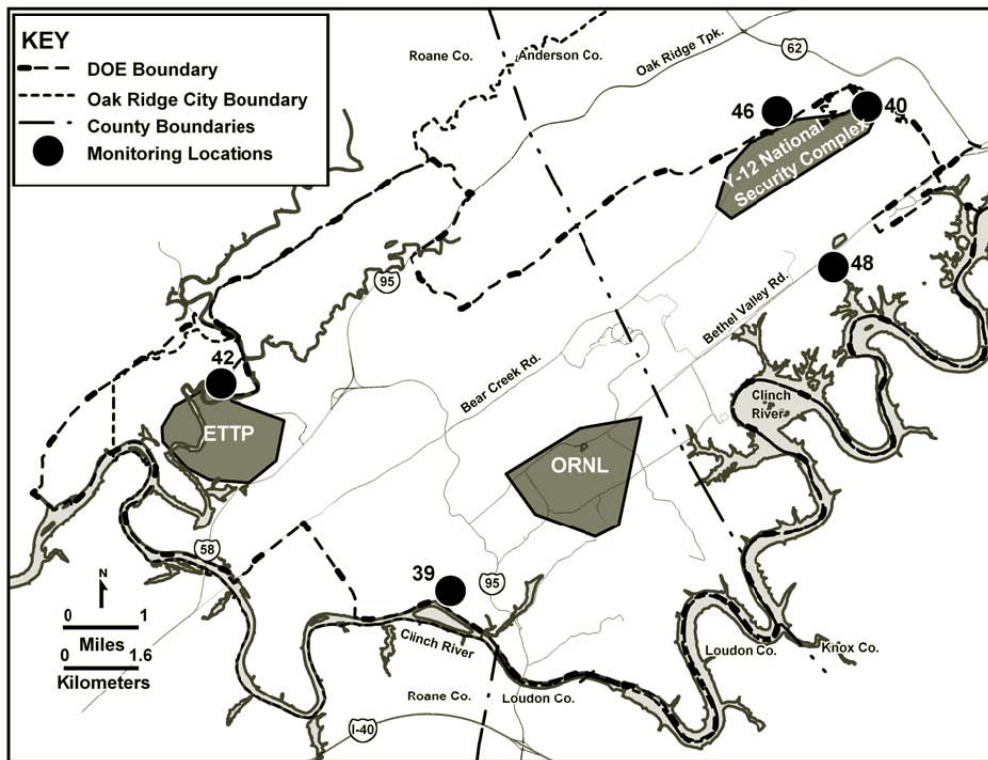


Fig. 4.2. External gamma radiation monitoring locations on the ORR.

4.3 SURFACE WATER

4.3.1 Purpose and Scope

The Oak Ridge Reservation surface water surveillance monitoring program includes quarterly monitoring at five locations on the Clinch River. This program is conducted in addition to surface water monitoring required for National Pollutant Discharge Elimination System permits at each of the major facilities and other facility specific monitoring activities.

4.3.2 Locations (Fig. 4.3)

- Clinch River above DOE inputs at Oak Ridge water supply intake (Clinch River Kilometer [CRK] 66)
- Clinch River at Knox County water intake (CRK 58)
- Clinch River downstream from ORNL at Jones Island (CRK 32)
- Clinch River at ETPP water supply intake (CRK 23)
- Clinch River downstream of DOE inputs at Brashear Island (CRK 16)

ENVIRONMENTAL MONITORING PLAN FOR THE OAK RIDGE RESERVATION

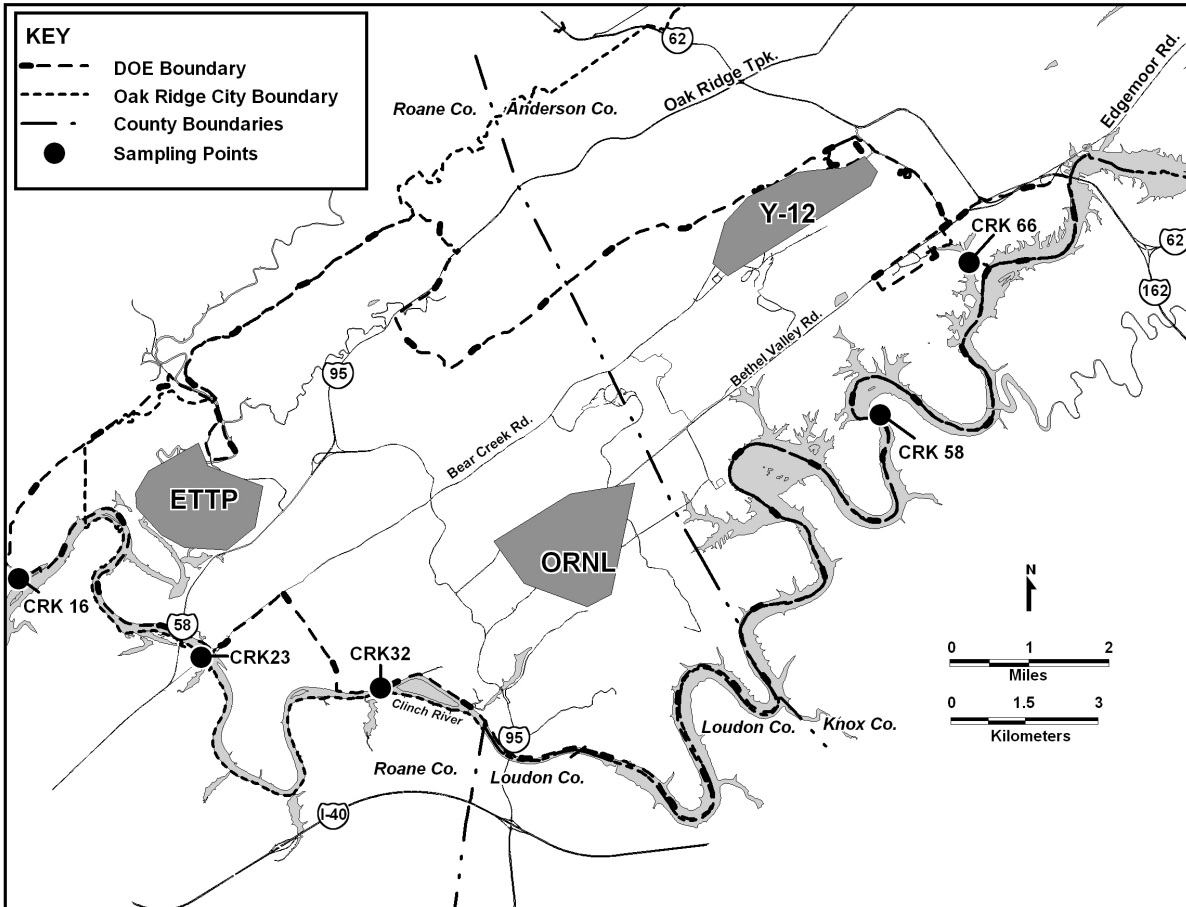


Fig. 4.3. Surface water sampling locations

4.3.3 Frequency

Quarterly for all locations.

4.3.4 Parameters and Methods

| Table 4.2 Surface Water Parameters and Methods | | |
|---|--------------------------|------------------|
| Location | Parameter | Suggested Method |
| CRK 16, 23, 66 | Mercury | EPA 7471 |
| All | Gross alpha ¹ | EPA 900.0 |
| All | Gross beta ² | EPA 900.0 |
| All | Gamma Scan | EPA 901.1 |
| CRK 32, 66 | Total Sr | EPA 905.0 |
| All | Tritium | EPA 906.0 |
| All | Field Measurements | NA |

¹Specific isotopic analyses are performed when gross alpha measurements exceed 15 pCi/L (National primary drinking water standard).

²Specific isotopic analyses are performed when gross beta measurements exceed 50 pCi/L.

4.4 VEGETATION

4.4.1 Vegetables

4.4.1.1 Purpose and Scope

Food crops will be sampled from garden locations which have the potential to be affected by airborne releases from the ORR in order to evaluate possible radiation doses received by consumers as a result of DOE activities in the area. Samples are also obtained from a reference location in an area not impacted by ORR activities for comparison. Crops that represent broad-leaf systems (lettuce, turnip greens) root-plant-vegetable systems (tomato) and root system vegetables (turnips) are obtained from each location.

4.4.1.2 Locations

- Maryville – Reference Location
- East of ORR (Claxton Area)
- North of ORR and Northeast of ETPP
- Southwest of ORNL – Jones Island area
- Southeast of ORNL – Gallaher Bend
- North of Y-12 – 2 locations in Scarboro Community

4.4.1.3 Frequency

Annually for all locations.

4.4.1.4 Parameters, Methods, and Detection Levels

All samples are analyzed for gross alpha, gross beta, and gamma emitting radionuclides, and for specific radionuclides that contribute ≥ 0.1 mrem to the ORR EDE.

| Parameter | Method | Detection Level |
|-------------|--------------|---|
| Gross Alpha | EPA 900.0 | 0.7 pCi/kg |
| Gross Beta | EPA 900.0 | 20 pCi/kg |
| Gamma Spec | EPA 901.1 | ⁷ Be - 2.1E4 pCi/kg; ⁴⁰ K - 170 pCi/kg |
| Uranium-234 | Lab specific | 10 pCi/kg |
| Uranium-235 | Lab specific | 10 pCi/kg |
| Uranium-238 | Lab specific | 10 pCi/kg |

4.4.2 Milk

There are no known dairy farm pathways in the ORR potential impact area. Therefore, representative milk sampling cannot be conducted. An availability assessment on potential dairy operations in the areas surrounding the ORR will be performed annually, and the need to collect milk samples will be reevaluated if dairy operations resume in areas potentially impacted by ORR activities.

4.5 WILDLIFE MONITORING

4.5.1 Wildlife Screening

The ORR Surveillance Program will continue to conduct annual screenings of Canada geese and to analyze data from radiological screenings and samples on deer and turkey harvested during hunts on the ORR.

4.5.2 Deer Hunts

Deer hunts are held annually on the ORR. Deer are screened for radioactivity prior to release to the hunters. This screening data and any data available from laboratory analyses will be used to estimate doses to consumers of deer harvested on the ORR.

4.5.3 Turkey Hunts

Turkey hunts are held annually on the ORR. Turkeys are screened for radioactivity prior to release to hunters. This screening data and any data available from laboratory analyses will be used to estimate doses to consumers of turkey harvested on the ORR.

4.5.4 Goose Roundup

An annual goose roundup is conducted by the ORR Surveillance Program on the reservation in the June-July timeframe. Canada geese will undergo live screenings for gamma emitting radionuclides to confirm that radionuclide levels remain negligible. No geese will be sacrificed for laboratory analyses based on historical results, which demonstrate multi-year correlations between field radiological screening results and laboratory analyses.

4.5.5 Fish

4.5.5.1 Purpose and Scope

Members of the public could be exposed to contaminants originating from DOE ORR activities through consumption of fish caught in area waters. To monitor this exposure pathway, two species of fish (sunfish and catfish) will be collected annually from three locations on the Clinch River and edible fish flesh will be analyzed for selected parameters (Fig. 4.4).

4.5.5.2 Locations

- Clinch River upstream from all DOE ORR inputs (CRK 70)
- Clinch River downstream from ORNL (CRK 32)
- Clinch River downstream from all DOE ORR inputs (CRK 16)

ENVIRONMENTAL MONITORING PLAN FOR THE OAK RIDGE RESERVATION

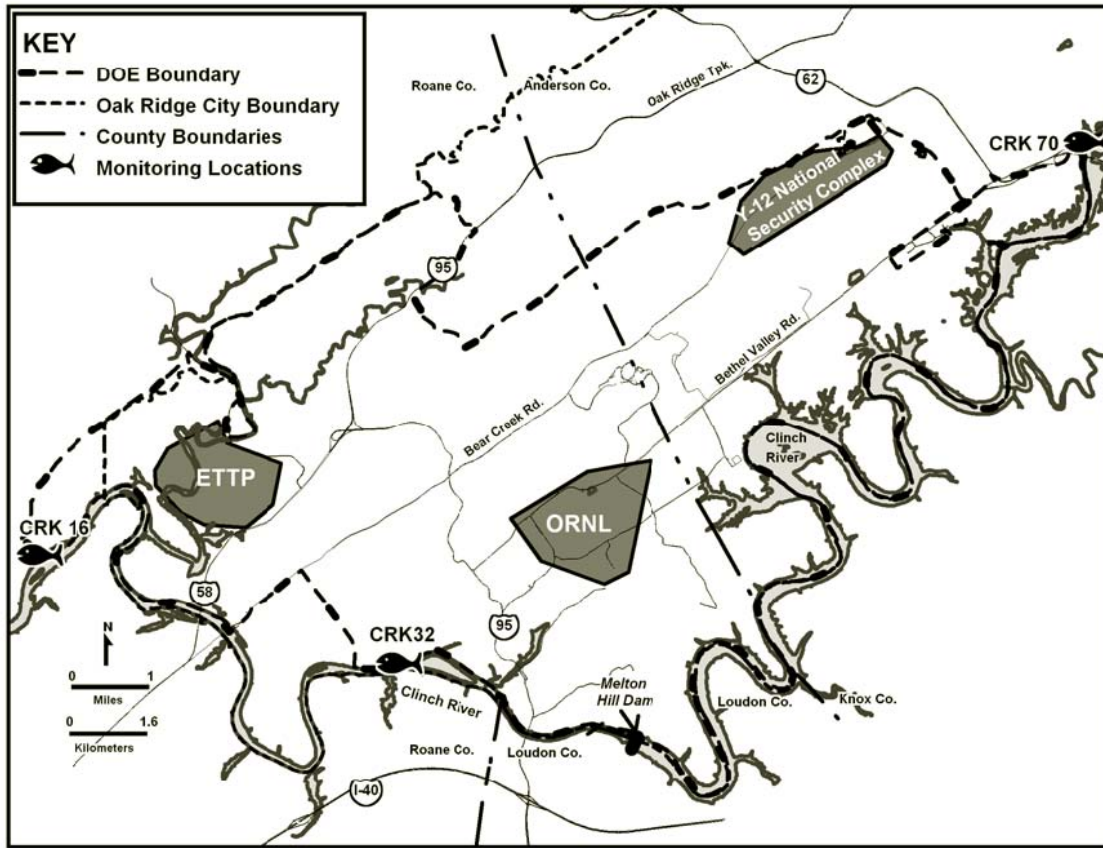


Fig. 4.4. Fish sampling locations for the ORR.

4.5.5.3 Frequency

Annually for all locations.

4.5.5.4 Parameters, Methods, and Detection Levels

Table 4.3. Fish Parameters, Methods, and Detection Levels

| Parameter | Method | Detection Level |
|----------------------|-----------|-----------------|
| Tritium | EPA 906.0 | 1.2E4 pCi/kg |
| Total Radiostrontium | EPA 905.0 | 31 pCi/kg |
| Gross alpha | EPA 900.0 | 1.1 pCi/kg |
| Gross beta | EPA 900.0 | 31 pCi/kg |
| Gamma spec | EPA 901.1 | |
| Mercury | 7471 | 0.04 mg/kg |
| Metals | 6010/6020 | |
| PCB | 8020 | |

4.6 OAK RIDGE RESERVATION TERRESTRIAL BIOTA DOSE ASSESSMENT

DOE Order 450.1 requires the protection of terrestrial and aquatic biota from ionizing radiation at DOE facilities, and DOE Order 5400.5 establishes a limit of 1.0 rad per day to protect aquatic biota “A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota” (DOE-STD-1153-2002) provides guidance for a monitoring program to evaluate compliance with these DOE orders.

As a result of CERCLA and programs initiated to remediate the effects of hazardous waste disposal on the ORR, baseline and ecological risk assessments (BERAs) were conducted between 1997 and 2000 for all major disposal sites at the three DOE facilities on the ORR. These sites included Bethel Valley and Melton Valley at ORNL, Bear Creek Valley and upper East Fork Poplar Creek at Y-12, and ETTP. In some cases, additional BERAs were conducted for specific waste sites (e.g., selected disposal ponds and burial grounds at ETTP in 1995; sitewide residual contamination in soils and Mitchell Branch at ETTP in 2006; Melton Valley Watershed in 2004). The results of these BERAs served as the basis for identifying additional sampling needs.

4.6.1 Sampling Strategy

The sampling strategy consists of two phases: (1) initial sampling to estimate doses based on the radionuclide concentrations in soil and (2) follow-up, site-specific sampling of biota if the benchmark of 0.1 rad per day for terrestrial biota is exceeded. In the initial sampling phase, doses will be estimated for soil invertebrates and small mammals, such as shrews and mice. If results indicate terrestrial biota are at risk from exposure to radionuclides, and if suitable habitat occurs at the site, site-specific sampling of earthworms and shrews and/or mice will be conducted. Doses to wide-ranging, terrestrial wildlife species are unlikely to exceed the terrestrial biota dose limit and will not be sampled.

4.6.2 Sampling Locations

Soil sampling will initially focus on unremediated areas, such as floodplains and some upland areas. Floodplains are often downstream of contaminant source areas and are dynamic systems where soils are eroding in some areas and being deposited in others.

Soil sampling will be conducted in the following areas:

- White Oak Lake Floodplain (between the lower boundary of the Intermediate Pond and White Oak) – Soils in this area that are less than 2500 micro roentgen per hour will remain in place. Hazard quotients greater than 1 have been estimated for soil invertebrates, shrews, and mice in this floodplain area.
- Bear Creek Valley Floodplain – Although data indicate that radionuclide concentrations in the soils are low, the results are based on a relatively small number of samples.
- West Bethel Valley (in the vicinity of the Contractor’s Landfill and Station) Solid Waste Storage Area (SWSA) 3-3 – Potential ecological risks to terrestrial biota were identified. Although contaminated soils were removed in four areas, any contamination that exists in the other undeveloped areas will not be verified until post-Record of Decision activities.
- Selected areas near the ETTP Powerhouse, North Trash Slope, and K-1070-F Construction Spoil Area. – Although maximum radionuclide concentrations were found at sites designated for remediation under the ROD for Zone 2, other areas with significant ecological risks are not yet remediated. Still others with soil concentrations in hundreds of picocuries per gram have not been identified for remediation.

4.6.3 Parameters

Soil analyses will focus on radionuclides that have been found in previous sampling conducted in the same area and include:

| Table 4.4. Soil Sampling for Initial Terrestrial Biota Dose Screening | |
|--|---|
| Location | Parameters |
| White Oak Creek Floodplain | ^{137}Cs , ^{60}Co , ^{90}Sr , $^{239/240}\text{Pu}$, ^{241}Am , ^{244}Cm |
| Bear Creek Valley Floodplain | $^{234,238}\text{U}$, ^{241}Am , ^{238}Pu |
| West Bethel Valley (in the vicinity of the Contractor's Landfill and SWSA 3-3) | ^{137}Cs |
| Selected Areas Near ETTP Powerhouse, North Trash Slope, and K-1070-F Construction Spoil Area | $^{234,238}\text{U}$, ^{239}Pu |

4.6.4 Frequency

Sampling frequency will be based on findings from the initial survey of soils. If the concentrations of radionuclides are low, additional sampling may not be necessary or may be conducted at a low frequency (e.g., once every 2-4 years). Initial sampling will be completed over a two-year period.

5. QUALITY ASSURANCE PROGRAM

5.1 INTRODUCTION

The application of quality assurance/quality control programs for environmental monitoring activities on the ORR is essential for generating data of known and defensible quality. Each aspect of an environmental monitoring program from sample collection to data management and record keeping must address and meet applicable quality standards.

The activities associated with administration, sampling, data management, and reporting for the ORR environmental surveillance programs are performed by the UT-Battelle Environmental Protection and Waste Services Division (EPWSD). Project scope is established by a task team comprised of members representing DOE and each of the three major ORR facilities. UT-Battelle utilizes the Standards Based Management System (SBMS) to provide a systematic approach to integrating quality assurance, environmental, and safety considerations into every aspect of ORR environmental monitoring. SBMS is a web-based system that provides a single point of access to all the requirements necessary for staff to safely and effectively perform their work. SBMS translates laws, orders, directives, policies, and best management practices into Laboratory-wide subject areas and procedures.

5.2 WORK/PROJECT PLANNING AND CONTROL

UT-Battelle's Work/Project Planning and Control Management System establishes the processes and requirements for executing work activities at ORNL. All environmental sampling tasks are performed following the four steps required in the work control subject areas.

- Define Scope of Work
- Work Planning: Analyzing Hazards and Defining Controls
- Work Execution
- Provide Feedback

In addition, EPWSD has approved project specific standard operating procedures (SOP) for all activities which are controlled and maintained through the ORNL Integrated Document Management System (IDMS). Requirements for the development and control of EPWSD documents, including SOPs, are established in Standard Operating Procedure for Document Control DCN: EPWSD-OQS-AP-200.

Environmental sampling SOPs developed for ORR environmental surveillance programs provide detailed instructions on maintaining chain of custody, sample identification, sample collection and handling, sample preservation, equipment decontamination, and collection of quality control samples such as field and trip blanks, duplicates, and equipment rinses.

5.3 PERSONNEL TRAINING AND QUALIFICATIONS

The UT-Battelle Training and Qualification Management System provides employees and nonemployee staff of UT-Battelle, LLC, with the knowledge and skills necessary to perform their jobs safely, effectively, and efficiently with minimal supervision. This capability is accomplished by establishing site-level procedures and guidance for training program implementation with an infrastructure of supporting systems, services, and processes.

A Functional Training Matrix (FTM) has been defined for all EPWSD job functions and is maintained on the [EPWSD Training Requirements web page](#). FTMs were derived using several resources, including verification analysis (i.e., similar job positions on the Internal Training Requirements Matrix document analysis (i.e., SBMS procedures, internal division and specific group standard operating procedures), and functional job analysis (i.e., interviews with EPWSD staff and management). Training status is routinely monitored by the Division Training Officer and notices of training needs or deficiency are automatically sent to individual employees. Assessments of EPWSD staff training activities and qualifications are included in the EPWSD Assessment Program.

The training program is supplemented by the EPWSD Required Reading Program. This program ensures that staff have reviewed new/revised documents (procedures, lessons learned, etc.) applicable to their jobs.

5.4 EQUIPMENT AND INSTRUMENTATION

5.4.1. Calibration

The UT-Battelle Quality Management System includes subject area directives that establish the standard that all ORNL staff shall use equipment of known accuracy based on appropriate calibration requirements that are traceable to an authority standard. The UT-Battelle Facilities and Operations Instrumentation and Control Technical Support (F&O/I&CTS) tracks all equipment used in ORR environmental monitoring programs through a maintenance recall program to ensure equipment is functioning properly and within defined tolerance ranges. Upon receipt, each instrument is clearly identified and entered into the recall system. The determination of calibration schedules and frequencies is based on a graded approach at the activity planning level. EPWSD environmental monitoring programs follow rigorous calibration schedules to eliminate gross drift and the need for data adjustments. Instrument tolerances, functions, ranges, and calibration frequencies are established based on manufacturer specifications, program requirements, actual operating environment and conditions, and budget considerations. At a minimum, equipment manufacturer recommendations are followed. F&O/I&CTS project plans and work control evaluations incorporate all calibration requirements.

5.4.2 Standardization

EPWSD sampling procedures, maintained on IDMS, include requirements and instructions for the proper standardization and usage of monitoring equipment. These requirements include the use of traceable standards and measurements, performance of routine, before-use equipment standardizations, and actions to follow when standardization steps do not produce required values. Sampling SOPs also include

instructions for designating nonconforming instruments as “out-of-service” and initiating requests for F&O/I&CTS maintenance.

5.4.3 Visual Inspection, Housekeeping, and Grounds Maintenance

EPWSD environmental sampling personnel conduct routine visual inspections of all sampling instrumentation and sampling locations. These inspections identify and address any safety, grounds keeping, general maintenance, and housekeeping issues or needs.

5.5 ASSESSMENT

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and that activities performed conform to expectations and requirements. The EPWSD assessment schedule is developed in the UT-Battelle Assessment, Tracking, and Commitment System (ACTS) (<https://acts.ornl.gov/ACTS/>) and includes information on both external and internal assessments. External assessments are scheduled based on requests from auditing agencies. EPWSD also conducts internal management assessments of ORR environmental monitoring procedural compliance, safety performance, and work planning and control. This includes surveillances by both direct line management and by organizations independent of the group performing work. As part of the required management observation activities, DOE ORNL site office representatives participate in several surveillance assessments annually. Surveillance results, recommendations, and completion of corrective actions, if required, are also documented and tracked in ACTS.

EPWSD utilizes a Problem Event Reporting System which enables staff to document and disseminate information on any unplanned or unexpected event. This includes events that do not meet any reporting thresholds and enables early detection and correction of any low-level problems or trends. This system also captures positive events and observations and provides a means for sharing information on improvement opportunities.

Tennessee Department of Environment and Conservation, Local Oversight Division, routinely oversees sample collection activities for the reservation monitoring programs and review data to confirm that no unusual or unexpected events or outcomes have occurred.

5.6 ANALYTICAL QUALITY ASSURANCE

The contract laboratories that perform analyses of environmental samples from the ORR environmental monitoring programs are required to have documented Quality Assurance (QA)/Quality Control (QC) programs, trained and qualified staff, appropriately maintained equipment and facilities, and applicable certifications.

A competitive award system is used by UT Battelle to select laboratories that are contracted under Basic Ordering Agreements to perform analytical work to characterize ORR environmental samples. EPWSD’s Guidance for Analytical Services Support (EPWSD-OQS-TP-252), maintained on the UT-Battelle IDMS, sets forth the processes that EPWSD follows to procure laboratory support. Commercial laboratories are required to comply with the quality requirements set forth in the Integrated Contractor Procurement

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Team (ICPT) Basic Ordering Agreement Terms and Conditions (<http://www.bechteljacobs.com/icpt/>). Oversight of subcontracted commercial laboratories is performed by the DOE Environmental Management Consolidated Audit Program. This program, administered by DOE and subcontractors from across the DOE complex, establishes required internal and external laboratory control and performance evaluation programs and conducts on-site laboratory reviews which monitor the performance of all subcontracted laboratories and verifies all quality requirements are met. The ICPT process achieves efficiencies across the DOE complex by providing leveraged procurement and the use of the consolidated audit program to eliminate the need for individual purchasers to conduct quality audits.

A statement of work for each project specifies any additional QA/QC requirements and includes detailed information on data deliverables, turnaround times, and required methods and detection limits. Blank and duplicate samples are routinely submitted along with ORR environmental samples to provide an additional check on analytical laboratory performance.

5.7 DATA MANAGEMENT AND REPORTING

ORR environmental surveillance and monitoring data management is accomplished using the Environmental Surveillance System (ESS), a web interface data management tool which was developed by UT-Battelle's Information Technology (IT) Services Division. IT performs routine system maintenance and completes modifications and upgrades through work authorizations with EPWSD. In managing ESS, IT adheres to the Information Technology Management System subject area, *Software Quality Assurance*, which defines the minimum requirements to be met with the development and acquisition of software at ORNL. This subject area requires that all software incorporates a level of formal quality assurance that is commensurate with the potential impact of the software on the environment, safety, health, security, legal requirements, costs, or mission of the Laboratory. In addition, Software Quality Assurance Plan for the Environmental Sampling System (EPWSD-EPS-PL-SQA-ESS) has been developed and posted on IDMS to document ESS user access rules; verification and validation methods; configuration and change management rules; release history; software registration information, and the employed methods, standards, practices, and tools.

Field measurements and sample information are entered into ESS, and an independent verification is performed on all records to ensure accurate data entry. Sample results and associated information are loaded into ESS from electronic files provided by analytical laboratories. An automated compliance screening is performed on each file during loading to ensure all required analyses were performed, appropriate analytical methods were employed, holding times were met, and specified detection levels were achieved.

Following the compliance screening, a series of checks is performed to determine if results are consistent with expected outcomes and historical data. QC sample results (i.e., blanks and duplicates) are reviewed to check for potential sample contamination and to confirm repeatability of analytical methods within required limits. More in-depth investigations are conducted to explain results that are questionable. This involves examination of field and laboratory generated records and log sheets, communication with analytical laboratory and/or sampling personnel, and determining any other factors that may account for the unexpected result (atypical weather or site activity that may have affected the sampling).

ORR environmental surveillance data are summarized and reported annually in the *Annual Site Environmental Report* and are provided to the OREIS.

5.8 RECORDS MANAGEMENT

The UT-Battelle Records Management System provides the requirements for managing all ORNL records. Requirements include creating and identifying record material, scheduling, protecting, and record storage in both office areas and the ORNL Inactive Records Center and destroying records.

5.9 DOSE CALCULATION QUALITY ASSURANCE

Each calculation is documented, along with all support information; and documentation is maintained in accordance with SBMS Records Management subject areas. A description of models used, implementing computer codes, values and sources of input data, and underlying assumptions are also maintained. This information may consist of references to published descriptions or to actual mathematical formulations developed for special calculations.

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