Oak Ridge Reservation

Annual Site Environmental Report Summary for 1994

On the cover: **The purple fringeless orchid (*Platanthera peramoena*). (ORNL PHOTO 7546-90)**

ES/ESH-58

Oak Ridge Reservation Annual Site Environmental Report Summary for 1994

September 1995

This document was prepared by staff of Environmental, Safety, and Health Compliance and Environmental Management at the Oak Ridge Y-12 Plant, Oak Ridge National Laboratory, and Oak Ridge K-25 Site, which are managed by Lockheed Martin Energy Systems, Inc., P.O. Box 2008, Oak Ridge, TN 37831-6285, for the U.S. Department of Energy under Contract No. DE-AC05-84OR21400.

Preface

The U.S. Department of Energy (DOE) requires an annual site environmental report from each of the sites operating under its authority. The reports present the results from the various environmental monitoring programs carried out during the year. In addition to meeting the DOE requirement, the reports also document compliance with various state and federal laws and regulations.

The *Oak Ridge Reservation Annual Site Environmental Report for 1994* (ES/ESH-57) was published to fulfill those requirements for the Oak Ridge Reservation (ORR) for calendar year 1994. The report is based on thousands of environmental samples collected on and around the ORR and analyzed during the year. The data on which the report is based are published in *Environmental Monitoring and Surveillance on the Oak Ridge Reservation: 1994 Data* (ES/ESH-59). Both documents are highly detailed. This summary report (ES/ESH-58) is meant for readers who are interested in the monitoring results but who do not need to review the details.

The ORR report and summary are public documents, distributed to government regulators, scientists, engineers, business people, special interest groups, and members of the public at large. They are available in public reading rooms and libraries. In addition, all three documents are available on request from

ORNL Laboratory Records
P.O. Box 2008
Oak Ridge, TN 37831-6285.

The authors encourage comments on these reports so that the needs of our readers can be better addressed. Please direct your comments to

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About the Oak Ridge Reservation

- The Oak Ridge Reservation (ORR) was established in the early 1940s as part of the Manhattan Project. Uranium was enriched and weapon components were fabricated in facilities on the reservation. Many production activities were curtailed during the 1980s.
- It is located in Anderson and Roane counties on 34,700 acres within the city of Oak Ridge, Tennessee (Fig. 1).
- About 880,000 persons live within a 50-mile radius of the reservation.
- The reservation comprises three major facilities: the Oak Ridge Y-12 Plant, Oak Ridge National Laboratory (ORNL), and the Oak Ridge K-25 Site (Figs. 2, 3, and 4). It is the home of the Graphite Reactor, a national historical landmark, and to a 12,375-acre national environmental research park, one of seven established across the nation by the U.S. Department of Energy (DOE).
- The reservation is owned by DOE and has been operated by Martin Marietta Energy Systems, Inc., (Energy Systems) since April 1984. (Following a corporate merger in 1995, Martin Marietta Energy Systems was renamed Lockheed Martin Energy Systems.)
- The Oak Ridge Institute for Science and Education (ORISE) has stewardship responsibility for two parcels on the reservation: the Scarboro Operations Site and the Freels Bend Tract. ORISE is managed for DOE by Oak Ridge Associated Universities, a nonprofit consortium of 82 colleges and universities (Fig. 5).

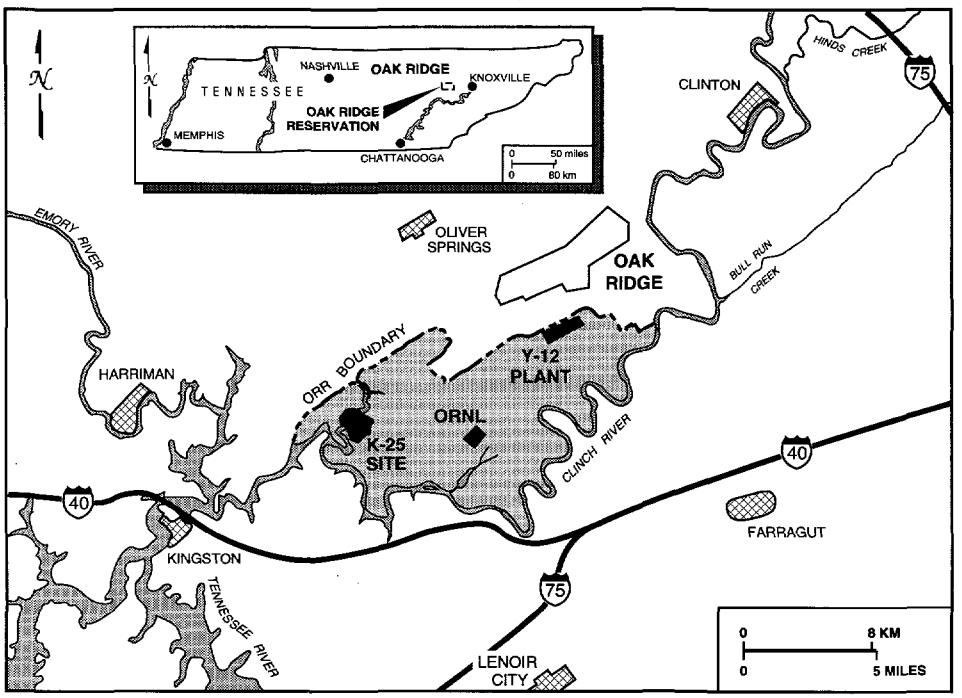

Fig. 1. The Oak Ridge Reservation and surroundings.

ROLE OF THE OAK RIDGE RESERVATION

The ORR's role has evolved over the years and continues to adapt to meet the changing defense, energy, and environmental needs of the United States. Currently, the reservation facilities are involved in areas such as environmental technology development, materials research and development, technology transfer, and radioisotope production.

In addition to support of the war effort, subsequent research, development, and production activities have produced hazardous wastes, and continue to do so today. For that reason, much of the current work on the reservation involves environmental monitoring, surveillance, waste management, and environmental restoration to deal with wastes from ongoing projects as well as the legacy of the past. In addition, DOE orders and federal and state regulations require documented environmental monitoring for these facilities, which is published in annual site environmental reports.

Fig. 2. The Oak Ridge Y-12 Plant.

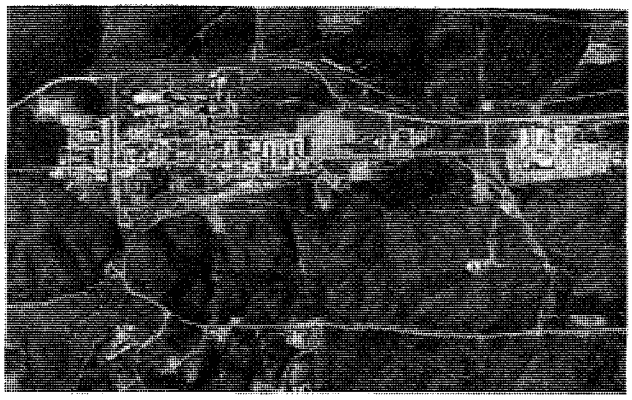

Fig. 3. Oak Ridge National Laboratory

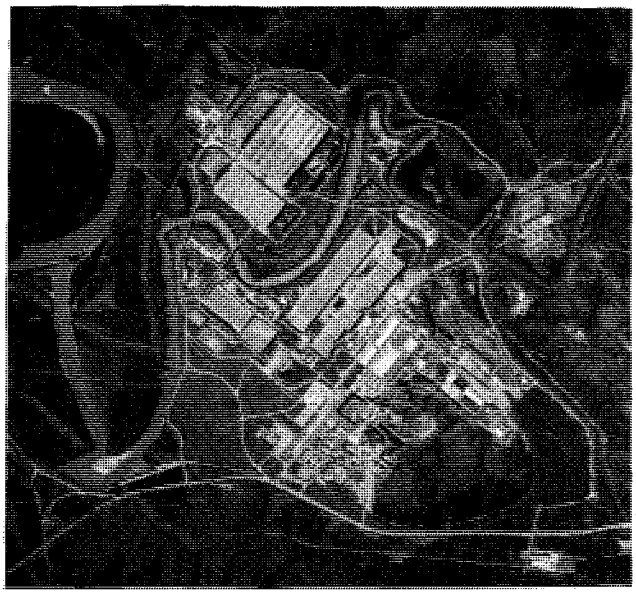

Fig. 4. The Oak Ridge K-25 Site.

RESERVATION ECOLOGY

When the ORR was acquired by the federal government in 1942 for the Manhattan Project, it consisted of about 1000 individual tracts of land, primarily farmsteads. This land was a patchwork of forests, wooded pastures, and fields.

Aerial photographs taken in the mid-1920s and late 1930s show that about half of the area was cleared. Some clearings for orchards and pastures were on upper slopes, rocky areas, and ridge tops; tillage crops were mostly restricted to lower slopes and bottomlands. Agricultural practices of the time resulted in severe erosion on most slopes. Erosion gullies are still evident in some areas. Except on very steep slopes, most of

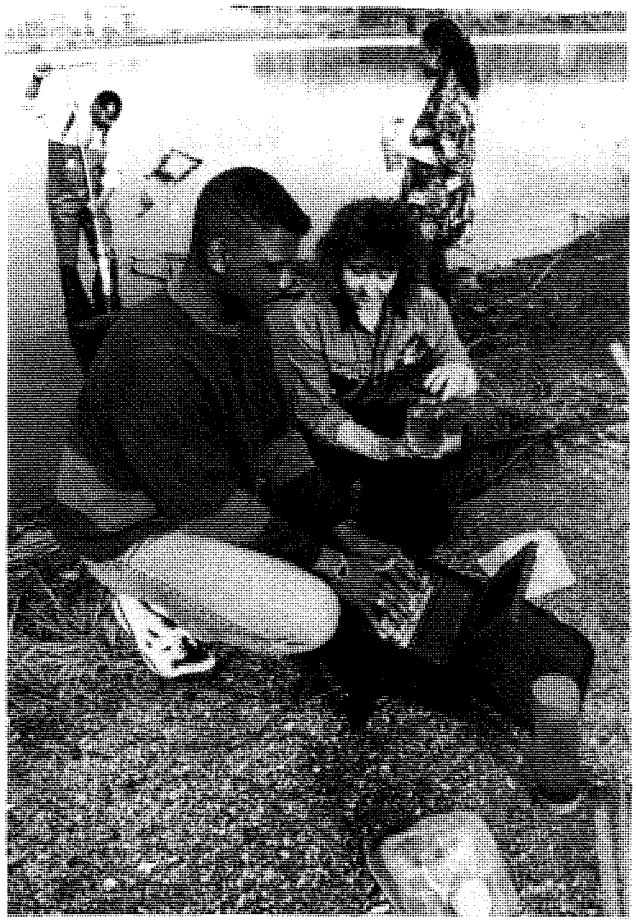

Fig. 5. An ORISE program provided training to these faculty and students from historically black colleges and universities, who are using the National Library of Medicine data bases in the field. DOE established ORISE to undertake national and international programs in science and engineering education, training and management systems, energy and environment systems, and medical sciences. (Photo courtesy of ORISE.)

the forest was cut for timber but not always cleared. Many partially cut forest areas were used as rough pasture.

The ORR was selected to be a Biosphere Reserve in 1988 and is a unit of the Southern Appalachian Biosphere Reserve. It plays an important role as the only representative of the ridge-and-valley physiographic province in the international United Nations Educational, Scientific, and Cultural Organization (UNESCO) Man and Biosphere Program.

On an area basis, the reservation is richer in federally protected plants than is the Great Smoky Mountains National Park. In fact, the ORR has about four times as many listed species per unit area as the Great Smoky Mountains National Park—an impressive return in species preservation per investment in area. This richness is just one of the reasons that the reservation is of great regional and national importance in conserving biological diversity.

Forests, primarily oak-hickory, pine-hardwood, or pine with oak-hickory, currently cover about 75% of the reservation. About 500 acres of wetlands are also found throughout the reservation. More than 1000 different species of vascular plants grow on the reservation. By comparison, 1300 known plant species have been observed in the Great Smoky Mountains National Park. Twenty different species of rare plants occur on the reservation; all of them are on the state's rare plant list, and four of them are under consideration for federal listing.

In addition, the ORR supports a wide variety of animal species, including 60 reptilian and amphibian species; 63 fish species; more than 120 species of terrestrial birds; 32 species of waterfowl, wading birds, and shorebirds; and about 40 mammalian species. The ORR also supports animal life listed as threatened by the state of Tennessee (Fig. 6). Habitats supporting the greatest number of species are those dominated by hardwood forests and wetlands.

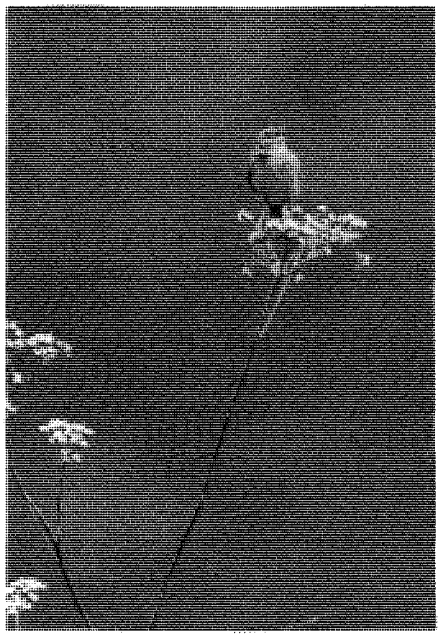

Fig. 6. This grasshopper sparrow, listed as threatened by the state of Tennessee, was spotted in the Freels Bend area of the ORR.

OUR OPERATIONS ARE GOVERNED BY STATE AND FEDERAL LAWS AND REGULATIONS

It is ORR environmental policy to conduct its operations in a safe and environmentally sound manner and to comply fully with all environmental rules and regulations. Growing public awareness and environmental concern in recent years have prompted Congress to pass increasingly stringent laws aimed at protecting the environment. In keeping with our policy, we continue to work closely with the regulating agencies to minimize the effect of our operations on public health and the environment and to ensure continued compliance with regulations (Fig. 7).

The U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (TDEC) are the principal regulators of ORR activities. These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations.

Fig. 7. Routine audits ensure compliance with state and federal regulations. (Photo courtesy of Energy Systems Public Affairs, Kevil, Kentucky.)

The following are a few of the numerous federal and state laws with which ORR facilities must comply:

- Clean Air Act
- Clean Water Act
- Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- Emergency Planning and Community Right-To-Know Act
- Endangered Species Act
- Federal Facilities Compliance Act
- Federal Insecticide, Fungicide, and Rodenticide Act
- National Environmental Policy Act
- National Historic Preservation Act
- Resource Conservation and Recovery Act
- Safe Drinking Water Act
- Toxic Substances Control Act

COMMUNITY PARTICIPATION

ORR staff participate in a variety of environmentally related activities that benefit the local community. These include Adopt-a-School and Adopt-a-Highway programs, Safety Day, donations of computing equipment to local schools, and demonstrations at local schools. The annual EnvironMENTAL Fair is a popular event that enhances the educational experience of middle school students by increasing their awareness of local and global environmental issues and by encouraging them to pursue environmentally related careers (Fig. 8).

Fig. 8. Two sixth-graders enjoy one of the many hands-on activities at the 1994 EnvironMENTAL Fair.

In addition, local citizens have access to information from a number of DOE-hosted outlets as well as independent watchdog groups:

- **The DOE Public Information Office** serves as the central point of contact for the public and the media for matters concerning DOE. The office issues news releases and other informational materials as needed.
- **The DOE Stakeholders Group** gives area citizens an opportunity to meet with DOE officials to discuss environmental restoration and waste management activities.
- ***Environmental Update*** is a newsletter published to keep area residents informed of environmental restoration and waste management activities under way or under consideration on the ORR. The newsletter is inserted into area newspapers and is kept on file at the DOE Information Resource Center.
- **The DOE Information Resource Center**, located at 105 Broadway in Oak Ridge, houses the Administrative Record, a collection of files that contains all the information on which environmental cleanup decisions are based.
- **The City of Oak Ridge Environmental Quality Advisory Board**, established in the early 1970s, advises and assists the city council in matters contributing to a quality environment and advises the city manager and regional planning commission on specific environmental matters. One current area of activity is to monitor DOE activities that may affect the environmental quality of the community. The monthly meetings, which are attended by a DOE representative, are open to the public.
- **The Clinch River Environmental Studies Organization (CRESO)** is a cooperative venture between Anderson County schools, Clinton City schools, and DOE's Waste Management and Technology Development Division. The purpose of CRESO is to engage in long-term ecological monitoring programs at the Anderson County Wildlife Sanctuary, formerly a county landfill. High school students perform hands-on, field-based investigations of plants and animals living in the sanctuary. These activities expose the students to practical environmental management issues associated with diverse local ecosystems.
- **The Oak Ridge Reservation Local Oversight Committee** was appointed by the governor of Tennessee following an agreement in 1991 between the state and DOE to provide independent monitoring of environmental restoration activities on the ORR. The committee identifies local

concerns; prepares special studies, surveys, and assessments; and disseminates facts concerning environmental restoration and related topics. It also represents the city of Oak Ridge and the counties surrounding the reservation during the selection of annual work and budget priorities and acts as liaison in activities requiring government action or participation.

- **Site-Specific Advisory Board.** In early 1995, DOE decided to establish a site-specific advisory board (SSAB) in Oak Ridge to advise the agency on environmental management issues, including recommendations for cleanup levels, technology development, and long-term waste management issues (Fig. 9). Most DOE sites across the country have already established SSABs. The group will include 15 to 20 representatives from communities potentially affected by cleanup decisions as well as governing bodies and other interested groups. Representatives from DOE and its regulator agencies (EPA Region IV and TDEC) will serve on the Oak Ridge SSAB as nonvoting members.

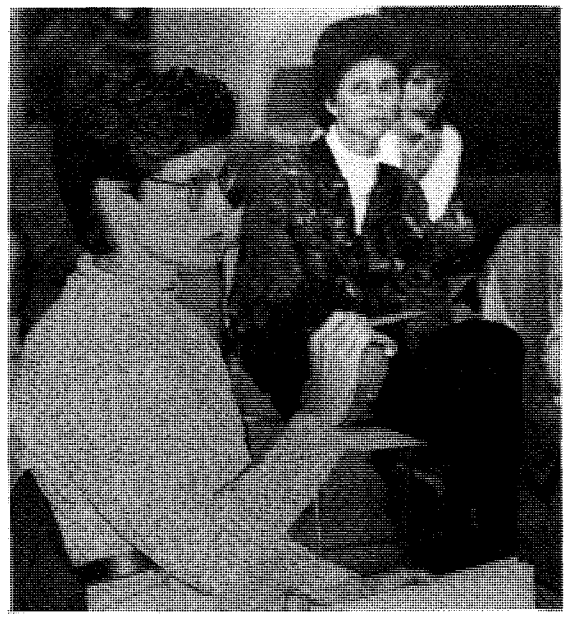

Fig. 9. An interested citizen expresses her thoughts at one of the public information meetings about the proposed ORR Site-Specific Advisory Board.

For Further Information . . .

- EnvironMENTAL Fair
  Mark Musolf
  423-574-8093
- The DOE Public Information Office
  Steve Wyatt
  423-576-0885
- The DOE Stakeholders Group
  Mark Musolf
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- *Environmental Update*
  Karen Bowdle
  423-541-4410
- The DOE Information Resource Center
  Bill Sawrey
  423-481-0695
- Environmental Quality Advisory Board
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  P.O. Box 1
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  423-482-8320
- The Clinch River Environmental Studies Organization
  Carolyn Davis
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- Oak Ridge Reservation Local Oversight Committee, Inc.
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  Suite 208,
  Oak Ridge, TN 37830
  423-483-1333
- Site-Specific Advisory Board
  Anne Armstrong
  423-574-3027

Restoring the Environment and Managing Waste

- Environmental restoration and waste management activities are carried out to protect the local population, to improve the quality of the environment, and to comply with federal and state regulations.
  - *Environmental restoration* includes the cleanup of wastes in the environment that originated from activities on the reservation as well as other activities designed to restore areas to an environmentally safe condition.

- *Waste management* is the control of wastes, including their destruction, reduction, or permanent storage.

- A number of specialized facilities on the reservation are operating to reduce and contain the wastes produced by past and current site operations (Fig. 10).

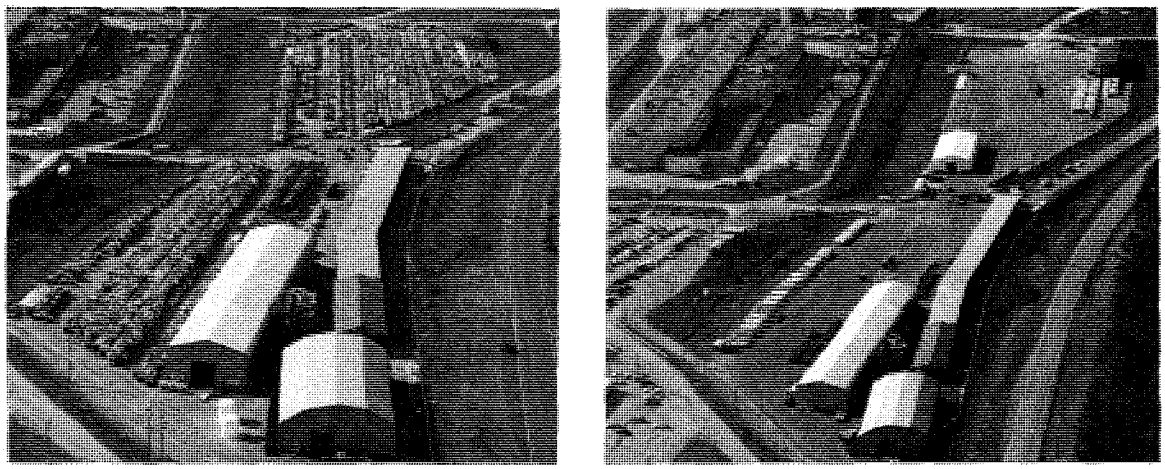

Fig. 10. An outdoor storage pad on the K-25 Site once contained 77,000 barrels of wastewater pond sludge (left). Temporary structures (right) contain treatment and packaging equipment.

Environmental Restoration

Environmental restoration is the process of cleaning up inactive waste sites and facilities to ensure that risks to human health and the environment are either eliminated or reduced. This task may be accomplished by removing, stabilizing, or treating hazardous substances. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the federal law that addresses the restoration of inactive waste sites, includes identification of waste sites with the most urgent need for cleanup because of the increased risk to public health or the environment. Identified sites are put on EPA's National Priorities List. In December 1989, the ORR was added to the list.

Waste Management

During 1994 more than 1.2 million m^3 of waste was generated on the ORR, 84% of which (1.04 million m^3) was sanitary/industrial waste. Ninety-three percent of the sanitary/industrial waste in the form of liquids was released through National Pollution Discharge Elimination System (NPDES) outfalls after treatment at water treatment facilities. The remaining 7% of sanitary/industrial waste was solid waste that underwent treatment and disposal.

Several hundred tons of cardboard and paper and several thousand soft drink cans are shipped onto the reservation each year. Of that, most are recycled (Fig. 11).

Ninety-nine percent of the solid waste accumulated and stored on the ORR (175,000 m^3) is composed of mixed waste (hazardous waste mixed with radioactive contaminants), low-level radioactive waste, and contaminated scrap metal. The remaining 1% is attributable to transuranic (TRU) waste. Although the volume of TRU waste is comparatively small, it represents a large amount of radioactive decay per unit of volume (curies per cubic meter) and therefore poses a potential health hazard.

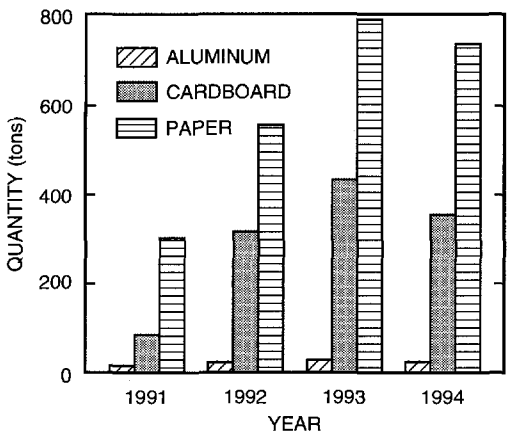

Fig. 11. Recycling has proven to be a very successful waste management method on the ORR.

WE STUDY THE EFFECTS OF RADIATION AND CHEMICALS

Activities on the ORR involve handling radioactive materials, operating radiation-producing equipment, and working with chemicals known to be harmful to people and the environment. Radiological and chemical "dose" assessments evaluate the possible exposure of public to radioactive elements and harmful chemicals as a result of routine operations on the ORR (Fig. 12). We assess and record compliance with regulations for protection of people and the environment. Thousands of samples of air, soil, and water are analyzed each year. The results are used to determine the amount of exposure that a hypothetical, "maximally exposed" individual could receive during the year as a result of operations on the ORR.

What Do We Mean by Risk?

When we estimate the risk associated with activities on the reservation, we are calculating the odds of activities on the reservation affecting the health of the local population. These calculations are based on known effects that chemicals and radiation have on the human body. All of the sampling and analysis compiled in the ORR annual site environmental report culminate in the calculation of "dose" of radiation and chemicals to the public (if any) that can be attributed to the activities on the reservation. For example,

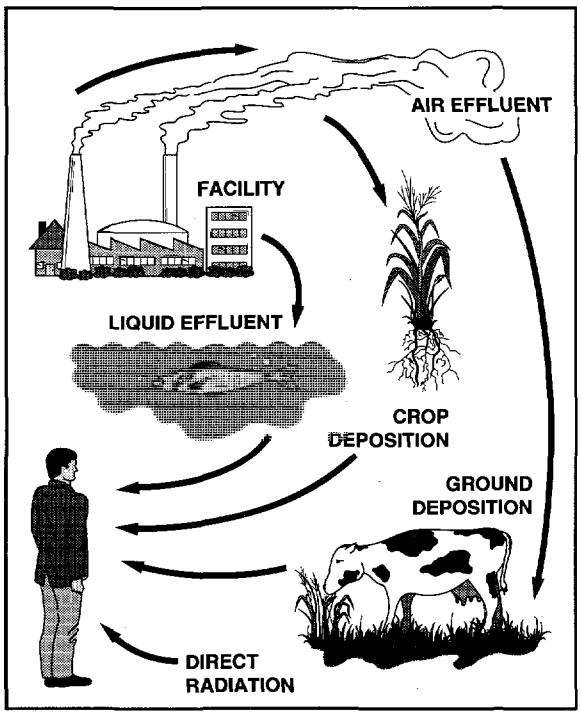

Fig. 12. Chemical and radiation pathways. We can receive internal or external exposure to chemicals, radioactive materials, and radiation by way of a number of pathways. We receive radiation directly from cosmic radiation and from particles embedded in soil and suspended in air and water. We can breathe air or drink water that have both chemical and radiological airborne contaminants suspended in them. In addition, airborne contaminants that settle on grass in pastures and hayfields can be eaten by cows, and the contaminants can show up in the milk we drink. Similarly, contaminants can be retained in honey, fish, and game animals.

- **Radiological definitions**
  - *Radioactive material* contains unstable atoms (isotopes) that become stable by emitting electromagnetic radiation and high-energy particles.
  - *Dose* is an estimate of the amount of radiation that a body has received (in units of rads or grays).
  - *Dose equivalent* is an estimate of damage to a specific organ based on the radiation it has absorbed (in units of rem or sieverts).
  - *Effective dose equivalent (EDE)* relates the dose equivalents to the risk to the whole body (in units of millirem or millisieverts).
- **Chemical definitions**
  - *Chronic reference dose* is the estimate of the amount of a chemical to which a human body is exposed daily that is likely to be without an appreciable risk of deleterious effects during a lifetime.
  - *Toxicity* refers to the adverse effects, ranging from mild irritation to death, that a chemical can have on human health.
  - *Carcinogens* are a class of chemicals that cause or increase the incidence of malignant neoplasms or cancers.

the maximum possible radiological effective dose equivalent (EDE) attributed primarily to the air and water pathways and direct radiation exposure was calculated in 1994 to be 5 mrem.

WE MONITOR THE ENVIRONMENT

- The ORR environmental monitoring program has two components: effluent monitoring and environmental surveillance, both of which are intended to demonstrate that reservation operations comply with DOE criteria as well as other applicable federal, state, and local standards and requirements.
  - *Effluent monitoring* involves sampling known air and water discharge points to determine the amount of radioactive and chemical contaminants (if any) contained in the released material.
  - *Environmental surveillance* involves sampling the air, water, and food to detect any radioactive or chemical contaminants that may be attributable to activities on the reservation.
- Information from these programs is then used to document compliance with applicable environmental laws and regulations, identify trends, inform the public, and contribute to general environmental knowledge.

We monitor the local environment to acquire data so that we can reduce and, where practical, eliminate the release of radioactive and hazardous materials. Information gathered during specific monitoring programs is published in routine reports to local, state, and federal agencies and to the public. The environmental monitoring program assists in fulfilling DOE's policy of protecting the public, employees, and the environment from harm that could be caused by its activities and in reducing negative environmental impacts to the greatest degree practical.

Air

We sample both effluent air and ambient air on the ORR. *Effluent air* flows from a source into the environment. *Ambient air* is the air that exists in the surrounding area. Both radiological and nonradiological air emissions from individual buildings and specific plant locations as well as locations in the surrounding communities are monitored. Air monitoring programs provide information to protect the health of plant workers and the general public, and to demonstrate compliance with state and federal air quality requirements (Fig. 13). Programs are revised through the years to meet revisions in state and federal requirements.

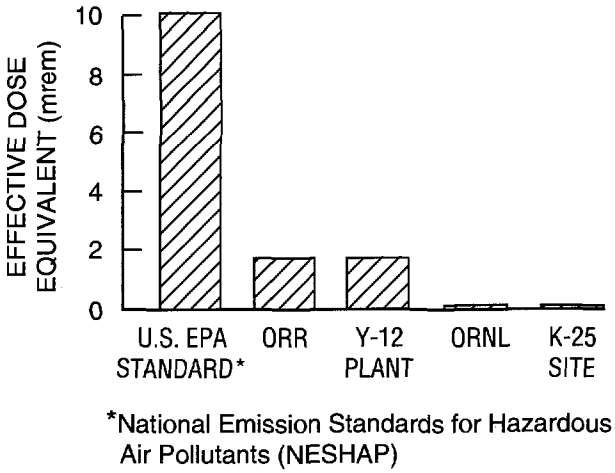

Fig. 13. Total 1994 effective dose equivalents to maximally exposed individual from airborne releases. In comparison, local natural background radiation is about 300 mrem (3 mSv) per year.

For all permitted air emission sources at the three facilities on the ORR, 1994 air emissions were lower than (in some cases significantly lower than) TDEC-permitted air emission limits. No noncompliances were noted by TDEC at any of the facilities during inspections of all permitted emission sources. Based on facility-specific and ORR nonradiological and radiological ambient air monitoring programs, ORR operations do not significantly affect local air quality.

The additional EDE received by a hypothetical maximally exposed individual from ORR emissions in 1994 was calculated to be 1.7 mrem, which is below the National Environmental Standards for Hazardous Air Pollutants (NESHAP) standard of 10 mrem, and well below the 300 mrem received from natural sources annually.

Direct Radiation

Direct radiation exposure rates are measured at a number of locations on and off the ORR to determine whether radioactive releases from the ORR are significantly increasing radiation levels above the normal background levels. External exposure rates from background sources in the state of Tennessee average about 6.4 microroentgens (μR)/hour and range from 2.9 to 11 μR/hour. These exposure rates translate into annual EDE rates that average 42 mrem/year and range from 19 to 72 mrem/year (T. E. Myrick et al. 1981. *State Background Radiation Levels: Results of Measurements Taken During 1975–1979*, ORNL/TM-7343, Oak Ridge, Tenn.)

The average exposure rate at perimeter air monitoring stations around the ORR during 1994 was about 8.5 μR/hour (55 mrem/year). Almost all measured exposure rates beyond the ORR boundaries are near background levels, except for two locations: Poplar Creek on the ORR (where exposure is highly unlikely because the site is posted against fishing) and a 1.7-km (1.1-mile) section of the Clinch River.

The radiation field along Poplar Creek emanates from storage areas within the K-25 Site. Anglers have been observed on the section of the creek affected by this area.

Exposure-rate measurements (corrected for background) taken along the creek during 1994 ranged between 3.9 and 8.3 μR/hour, which is equivalent to an EDE rate of 0.003 to 0.006 mrem/hour (0.00003 to 0.00006 mSv/hour). Actual fishing activity on the affected stretch of Poplar Creek needs to be determined. A 4-hour fishing trip could have resulted in an EDE between 0.01 and 0.02 mrem (0.0001 to 0.0002 mSv). It is extremely unlikely that anyone would fish this stretch of Poplar Creek for 250 hours per year.

Exposure from the area on the Clinch River has been attributed to radiation from experimental plots containing cesium-137. Exposure rates measured in 1987 averaged 13 μR/hour and ranged between 3.5 and 18 μR/hour. The site has since been remediated, but it has not yet been surveyed. For that reason, the exposure rate during 1994 was assumed to be the same as during 1993, 8 μR/hour (equivalent to 0.006 mrem/hour). Hypothetically, if someone spent 250 hours during 1994 fishing at either location, he or she could have received an EDE of about 1 mrem.

Water

Surface Water

The federal Clean Water Act allowed the U.S. Environmental Protection Agency to establish NPDES. NPDES provides limits for effluents discharged into the surface water. On the ORR, 438 water locations are sampled at various frequencies during the year (from once every five minutes to once per year) for NPDES compliance monitoring. About 69,000 water samples were collected in 1994 and were subjected to laboratory analyses. In addition, technicians looking for discharges along surface water streams made more than 160,000 observations in 1994. Fifty-three NPDES noncompliances with permit requirements were found among these measurements and field observations. Nearly half of these were for suspended solids (sediment) in stormwater runoff. The compliance rate for 1994 was greater than 99%.

In addition to the NPDES program, surface water from 22 locations around the ORR are analyzed to ensure that water quality standards are met; to describe background water quality; to evaluate potential contaminant releases; and to comply with monitoring requirements of regulations, permits, and agreements. Water quality testing programs look for 79 elements, industrial chemicals, radioactive components, inorganic elements, and organic compounds. Hundreds of discharge points, storm sewers, and local streams and rivers are monitored on and around the ORR (Figs. 14 and 15).

Tennessee water quality criteria for domestic water supplies and for freshwater fish and aquatic life are used as reference values for locations where they are applicable. Out of 79 parameters sought at each of the 22 locations, silver and chromium at White Oak Dam and copper at White Oak Creek downstream from ORNL on the ORR are the only parameters that exceeded a reference value.

Averaged annual concentrations of radionuclides in water samples at the K-25 Site (Gallaher) Water Plant and

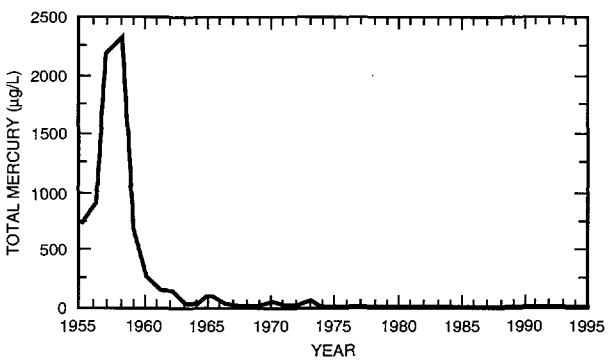

Fig. 14. Mercury concentrations in surface water leaving the Y-12 Plant, 1955–1995. Although most of the mercury was discharged during the 1960s and 70s, its legacy remains downstream, in East Fork Poplar Creek.

Fig. 15. East Fork Poplar Creek runs through the city of Oak Ridge for about 14.5 miles before emptying into Poplar Creek, near the K-25 Site. Mercury released from the Y-12 Plant in the 60s and 70s is now deposited along the banks of East Fork Poplar Creek. A proposed environmental restoration plan to reduce the amount of mercury along the creek is currently being reviewed.

at the Kingston Municipal Water Plant were used to calculate potential individual EDEs for drinking water. A person who drank 365 L of K-25 Site water during 1994 could have received an EDE of about 0.3 mrem; a person who drank a greater amount of Kingston water (730 L) could have received a lower EDE of about 0.04 mrem.

The maximum annual EDE associated with water exposure routes other than drinking water or eating fish was calculated to be 0.4 mrem, which is attributed to shoreline use. Doses from boating or swimming in the Clinch River are negligibly small.

Groundwater

Local groundwater provides some domestic, municipal, farm, irrigation, and industrial uses, but most of the population in the Oak Ridge area does not rely on groundwater for potable water supplies. The local groundwater must be viewed as both a potential pathway for exposure to hazardous wastes and as a means for contaminant transport, however, because suitable water is available (Fig. 16).

We are able to evaluate the impact of ORR activities on local groundwater and to limit any activities that have an adverse effect on the groundwater by sampling. Major federal regulations specify actions to be followed in the groundwater monitoring program. Groundwater is monitored for radioactive elements, organic compounds that evaporate easily, (volatile organic compounds), trace metals, and major ions (electrically charged atoms and molecules).

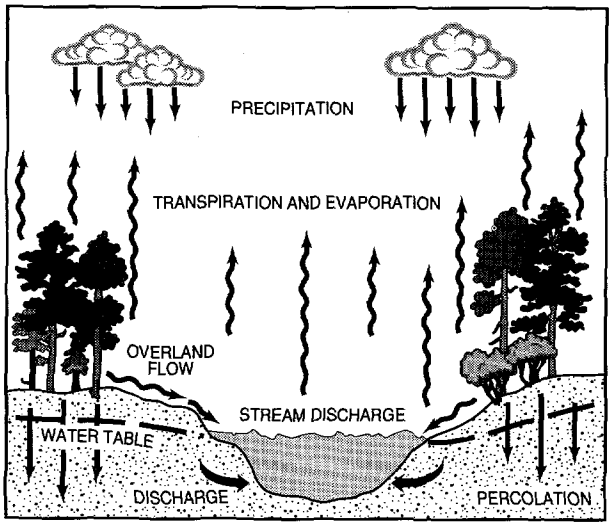

Fig. 16. Groundwater is precipitation that has percolated into subsurface rock and soil. The water table, the depth to which the ground is saturated with water, varies seasonally with the precipitation rate. Groundwater moves through the ground and discharges to bodies of surface water where the two meet. Because groundwater can transport both chemical and radiological pollutants from underground waste-burial sites, both surface water and groundwater are sampled on and off the reservation to determine the presence, amount, and movement of wastes.

The numerous wells on the ORR provide for surveillance of groundwater quality. Additional characterization is being conducted in the Environmental Restoration Program. Radiological groundwater monitoring is conducted for specific radionuclides as well as general levels of radioactivity.

Plant perimeter groundwater monitoring stations are used to assess potential migration of contaminants beyond the boundary of the ORR. Groundwater data collected from these stations during 1994 indicate that only a few locations at the Y-12 Plant and ORNL show any evidence of contamination. At the Y-12 Plant, results from several recently completed wells and a group of off-site U.S. Geological Survey wells indicate that groundwater contaminated with volatile organic compounds is migrating eastward across Scarboro Road and into Union Valley. There are no users of groundwater in the affected area. Results from the off-site spring and residential well monitoring program indicate no evidence of contamination at these locations during 1994.

Other Media

Several other media are sampled and analyzed to evaluate the impact of the ORR on its surroundings and to comply with federal and state regulations. These media include soil, sediment, hay, vegetables, (lettuce, turnips, and tomatoes), milk, fish, and resident wildlife (white-tailed deer and Canada geese). Samples are analyzed for radioactive elements as well as for chemicals of interest (such as fluorides in hay and PCBs in fish, for example). Samples are taken locally, both from the ORR and from surrounding communities.

Soil

Soil is sampled to determine whether airborne radionuclides are accumulating in the soil. Soil samples are taken annually at nine locations on the reservation. Detected radionuclides and levels of radioactivity in 1994 samples were similar to 1993 levels and were all within acceptable ranges.

Sediment

No regulatory requirements apply to stream or lake sediments; however, sediments can act as a record of water quality by storing and concentrating certain contaminants. For that reason, annual sediment sampling was begun on the ORR in 1993. Sediment samples collected from 16 locations on and around the reservation are analyzed for certain radionuclides, metals, chlorinated pesticides, PCBs, and hazardous organic compounds. Data collected in 1993 and 1994 proved to be highly variable; further sampling will determine whether any patterns or trends can be established for sediment sampling.

Hay

Hay from the ORR is sold to area farmers. Six locations from which hay is cut have been identified as areas where airborne materials could be deposited from ORR sources. (A reference site has been added to the sampling locations; reference data will be available in 1995.) The hay was collected and composited into three samples, which were analyzed for fluoride, tritium, beryllium-7, potassium-40, cobalt-60, iodine-129, and cesium-137. These analyses show that essentially all of the dose from consuming beef and milk from cattle that had eaten the hay would have come from naturally occurring potassium-40. The EDE from eating beef and drinking milk from cattle that ate this hay in 1994 was estimated to be

about 16.4 mrem; if potassium-40 (a naturally occurring isotope) were excluded, the EDE would be 0.6 mrem.

Vegetables

Tomatoes, lettuce, and turnips were grown in soil plots on the ORR. Because of some crop failure, turnips from private local gardens were also purchased. The vegetables were analyzed for radionuclides. The radionuclide concentrations did not vary significantly from those grown in a reference plot. The maximum individual EDE from eating all three vegetable types in 1994 was estimated to be about 2.7 mrem. If potassium-40, a naturally occurring isotope, is excluded, the maximum EDE would be about 0.1 mrem.

Milk Ingestion

Milk is a potentially significant exposure pathway of some airborne radionuclides such as iodine and strontium, which can be deposited on pasture grass, and thus consumed by dairy cows.

Potential dose from milk ingestion was evaluated using concentrations of strontium and iodine measured in milk collected from nearby farms. An individual was assumed to drink 310 liters of milk containing the highest measured quantity of total strontium. Such an individual could have received an EDE of about 0.2 mrem. No iodine or tritium detected in milk samples during 1994.

Honey

Several bee colonies are located on the ORR. The honey produced in these hives was sampled, and the sampling results were used to give an indication of potential EDEs to persons who eat honey produced by bees that may have collected pollen on the ORR. If an adult consumed 1 kg (2.2 lb) of the sampled honey during the year, the resulting EDE could be about 0.2 mrem. The average adult likely consumes less than 1 kg of honey per year.

The total production of honey in Anderson, Loudon, and Roane counties during 1992 (the latest available data) was about 1500 kg (3200 lb). In the extremely unlikely event that all the honey produced in the three counties contained the sampled concentrations of radionuclides, the resulting collective dose could be 0.3 person-rem.

Fish

Members of the public potentially could be exposed to contaminants originating from DOE activities through consumption of fish caught in area waters. This exposure pathway is monitored by annually collecting and analyzing fish from 14 locations (Fig. 17). Sampling sites are located

Fig. 17. Fish are routinely sampled from local streams. Fish are collected for population studies as well as for chemical and radiological analyses.

upstream and downstream of DOE activities and at one off-site (background) location. Sunfish are collected from each of the six river locations, filleted, and frozen. When enough fish have been collected (typically 150 to 200 per location), the samples are thawed and fillets from six of the largest samples are analyzed for selected metals, pesticides, and PCBs. To provide data from a second species, six to ten catfish are also collected at two locations, and a composite sample is analyzed for selected metals, pesticides, and PCBs. In 1994, most parameters analyzed for in both sunfish and catfish were undetected. For PCBs, reported values for sunfish and catfish were below the federal Food and Drug Administration (FDA) tolerance of 2 parts per million; for mercury, all reported values were below the FDA action level of 1 part per million. Doses that would result from eating fish ranged from 0.001 to 1.6 mrem/year.

White-Tailed Deer

The tenth annual deer hunts managed by DOE and the Tennessee Wildlife Resources Agency were held on the ORR during the final quarter of 1994 (Fig. 18). From the total harvest of 495 animals, 309 (62.4%) were bucks and 186 (37.6%) were does. The heaviest buck had 8 antler points and weighed 185 lb. The greatest number of points (11) were found on three bucks, weighing 123, 132, and 136 lb.

The heaviest doe weighted 123 lb. The average EDE for an individual consuming an average-sized deer (90 lb) from the ORR in 1994 having a cesium-137 concentration of 0.24 pCi/g would be 0.27 mrem. Given the average concentration of cesium-137, the collective EDE from eating all harvested deer in 1994 was estimated at about 0.13 person-rem.

Fig. 18. White-tailed deer are a common sight on the reservation.

Of the 495 deer harvested, 8 were confiscated because they exceeded established release limits (5 pCi/g for ^{137}Cs and 20 pCi/g for ^{90}Sr). Concentrations of ^{90}Sr in bone exceeded the confiscation limit in all eight confiscated deer. Elevated ^{137}Cs concentrations were also detected in two of the eight confiscated deer, which is unlike results from recent years. The deer confiscated during the 1994 hunt represent 1.6% of the total deer harvested.

Canada Geese

One objective of the ORR waterfowl program is to determine concentrations of gamma-emitting radionuclides accumulated by waterfowl that use waste disposal areas. The sampling areas are chosen because Canada geese congregate there (Fig. 19). Geese are highly mobile animals that range freely between sites on and off the reservation. For that

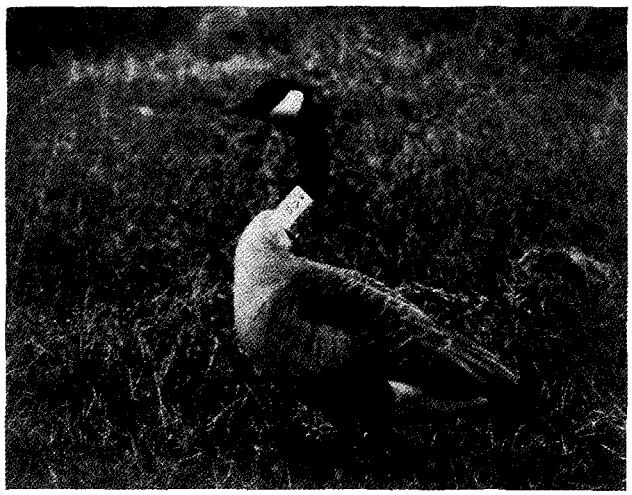

Fig. 19. Many Canada geese found on the reservation are year-round residents of the local area. Some, like this one, are tagged and studied.

reason, the results in this report should be taken as an indication of the possible overall impact that the reservation has on the geese rather than as an evaluation of the collection sites.

The annual roundup of Canada geese for leg banding and collaring took place on June 28 and 29, 1994. During the roundup, whole-body gamma scans were conducted on 105 geese at the deer-checking station: 20 geese each from ORNL, the K-25 Site, Melton Hill Dam, Oak Ridge Marina, and Clark Center Park and 5 from the Y-12 Plant were analyzed. Afterward, the geese were returned to their original areas.

Of the 105 geese counted in 1994, 66 had concentrations of cesium-137 that were considered to be statistically greater than zero. Of these, the highest concentration, 1.2 pCi/g, was found in a goose collected at ORNL. The average cesium-137 concentration in the 66 geese was estimated to be 0.13 pCi/g. A person eating a Canada goose containing the maximum 1994 concentration of cesium-137 would receive an EDE of about 0.1 mrem. The 1994 collective EDE from all harvested geese would be about 0.0024 person-rem.

SO . . . WHAT DOES IT ALL MEAN?

Environmental monitoring and surveillance are necessary to determine the effect that the ORR has in it neighbors. The relative contribution of the air, water, and direct radiation exposure routes on the maximum individual EDE from ORR operations is shown in Fig. 20. In many cases the maximum EDEs are calculated using conservative assumptions. Even so, the annual EDE of 5 mrem (sum of EDEs attributed to these exposure routes) is considerably less than the annual dose from background (300 mrem). As shown in the figures, the sum of the maximum EDEs for 1994 is about 2% of the average background radiation dose for the Oak Ridge area.

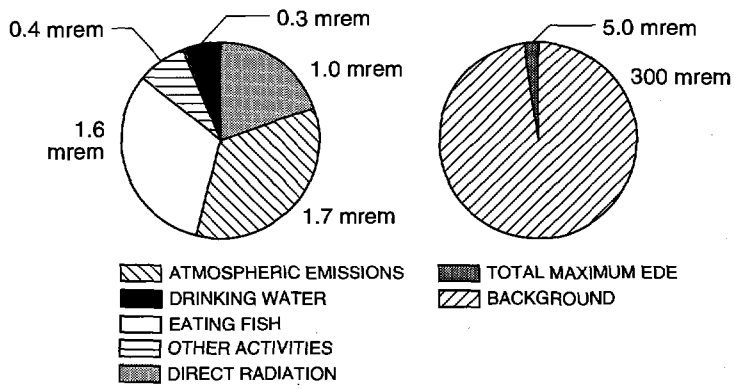

Fig. 20. A comparison of maximum EDEs via various exposure pathways.

Environmental surveillance of locally grown produce, such as vegetables, milk, honey, and hunted wildlife (i.e., deer and geese) is used to demonstrate compliance with applicable standards, to assess doses to members of the public, and to monitor potential environmental trends associated with these exposure pathways.

Our mission is changing from working solely for the national defense to working on environmental restoration, waste management, decontamination and decommissioning, and technology transfer projects. Everyone who works on the ORR remains committed to working safely with regard to each other, the public, and the environment. This goal will be accomplished by keeping emissions as low as reasonably achievable, enhancing the strict safety controls that are already in place, and using state-of-the-art technology to complete environmental remediation projects in the most cost-effective and efficient manner possible. Although our mission is changing, our new tasks remain essential as the nation moves forward to restore and preserve the environment for future generations.

Photographs and Figures

Cover	ORNL PHOTO 7546-90
1.	ORNL DWG 93M-6313R
2.	ORNL PHOTO 2623-94
3.	ORNL PHOTO 2622-94
4.	ORNL PHOTO 2624-94
5.	ORNL PHOTO 4541-95 (courtesy of the Oak Ridge Institute for Science and Education)
6.	ORNL PHOTO 5739-95
7.	ORNL PHOTO 4036-95 (courtesy of Energy Systems Public Affairs, Kevil, Kentucky)
8.	K/PH 94-6731
9.	ORNL PHOTO 3946-95
10. (before)	K/PH 93-8145
10. (after)	K/PH 94-8223
11.	ORNL DWG 95M-6712
12.	ORNL DWG 94M-5235R3
13.	ORNL DWG 95M-8097
14.	ORNL DWG 93M-9236R2
15.	K/PH 92-3067
16.	ORNL DWG 95M-8354
17.	ORNL PHOTO 10366-88
18.	ORNL PHOTO 6792-95 (taken by Steve Eberhardt, ORNL Information Management Services)
19.	ORNL PHOTO 1569-90
20.	ORNL DWG 94M-11869R