Closing the Circle on the Splitting of the Atom

IV. Contamination and Cleanup

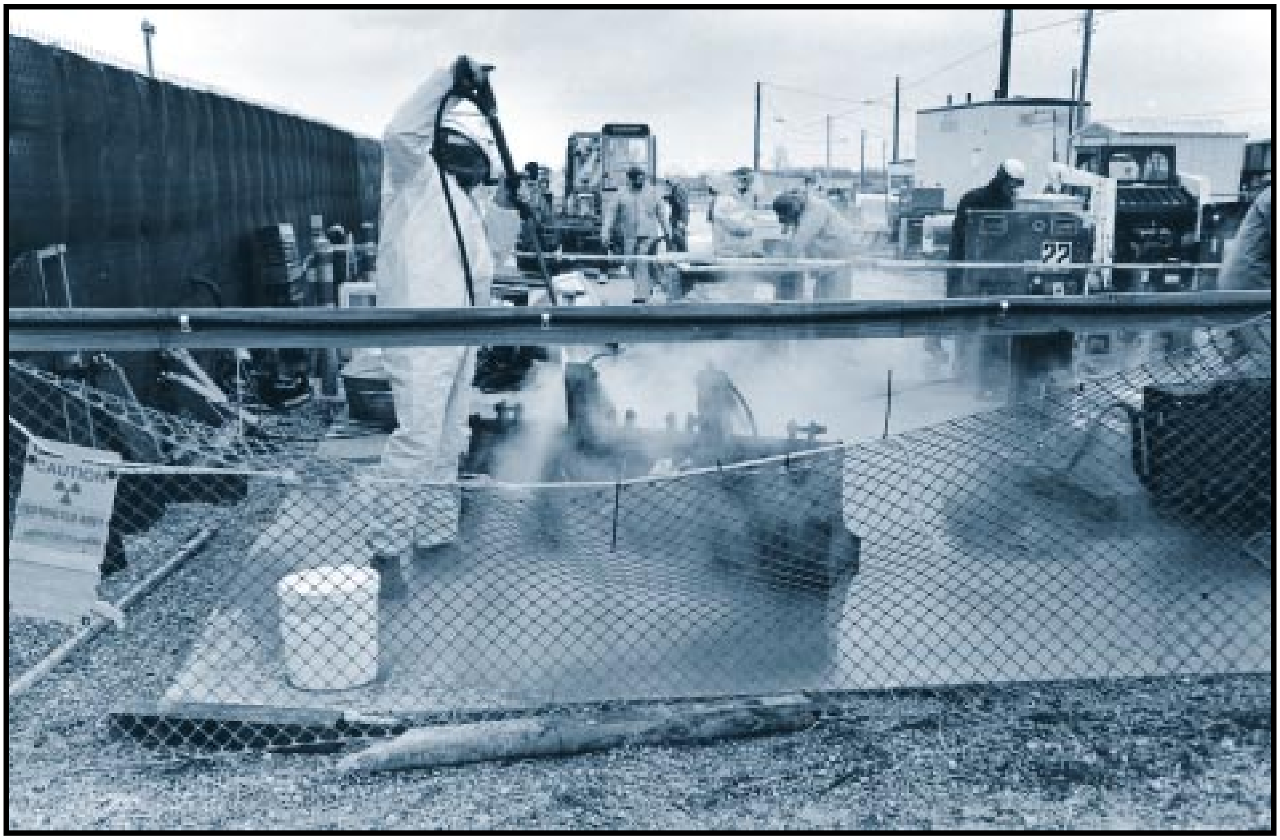
Every site in the complex is contaminated to some extent with radioactive or other hazardous materials. This contamination occurs not only in buildings; it is also found in soil, air, ground water, and surface water at the sites. Some sites and many of the buildings that were used during the Manhattan Project have already been cleaned up. However, most sites have significant and complicated problems that have been compounded over several decades.

For example, at the Hanford Site in the State of Washington, tritium has been detected in ground water, and high-level waste has leaked from storage tanks. At Oak Ridge, Tennessee, an estimated 1,000 tons of mercury have been released into the environment. At Fernald, Ohio, several hundred tons of uranium dust were emitted into the atmosphere, and drinking-water wells were contaminated with uranium. Traces of plutonium have been found in the soil and sediments around the Rocky Flats site in Colorado.

Fallout from aboveground nuclear tests in the United States and other countries has radioactively contaminated the atmosphere surrounding the entire Earth. Contamination with radioactive iodine released from early operations at the Hanford Site in Washington was also widespread. The large buildings used for reprocessing spent fuel at the Hanford Site and the Savannah River Plant in South Carolina are so contaminated with radioactive materials that decontamination must be done by remote control to protect the workers.

Decontamination worker at Hanford's UO_3 Plant scrapes down a workshop interior to remove low-level radioactive contamination on floor surfaces. *UO_3 Plant, Hanford Site, Washington. July 11, 1994.*

Every site in the complex is contaminated to some extent with radioactive or other hazardous materials.



Workers are decontaminating equipment used to move contaminated soil at the Weldon Spring site. Facilities at this site once performed many of the same functions as the Fernald Plant. *Weldon Spring site, Missouri. January 29, 1994.*

Actions in Cleanup

To understand environmental remediation, it is useful to look at the sequence of actions that are undertaken at contaminated sites:

1. A site is "characterized" by collecting data from soil and sampling wells, for example, in order to understand the nature and extent of contamination, its potential consequences, and the response alternatives. Computer modeling is often used to help estimate the spread of contamination.

2. The spread of contaminants is contained by using proven methods to slow or stop it.

3. Buildings are decommissioned and decontaminated. The first priority is safely maintaining the buildings before final disposition. When resources are available, the buildings are cleaned and then, in most cases, demolished.

4. The site and land are cleaned up by removing, consolidating, and stabilizing contaminants; the site is then prepared for future use.

In daily practice, contamination is addressed first through prevention, including the sound management of waste and other contaminants. When contamination does occur, cleanup options must be evaluated to avoid actions that might compound the problem. Finally, decontamination is undertaken where practical.

Deciding When and How To Take Action

The Department of Energy is committed to "moving dirt more than paper" and making progress. It is also committed to investing in technology that leads to more effective and efficient treatment. Although aggressive action sounds appealing, cleanup and decontamination are not so simple.

For example, while cleaning up contaminated soil, water, or buildings, workers will likely generate huge amounts of new waste that will require adequate storage, treatment, and disposal.

Another problem is that, by their very nature, radioactive materials and heavy metals cannot be destroyed. Over time–from fractions of a second to tens of thousands of years–radioactivity decays naturally. Meanwhile, radioactive wastes must be contained, stabilized, or moved to a safer place.

If contamination is not removed or stabilized, workers or the public could be exposed to radiation and other hazards. In some cases greater hazards can result from cleanup. One of the largest offsite releases of plutonium from the Rocky Flats Plant stemmed from an effort to scrape up contaminated soil on a hillside where drums filled with plutonium-contaminated waste had leaked. While the area was being scraped, strong winds carried plutonium-contaminated dust across a large area of nearby land. Cleanup workers were especially at risk.

Finally, some sites appear too severely or broadly contaminated to be cleaned up by the methods, resources, and funds currently available. Although technology development might help, no cost-effective remedies are on the horizon. Moreover, at many sites the benefits of cleanup are not worth the additional damage that might be inflicted on the environment or the potential risks to cleanup workers.

The Department has made significant progress. Many Manhattan Project facilities and 5,000 vicinity properties have already been cleaned up.

Specific sites that fit these categories cannot be easily listed, but they clearly exist. For example, hundreds of nuclear detonations left residual radioactivity at the Nevada Test Site. Most of this radioactivity is in highly inaccessible underground locations. There is no cost-effective technology for decontaminating such sites. Other facilities face similar difficulties. Many such sites will be isolated and monitored until practical cleanup methods are developed or until risks from the contaminants have diminished to a point where the land can be used again.

The White Oak Creek embayment is sited where the Clinch River meets White Oak Creek, whose waters flow through the site of the Oak Ridge National Laboratory. When creek waters leave the site, they are contaminated with cesium 137, strontium 90, and PCBs. Until 1991 there was a cable with a warning sign at this point. In 1992 the Department constructed a state-of-the-art sediment-retention dam that uses interlocking sheets of metal driven into bedrock to retard the flow of water so that contaminated sediments can settle behind the dam. *Oak Ridge, Tennessee. January 11, 1994.*

It is also true that while cleaning up some parts of sites will benefit ecosystems, other remediation efforts might damage them. At the Savannah River Site, a 2,600-acre lake used for cooling a production reactor became contaminated, primarily with cesium 137, a highly radioactive isotope. One remedy would be to drain the lake, then scrape up and contain the contaminated sediments. However, that action would destroy a valuable habitat for migratory birds and other animals. It would also expose workers and the public to greater risks. A better approach in this case might be to fence off an area around the lake for 100 to 200 years, allowing the sediment's radioactivity to decline by 10 to 100 times.

Progress in Cleanup

The Department has made significant progress in cleaning up sites and facilities. Many of the sites involved in the early stages of the Manhattan Project have been cleaned up and their buildings have been decontaminated or demolished under the Formerly Utilized Sites Remedial Action Program. Although most of these facilities are relatively small, some had been heavily contaminated. Cleanup has been completed at 21 such formerly used plants in Illinois, New York, New Jersey, and elsewhere.

Other contaminated sites have demanded an immediate response because people live in or on them, or because large concentrations of hazardous material were exposed to the elements.

For example, uranium-mill tailings emit radon gas, an identified health hazard. Large volumes of sandy radioactive tailings were left in open piles, subject to rain and wind, and some of this material was used for constructing roads, houses, schools, and other buildings. About 5,000 of these vicinity properties have been cleaned up under the Uranium Mill Tailings Remedial Action Program. This program has made steady progress in consolidating and capping huge tailings piles at dozens of former mill sites in several western states. Sixteen of the 24 mill sites have been remediated to date.

At the Y-12 site in Oak Ridge, Tennessee, several large settling ponds were part of a wastewater-treatment facility for acids and organic wastes containing uranium. Beginning in 1985 the liquid in these ponds was treated to remove contaminants and the ponds were drained and

During the cleanup of mercury contamination, this worker uses a special suit and respirator for protection against mercury-vapor poisoning. Many tons of mercury were released to the environment at Oak Ridge's Y-12 Plant during lithium-enrichment operations. Enriched-lithium targets are needed to make tritium, a radioactive gas used in nuclear weapons. *Oak Ridge, Tennessee. January 11, 1994.*

capped. Since 1990 the area has been safely used as a parking lot (see page 69).

A hillside, called the 881 Hillside, within the site boundaries of the Rocky Flats Plant in Colorado, was contaminated with a variety of radioactive isotopes, toxic metals, solvents, and petroleum products. The Department of Energy installed monitoring wells that identified the potential for releasing contaminants into offsite ground water and surface streams. Along the downhill edge of the site, an impermeable barrier and a “french drain” collection system were installed. Contaminated ground water has been pumped out of the collection system and treated. Cleanup workers also removed “hot spots” of radioactively contaminated soil and stored it in drums.

Challenges To Be Met

The Department faces more-expensive, longer-term decontamination challenges than the examples given above. Decontamination is needed at several thousand facilities that have been declared surplus. These include more than a dozen large reactor buildings, nine chemical separation plants, three vast uranium-enrichment complexes, and an array of smaller plants. The interiors of some of these buildings are too radioactive for unshielded workers to enter them. Robotics technology once used for production is now being adapted for decontamination and dismantlement work in these plants.

Cleanup planning goes hand-in-hand with facility transition and maintenance. To prevent accidental releases of radioactive materials, and to minimize hazards to cleanup workers, it is important to keep these buildings in stable condition as cost effectively as possible.

The sealed door to an “infinity room” at Rocky Flats. More than 20 such rooms have been contaminated by releases during plutonium operations at the site. The rooms are called “infinity rooms” because the rates of alpha radiation are too high for standard monitoring equipment to measure. The radioactivity in these rooms is nearly 25,000 times natural background. *Building 776/777, Rocky Flats Plant, Colorado. March 18, 1994.*

Although aggressive action sounds appealing, cleanup and decontamination are not so simple.

Ventilation ducts contaminated with plutonium in dust, oxides, and smoke exhausted from gloveboxes in the pyrochemistry area of Rocky Flats. When a buildup of plutonium becomes too great, it can pose a criticality threat. The buildup in these ducts was close to the limit for such a threat. *Building 776, Rocky Flats Plant, Colorado. December 20, 1993.*

Health-physics technician conducts a whole-body survey for potential radioactive contamination. She slowly moves a detection instrument over a worker, holding the meter within a quarter of an inch of his body. *Plutonium Finishing Plant, Hanford Site, Washington. December 20, 1993.*

Improving Performance

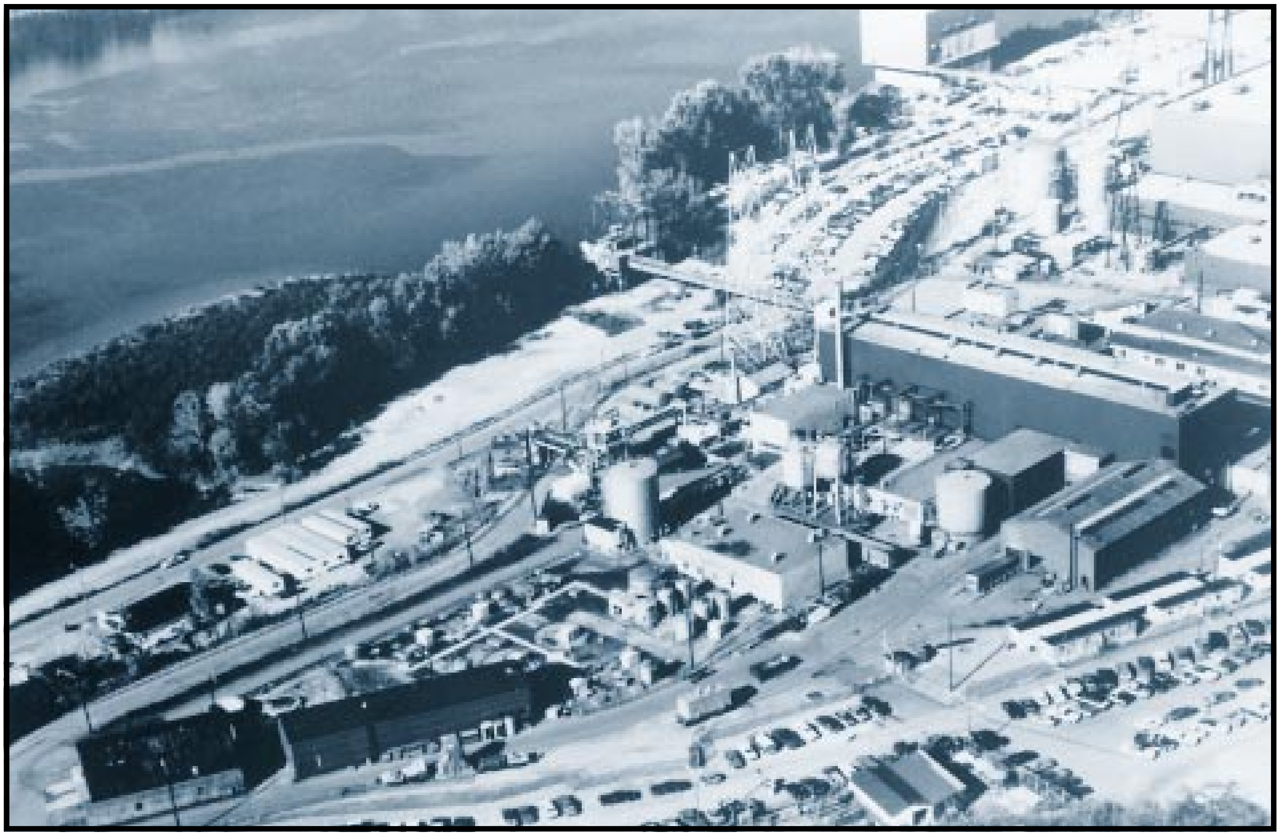
Along with radioactive isotopes, toxic metals and organic chemicals can also be difficult to remove from facilities, soils, and ground water. Some large buildings at Oak Ridge, Tennessee, became heavily contaminated with mercury during lithium enrichment operations. The leftover mercury used in this process is being gradually accounted for and stabilized. Because high concentrations of mercury are very toxic, workers in the area must wear special clothing and respirators, and they must proceed cautiously. The environmental management program at Oak Ridge is mapping this contamination and taking steps to prevent its further spread.

As workers and contractors become more proficient at environmental restoration, they are finding creative ways to improve performance. A good example is Hanford's T Plant, which was a reprocessing plant that extracted the plutonium used for the Trinity test, the Nagasaki bomb, and other early weapons. This huge building is now being used for cleaning equipment with high-activity contamination. Using an already contaminated building for such a purpose avoids the costly construction and decontamination costs of a new facility.

The Department is investing in technologies to make cleanup more effective. In this new era of openness and public involvement, citizens and the government can work together to ensure that progress continues and that environmental and public-health risks are reduced and workers are protected.

As workers and contractors become more proficient at environmental restoration, they are finding creative ways to improve performance.

Wastes from the earliest days of the Manhattan Project were buried in a 21.7-acre field just north of the St. Louis Airport, starting in 1946 and continuing for about 10 years. Today water draining from the field into a ditch bordering the site gives radiation readings 10 to 15 times higher than the natural background. Certain contaminants, such as thorium 230, tend to cling to the sediments in these ditches and have accumulated to significantly greater concentrations than in the water. *St. Louis Airport FUSRAP Site, Missouri. January 30, 1994.*



BEFORE – The Shippingport atomic power station before decomissioning. Built in 1957, Shippingport was the first large-scale nuclear power plant in the world. *Shippingport, Pennsylvania.*

AFTER – The Shippingport site after decontamination and decommissioning by the Department of Energy in 1990. This was the first complete decontamination and decommissioning of a power-producing reactor in the nation. *Shippingport, Pennsylvania.*

BEFORE – These four ponds received wastewater until 1985 from operations at the Y-12 Plant. *Oak Ridge, Tennessee.*

AFTER – A parking lot is now located where the four ponds shown above once stood. The liquids in these ponds were treated to remove contaminants beginning in 1985; the ponds were then drained and capped with asphalt. The project was completed in 1990. *Oak Ridge, Tennessee.*

The Department owns more than 2,000 contaminated facilities that will require decontamination and decommissioning.

Robotics technology once used for production is now being adapted to clean up contaminated facilities.

Moving Forward

The Department of Energy is decontaminating and demolishing old buildings, pumping and treating contaminated ground water, packaging contaminated soils, capping old dumping grounds to keep rainwater out, and moving drums of waste into sheltered structures. Many of these activities do not provide permanent solutions. Often they are the least costly and least risky means of holding contamination in place while priorities are set and decisions are made for the long term.

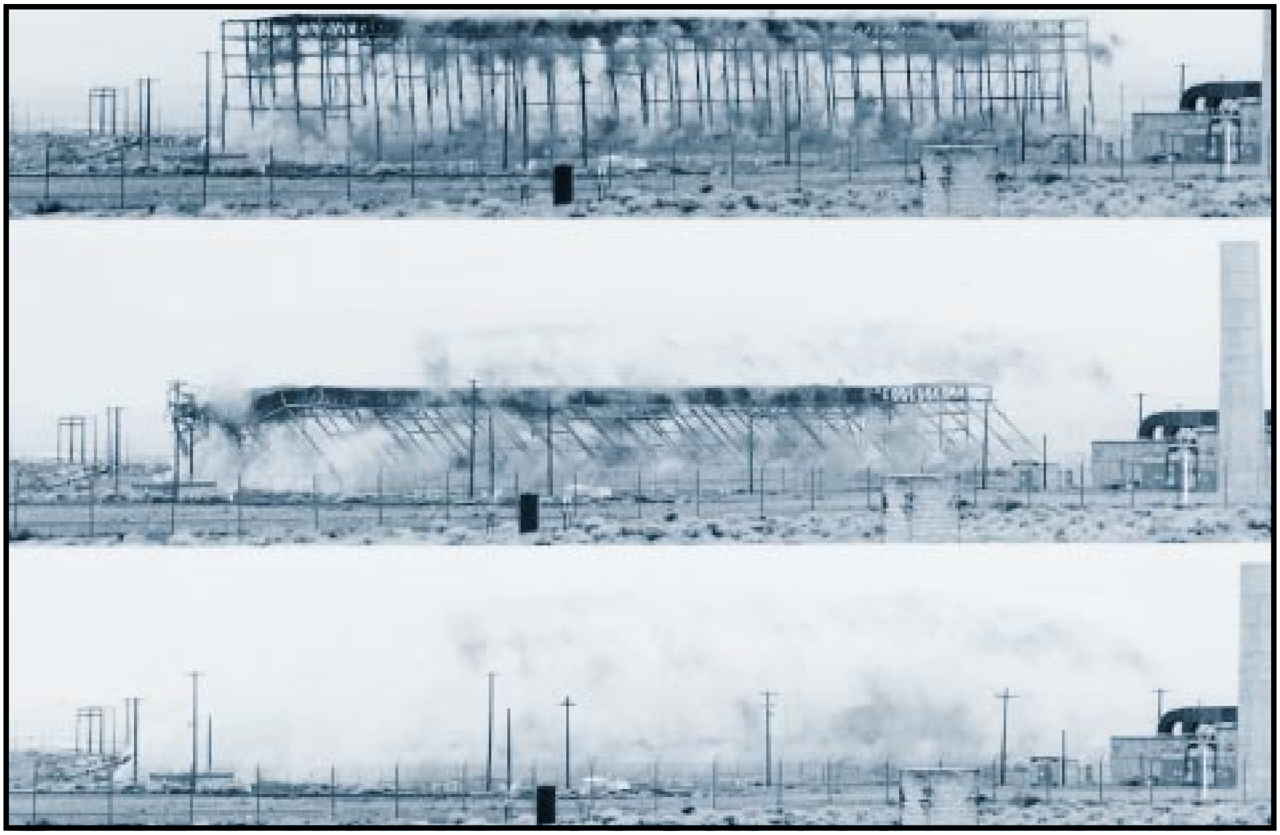
Affected citizens and workers, the Congress, Native American Tribes, and State and Federal regulatory agencies are actively participating in these decisions. They are addressing some of the following difficult questions:

How clean is clean? Given that radiation is everywhere, how do we decide when additional manmade radiation is a problem and when it is not? There is no universal right answer. This decision depends on site characteristics, the costs of remediation, and the use of the land. However, many immediate hazards are recognized, and the Department of Energy is addressing urgent risks on the basis of what is known rather than waiting for more information at the risk of increasing potential adverse impacts.

Should we decontaminate sites now or wait for better technology? The Department of Energy is working to evaluate emerging cleanup methods. It supports reseach and development in cases where both risks and current remediation costs are high, and it is developing contract incentives to encourage innovation and efficiency. However, some of the best technologies currently available preclude further treatment in the future.

How much scientific certainty is needed? Risk assessment is subject to many unknowns. How much additional research is needed to reduce uncertainty? How do we decide what to do with imprecise data? When do we stop studying and start acting?

What are the benefits of cleanup? While the financial cost of responsible environmental management can be calculated, its benefits are difficult to put in dollar terms. The positive results of cleanup can include reductions in worker and public risk as well as the value of land and facilities turned over to public or private use.



Demolition of a 456-foot-long structure built in 1943 brings an end to one of the original buildings at the Hanford Site. The building housed 1.7-million-gallon water-storage tanks that fed the cooling pumps of the Hanford B Reactor. Decommissioning crews removed the tanks, knocked down concrete walls, took out underground piping, filled in piping tunnels, and then collapsed the steel structure with explosive charges. Demolishing this building reduced hazards as well as surveillance and maintenance costs. Noncontaminated concrete and steel are recycled. *Hanford Site, Washington. December 1993.*

Workers remediate the 881 Hillside at Rocky Flats, an area that became heavily contaminated with toxic and radioactive substances. As part of the remediation action at the site, workers cleaned up six "hot spots" of highly radioactive contaminated soil. *Rocky Flats Plant, Colorado. September 1994.*

This exhaust stack was used to control emissions from the Plant 9 facility, where enriched uranium materials were processed. The malfunctioning of systems like this resulted in several releases of uranium dust, totalling several hundred tons, to the environment outside the plant buildings over the course of operations. *Fernald Plant, Ohio. December 30, 1993.*

Lisa Crawford: A Citizen of Fernald, Ohio

Lisa Crawford's husband Ken worked at a General Motors plant in rural Ohio outside Cincinnati. The Crawfords, with their two-year-old son Kenny, moved to Fernald in 1979. They rented a farmhouse across the road from a plant with red-and-white checkered water towers called the "Feed Materials Production Center." "Like a lot of people around here," Lisa said, "we thought it made cattle feed or dog chow."

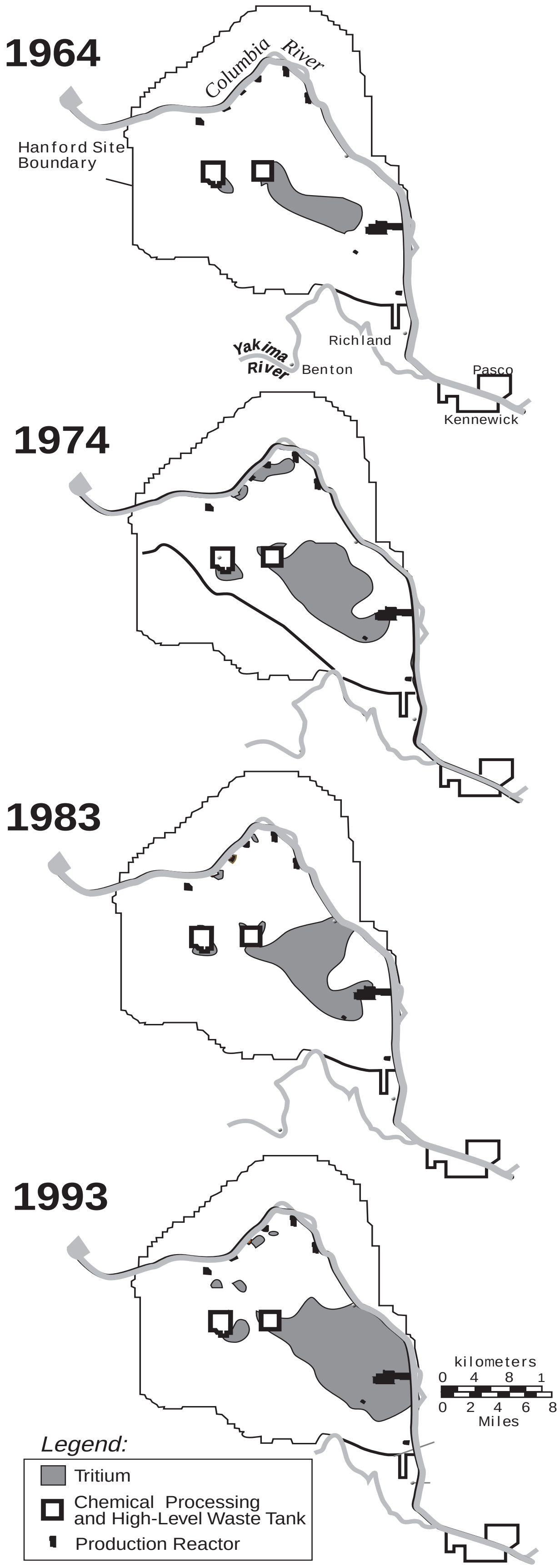
In late 1984, a local journalist reported that the plant had released a large amount of radioactive dust into the air and that three local wells were contaminated with uranium. One of the wells served the Crawford farmhouse. Lisa and her husband learned that the Feed Materials Production Center made components for nuclear weapons. They also found out that the Department of Energy had been aware that their well was contaminated as early as 1981–yet sent annual reports to their landlord saying tests had proved the water safe.

Soon after discovering that her family had been using contaminated well water for years, Lisa helped found a community organization called Fernald Residents for Environmental Safety and Health, or FRESH. In January 1985 she and her husband filed a $300 million class-action suit on behalf of the 14,000 citizens living within 5 miles of the plant against the contractor for the Department of Energy site, National Lead of Ohio.

Three years after the lawsuit was filed, the Department of Energy acknowledged that there had been uranium leakage at the plant since it had opened in 1951. In all, more than 100 tons of uranium dust had been released into the air, and more than 70 tons had been dumped into a local river. The ground water was found to be contaminated with chlorides, nitrates, fluorides, and uranium. In 1989, the lawsuit was settled, and the Department paid $78 million in damages to the citizens of Fernald.

In the late 1980s, the Fernald site shut down its weapons-production operations completely, and a new contractor took over the site. The Department of Energy has begun to clean up the site, a task expected to take several years.

Lisa Crawford and FRESH have been instrumental in shaping public involvement at Fernald. Working with site personnel, thay have found innovative ways to achieve meaningful public participation. "Once trust is taken away," Crawford said, "it's very hard to get it back. DOE must continue to work cooperatively with the community and clean up the Fernald site. Then, and only then, will the possibility of trust be restored."



Spreading tritium contamination at the Hanford Site in Washington. The shaded areas on these maps show how tritium contamination in concentrations above safe drinking-water standards has spread over time.

Dose Reconstruction: Estimating Past Human Exposures

Releases of radioactive materials associated with nuclear weapons production at sites throughout the weapons complex have aroused concern about potential public-health consequences. No one knows exactly who among the general public was exposed to how much radioactivity during the Cold War or what actual health impacts resulted. The Centers for Disease Control has undertaken “dose reconstruction” studies around several major Department of Energy facilities to gain a clearer understanding of potential health effects through epidemiological research. Efforts begin with trying to determine how much radiation was received by citizens living near nuclear weapons sites.

One of the earliest and most extensive research efforts began at Hanford in Washington in 1986. After the DOE assembled hundreds of documents addressing the environmental impacts of its operations from 1945 to 1985, a committee of represenatives from Washington, Oregon, the Yakima Indian Nation, the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe concluded that radioactive releases and biological pathways should be studied in order to “reconstruct” potential radiation doses to the public. The objectives of the Hanford Environmental Dose Reconstruction Project are to estimate the radiation doses that populations could have received from nuclear operations at Hanford since 1944, and to make public all the information used in the project. In order to obtain dose estimates from past radioactive releases, historical data are being identified, reviewed, and analyzed in order to understand atmospheric, river, and ground-water conditions that affected the transport of radioactivity from operating facilities to offsite populations. The types and quantities of radioactive materials emitted by Hanford’s operations are also being evaluated. As information on population distributions, agricultural practices, and eating habits is obtained, the migration of radionuclides through environmental pathways to regional populations will be modeled.

To provide independent technical direction to the effort, professors from area universities selected a Technical Steering Panel from a list of candidates. The technical steering panel currently has nine members and includes representatives from a range of organizations. All project reports that have been approved by the technical steering panel and references used in the reports are being placed in a local public reading room.

Dose reconstruction studies at Hanford and other sites will help build the informational foundations for sound risk assessment. The experience gained in these pioneering efforts should be valuable in a wide range of environmental projects.

The U.S. DOE Environmental Management Program: Responsibilities from Coast-to-Coast and Beyond

This remediated railroad spur in Maywood, New Jersey was radioactively contaminated with thorium unloaded at the site and taken to a nearby factory in Wayne. The thorium was used to produce mantles for gas lanterns. *December 10, 1993.*

DEFENSE SITES

Alaska
Amchitka Island Test Site, Amchitka Island
Arizona
Monument Valley (uranium mill tailings)
Tuba City (uranium mill tailings)
California
Lawrence Livermore National Laboratory, Livermore (Main site and Site 300)
Oxnard Site, Oxnard
Salton Sea Test Base, Imperial County
Sandia National Laboratories, Livermore
University of California, Gilman Hall, Berkeley
Colorado
Durango (uranium mill tailings)
Grand Junction (uranium mill tailings)
Grand Junction vicinity properties (uranium mill tailings)
Gunnison (uranium mill tailings)
Maybell (uranium mill tailings)
Naturita (uranium mill tailings)
New Rifle Mill, Rifle (uranium mill tailings)
Old Rifle Mill, Rifle (uranium mill tailings)
Old North Continent, Slick Rock (uranium mill tailings)
Rocky Flats Environmental Technology Site, Golden (formerly Rocky Flats Plant)
Union Carbide, Slick Rock (uranium mill tailings)
Connecticut
Combustion Engineering Site, Windsor
Seymour Specialty Wire Co., Ruffert Building, Seymour
Florida
Peak Oil Petroleum Refining Plant, Largo
Pinellas Plant, St. Petersburg
4.5 acre site, St. Petersburg
Hawaii
Kauai Test Facility, Kauai
Idaho
Idaho National Engineering Laboratory, Idaho Falls
Lowman (uranium mill tailings)
Illinois
Granite City Steel, 1417 State St., Granite City, (Formerly General Steel Castings Corp.)
Illinois National Guard Armory, 52nd Street & Cottage Grove Ave., Chicago
University of Chicago: New Chemistry Laboratory and Annex, West Stands (Stagg Field), Ryerson Physical Laboratory, Eckhart Hall, Kent Chemical Laboratory and Annex, Ricketts Laboratory
Iowa
Ames Laboratory, Ames
Kentucky
Maxey Flats, Hillsboro (LLW Disposal Site)
Paducah Gaseous Diffusion Plant
Maryland
W.R. Grace & Co., Building No. 23, Curtis Bay
Massachussetts
Chapman Valve Building 23, Indian Orchard
Shpack Landfill, Norton and Attleboro
Ventron Corp., Beverly (formerly Metal Hydrides Corp.)
Michigan
General Motors, 1450 East Beecher St., Adrian, (Formerly Bridgeport Brass Co.)
Missouri
Kansas City Plant, Kansas City
Latty Avenue Properties, 9200 Latty Ave., Hazelwood
Weldon Spring Site, Weldon Spring
St. Louis Airport Site, St. Louis
St. Louis Airport Vicinity Properties, St. Louis
Mallinckrodt Chemical Co., 65 Destrehan St., St. Louis
Nevada
Nevada Test Site, Mercury
Tonopah Test Range, Nellis Air Force Base, Tonopah
New Jersey
Chambers Dye Works, DuPont & Co., Deepwater
Kellex/Pierpont site, NJ Route 440 & Kellog St., Jersey City (Kellex Corp.)
Middlesex Municipal Landfill, Middlesex
Middlesex Sampling Plant, 239 Mountain Ave, Middlesex
New Brunswick Laboratory, New Brunswick
New Mexico
Ambrosia Lake (uranium mill tailings)
Acid/Pueblo Canyon, Los Alamos
Bayo Canyon, Los Alamos
Chupadera Mesa, White Sands Missile Range, (Trinity test fallout)
Holloman Air Force Base, Albuquerque
Inhalation Toxicology Research Institute (ITRI), Albuquerque
Los Alamos National Laboratory, Los Alamos
Pagano Salvage Yard, Los Lunas
Sandia National Laboratories, Albuquerque
Shiprock (uranium mill tailings)
Waste Isolation Pilot Plant, Carlsbad
South Valley Site, Albuquerque
New York
Ashland Oil Co., Tonawanda
Baker and Williams Warehouses, New York
Bliss & Laughlin Steel, 110 Hopkins St. Buffalo
Colonie Interim Storage Site, Central Ave., Colonie
Separations Process Research Unit, Knolls Atomic Power Laboratory, Schenectady
Linde Air Products, Tonawanda
Niagra Falls Storage Site, Lewiston
Niagra Falls Storage Site Vicinity Properties, Lewiston
Seaway Industrial Park, Tonawanda
North Dakota
Belfield (uranium mill tailings)
Bowman (uranium mill tailings)
Ohio
Alba Craft, 10-14 West Rose Ave, Oxford
Associated Aircraft and Tool Manufacturing, 3660 Dixie Highway, Farfield
B&T Metals, 425 West Town St. Columbus
Baker Bros., 2551-2555 Harleau Place, Toledo
Fernald Environmental Management Project, Fernald (formerly Feed Materials Production Center)
HHM Safe Site, Hamilton
Luckey Site, 21200 Luckey Rd., Luckey
Mound Plant, Miamisburg
Painesville Site, 720 Fairport-Nursery Rd., Painesville
Portsmouth Gaseous Diffusion Plant
Reactive Metals, Inc. (RMI), Ashtabula
Oregon
Albany Research Center, Albany
Lakeview (uranium mill tailings)
Pennsylvania
Aliquippa Forge, Aliquippa
Bettis Atomic Power Laboratory, West Mifflin
Canonsburg (uranium mill tailings)
C.H. Schnoor, Springdale
South Carolina
Savannah River Site, Aiken
South Dakota
Edgemont Vicinity Properties (uranium mill tailings)
Tennessee
Elza Gate Site, Melton Dr., Oak Ridge
Oak Ridge K-25 Site, Oak Ridge
Oak Ridge National Laboratory, Oak Ridge
Y-12 Plant, Oak Ridge
Texas
Falls City, (uranium mill tailings)
Pantex Plant, Amarillo
Utah
Green River (uranium mill tailings)
Mexican Hat (uranium mill tailings)
Monticello Millsite and Vicinity Properties (uranium mill tailings)
Salt Lake City (uranium mill tailings)
Washington
Hanford Site, Richland
Wyoming
Riverton (uranium mill tailings)
Spook (uranium mill tailings)
South Pacific Ocean
Bikini Island
Enewetak Atoll

NONDEFENSE SITES

Alaska
Cape Thompson (Project Chariot)
California
Stanford Linear Accelerator, Stanford
Energy Technology Engineering Center (ETEC), Santa Susanna
General Atomics, La Jolla
General Electric Vallecitos Nuclear Center, Vallecitos
Laboratory for Energy-Related Health Research (LEHR), Davis
Lawrence Berkeley Laboratory, Berkeley
Rockwell International (Formerly Atomics International), Canoga Park
Santa Susanna Field Laboratory, Santa Susanna,
Colorado
Project Rio Blanco peaceful nuclear explosion site, Rifle
Project Rulison peaceful nuclear explosion site, Grand Valley
Idaho
Argonne National Laboratory-West, Idaho Falls
Illinois
Argonne National Laboratory-East, Lemont
Dow Chemical Co., College & Weaver Streets, Madison
Fermilab, Batavia
Site A/Plot M, Palos Forest Preserve, Cook County
Kentucky
Paducah Gaseous Diffusion Plant, Paducah
Mississippi
Salmon peaceful nuclear explosion site, Hattiesburg
Montana
Component Development and Integration Site, Butte
Nebraska
Hallam Nuclear Power Facility, Lincoln
Nevada
Project Faultless peaceful nuclear explosion site, Central Nevada Test Area Tonopah
Project Shoal peaceful nuclear explosion site, Fallon
New Jersey
Maywood Chemical Works, Maywood
Princeton Plasma Physics Laboratory, Princeton
Wayne Interim Storage Site, 868 Black Oak Ridge Rd., Wayne
New Mexico
Project Gnome peaceful nuclear explosion site, Carlsbad
Project Gasbuggy peaceful nuclear explosion site, Farmington
New York
Brookhaven National Laboratory, Upton (Long Island)
West Valley Demonstration Project, West Valley
Ohio
Battelle Columbus Laboratories, Columbus
Piqua Nuclear Power Facility
Pennsylvania
Shippingport Atomic Power Station
Puerto Rico
Center for Energy & Environmental Research, Mayaguez