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A Background Report for the Formerly Utilized Manhattan Engineer District/Atomic Energy Commission Sites Program

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Assistant Secretary for Environment
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Washington, D.C. 20585

PREFACE

This report was prepared as part of the Department of Energy Formerly Utilized Sites Program, which was initiated in 1974 by the Atomic Energy Commission to determine the radiological condition of sites formerly used by the Manhattan Engineer District and the Atomic Energy Commission for operations involving radioactive materials. After the early 1940s, control of many sites no longer required for nuclear programs was returned to private industry or the public for unrestricted use. This is the first report summarizing the Department's efforts to identify the sites, characterize their conditions and, where appropriate, resolve any unacceptable radiological conditions.

A description of this program, a brief history of Manhattan Engineer District and early Atomic Energy Commission operations, and summaries of the current status of over 70 of the formerly utilized sites are contained in this report. The site-specific summaries, based on reviews of records, are not comprehensive histories of the sites, but are presented as an overview of site activities through June 1980. The summaries have been reviewed by owners and/or former owners, State representatives, representatives of the national laboratories, and persons cognizant of former nuclear operations, who have been instrumental in providing and verifying information. Supplemental reports will be published as required to document status changes and additional information regarding these sites or new sites.

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I. INTRODUCTION

The Department of Energy is conducting a program to determine radiological conditions at sites formerly used by the Army Corps of Engineers' Manhattan Engineer District and the Atomic Energy Commission in the early years of nuclear energy development. The program is being administered by the Office of the Assistant Secretary for Environment through the Environmental and Safety Engineering Division, which is within the Office of Environmental Compliance and Overview. The sites of concern were federally, privately, and institutionally owned and were used primarily for research, processing of uranium and thorium ores, and storage of radioactive ores or residue. Also included in the program are sites used in the Los Alamos plutonium development program and the Trinity atomic bomb test site. The purpose of this background report is to provide a consolidated historical summary of these formerly utilized sites based on information collected to date.

For the initial activities of the nuclear energy program, most of the uranium was extracted from foreign ores. Pitchblende was imported, stored for short periods, transported to sampling plants in the East, and then transferred to mills and refineries for uranium extraction. Some ores were also processed for thorium. Much of the Government-sponsored research and development was centered at the national laboratories, with commercial firms producing the needed raw and finished material. Ores were processed to obtain a mill concentrate that was then refined and converted to other uranium or thorium compounds or transformed into metal and distributed to other participants in the program. Most of the metals manufactured from these various operations were ultimately transported to the Hanford site at Richland, Washington, for use in plutonium production. Commercial firms also conducted operations to recover uranium from scrap and salvaged material.

As a result of these activities, materials, equipment, buildings, and land became contaminated, primarily with naturally occurring radioactive nuclides. They were later decontaminated in accordance with the standards and survey methods in use at that time. Since then, however, radiological criteria, guidelines, and proposed guidelines for release of such sites for unrestricted use have become more stringent as research on the effects of low-level radiation has progressed. In addition, records documenting some of these decontamination efforts cannot be found, and the final radiological conditions of the sites could not be adequately determined from the records. As a result, the Formerly Utilized Sites Program was initiated in 1974 to identify these formerly used sites and to reevaluate their radiological status.*

* Inactive uranium mill tailings sites in the Western States are being investigated under a separate program, as authorized by Public Law 95-604 (Uranium Mill Tailings Radiation Control Act of 1978).

Since 1974, a considerable amount of radiological site status information and records have been recovered or regenerated. This report covers efforts through June 1980 to determine the radiological status of sites for which the existing conditions could not be clearly defined. Principal contractor facilities and associated properties have already been identified and activities are continuing to identify additional sites. Any new sites located will probably be subcontractor facilities and areas used for disposal of contractor waste or equipment; however, only limited information regarding this equipment and material has been collected to date. As additional information becomes available, supplemental reports will be published.

The purpose of assembling this historical data under a single cover is to provide a consolidated, quick-reference source for use at the program management level and to promote public participation in the program. This document also highlights unresolved questions, primarily on the location of disposal sites used during previous decontamination operations. Where available, information on the following is provided: (a) type of activities conducted, (b) current site use and description, (c) ownership, and (d) radiological history and status.

II. BACKGROUND

HISTORICAL RECORDS REVIEW

During the Manhattan Engineer District and early Atomic Energy Commission programs, principal efforts were directed at defense-related projects and involved technology to develop nuclear energy for military objectives. Information regarding these activities was protected from public disclosure by defense security classification procedures. At contract termination, sites used by contractors were decontaminated according to the criteria and health guidelines then in use. The radiological criteria for releasing sites for unrestricted use were generally site specific and have changed over the ensuing years; in some cases, they are still not clearly defined. It was thus necessary to reevaluate the current radiological conditions at these sites, and a records search was conducted.

Changes in ownership and land use and the absence of licensing procedures prior to 1955 made locating the sites and defining their radiological condition difficult. In addition, documentation relating to both site operations and decontamination activities was retired to Federal records storage centers and, in some instances, destroyed in accordance with Government records management practices. The records search helped to identify the majority of formerly utilized sites but did not always generate sufficient information to characterize the radiological condition of every site. Other information found lacking in many cases included the location of contaminated materials, equipment, and process wastes removed from contractor facilities during operations and/or decontamination activities. A site survey program was therefore initiated. Efforts are continuing to determine the existence and location of any offsite disposition of contaminated waste materials.

SITE SURVEY PROGRAM

In 1974, the Atomic Energy Commission's Division of Waste Management and Transportation initiated the survey program to identify all formerly used nuclear program sites and to determine their radiological status. In mid-1974, the responsibility for this survey was assumed by the Division of Operational Safety. At that time, all divisions and field offices of the Commission were requested to search their files for records documenting the current radiological condition of the sites, the conditions at the termination of Atomic Energy Commission activities, and land use and ownership, as well as for records identifying any additional sites. This effort identified gaps in the information on sites recognized from the start of the program as well as on newly identified sites.

In January 1975, the Energy Research and Development Administration assumed responsibility for the survey program. The Administration's field office personnel contacted owners and coordinated site visits to determine the need for radiological surveys. Press releases were issued to inform the public of the program and site status.

Pursuant to the Department of Energy Organization Act of 1977, the functions and authority of the Energy Research and Development Administration were transferred to the Department. The Environmental Control Technology Division (now Environmental and Safety Engineering Division) was assigned the responsibility for the site survey program. Due to the importance of this effort, the Formerly Utilized Sites Program was formalized, and a generic plan for identifying and surveying sites and resolving any potential radiological problems was drafted.

In mid-1979, using the generic plan as a guide, responsibility for the Formerly Utilized Sites Program activities was divided between the Assistant Secretary for Environment and the Assistant Secretary for Energy Technology (now Assistant Secretary for Nuclear Energy). The Assistant Secretary for Environment is responsible for identifying, characterizing, and ultimately certifying the radiological condition of the sites; the Assistant Secretary for Nuclear Energy is responsible for implementing required remedial actions and identifying disposal sites for residual radioactive material.

OVERVIEW OF MANHATTAN ENGINEER DISTRICT/ATOMIC ENERGY COMMISSION ACTIVITIES

In 1942, under the jurisdiction of the Army, the Manhattan Engineer District was established as the lead agency in the development of nuclear energy. The authority previously assigned to the Department of the Army's Office of Scientific Research and Development for process development, engineering design, materials procurement, and site selection associated with the program was transferred to the District. District headquarters was originally established in New York City and, in 1943, was transferred to Oak Ridge, Tennessee.

On December 31, 1946, the Manhattan Engineer District was deactivated and its responsibilities were transferred to the newly constituted Atomic Energy Commission. At that time, more than ten prime contractors and several hundred subcontractors were involved in production and research operations. These contractors included industrial concerns, universities, and other scientific organizations. In contrast to the highly centralized operation of the Manhattan Engineer District, the Atomic Energy Commission decentralized and established five major centers of operation located in New York, New York; Santa Fe, New Mexico; Oak Ridge, Tennessee; Hanford, Washington; and Chicago, Illinois. The Commission continued the Manhattan Engineer District practice of contracting with industrial concerns and academic institutions to perform the actual operations.

The most readily available source of historical information on the early activities of Manhattan Engineer District and the Atomic Energy Commission is A History of the United States Atomic Energy Commission, Volume I - The New World and Volume II - Atomic Shield. A synopsis of the procurement, storage, and processing of the raw materials containing uranium is presented in this report to give the reader a general overview of these activities. The synopsis, although covering both Manhattan Engineer

District and Atomic Energy Commission operations, focuses on the District's operations and is limited to major contractors. The formerly utilized sites program activities address all former Manhattan Engineer District and early Atomic Energy Commission sites, including facilities used by prime contractors and subcontractors and locations where equipment or radioactive materials used in nuclear operations were stored or disposed.

All of the companies and locations in this overview were identified during the records review. The companies are identified in Figure 1, a flow diagram showing the processing of uranium ores, tailings, or slimes into the finished product.

Uranium Procurement

The Manhattan Engineer District relied on three sources of uranium during the war years. About two-thirds came from mines in the Belgian Congo; slightly more than one-sixth from mines near Great Bear Lake in Canada; and the remainder from American ores, which in reality were tailings from vanadium refinery operations.

African Sources--At the beginning of the nuclear program in the late 1930s and early 1940s, it was determined that although there were significant quantities of uranium ore available in Czechoslovakia and Canada, by far the most important sources were the mines of the Belgian Congo. The supplies of ore in the United States were not considered extensive and, with the growing interest in uranium, Germany had ceased all sales of the Czechoslovakian ores. As a result of this, plus the German takeover of Belgium and increased German activity in Africa, the United States, Great Britain, and Canada made an all-out effort to obtain as much of the Belgian Congo ore as quickly as possible to guarantee adequate supplies of uranium. Through activities that began in September 1942, the United States was able to purchase all the aboveground supplies of uranium ore from the Belgian Congo. This included 1200 tons of ore that had already been imported into the United States in 1940 by a Belgian Company, African Metals, Inc., and stored in the Archer-Daniels Midland Company warehouse (also known as the Staten Island Warehouse), Port Richmond, Staten Island, New York, plus some 3000 tons of similar ore still in the Congo. By the end of 1944, the Manhattan Engineer District had received approximately 3700 tons of Congo ore.* The amount of ore being received far exceeded the processing capacity in North America at that time. The Manhattan Engineer District used three primary storage areas: Seneca Ordnance Depot (also known as Seneca Army Depot), Romulus, New York; Clinton Engineer Works (now Oak Ridge National Laboratory), Clinton, Tennessee; and Perry Warehouse (Middlesex Sampling Plant), Middlesex, New Jersey.

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* By the end of 1946, the Manhattan Engineer District had contracted for the extraction of approximately 3800 tons of U_3O_8 from over 29,000 tons of African ore containing from 5 to 65 percent uranium oxide.

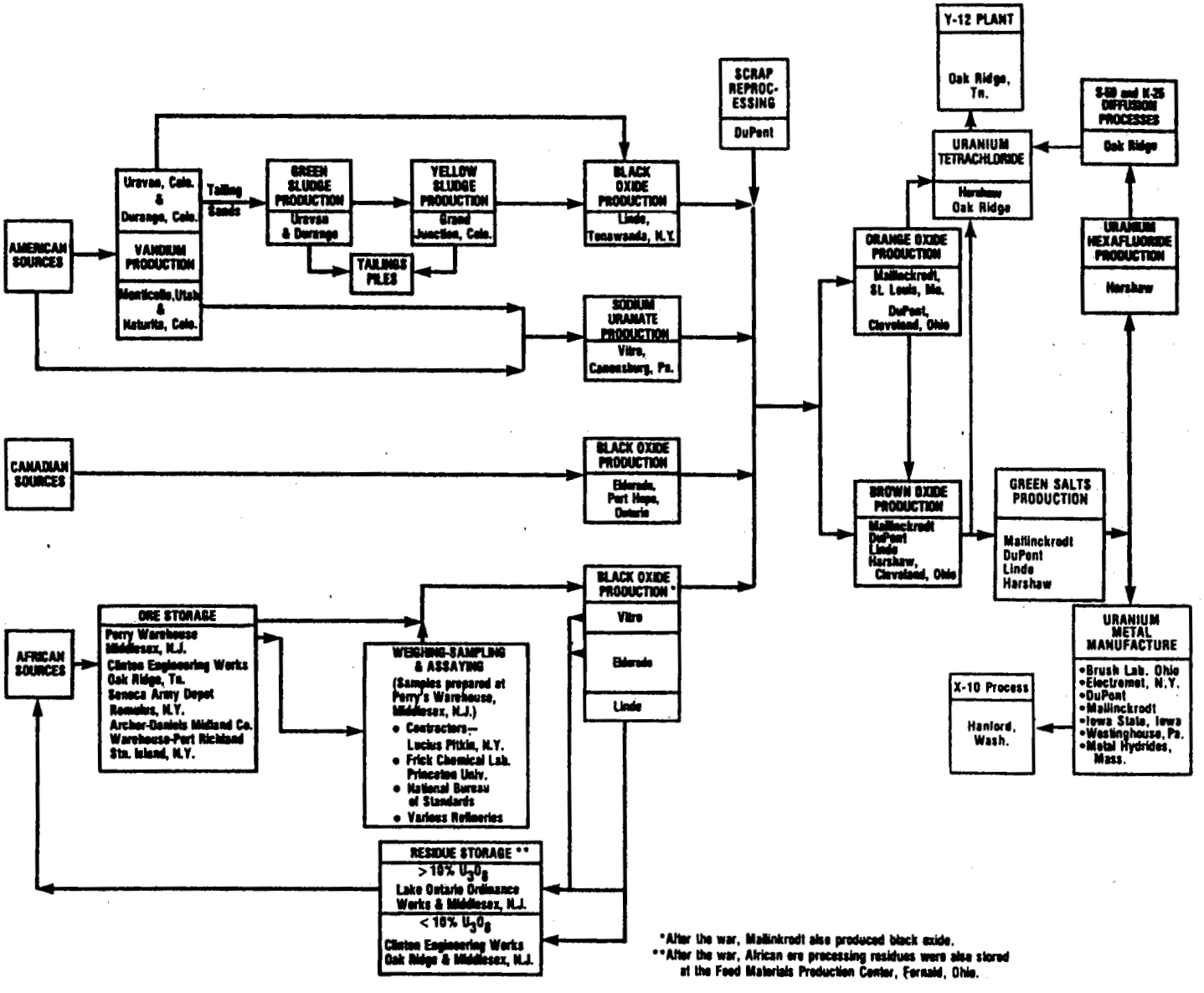

Figure 1. Processing of Uranium Ores, Tailings, or Slimes to Finished Processing by Various Companies

The Manhattan Engineer District contracts with African Metals, Inc., involved only the recoverable uranium oxide (U_3O_8, black oxide*) in the ore. African Metals maintained ownership of the residue or tailings, which contained radium and other precious metals. As a result, it was necessary to establish weighing and assaying operations. Initially, the weighing and assaying were performed at contractor facilities. However, in November 1943, the Manhattan Engineer District set up a separate sampling program at the Perry Warehouse. The assaying and weighing of the ore samples were performed for the Federal Government by Lucius Pitkin, New York, New York; Frick Chemical Laboratory, Princeton University, Princeton, New Jersey; and the National Bureau of Standards, Washington, D.C. Assaying and weighing for African Metals, Inc., were performed by Ledoux and Company, New York, New York.

Following weighing and assaying, the ore was shipped to the various refineries to be processed to black oxide or sodium uranate concentrates. Because the tailings were owned by African Metals, the Manhattan Engineer District was required to store residues from these operations until they could be returned to the owner. Those residues from ores containing greater than 10 percent U_3O_8 were stored at the Clinton Engineer Works or the Perry Warehouse before return shipment. Residues from ores containing less than 10 percent U_3O_8 were stored at the Lake Ontario Ordnance Works, Lewiston, New York. Some of the African Metals residues have been returned; some are still at the U.S. storage sites.**

Canadian Sources--The Office of Scientific Research and Development placed an order with Eldorado Gold Mines, Ltd. (later Eldorado Mining and Refining, Ltd.) to obtain uranium oxide refined from the Canadian ore. Eldorado was to mine uranium ore at its Great Bear Lake mine and refine the ore at its facility at Port Hope, Ontario. By 1944, about 400 tons of the oxide had been produced and enough Canadian ore had been mined to produce an additional 500 tons of the refined oxide. By the end of 1946, over 4000 tons of ore concentrate containing over 1100 tons of U_3O_8 in the form of black oxide had been delivered to the District. Because the Canadian ore was processed to black oxide at the Eldorado facility and the entire concentrate was sold to the Government, no assaying and weighing program was set up for the Canadian ore.

Domestic Sources--Most of the uranium in the United States was extracted from the carnotite ores of the Colorado plateau; however, the high-grade deposits had previously been mined primarily for their radium

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* The various steps of the uranium recovery and refining process produced concentrates and compounds of uranium oxide, which were generally referred to by their color and physical characteristics for nontechnical characterizations and for security reasons.

** Some of the residues still in the United States are currently stored at the Feed Materials Production Center, Fernald, Ohio, as well as at the Lake Ontario Ordnance Works site.

content. The heavy demand for vanadium during the war created the potential for a practical source of uranium oxide as a byproduct of the vanadium processing. However, the tailings from vanadium processing were of such low uranium content that it was necessary to concentrate them at or near the mine prior to their shipment to the processing facilities.

The United States Vanadium Corporation concentrated vanadium tailings stockpiled at its Uravan, Colorado,* plant to produce a sludge containing 15 to 20 percent black oxide. This sludge was sent directly to the Linde Air Products Company, Tonawanda, New York. The Corporation also produced a green sludge (5 to 10 percent black oxide) from vanadium tailings and sands at its Uravan facility and another processing plant** at Durango, Colorado.* The green sludge output from both facilities was trucked to Grand Junction, Colorado,* for the removal of vanadium and for further concentration of the uranium to produce yellow sludge (10 to 15 percent U_3O_8). This product was then shipped to the Linde facility.

Concurrent with these operations, the Vanadium Corporation of America processed American ores for vanadium at its plants in Naturita, Colorado,* and Monticello, Utah. Most of the slimes (50 percent U_3O_8 by weight) from these plants were shipped directly to the Vitro Manufacturing Company, Canonsburg, Pennsylvania, for processing. A portion of the 50-percent slime tailings was sold to the Government and processed at the Uravan facility. In addition to the United States Vanadium Corporation and Vanadium Corporation of America concentrates, similar materials, accounting for less than 8 percent of the domestic uranium oxides produced, were procured by the Government from various small operations. By the end of 1944, domestic ore processing had yielded about 800 tons of uranium oxide and, by the end of 1946, concentrates containing over 1300 tons of uranium oxide had been produced from the domestic sources.

Uranium Processing Operations and End Use

The initial concentrate refining operations consisted of mechanically grinding and crushing the ores to a sandy material. Acid was used to dissolve the uranium. The uranium-bearing acid solution extract was treated with other chemicals to precipitate the majority of impurities, and the uranium-bearing solution was further treated to precipitate the uranium. The final products from this refining operation, either black oxide (U_3O_8) or yellow cake (sodium diuranate ($Na_2U_2O_7$) concentrate), were roasted and dried prior to the next stages of processing.

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* Uranium mills producing concentrates for uranium refining are covered under the Inactive Uranium Mill Tailings Program and are discussed in detail in "A Background Report for the Inactive Uranium Mill Tailing Sites Remedial Action Program," to be published by the Department of Energy.

** A processing plant at Durango was operated by the United States Vanadium Corporation but was owned by the Metals Reserve Corporation.

During World War II, the ores were refined to black oxides at the facilities of Linde and Eldorado. Vitro (at Canonsburg) refined the ores to produce sodium diuranate. Following the war, Mallinckrodt, Inc., also produced black oxide at its facilities in St. Louis, Missouri, and later at the Atomic Energy Commission Weldon Spring Chemical Plant, Weldon Spring, Missouri.

The black oxide and sodium diuranate were further refined to orange oxide (UO_3) and brown oxide (UO_2). The orange oxide was produced by Mallinckrodt and E.I. duPont de Nemours and Company, Deepwater, New Jersey. At the DuPont plant, brown oxide was also made from black oxide and from uranium peroxide ($UO_4 \cdot 2H_2O$) obtained from the processing of uranium-bearing scrap. Brown oxide was also produced by Mallinckrodt, Linde, and Harshaw Chemical Company, Cleveland, Ohio. Brown and orange oxides were in turn refined into green salt (UF_4) by DuPont, Harshaw, Mallinckrodt, and Linde.*

Harshaw made uranium hexafluoride (UF_6) from the green salt for the S-50 (thermal diffusion) and K-25 (gaseous diffusion) uranium-235 enrichment projects. The Y-12 electromagnetic enrichment plant in Oak Ridge received orange oxide from the various producers along with partially enriched uranium hexafluoride from the S-50 and K-25 plants. These feed materials were converted to uranium tetrachloride prior to enrichment at Y-12. Harshaw also supplied uranium tetrachloride for the Y-12 plant.

Green salt and, in some cases, scrap metal were used in uranium metal manufacturing by DuPont; Mallinckrodt; Iowa State College (now University), Ames, Iowa; Westinghouse Electric Corporation, Bloomfield, New Jersey; Brush Beryllium Company, Cleveland, Ohio; and Electromet Corporation, Niagara Falls, New York. Scrap metal recovery operations were conducted at Metal Hydrides, Inc., Beverly, Massachusetts, and Iowa State. Uranium metal in the form of powder was also produced directly from uranium oxides instead of green salt by Metal Hydrides. Various fabricators were contracted as required to develop fabrication techniques and form (rolling and machining) the metal. The metal manufactured by the various companies was ultimately shipped to the Hanford site at Richland,

* Following World War II and after the construction of the Weldon Spring Chemical Plant, many of the Atomic Energy Commission uranium conversion operations were centralized and transferred to Weldon Spring, operated for the Government by Mallinckrodt, and later to the Feed Materials Production Center at Fernald, Ohio, operated by National Lead Company of Ohio. The latter facility is currently a center for the processing of uranium and thorium ores and concentrates to useful compounds and metal shapes. Other Department of Energy facilities at Paducah, Kentucky; Oak Ridge, Tennessee; and Portsmouth, Ohio, also have the capability to refine various uranium products.

Washington, for use in plutonium production.* Plutonium produced at Hanford was then shipped to Los Alamos, New Mexico, for use in the weapons development program.

Quality control of the various processes in the ore/metal chain was performed by the University of Chicago, Metallurgy Laboratory, Chicago, Illinois; Princeton University; Massachusetts Institute of Technology, Cambridge, Massachusetts; and the National Bureau of Standards.

In addition to the actual contractor-owned facilities, contractors used a number of offsite storage locations, such as landfills, for storing and disposing of their wastes. Examples include the St. Louis Airport Storage Site, where residue from Mallinckrodt operations was deposited; the former Haist property (now Ashland Oil Company), Tonawanda, New York, where material from Linde operations was deposited; the Pennsylvania Railroad Landfill Site, Burrell Township, Pennsylvania, where Vitro Corporation deposited wastes from the Canonsburg operation; and the Middlesex Municipal Landfill, Middlesex, New Jersey, where wastes produced during some construction activities at the Middlesex Sampling Plant were deposited. Some private residences were also contaminated as a result of natural radionuclide migration or through the use of contaminated soil from these operations as fill material.

Nuclear activities following World War II broadened in scope. The Atomic Energy Commission entered into a number of research, development, and production contracts to recover uranium as byproducts of certain industrial processes such as phosphoric acid production. In addition, contracts were terminated or established as product needs and research needs varied; hence, the number of formerly utilized sites exceeds the number of facilities shown in Figure 1 and discussed in this overview.

Thorium Operations

Operations with thorium after the war were similar to the uranium operations but were conducted on a much smaller scale. The first major research for the Manhattan Engineer District on thorium began early in 1946 with the procurement of thorium salts for a project at Iowa State College. The thorium salts were supplied by Lindsay Light and Chemical Company,**

* An experimental gas-cooled pile and chemical pilot plant used to produce plutonium, called the X-10 process, was operated at Richland. The initial development of the X-10 process was completed at Oak Ridge.

** Lindsay Light and Chemical Company was using thorium for producing gas mantles, catalysts, and electron tube cathodes prior to its consideration for nuclear applications. Remedial action activities at this site and associated properties are being undertaken by the State of Illinois and Kerr-McGee Chemical Corporation, under the regulatory authority of the Nuclear Regulatory Commission.

Chicago, Illinois, which was the major supplier through most of the early years of the program. Lindsay first received thorium from Germany and later processed monazite from India and Brazil. In later years, processing studies were performed by Dow Chemical Company, Walnut Creek, California, as well as by Iowa State. Extractive research, metal production and handling, and other research and development activities were conducted by a number of companies also involved in similar work with uranium, including Mallinckrodt; Simonds Saw and Steel, Lockport, New York; Sylvania Corning Nuclear Corporation, Bayside, New York; Battelle Columbus Division, Columbus, Ohio; Brush Beryllium Company; and Horizons Metal, Inc., Cleveland, Ohio. The National Bureau of Standards was involved in quality control for the thorium programs, and the Middlesex Sampling Plant was used for storage of some thorium. A major part of the current formerly utilized sites program effort is to ensure that all of the thorium sites have been identified and verified for radiological safety. More in-depth records searches and interviews with former Atomic Energy Commission employees and other cognizant persons are being conducted.

III. PROGRAM DESCRIPTION

OBJECTIVES

The purposes of the formerly utilized sites program are to identify former Manhattan Engineer District and Atomic Energy Commission sites, assess their radiological condition, decontaminate sites as required and authorized by Congress, and ultimately certify their acceptability for future use. Sites are being identified through searches of existing Manhattan Engineer District and Atomic Energy Commission records and public assistance obtained through requests for information in press releases and letters.

After a site has been identified, the responsibility for assessing its radiological condition is assigned to a national laboratory, which then reviews old radiological survey documents and performs radiological surveys as required. A series of engineering studies and environmental reports, including any documents required by the National Environmental Policy Act, is prepared to evaluate remedial action alternatives. After these evaluations, appropriate measures (remedial actions, if required) are selected and implemented to ensure public safety. Following completion of these activities and a certification process, the former Manhattan Engineer District or Atomic Energy Commission site is cleared for unrestricted or restricted use, as appropriate.

During the course of the investigation, press releases and public meetings serve to inform the public of the nature of the Government work done at the site, survey results, and remedial actions contemplated and undertaken. Detailed reports of the survey findings are also published by the Department of Energy and are available to the public for a nominal fee.

SCOPE

The scope of the Formerly Utilized Sites Program is confined to those public and private sites that were formerly used under contract to the Department of Energy or its predecessor agencies or owned by the Federal Government and controlled by these agencies. These sites include those directly involved in the handling of radioactive materials for the Manhattan Engineer District and the Atomic Energy Commission and nearby properties contaminated by radioactive material originating from these activities. The materials processed consisted primarily of pitchblende, carnotite, or thorium ores and their refined or residue products. Products included uranium and thorium metals and compounds. The residue consisted of the process wastes, which generally contained low-level radioactivity due to the presence of components of the uranium and thorium radioactive decay chains that remained in the residues. Included in the site list are the remains of two Chicago research reactors (Palos Park, Illinois); the site near the location of the Trinity atom bomb test (Chupadera Mesa, New Mexico); and other sites involved in the weapons development program (Los Alamos, New Mexico).

At the processing sites, the major contaminants are uranium, thorium, and radium and their radioactive decay products (daughters). Radium contamination is a major concern because its radioactive daughter, radon, is a noble gas that can diffuse into the air and be inhaled. At the research reactor sites, the weapons development sites, and certain other research related facilities, nuclides such as plutonium, other transuranics, strontium, cesium, tritium, and uranium-235 are also potential contaminants.

Throughout the program, emphasis has been on characterizing the radiological condition of the site itself. Where onsite contamination has been found, the possibility of offsite radionuclide contamination has also been or is being investigated.

APPROACH TO REMEDIAL ACTION

The approach to identifying and eventually correcting actual or potential conditions of radiological contamination at Manhattan Engineer District and Atomic Energy Commission sites entails two separate but interrelated efforts: institutional activities and site characterization and remedial action related activities.

Institutional Activities

Two important activities must be completed before the remedial actions can be performed:

- Legislative authority must be established under which the Federal Government (Department of Energy) can act to correct problems of radiological contamination at formerly utilized sites. Although the Department of Energy has authority at some sites, many will require new legislative authority. Initiation of any required legislation is the responsibility of the Office of the General Counsel within the Department of Energy, with support from the Assistant Secretary for Environment and the Assistant Secretary for Nuclear Energy.

- Radiological criteria must be developed for use as guidelines to determine if a radiological problem exists as well as to determine the extent of decontamination required at each site. This activity will involve the Department of Energy as well as the Environmental Protection Agency and the Nuclear Regulatory Commission.

Site Characterization and Remedial Action Related Activities

Although each formerly utilized site will have certain unique characteristics, a general sequence of events can be outlined that will lead to the program objective, which is to preclude any future radiological problems. Figure 2 is a schematic presentation of four activities considered essential to the execution of a remedial action program. The figure also indicates the primary responsibilities or functions of the Office of Environment and the Office of Nuclear Energy throughout the program. The first activity, site analysis, determines which sites need remedial action.

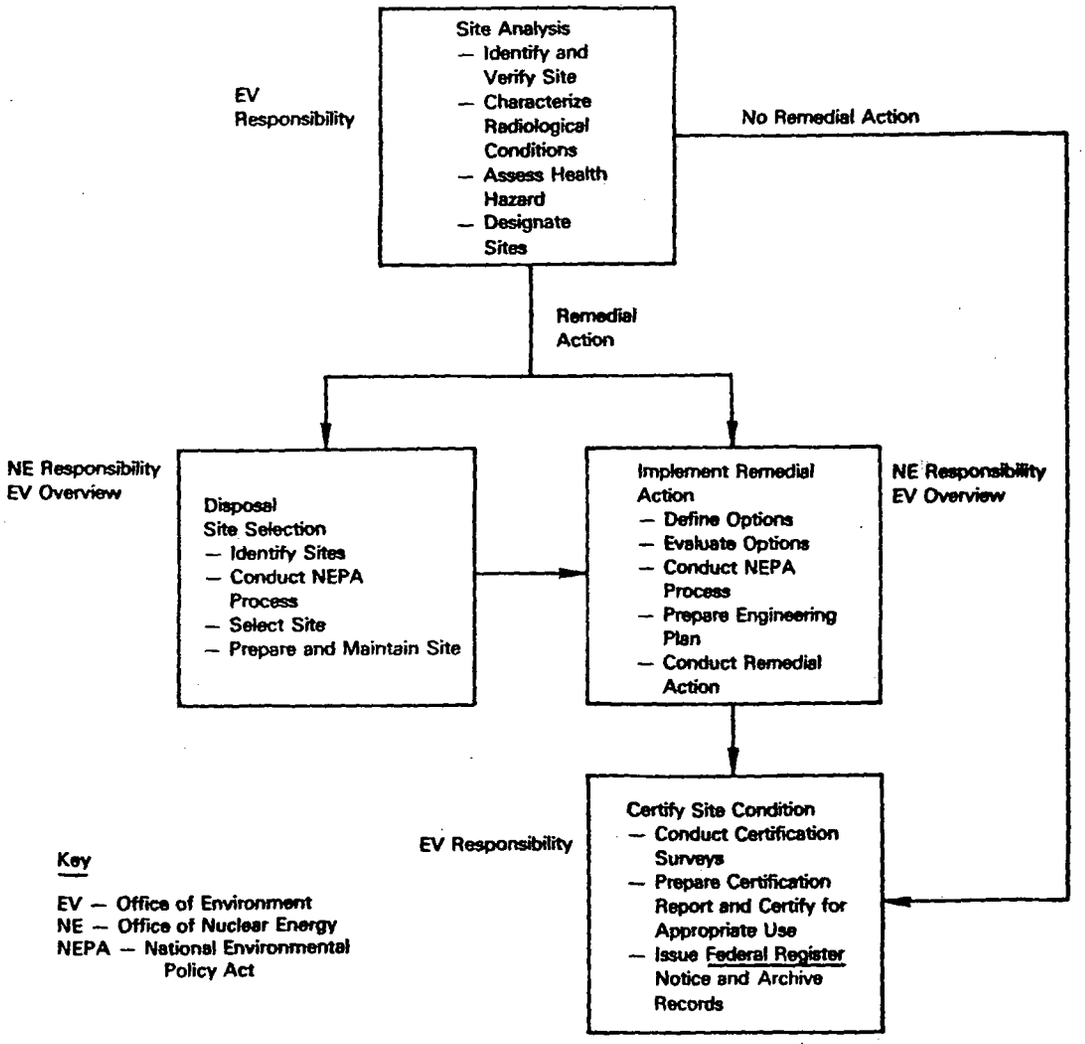

Figure 2. Formerly Utilized Sites - Basic Steps Involved in the Generic Plan

When remedial action is required, all four phases shown in Figure 2 are implemented. If no remedial action is necessary, only the first and last phases are implemented. A "Generic Program Plan for the Formerly Utilized Sites Remedial Action Program," now in draft, details the decision points and activities for accomplishing remedial action and identifies points where institutional activities must be completed before an action can progress. A brief discussion of these phases follows.

Site Analysis--This phase of the Formerly Utilized Sites Program involves two major activities: site identification and verification and site characterization. The overall objective of the identification and verification step is to identify and locate all candidate sites and determine through the analysis of all available records whether there is any possibility that the site was exposed to radioactive materials as a result of operations conducted under contract to, or by the Manhattan Engineer District or Atomic Energy Commission.

If there is adequate documentation to demonstrate that the site is not contaminated or that the site is presently operating under an appropriate license, no additional actions may be necessary. If, however, the records are inadequate or indicate the site may be contaminated, efforts will be initiated to determine or verify the radiological condition of the site.

Initially, a preliminary (screening) survey is performed. Data from this survey along with available records from past surveys are used to determine the need for and the extent of a more comprehensive survey. In some cases where earlier survey reports are adequate, only supplemental information may be required to characterize the site. In other cases, no data are available and an exhaustive effort is required. A complete radiological survey consists of the following elements:

- Measurements of total or fixed and removable alpha and beta-gamma contamination on buildings and equipment surfaces
- Gamma-ray exposure rates
- Beta-gamma dose rates
- Alpha exposure rates
- Radionuclide contamination in surface water and groundwater
- Radionuclide contamination in building drains
- Radionuclide contamination in undergound drains and surface drainage ways
- Concentrations of surface and subsurface deposits of radioactive material

To place all measurements and results in the proper perspective, measurements of a similar nature are performed in surrounding control areas not affected by former Manhattan Engineer District or Atomic Energy Commission activities. These results are used to represent the natural background radiation of the area.

Aerial radiological surveys are performed in support of radiological assessments for both newly identified and previously recognized sites. In the former case, they are used to indicate the need for and extent of ground surveys. In the latter case, the main objective is the identification of any offsite contamination. If the aerial survey indicates the presence of contamination not previously identified, the new area is surveyed from the ground.

When the survey work is complete, a report describing the radiological condition of the site is prepared. The report (or report supplement) also includes an evaluation of potential radiation exposures from credible radiation-to-man pathways at the site. The evaluation outlines the exposure levels to which humans could be subjected under present site usage. These levels are compared to acceptable levels of exposure in order to place them in perspective. Exposure evaluations are not performed at sites determined to be radiologically clean. In cases where the possibility of radiation exposure above background is identified, summaries or the complete reports are submitted to the appropriate Federal, State, or regulatory authorities and the site, where appropriate, is designated to require consideration for remedial action. Priority for remedial actions at the site are determined on the basis of health considerations.

Discussions are held with property owners and, where applicable, with concerned agencies to explain the results of the survey and future Department of Energy plans. Press releases may also be used to ensure that the public is informed of the survey results.

Implement Remedial Action--Once a site is designated as requiring consideration for remedial action, options for such actions are evaluated. If the evaluations demonstrate that a remedial action is required and if the Department has authority, an appropriate remedial action is selected and implemented. The major elements of this activity include the following:

- An Engineering Evaluation is conducted to identify and assess the remedial action options on a technical and economic basis. The evaluation will consider the area's hydrology, geology, meteorology, and so forth along with preliminary engineering estimates for the quantity of material to be removed, the time required for completion of the actions, the boundaries of the action, and approximate costs of each remedial action option.

- An Environmental Analysis is completed to compile pertinent environmental data and provide an environmental evaluation of the remedial action options identified in the engineering evaluation. The evaluation will cover the environmental impacts of status quo, stabilization of material onsite, and decontamination and removal of material to a disposal site.

- The National Environmental Policy Act Process is implemented to ensure that all environmental factors have been considered and adequately addressed in selecting and conducting the remedial action. The data developed for the environmental analysis, along with any necessary additional data, are used in the preparation of an environmental assessment or an environmental impact statement, when required. The National Environmental Policy Act documentation is prepared in accordance with the Council on Environmental Quality National Environmental Policy Act Regulations (Title 40, Code of Federal Regulations, Parts 1500-1508); the Department of Energy guidelines for compliance with the National Environmental Policy Act (Federal Register, Vol. 45, No. 62, March 28, 1980, pp. 20694-20701); Department of Energy Order 5440.1; the Department of Energy Environmental Compliance Guide; and other internal guidance.

- The Selection of a Remedial Action is made following the completion of the Engineering Evaluation, the Environmental Analysis, and the National Environmental Policy Act process. The decision will be based upon technical, environmental, and economic considerations and will be coordinated with State and local governments as well as other Federal agencies.

- An Engineering Plan is prepared to define the scope, specifications, and details of the remedial action that is selected. The plan presents workplans, schedules, specifications, and detailed cost estimates to be used to conduct the remedial action.

- The Remedial Action is conducted to resolve any actual or potential problems associated with residual radioactivity resulting from former Manhattan Engineer District and Atomic Energy Commission activities. The remedial action is conducted as outlined in the engineering plan. The Department of Energy monitors the action on a radiological, environmental, engineering, and contractual basis and reviews periodic status reports.

Disposal Site Selection--The objective of this phase is to identify a terminal disposal site for wastes from remedial actions at formerly utilized sites. There are two basic generic options for any required offsite disposal that will be evaluated during this process:

- A disposal site within the state where the wastes are located

- A centralized regional disposal site for wastes from remedial actions located within the region of the involved states.

The selection of a disposal site would probably be necessary only for the first formerly utilized sites undergoing remedial action in a state or region, assuming that offsite disposal is required. Waste generated during subsequent

remedial actions at other sites in the state or region would likely be sent to the existing disposal facility. The choice of a remedial action depends on details such as cost and environmental analyses, which are highly dependent on the selected disposal site. The basic elements of this activity are as follows:

- Disposal Options are identified and evaluated to determine a number of specific locations that are candidates for use as disposal sites for remedial action wastes. The Department of Energy will work with State and local governments, as required, possibly through the establishment of siting committees.

- A National Environmental Policy Act review is conducted to ensure all practicable alternatives will be evaluated with respect to their environmental impacts. The National Environmental Policy Act process will be conducted as outlined above in the implement remedial action activity. The Nuclear Regulatory Commission or agreement state licensing process will be initiated in parallel with this step.*

- An Engineering Plan is prepared for the disposal site and will contain detailed plans and specifications for developing the site. The plan will present costs, work plans, and schedules suitable for use in preparing a request for proposal for site development and maintenance.

- Disposal Site Preparation and Maintenance includes surveillance of the site before and during operation and will continue after site closure. The maintenance and surveillance procedures will be developed on a site-by-site basis and will depend on both waste and site characteristics. The maintenance and surveillance of the disposal site will be conducted by the licensee or operator in accordance with the followup procedures specified in the environmental impact statement and the Nuclear Regulatory Commission license.

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* In accordance with the provisions of the Atomic Energy Act of 1954, as amended, the sites selected for permanent disposal of wastes from the formerly utilized sites will be subject to licensing by the Nuclear Regulatory Commission or an agreement state. When proposed disposal sites have been selected, preliminary evaluation of the licensing and regulatory requirements will be initiated in parallel with initiation of the National Environmental Policy Act process. The licensing process will continue through subsequent disposal site selection, engineering, and design steps, with the requirement that a license be issued by the Nuclear Regulatory Commission or the appropriate agreement State agency before waste disposal commences.

Certify Site Condition--During and upon completion of any required remedial action, an independent radiological survey is performed to verify that the levels of residual radioactivity meet criteria for unrestricted or proposed limited use. The public is informed by Federal Register notice of the completion of the remedial action. The survey report and other pertinent site records are then reviewed by a Certification Committee, and if appropriate, the site is released for unrestricted use. In the event that effective measures cannot be found to reduce residual radiation to levels defined by criteria for unrestricted use, the condition of the site is documented and the site placed under appropriate control. The control may involve restricted land use, such as making the area into a park where no permanent structures may be constructed, or possibly licensing the site in cases in which it is still used for nuclear activities.

In all cases, upon completion of the decontamination efforts, a final report is prepared documenting the entire remedial action effort and the final radiological condition of the site. This report also notes the quantity of material removed from the site and its disposition. The final report and all supporting documentation are stored in Government archives. Complete copies or summaries are also placed on file at appropriate local centers such as public libraries and state and local government planning or record offices.

Certification procedures are similar for sites where no residual radioactivity is identified during the site analysis phase (i.e., sites not requiring remedial actions). The certification committee reviews the available data and survey reports and if sufficient information exists to certify the site for unrestricted use, the findings are documented in the same manner as described for the certification of a site where a remedial action has been completed. However, if the data are not sufficient, then additional records searches and/or radiological surveys are conducted as necessary.

IV. SITE-SPECIFIC SUMMARIES

This section provides a brief summary of the history and current status of 71 formerly utilized sites that required evaluation by the Environmental and Safety Engineering Division to determine their radiological condition. In addition, three sites controlled by the Department of Energy (Weldon Spring Site, St. Charles County, Missouri; New Brunswick Laboratory, New Brunswick, New Jersey; and the Department of Energy Niagara Falls Storage Site,* Lewiston, New York) and used by the Atomic Energy Commission are summarized for completeness. The former Vitro Rare Metals Plant at Canonsburg, and an associated property in Burrell Township, Pennsylvania, are former Manhattan Engineer District and Atomic Energy Commission sites; however, they have now been included in the Inactive Uranium Mill Tailings Remedial Action Program. The Environmental and Safety Engineering Division is currently reviewing information concerning other formerly utilized sites that may eventually require survey work; however, as of this printing, there are insufficient data to include other sites in this document. A supplemental report will be prepared for these additional sites when information is available.

The objective in preparing the site summaries was to produce a synopsis of the operations and radiological conditions at each of the sites, based on the best information available at the time, to document program status at each site. The summaries are not intended to be comprehensive site histories. Ideally, each site summary should follow the basic outline shown below, supplying specific information in several categories.

- Name of Site**
  - Current name of facility or owner
  - Name of facility or owner during Manhattan Engineer District or Atomic Energy Commission use
  - Location
- Site Function
  - Use
  - Dates of operation

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* This facility was once part of the portion of the Lake Ontario Ordnance Works that was used by the Atomic Energy Commission. The Department of Energy now controls only 191 of the original 1511 acres.

** It should be noted that the name usually refers to a company or facility and that typically only a small part of the overall area was used for Manhattan Engineer District or Atomic Energy Commission operations. The specific location of the contamination is given in the site description section.

- Operator, if different from owner
- Contract number(s) during Manhattan Engineer District or Atomic Energy Commission operations

- Site Description
  - Physical layout during use
  - Remains of the old site
  - Any changes in physical characteristics of the site and their cause(s)
  - Description of any offsite location(s) affected

- Owner History
  - History of ownership from the initiation of operations to the present

- Radiological History and Status
  - Radiological history (including decontamination and surveys performed) from the initiation of operations to the present
  - Disposition of any potentially contaminated equipment or materials removed from the site during Manhattan Engineer District or Atomic Energy Commission operation or during subsequent decontamination
  - Current status
  - Magnitude of any contamination onsite and offsite
  - Any actions taken to decontaminate the site and release it for public use; the acting party; and the date
  - Any need for further action

Although attempts were made to collect all of the information discussed above, one or more of the items could not be adequately addressed for most of the sites. In addition, the disposition of materials and equipment from most of the identified sites has still not been completely ascertained. There is an ongoing effort to identify the current location and radiological condition of such materials and equipment.

These summaries have been reviewed by the owners and/or former owners, State representatives, representives of the involved national laboratories, and cognizant Atomic Energy Commission employees. These groups and individuals have been instrumental in providing information on the sites. Additional information from these and other sources is being investigated as received.

Figure 3 shows the approximate locations of the formerly utilized sites outlined in this report. In addition, a state map showing more exact locations of all sites described is presented at the end of each state section.

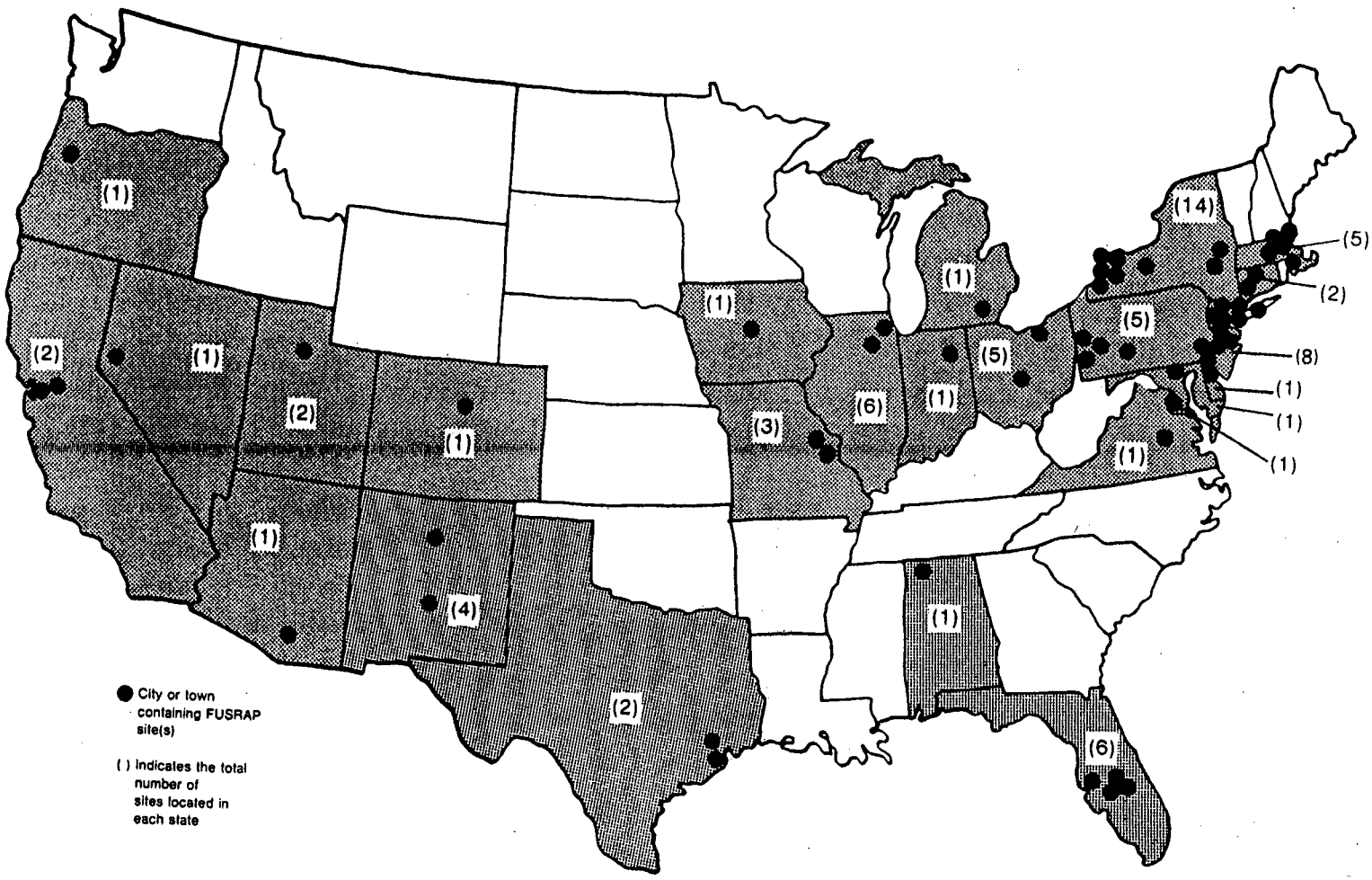

Figure 3. States Containing Sites Formerly Utilized by the Manhattan Engineer District and the Atomic Energy Commission and Related DOE Sites Discussed in This Report

TENNESSEE VALLEY AUTHORITY
Muscle Shoals, Alabama

Site Function

From 1951 to 1955, the Tennessee Valley Authority performed research and development on uranium recovery under formal agreement with the Atomic Energy Commission. The work involved extraction of uranium during the production of fertilizer from leached zone phosphate ore (aluminum phosphate) from Florida. The method used for separation was a solvent extraction process developed by DOW Chemical of Walnut Creek, California. A laboratory and pilot plant were operated at the fertilizer plant, but little uranium (about 2.5 kilograms of uranium concentrate) was produced and the amount of associated phosphate slag processed to concentrate the uranium is insignificant when compared to the total amount of phosphate slag produced by the fertilizer plant operations.

Site Description

The portions of this facility used for Atomic Energy Commission work were Rooms 20 and 21 of the Research and Engineering Building, the pilot plant area of Building 411, and two laboratories of the National Fertilizer Development Center (Rooms T-283 and L-275/6). Except for Building 411, which has been modified three times, these areas have remained unchanged. Pilot-scale studies of solvent extraction were carried out in a wooden structure inside the pilot plant building, and the wooden structure was later dismantled. The disposition of the product and original process laboratory and pilot plant equipment is not known.

Owner History

The laboratories and pilot plant were owned and operated by the Tennessee Valley Authority.

Radiological History and Status

The site was visited and a screening survey was conducted by Oak Ridge Operations Office and Oak Ridge National Laboratory personnel on November 3, 1977. Measurements made during the survey indicated that there were no radiation levels above background onsite. Oak Ridge National Laboratory recommended that no further radiological measurements were necessary. A final determination regarding any subsequent activity at this site is pending; however, based on the findings to date, no further Department of Energy action is anticipated.

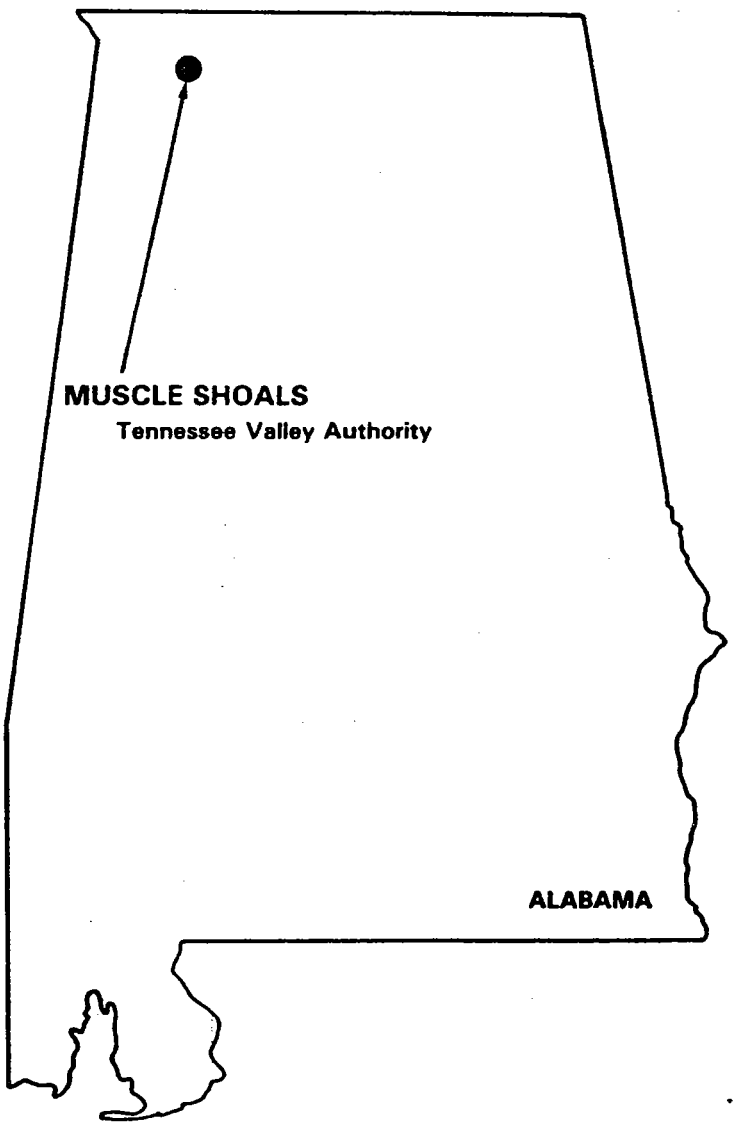

Figure 4. Formerly Utilized Sites in the State of Alabama

UNIVERSITY OF ARIZONA
(U.S. Bureau of Mines)
Tucson, Arizona

Site Function

The U.S. Bureau of Mines conducted research and development work at this site under contract to the Atomic Energy Commission on the processing of uranium ores. The work was conducted from about 1946 to 1950.

Site Description

Facilities involved in this work consisted of a warehouse and ore storage building, located at Chauncey Street and Vine Avenue, and floor space on the ground floor, southwest corner of the Engineering Building, on the University of Arizona campus. The Chauncey Street storage building has been razed, and the Engineering Building now houses offices and classrooms.

Owner History

The Bureau of Mines activities have been closed down for about 25 years. The property of concern was and still is owned by the University of Arizona.

Radiological History and Status

The facilities used for the Atomic Energy Commission research are no longer being used for any operations involving radioactive materials; they are now used for research in various geologic and engineering disciplines. The site was visited and a screening survey was performed on January 17, 1978, by representatives of the Chicago Operations Office and Argonne National Laboratory. The survey of the facility revealed no radioactivity levels above background. No additional survey effort appears required.

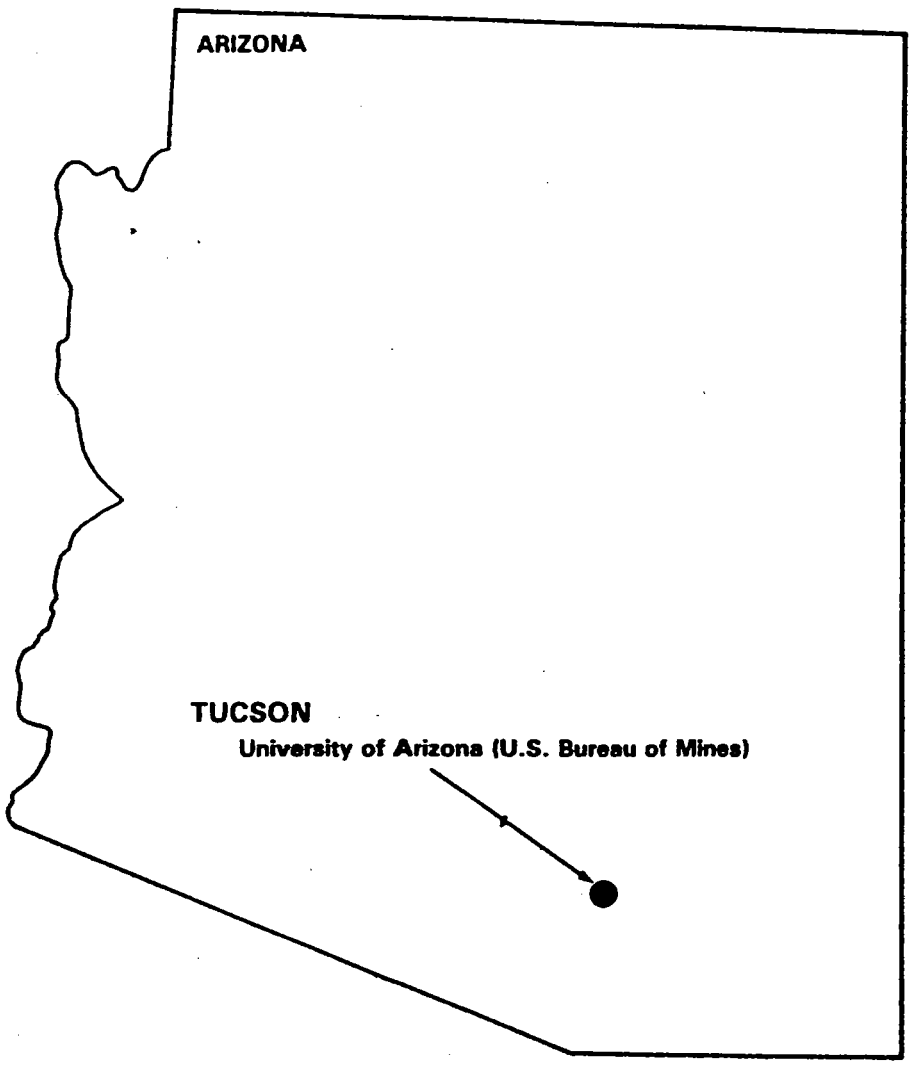

Figure 5. Formerly Utilized Sites in the State of Arizona

DOW CHEMICAL COMPANY
Walnut Creek, California

Site Function

The Dow operation involved process studies and experimental investigations on different uranium ores and thorium-bearing ores. The defined period for the work under Contract AT(40-1)-GEN-236 was October 1, 1947, to June 30, 1948, and was extended to June 30, 1949, by Supplement 1 of the contract. Supplement 2 added studies on liquid waste disposal, and Supplements 4 to 12 extended the period of performance to June 30, 1957.

Site Description

Four rooms (1, 2, 18, 25) in the Research Building were used. These rooms have been remodeled and all are now in use.

Owner History

The facilities have been and are still owned and operated by Dow Chemical Company.

Radiological History and Status

A radiological screening survey of the facility was performed by Chicago Operations Office and Argonne National Laboratory personnel on December 8, 1977. No levels of radioactivity above background were detected anywhere, except for the inaccessible areas of a fume hood located in Room 18. Subsequent remodeling of the laboratory room included removing the hood and scrubbing the area until no activity above background could be detected. These findings were conveyed to and confirmed by the State of California. Because no residual radioactivity due to Atomic Energy Commission operations was detected at this site, no further Department of Energy activity is anticipated.

UNIVERSITY OF CALIFORNIA,
GILLMAN HALL
Berkeley, California

Site Function

Gillman Hall was used in support of Manhattan Engineer District and early Atomic Energy Commission activities. Research apparently involved the production of minute quantities of plutonium by bombarding uranium with cyclotron-produced neutrons. Other work included verification of plutonium's existence and chemical properties, and demonstration of the feasibility of chemically separating plutonium produced in the first chain-reacting pile at the University of Chicago.

Site Description

Gillman Hall is located on the University of California Berkeley campus. The third floor and basement floor areas were associated with the Manhattan Project and early Atomic Energy Commission activities.

Owner History

Gillman Hall is owned by the University of California.

Radiological History and Status

A radiological survey of Gillman Hall was conducted by representatives of the Lawrence Livermore Laboratory and the Lawrence Berkeley Laboratory in 1976. The key findings of the survey were as follows:

- The area surveyed was free of removable contamination.
- Low-level but measurable alpha activity was detected under the asphalt tile covering small areas in two rooms on the third floor.
- Low but measurable levels of cesium-137 were detected in and around a floor drain and two other areas in the basement.

Because the contamination is fixed, the measured levels of alpha emitters and cesium-137 do not represent a health hazard to the occupants of the two areas surveyed. However, the activity does exceed Nuclear Regulatory Commission guidelines for surface contamination at unrestricted facilities.*

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

The San Francisco Operations Office of the Department of Energy provided the following three options, which should be considered in determining the appropriate remedial action:

a. Leave the area as it is since the activity is low and has been fixed in place for many years.

b. Leave the survey area as it is for now, but provide a control procedure that would require any future renovation and/or demolition work to be covered by contamination removal and control procedures.

c. Require complete removal of all activity to levels meeting Nuclear Regulatory Commission guidelines. This would require stripping away floor tile and probably sandblasting concrete surfaces to remove fixed contamination, followed by floor restoration.

On November 28, 1979, the Office of Environment notified the Office of Nuclear Energy that the Gillman Hall site required consideration for remedial action. The Office of Nuclear Energy determined that the University of California's license for possession of radioactive material was broad enough to cover Gillman Hall, and the site was for the time being adequately controlled (as recommended in option b). The State of California was informed of the Department's survey results at this site and also recommended that option b be implemented with the condition that the final notification contain a proviso for restrictions and control procedures. As a result, the Department of Energy has no plans for remedial actions at this site in the immediate future; however, a final decision regarding the ultimate dispostion of the contamination is pending.

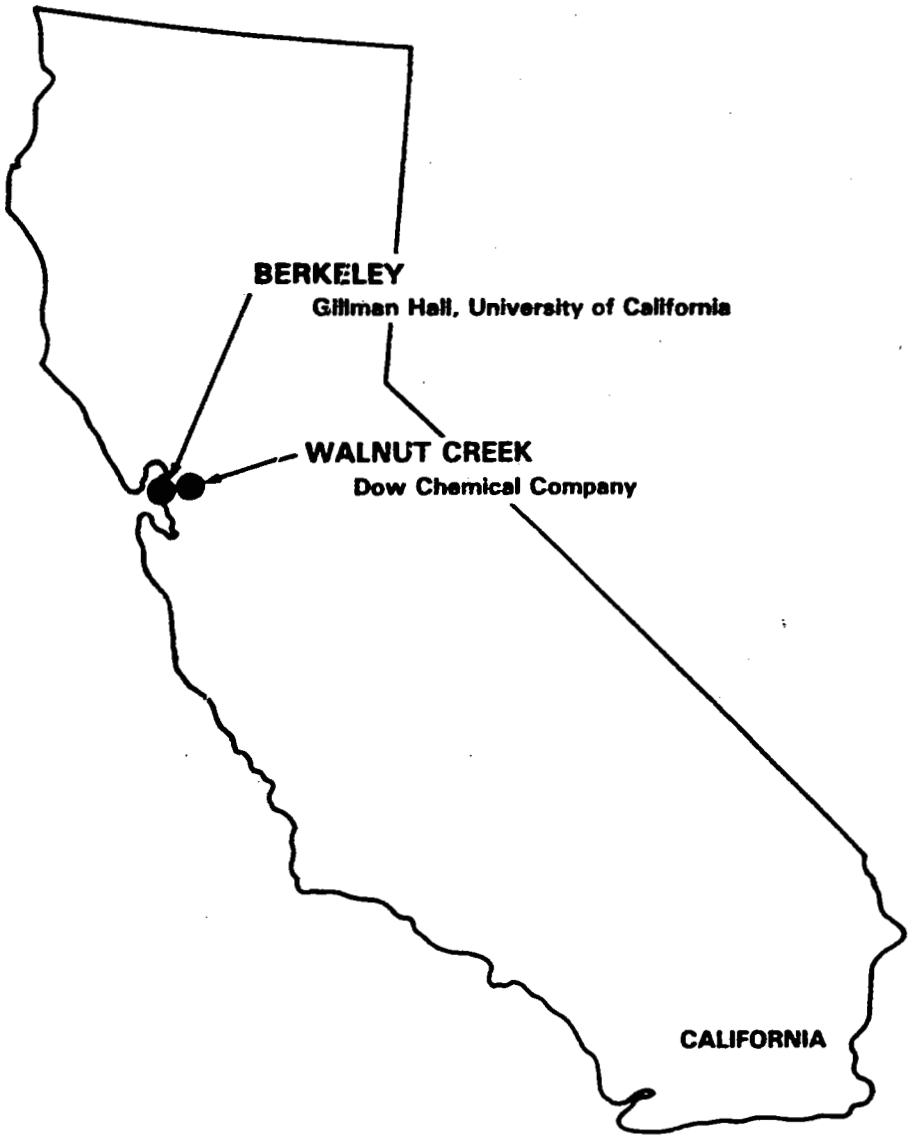

Figure 6. Formerly Utilized Sites in the State of California

COLORADO SCHOOL OF MINES
Golden, Colorado

Site Function

The Atomic Energy Commission entered into two contracts with the Colorado School of Mines. One contract, AT(49-6)-916, involved physical concentration and pilot plant testing of various uranium ores. Another, AT(05-1)-462, involved the preparation of a book on uranium ore processing. Work with uranium ores continues under a State of Colorado license.

Site Description

The site is located off campus and consists of a large wooden building and a tailings pond. The front portion of the building contains offices and is a two-story structure. The remaining part of the building is a high one-story structure containing laboratories.

Owner History

The Colorado School of Mines Research Institute is the current owner of the facility. During the contract period (1950s), the Institute was referred to as the Colorado School of Mines Research Foundation, Inc.

Radiological History and Status

A screening survey was performed by Chicago Operations Office and Argonne National Laboratory personnel on December 7, 1977. Although some measurable levels of radiation were noted, no action was recommended. The facility is operating under a State license for research using uranium and is being monitored by the organization's radiation protection officer. Any residual radioactivity due to Atomic Energy Commission work would be indistinguishable from activity resulting from present licensed operations. No further Department of Energy action is anticipated.

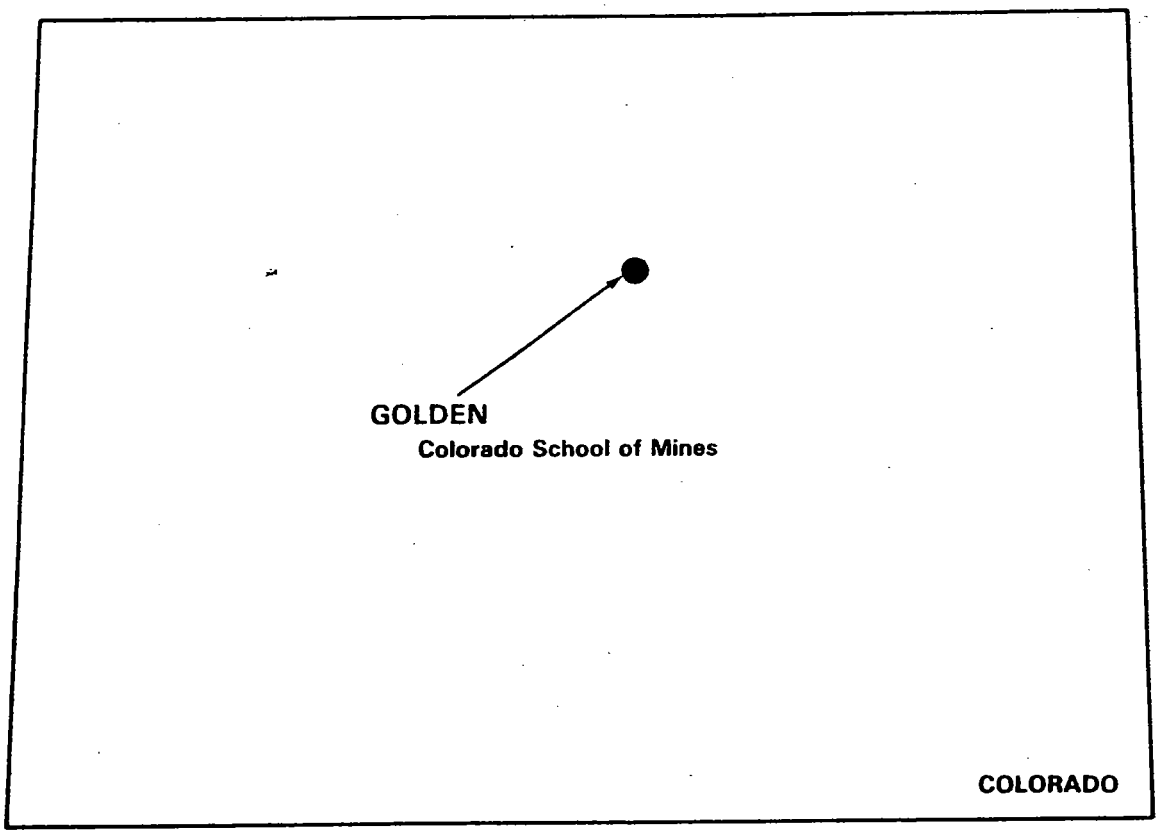

Figure 6. Formerly Utilized Sites in the State of Colorado

ANACONDA COMPANY
Fabric Metal Goods Plant, and West Tube Mill
(The Former American Brass Company)
414 Meadow Street
Waterbury, Connecticut

Site Function

From October 19 through 21, 1959, American Brass extruded copper-clad uranium billets for Nuclear Metals, Inc.,* a Savannah River Operations Office contractor during the 1950s. Plans existed for as many as 500 billets; however, no more than 50 were actually produced. The process involved extrusion, shaping, cleaning, testing, crating, and shipping.

Site Description

The processing site consists of the Fabricated Metal Goods Plant, the West Tube Mill, and associated equipment.

Owner History

American Brass is now known as Anaconda Company, Brass Division.

Radiological History and Status

During the extrusion activities, air samples and radiation measurements were taken by the Health and Safety Laboratory (in 1956 and 1959). The results were documented and confirmed the insignificance of surface contamination. Based on the Health and Safety Laboratory surveys, Oak Ridge Operations Office recommended that no further radiological surveys be performed. The Office of Environment is reviewing this recommendation, and any subsequent activity at this site awaits completion of the review.

* Nuclear Metals, Inc., is a Massachusetts firm operating under Atomic Energy Commission license SMB-179.

BRIDGEPORT BRASS COMPANY
(The Former Reactive Metals, Inc.)
Seymour, Connecticut

Site Function

From 1962 through 1964, the Seymour site was used for developmental cold forming (extrusion) of natural uranium metal and associated storage and laboratory support. The areas are presently used for corporate printing operations and as a warehouse.

Site Description

The surveyed areas that were used under the Atomic Energy Commission contract include the machine shop, metal storage area, cutting and grinding room, Dynapak area, laboratory hood area, and hallways. Most areas have painted concrete floors, except for the laboratory hood area and the cutting and grinding room, which have asphalt tile floors.

Owner History

The facility formerly occupied by Reactive Metals, Inc., is owned and occupied by Bridgeport Brass Company, a subsidiary of National Distillers and Chemical Corporation.

Radiological History and Status

On October 21, 1964, a closeout radiological survey of the facility was conducted by Health and Safety Laboratory personnel, who judged that the process areas had been cleaned of uranium contamination and recommended that the facility be released for unrestricted use. On January 26, 1977, Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site and performed a screening survey. During the survey, most of the measurements were found to be within existing Nuclear Regulatory Commission guidelines for unrestricted use.* However, at one location, radiation levels were found to approach or exceed these guidelines. Oak Ridge National Laboratory recommended that further radiological measurements should be taken at this location. Additional survey work is planned, but due to the low potential for exposure, this site is considered low priority. The survey is tentatively scheduled for late fiscal year 1980.

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* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

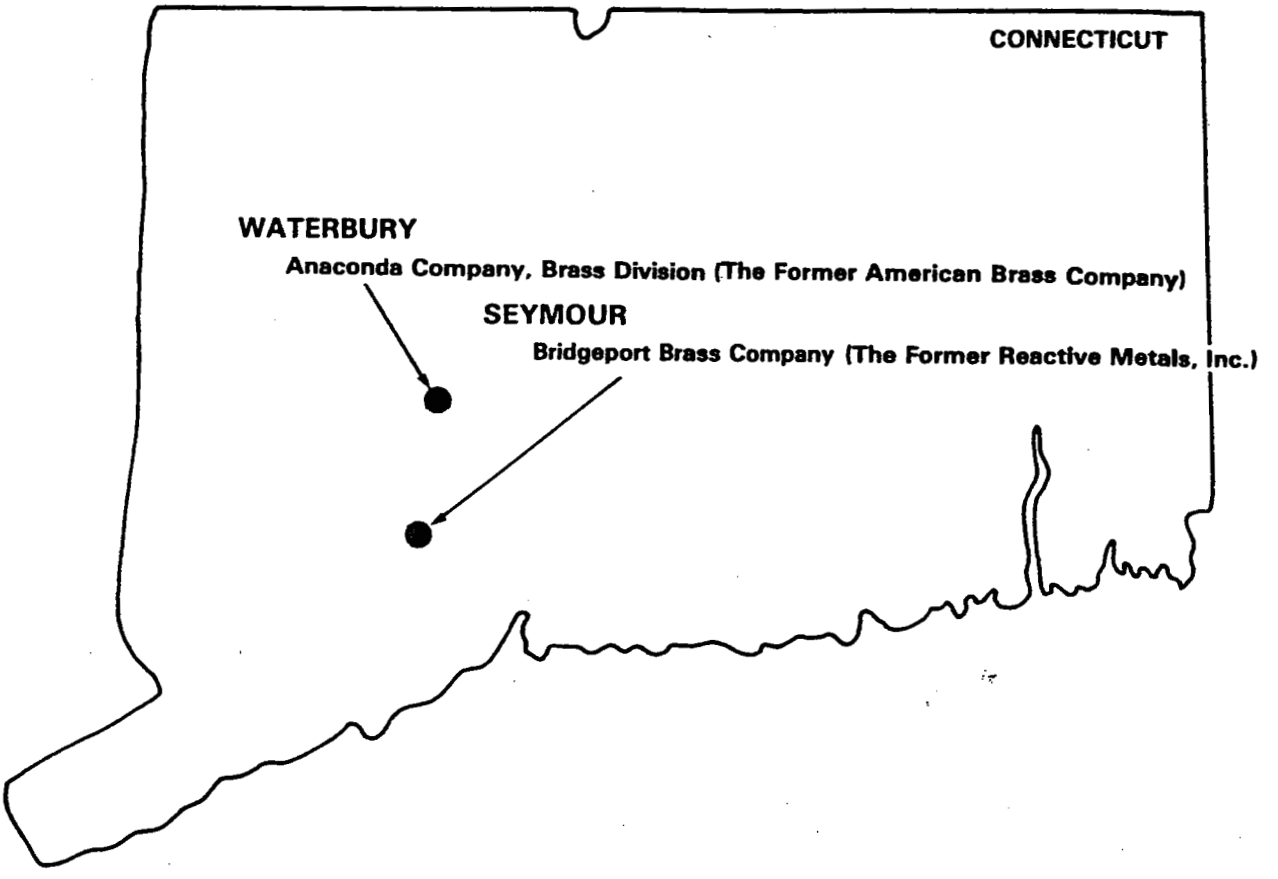

Figure 8. Formerly Utilized Sites in the State of Connecticut

ALLIED CHEMICAL CORPORATION,
UNION TEXAS PETROLEUM DIVISION
(The Former General Chemical Division, Allied Chemical and Dye Corporation)
North Claymont, Delaware

Site Function

In the early 1950s, Allied Chemical was engaged in research and development and small pilot-scale operations on uranium recovery from a phosphoric acid plant at North Claymont. The work under Contracts AT-(49-1)-610 and AT-(49-6)-913 was performed on a small scale. Former Atomic Energy Commission employees estimated that, at most, only a few pounds of uranium were concentrated.

Site Description

The present facility occupies an 83-acre site and is used for manufacturing sulfuric acid and related sulfur-containing products. Operations at the phosphoric acid plant ceased in the late 1960s, and the plant was demolished in the early 1970s. The contractor, Cleveland Wrecking, salvaged reusable building materials and disposed of the remaining rubble in local landfills. The exact location on the site where the Manhattan Engineer District work was performed is not known.

Owner History

The site is owned and operated by Allied Chemical Corporation, Union Texas Petroleum Division. At the time of the contract with the Atomic Energy Commission, the company was known as the General Chemical Division of the Allied Chemical and Dye Corporation.

Radiological History and Status

Oak Ridge Operations Office contacted the company on July 18, 1977. A contact report, furnished to Department of Energy Headquarters on December 12, 1977, concluded that the potential for measurable contamination at this site was insignificant due to the limited scale of operations, and no further investigation appeared warranted. The Office of Environment is conducting a final review of the available information; any subsequent activity at this site will be determined following that review.

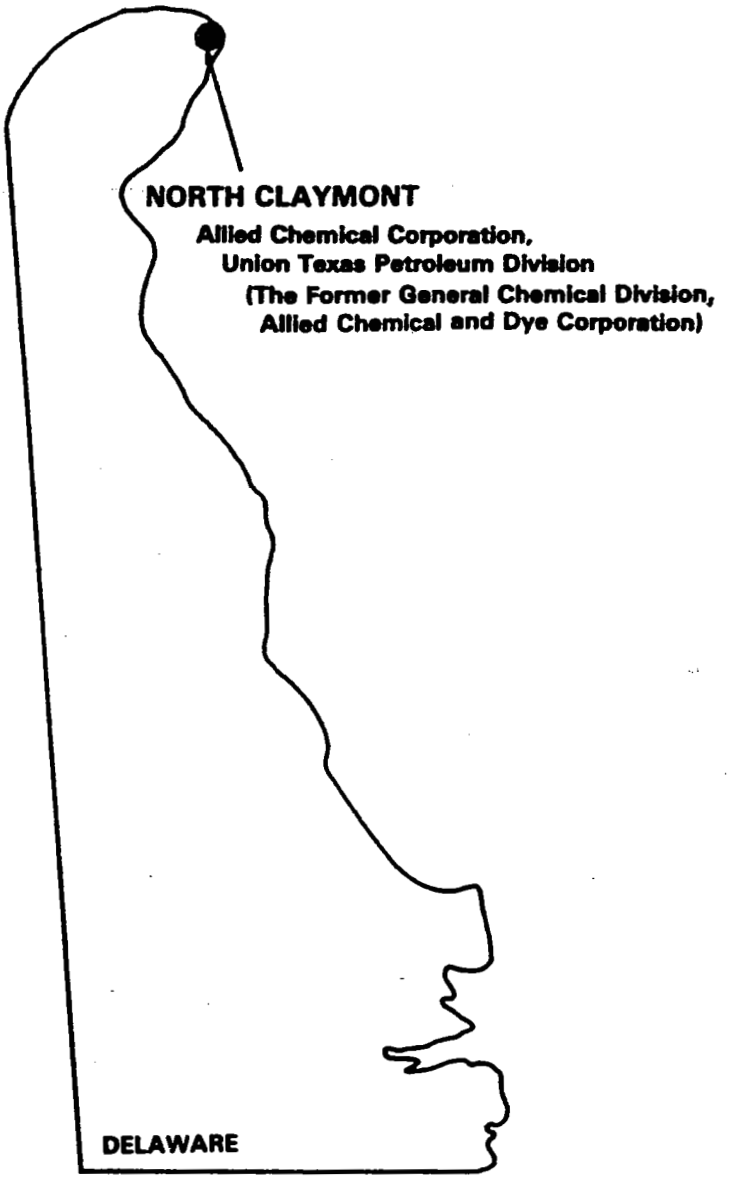

Figure 9. Formerly Utilized Sites in the State of Delaware

CF INDUSTRIES, INC.
(The Former International Minerals & Chemical Company
Uranium Recovery Unit at the Bonnie Plant)
Bartow, Florida

Site Function

The Bonnie Uranium Extraction Plant was designed to remove uranium from a monocalcium phosphate solution with a concentration of about 18 percent phosphorus pentoxide (P_2O_5). During early plant operation, several of the facilities were modified to improve the plant's operating factor. The plant was operated under Atomic Energy Commission Contract AT(49-1)-630, effective July 23, 1952. During 1954 or 1955, the Bonnie plant switched from a monocalcium phosphate operation to phosphoric acid, which necessitated additional modification of the uranium extraction plant to handle the change in feed material.

This plant processed the entire acid stream from the phosphate operation, removing 75 to 90 percent of the associated uranium. The uranium was recovered as green salt (uranium tetrafluoride, UF_4), containing significant quantities of uranium oxide (U_3O_8). The product was shipped to the National Lead Company in Fernald, Ohio,* for further processing.

Site Description

The extraction plant has been completely demolished, including the foundations. The electrical substation presently located on the plant site was not part of the extraction plant.

Owner History

During the plant's operation, it was owned by the International Minerals & Chemicals Company. The plant was shut down in December 1959. International Minerals & Chemical Company later demolished the plant except for the main process building, which was used for storage. Ownership of the property was transferred to Central Farmers (now CF Industries) in early 1969. The plant became CF Chemicals, Inc., Bartow Phosphate Works. CF Chemicals demolished the old process building and removed the concrete pad. All of the chemical plant equipment and structures were removed and sold for salvage value.

Radiological History and Status

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site and performed a screening survey on April 6, 1977. Results of the preliminary Oak Ridge National Laboratory survey

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* The Feed Materials Production Center.

indicated that concentrations of radionuclides in soil present at this site may exceed the interim standards promulgated by EPA* for inactive uranium mill tailings sites. However, radiation levels are similar to those that can be found in phosphate products plants currently operating for nonuranium recovery purposes. Uranium happens to be a coincidental element associated with the leaching of phosphate rock and is present to some degree in all phosphate operations. A final determination regarding subsequent activity at this site is pending, but based on the findings to date, no further Department of Energy action is anticipated.

* "Interim Cleanup Standards for Inactive Uranium Processing Sites," Federal Register, Environmental Protection Agency, April 22, 1980.

CONSERV
(The Former Virginia-Carolina Chemical Corporation)
Nichols, Florida

Site Function

The Virginia-Carolina Chemical Corporation operated a uranium recovery pilot plant in Nichols, Florida, for the Atomic Energy Commission's Division of Raw Materials. The plant was designed to recover uranium from wet-process-produced phosphoric acid, a company product. The work was performed under Atomic Energy Commission Contract AT(49-1)-623 and Amendment 1, effective May 23, 1952 through April 30, 1957.

Site Description

Only the concrete pad of the pilot plant remains. Since the termination of the pilot plant operation, a small building has been constructed on an adjoining concrete pad. The building contains a maintenance shop, lunchroom, tool storage cage, and small office.

Owner History

The present owner is the Conserv Department of the Philipp Brothers Division, Engelhard Minerals and Chemicals Corporation. The site was originally owned and operated by the Virginia-Carolina Chemical Corporation. Since its construction in 1951, the complex has changed owners three times and for 4 years, between 1969 and 1973, the plant was completely shut down.

Radiological History and Status

The pilot plant was disassembled after contract termination (approximately 1960). As a result of the many changes in ownership, the present location of tanks, piping, and other equipment used in the operation is unknown.

Oak Ridge National Laboratory personnel conducted a preliminary survey on April 4, 1977. Conserv performed a survey and decontamination between April and November 1977. Approximately 4 cubic yards of contaminated soil was removed and subsequently buried in an inactive gypsum pile located about 2600 feet from the original site. Oak Ridge National Laboratory personnel then performed a complete site survey in December 1977.

Alpha and beta-gamma contamination levels in the maintenance building were below guidelines set by the Nuclear Regulatory Commission.* Transferable alpha and beta-gamma contamination was negligible both on the

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

floors and walls and on overhead surfaces. For the most part, contamination measurements on the original concrete pad revealed alpha and beta-gamma levels below Nuclear Regulatory Commission guidelines except for the two small points. Soil samples from around the pad were analyzed and found to contain significant concentrations of uranium and radium. Small concentrations of radium and uranium were still detectable in the soil removed to the gypsum pile from the pad area in 1977. Although radium concentrations are in excess of the interim standards for remedial action at inactive uranium mill tailings sites,* they are generally within background levels normally found at phosphate product plants currently operating without uranium recovery (with the exception of those areas surrounding the pad having had beta-gamma dose rates exceeding the NRC guidelines).

On February 7, 1980, the Office of Environment notified the Office of Nuclear Energy that the Conserv site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

* "Interim Cleanup Standards for Inactive Uranium Processing Sites," Federal Register, Environmental Protection Agency, April 22, 1980.

GARDINIER, INC.
(The Former U.S. Phosphoric Plant Uranium Recovery Unit)
Tampa, Florida

Site Function

The U.S. Phosphoric Products Division of the Tennessee Corporation extracted uranium from phosphoric acid using a process consisting of (1) pretreatment of wet-process phosphoric acid; (2) solvent extraction of uranium; (3) precipitation of the uranium product; (4) drying and crushing; and (5) handling, packaging, and shipping. Pilot operations were carried out from 1951 through 1954, and the process plant was operated from 1956 through 1960. The maximum production was 60 tons of uranium concentrate per year. The work was conducted under Atomic Energy Commission Contracts AT(49-1)-534 and AT(49-6)-912. The old uranium recovery facility is part of a larger plant that is still used for the production of phosphoric acid and other phosphate products.

Site Description

The site is located on the west side of U.S. Highway 41, approximately 7 miles south of its intersection with Interstate 4, Tampa, Florida. The site consisted of a three-story building that housed the former uranium recovery plant (process building), the former pilot plant (pilot operations building), and a small area where drying and crushing equipment was located. The first floor of the process building is used as a workshop, a lunchroom, and offices. The third floor contains an office and machinery. The second floor serves as a storage area for some previously used equipment from the uranium recovery operations. A rotary drum dryer, formerly stored there, has been removed and shipped to the commercial radioactive waste burial ground at Barnwell, South Carolina.* The pilot operations building is used for office space. Approximately 30 full-time employees now use these buildings.

Some pilot uranium recovery operations are presently underway in an area immediately west of the processing plant. Because this work is being performed under a license issued by the State of Florida, no measurements were made in this area.

Owner History

U.S. Phosphoric Products Division, Tennessee Corporation, owned and operated the facility until 1962 when it became a subsidiary of Cities Service Company. In 1973, it was sold to the Societe des Participation des Gardinier, Paris, France.

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* The radioactive waste burial ground is operated by Chem-Nuclear, Inc., under a license issued by the Nuclear Regulatory Commission.

Radiological History and Status

Following a site visit in April 1977, Oak Ridge National Laboratory personnel performed a complete radiological survey of the site in December 1977. The survey determined the extent of residual radioactivity on the site resulting from the former uranium recovery operations. Beta-gamma and/or alpha radiation levels on surfaces at some points inside the process building and in the outdoor area near the process building and pilot operations building exceeded current Nuclear Regulatory Commission guidelines* for the release of property for unrestricted use. Some samples taken from the floor and equipment on the second level of the process building contained licensable concentrations of natural uranium as defined in Title 10, Code of Federal Regulations, Part 40. Also, samples from the floor contained above-background concentrations of radium-226. Uranium concentrations outdoors were not as high as in the buildings. The concentration of nuclides in samples of water taken outdoors conformed with concentration guides in Title 10, Code of Federal Regulations, Part 20.

The radiological survey report is expected to be completed in 1980. On February 15, 1980, the Office of Environment notified the Office of Nuclear Energy that the Gardinier site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
(Pilot Facility)
Mulberry, Florida

Site Function

International Minerals & Chemical Corporation conducted research and development on uranium recovery from leached zone material (Bartow clay) in the Florida Land Pebble Phosphate Field. The operation included the production of uranium from a pilot plant for developing engineering data for a full-sized facility. This work was performed under Contracts AT(49-1)-538 and AT(49-1)-545, effective April 26, 1951. An earlier contract with International Minerals and Chemicals, AT(30-1)-942, was destroyed, but probably involved similar work.

Site Description

The pilot plant research and development work was performed at the company plant in Mulberry. All that remains of the pilot facility is a 205-foot by 50-foot concrete slab. The location of the scrap and rubble from the facility is not known.

Owner History

The land is owned by International Minerals & Chemical Corporation.

Radiological History and Status

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel conducted a screening survey at this site on April 6, 1977, and found radiation levels above normal background levels. It could not, however, be determined that the levels were the result of former Atomic Energy Commission operations. Furthermore, the radiation levels at this site are similar to those at other phosphate products plants currently operating for nonuranium recovery purposes. Uranium happens to be an associated impurity in the leaching of phosphate rock and is present to some degree in all phosphate production operations. A final determination regarding subsequent activity at the site is pending; however, based on findings to date, no additional Department of Energy action is anticipated.

U.S. STEEL CORPORATION,
USS AGRI-CHEMICALS DIVISION
(The Former Armour Fertilizer Works)
Bartow, Florida

Site Function

This facility was used for research and development of uranium recovery by solvent extraction from phosphoric acid. It was operated under Contracts AT(30-1)-1391, AT(30-1)-1404, and AT(49-6)-915 from 1951 to 1955. According to plant personnel, the facility produced only gram quantities of uranium.

Site Description

The plant is located about 1 mile west of Bartow on State Highway 60.

Owner History

The company name changed from Armour Fertilizer Works to Armour Agricultural Chemical Company; it then became USS Agri-Chemicals Division of the United States Steel Corporation.

Radiological History and Status

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site and performed a screening survey on April 4, 1977. Radiation levels and soil radionuclide concentrations were found to be normal for operating phosphate product plants of this type, regardless of the nature of the operation. Uranium happens to be an associated impurity in the leaching of phosphate rock and is present to some degree in all phosphate operations. Oak Ridge National Laboratory concluded that no formal survey of this site is required because it is unlikely that further measurements will result in additional information about radiological conditions there at the time Atomic Energy Commission contract operations ceased. A final determination regarding any subsequent activity at the site is pending; however, based on the findings to date, no further Department of Energy action is anticipated.

W.R. GRACE & COMPANY,
AGRICULTURAL CHEMICALS DIVISION
Ridgewood, Florida

Site Function

This facility was under Atomic Energy Commission Contract AT(49-6)-920 from 1954 to 1955. A uranium recovery pilot operation was conducted to obtain research and development information on the removal of uranium from phosphoric acid. There was approximately 0.05 percent uranium in the acid. According to W.R. Grace & Company personnel, the plant was only operated from late November to late December 1954. Other equipment for phosphoric acid production is now in operation at the site.

Site Description

Only one building on the W.R. Grace & Company property was involved in the research. It has since been completely dismantled. No information is available regarding the location or disposition of equipment and building remains.

Owner History

The facility is owned and operated by W.R. Grace & Company.

Radiological History and Status

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site on April 6, 1977. Results of formal surveys conducted at two other Florida sites indicate that radiation levels and soil radionuclide concentrations similar to those found at this site may be found in the immediate vicinity of a typical operating phosphorous products plant, regardless of the nature of the operation. Uranium happens to be an impurity associated with the ore used in the leaching of phosphate rock and is present to some degree in all phosphate operations. Oak Ridge National Laboratory recommended that additional survey efforts do not appear to be required because it is unlikely that further measurements will produce any additional useful information. A final determination regarding any subsequent activity at the site is pending; however, based on the findings to date, no further Department of Energy action is anticipated.

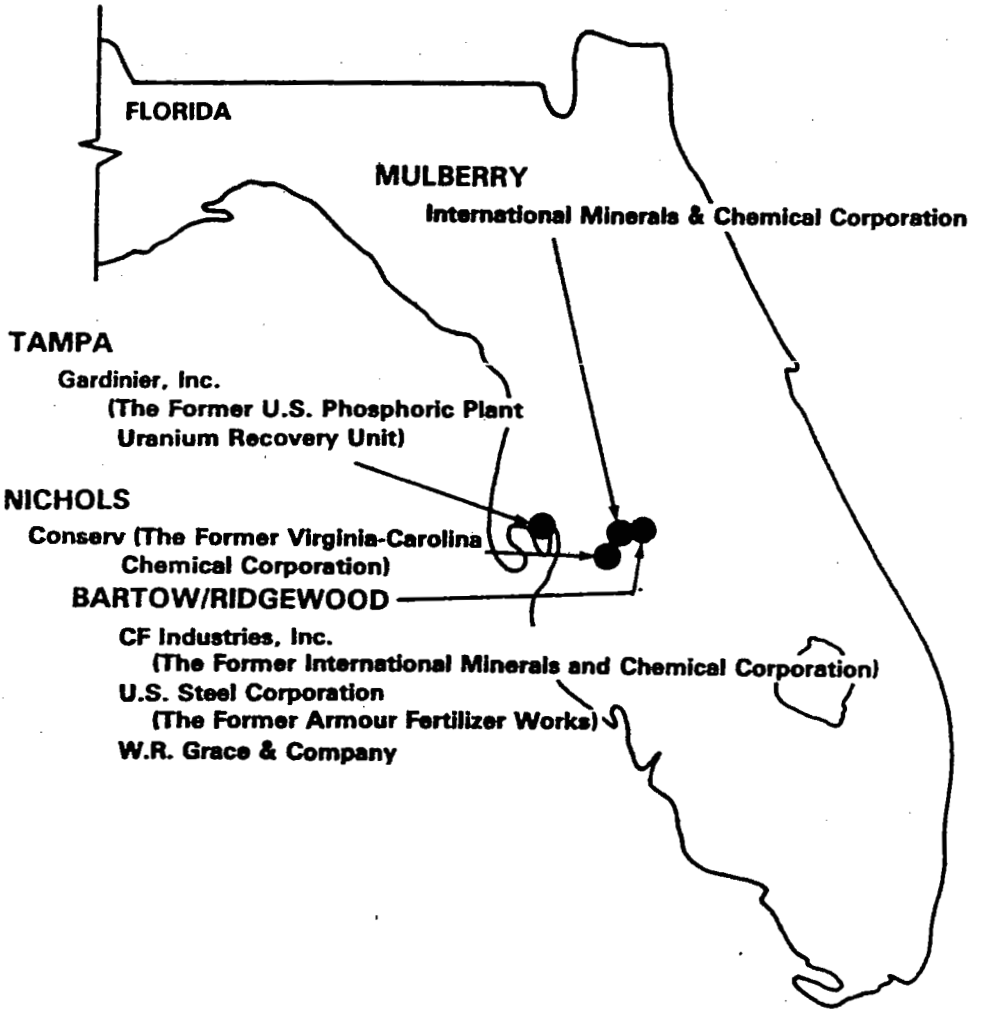

Figure 10. Formerly Utilized Sites in the State of Florida

THE FORMER GENERAL SERVICES ADMINISTRATION 39TH STREET WAREHOUSE
Chicago, Illinois

Site Function

The 39th Street Warehouse was occupied by Argonne National Laboratory or its predecessor, the Metallurgical Laboratory, until approximately 1949. Activities at the building included the storage of radioactive materials.

Site Description

The area used by Argonne National Laboratory included a warehouse and office area at 1716 West Pershing Road.

Owner History

The building was initially used under the Manhattan Engineer District and the Atomic Energy Commission by Argonne National Laboratory. The property at the time of the survey was used as an office and warehouse for RESCO, an air conditioning, refrigeration, and heating firm. The property is now privately owned.

Radiological History and Status

A radiological survey of this property, including soil surface, sheds, and loading platforms in the rear yard was completed on July 7, 1949. After decontamination, the building and grounds were determined to be acceptable for unrestricted use.

Argonne National Laboratory resurveyed the site in July 1977 and found no radioactivity above natural background. Hence, no apparent radiological health hazard exists at the facility and no remedial action is required. Department of Energy certification of the radiological condition of this site is pending.

ILLINOIS NATIONAL GUARD ARMORY
(Washington Park Armory)
52nd Street and Cottage Grove
Chicago, Illinois

Site Function

To resolve the critical space problem suffered by the Manhattan Engineer District, the Federal Government leased the Washington Park (124th Field Artillery) Armory from the State of Illinois. The building was used, beginning in March 1942, jointly by the Manhattan Engineer District Metallurgical Laboratory and the University of Chicago. Portions of the facility were used for uranium processing and storage of radioactive materials. The Atomic Energy Commission terminated use of the facility in 1951 and returned the property to the State of Illinois for use by the National Guard.

Site Description

The Armory is located at 52nd Street and Cottage Grove, Chicago, Illinois. The area surveyed encompassed the main portion of the Armory as well as the multistory office areas on each end of the building, the garage, and surrounding areas.

Owner History

The property is owned by the State of Illinois.

Radiological History and Status

Documentation of the final radiological survey of this facility (prior to release), conducted some time between 1949 and 1951, cannot be located. However, personnel involved in the survey indicate that the facility was decontaminated, during which time the dirt floor in the area used for uranium processing was removed to an unknown disposal site. The area was subsequently covered with gravel and concrete.

Chicago Operations Office and Argonne National Laboratory personnel visited the site in August 1976 and determined that a full radiological survey would be required. The survey was conducted in September and October 1977, and a draft report was completed. Results indicate that there is some contamination at this site. Material under the concrete floor could not be sampled during the survey; however, there is information suggesting that contamination may be present under portions of the floor. Some form of remedial action may be warranted.

MUSEUM OF SCIENCE AND INDUSTRY
East Pavilion
Chicago, Illinois

Site Function

Portions of the East Pavilion of the Museum of Science and Industry were occupied by the Argonne National Laboratory or its predecessor, the Metallurgical Laboratory, from August 15, 1946, to July 15, 1953. It is believed that some radioactive materials were handled at this facility; however, the type and activity is unknown.

Site Description

The area occupied by Argonne National Laboratory included the ground, first, and balcony floors of the East Pavilion, located at 1701 East 57th Street.

Owner History

The ground and first floors of the East Pavilion are now occupied by the University of Chicago for storage and office space and are also used in support of the museum's operations. The second balcony of the west court of the pavilion is used as office space by the Museum of Science and Industry and the Academy of Interscience Methodology.

Radiological History and Status

A radiological survey of this facility was completed on July 12, 1949. No radioactivity above background levels could be detected on any parts of the building or equipment remaining in the building. The Chicago Operations Office and Argonne National Laboratory conducted a resurvey of the facility from January 11 to April 13, 1977. The survey detected no radioactivity above background in the areas of the museum used for the Manhattan Engineer District or the Atomic Energy Commission work. No remedial action is required. The Department of Energy certification of the radiological condition of this site is pending.

OLIN CORPORATION, CHEMICALS GROUP
(The Former Blockson Chemical Company)
Joliet, Illinois

Site Function

The former Blockson Chemical Company conducted a development program for extracting uranium from phosphoric acid. A small pilot plant was operated under Atomic Energy Commission Contracts AT(49-1)-606 and AT(49-1)-611, and production was limited to not more than 50,000 pounds of uranium per year. The terms of the contract and amendments covered the period from March 1951 to March 1962.

Site Description

The Atomic Energy Commission work was conducted at a one-story brick structure (Building 55). The building is now used for the chemical processing of phosphoric acid.

Owner History

Blockson Chemical Company was sold in June 1955 to Olin Mathieson Chemical Corporation, now known as Chemicals Group, Olin Corporation.

Radiological History and Status

Chicago Operations Office and Argonne National Laboratory personnel visited the site for a screening survey in August 1977 and conducted a full survey in March 1978. Uranium was present throughout the building, and radium-226 was present on the roof. Radiation levels on surfaces in 25 areas exceeded Nuclear Regulatory Commission guidelines.* Levels of radon daughters were measured at five locations and found to be within applicable guidelines developed for remedial actions in Grand Junction, Colorado (Title 10, Code of Federal Regulations, Part 712). Some of the soil samples taken on the grounds adjacent to the building contained concentrations of naturally occurring radionuclides above background levels. Some remedial action may be warranted at this site; however, because these nuclides are present to some degree in all phosphate operations, it is impossible to distinguish between contamination resulting from the Atomic Energy Commission work and that resulting from current operations. A draft survey report has been completed, and the final report is being prepared. The determination regarding remedial action needs will be made following the completion and analysis of the radiological survey report and available data.

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

PALOS PARK FOREST PRESERVE
Site A/Plot M
Chicago, Illinois

Site Function

Site A contained two nuclear reactors plus associated buildings and laboratories. The first successful nuclear reactor, CP-1 at the University of Chicago, was rebuilt as CP-2 at Site A. The first heavy-water cooled and moderated reactor, CP-3 (designated CP-3' when modified in 1953), was also built and operated at Site A. Among the programs carried out at this site during and after World War II were fission product separations, reactor physics, tritium recovery from irradiated lithium, and studies of the metabolic effects of radionuclides on laboratory animals. Plot M refers to a radioactive waste burial site about 2000 feet north of Site A.

Site Description

The land is located in Cook County at the Palos Park Forest Preserve, south and east of Archer Avenue, north of 107th Street, and west of Wolf Road. Only 20 of the 1025 acres leased were used for Manhattan Engineer District or Atomic Energy Commission operations: 19 acres for Site A and 1 for Plot M. Figure 11 shows the general location of this site in Cook County.

Owner History

The U.S. Army Corps of Engineers leased the site from the Cook County Forest Preserve District on July 3, 1942. In 1947, the Federal Government returned all of the property except Site A and Plot M to the Forest Preserve District. In June 1956, after demolition of the structures and restoration of the area, the remainder of the site was returned to the Forest Preserve District, which still controls the land.

Radiological History and Status

The research reactors ceased operations in 1954 and were decommissioned from 1955 to 1956. Some radioactive materials were removed from the site, and the remaining radioactive components, including the reactor vessel, were encased in concrete and buried onsite. The empty buildings were surveyed, decontaminated as necessary, and demolished.

Plot M was decommissioned by digging 8-foot-deep trenches around the perimeter and filling them with concrete. A 1-foot-thick concrete pad was poured over the top. The plot was then covered with soil and seeded.

By the summer of 1956, decommissioning of both sites was complete, and the two areas were surveyed with state-of-the-art portable survey equipment. No detectable surface contamination was found. At this time, the two sites were returned to the Forest Preserve District.

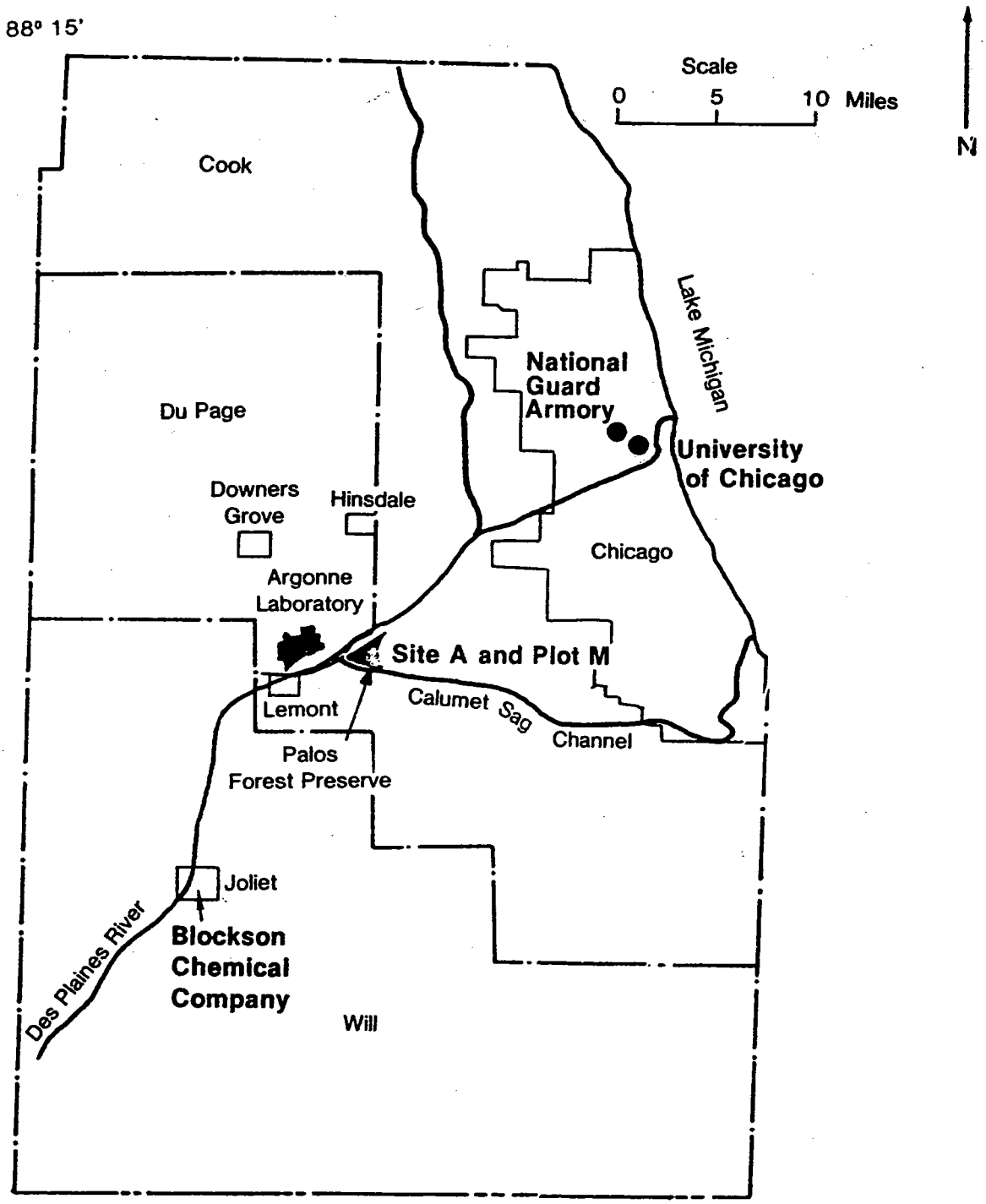

Figure 11. Palos Park Forest Preserve Location

A limited environmental monitoring program was begun at the Palos site in 1954, continuing about every other year until 1975. Chicago Operations Office and Argonne National Laboratory personnel conducted an extensive survey in 1976 and 1977. They found elevated concentrations of tritium in three park wells; however, the levels were below the Environmental Protection Agency limit* for drinking water of 20 nanocuries per liter. Tritium is the only radionuclide found to be migrating from Plot M. Low-level contamination was found in the vicinity of Site A. Continued radiological monitoring of both sites was recommended.

Argonne National Laboratory completed an engineering evaluation and an environmental analysis of this site in September 1979. The engineering evaluation listed eight options for remedial action, including continued monitoring, excavation and removal of buried materials, installation of various structures designed to prevent or reduce groundwater contamination, and provision of a substitute source of water for the public normally using picnic wells on the site. The environmental analysis concluded that some of the remedial action options involving construction would cause disruption and injury to terrestrial biota, and one might actually result in deterioration of groundwater quality.

On February 7, 1980, the Office of Environment notified the Office of Nuclear Energy that Site A/Plot M required consideration for remedial action. The Office of Nuclear Energy is currently in the process of reviewing remedial action options, and the monitoring program at the site is continuing.

* Title 40, Code of Federal Regulations, Part 141, National Interim Primary Drinking Water Standards.

UNIVERSITY OF CHICAGO
Chicago, Illinois

Site Function

The University of Chicago was involved in theoretical, radiochemical, and physical research associated with the first successful nuclear pile (CP-1) that was constructed and operated in the West Stands (racquet courts) under Stagg Field. Research conducted under the Manhattan Engineer District and the Atomic Energy Commission during the 1940s and 1950s included development of a process for producing high-purity uranium compounds, testing of uranium metal, research associated with operation of the pile, and plutonium separation.

Site Description

The University of Chicago buildings associated with the Manhattan Engineer District work were the New Chemistry Lab and Annex, West Stands, Ryerson Physical Lab, Eckhart Hall, Kent Chemistry Lab, Jones Lab, and Ricketts Lab. The New Chemistry Lab and Annex, the West Stands, and Ricketts Lab have been torn down. It was initially thought that a small animal facility (animal quarters) was used by the Manhattan Engineer District or the Atomic Energy Commission; however, a comprehensive investigation failed to confirm the existence of such a facility.

Owner History

The site is owned by the University of Chicago.

Radiological History and Status

All of the buildings were apparently decontaminated prior to release, but some of these activities may never have been documented and other documents known to have once existed were inadvertently destroyed. Records of the disposal of decontamination wastes and building rubble are also lacking. However, it is known that CP-1 and associated equipment was moved from the West Stands to Site A at Palos Park.

Argonne National Laboratory completed a radiological survey of the building at this site in 1976 and 1977 and prepared draft reports for the laboratories. The preliminary analysis has determined that some minor contamination was present in the laboratories. These laboratories are still under license and used for nuclear research and are therefore of no significant hazard to the public. Although the animal quarters cannot be located, discussions with university personnel indicated that the quantity of radioactive material used for animal research was small, and no significant hazard was anticipated. As a result, efforts to identify the site of the research were terminated. Some form of remedial action may be needed at some of the laboratories, and analysis of options will begin upon completion of the final radiological survey report. Options include the possibility of covering the contaminated building areas under the existing license.

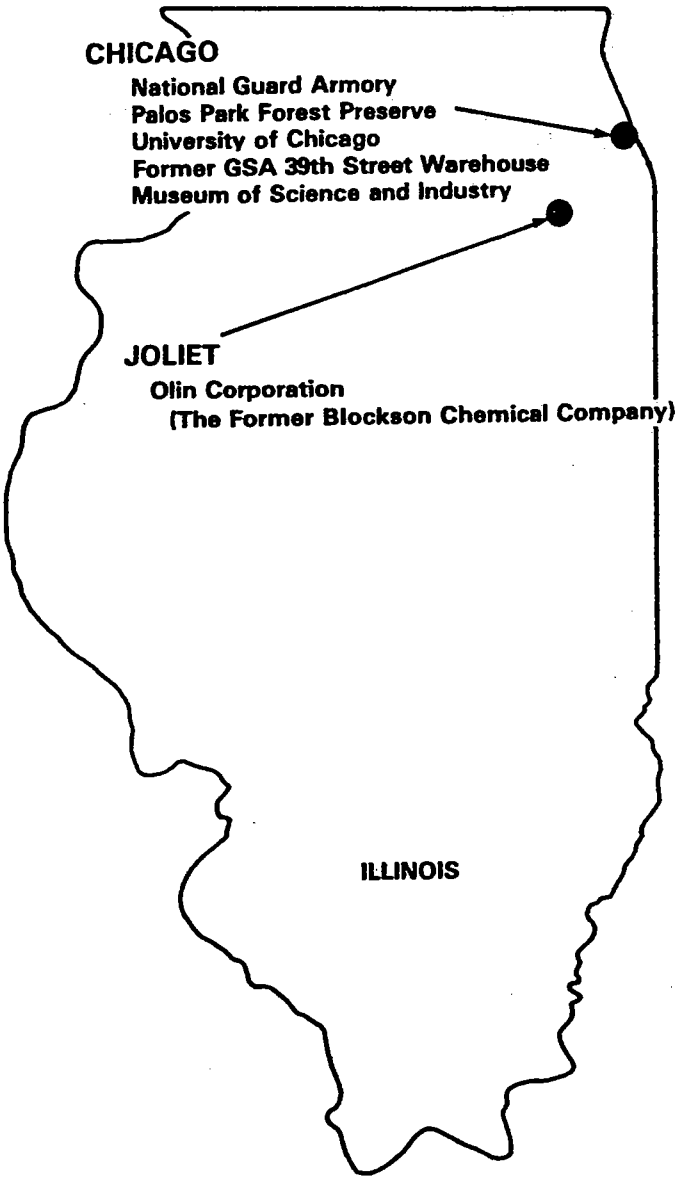

Figure 12. Formerly Utilized Sites in the State of Illinois

JOSLYN STAINLESS STEELS
Joslyn Manufacturing and Supply Company
Fort Wayne, Indiana

Site Function

From 1944 to 1949, this site was contracted by the Manhattan Engineer District and the Atomic Energy Commission to roll and machine uranium rods from billets. The billets were received by box car. Work was conducted under constant supervision, and scraps generated were retained by Atomic Energy Commission personnel for uranium accountability. Small furnaces were used to heat the material. Three mills (9-inch, 14-inch, and 18-inch) and straightening, cutting, and grinding equipment were used in the operation.

The 14-inch mill is still in operation. The 18- and 9-inch mills were sold, but have been tentatively located. Plans are being made to visit the sites to ensure that the mills were adequately decontaminated. The furnaces were constructed for the Atomic Energy Commission and, under their direction, were removed at the end of the contract. The other equipment has been scrapped, and its location has not yet been determined.

Site Description

The site, now consisting of 13 buildings, has been considerably developed since the time of the Atomic Energy Commission contract. However, several of the buildings used in the uranium operation still exist and have been refurbished (for example, new concrete floors have been installed).

Owner History

The facilities are owned and operated by Joslyn Stainless Steels, a division of Joslyn Manufacturing and Supply Company.

Radiological History and Status

A radiological survey was conducted by the Health and Safety Laboratory on August 1, 1949, at the time of contract termination. At that time, certain areas of the site were reported to have radioactivity levels above guidelines. Because no record of a decontamination was identified, Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited this site on October 23, 1976. They performed exploratory measurements to determine whether any significant contamination remained. A draft letter report indicated that radioactive surface contamination measurements were, in general, indistinguishable from instrument background. A few isolated spots showed traces of alpha and beta-gamma radiation, but readings were

below Nuclear Regulatory Commission guidelines.* A final determination regarding any subsequent activity at this site is pending; however, based on the findings to date, no further Department of Energy action is anticipated.

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

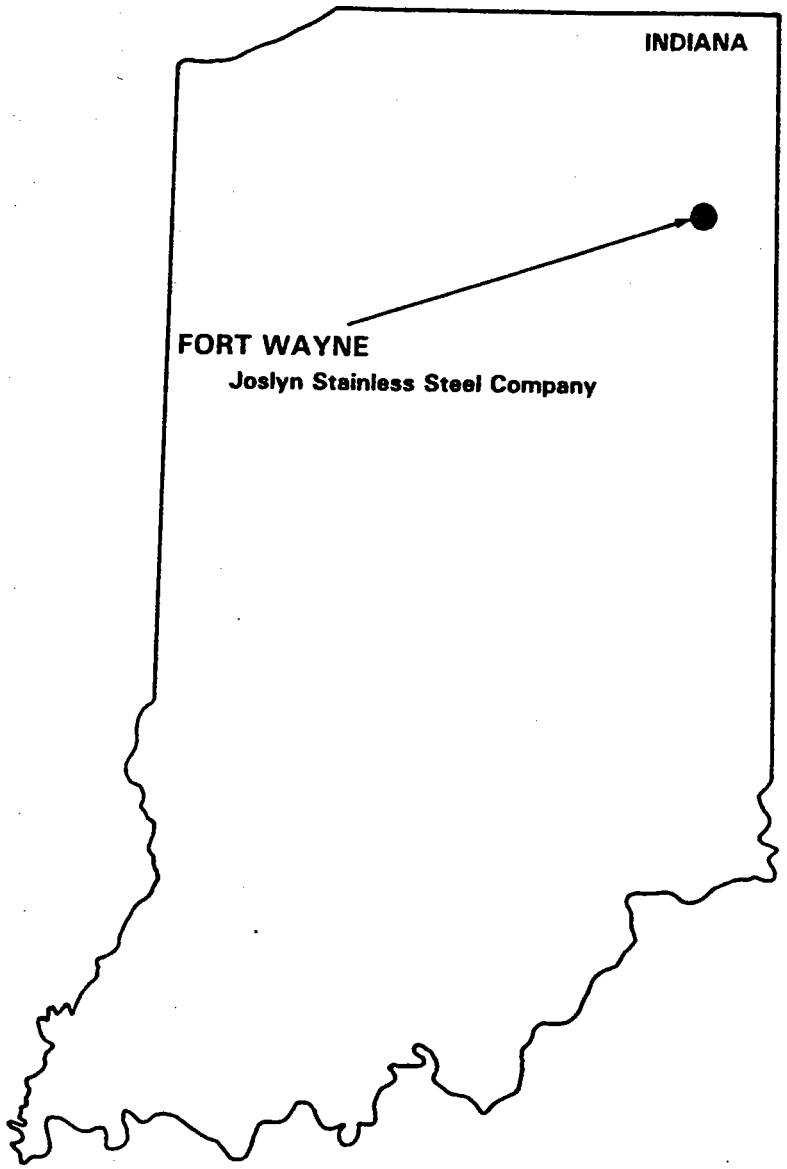

Figure 13. Formerly Utilized Sites in the State of Indiana

IOWA STATE UNIVERSITY
Ames Laboratory
Ames, Iowa

Site Function

In 1942, meetings of personnel of Iowa State College (now University) and the University of Chicago resulted in the decision to start a nuclear research-related program at Iowa State. The program was concerned with metallurgical research, fundamental chemical and analytical research, and the development of processes to produce pure uranium and other materials. A method was developed by the summer of 1942 for the production of high-purity uranium metal by a low-cost process that was capable of expansion to large-scale production. During the 1942 period, the small-scale production in the physical chemistry laboratory furnished about 2 tons of uranium for use in the first chain-reacting pile in Chicago early in December 1942. About 2 million pounds of uranium were produced up to January 1, 1945, at which time this operation was discontinued. A recovery process developed at Ames also resulted in the recovery of over 600,000 pounds of metal from scrap supplied by all Manhattan Engineer District sites. This operation was discontinued in December 1945. The Ames project was operated by Iowa State University under Manhattan Engineer District Contracts OEMsr-410, OEMsr-433, W-7405-Eng-7, and W-7405-Eng-82.

In 1947, the project at Ames was declared a major research facility and a program to produce thorium metal was initiated. Prior to 1947, approximately 4500 pounds of thorium had been produced. Approximately 65 tons were produced in total.

Site Description

A total of four campus buildings were used for the research, development, and production programs. Portions of the Chemistry Building were used for analytical research and operations. The uranium production took place in a wooden building known as Chemistry Annex I or "Little Ankeny." The recovery of scrap uranium was done at a brick building known as Chemistry Annex II. Other research work and the thorium production took place in the Metallurgy Building.

The Water Pollution Control Plant of Ames, Iowa, was accidentally contaminated by the operations in the Metallurgy Building. Some thorium and mesothorium (daughters of thorium) were released with the effluent to the sewage lines and the Water Pollution Control Plant and were retained as sludge. This was disposed of at the Ames Iowa Municipal Airport, the Grand Avenue underpass, and the Ames Municipal Cemetery (all grass covered areas).

Owner History

The site has always been owned by Iowa State University. Properties affected by the offsite contamination incident are municipally owned.

Radiological History and Status

Between July 1951 and August 1952, filtrates containing thorium and mesothorium were released into the sewage lines. Water removal operations at the Water Pollution Control Plant produced a dry sludge cake that contained much of the released thorium and mesothorium (less than 1 curie). This sludge cake was collected and held at the west end of the drying beds at the Water Pollution Control Plant. In accordance with the recommendations of the Atomic Energy Commission, Division of Biology and Medicine, the sewage sludge cake containing mesothorium was placed on the City of Ames Municipal Airport grass runway, the Municipal Cemetery, and the grass areas of the Grand Avenue underpass.

An initial radiation survey was conducted on May 12, 1976, at the Municipal Airport of Ames, the Municipal Cemetery, the Grand Avenue underpass, and the site of Chemistry Annex I on the Iowa State University campus. Based on preliminary results of this and subsequent surveys, minor contamination of some land does exist. The Municipal Cemetery and the Grand Avenue underpass show no significant contamination. There was no discernible radiation different from background at the sites of Chemistry Annexes I and II. A single area in a taxi strip at the Municipal Airport contained some measurable thorium. The area west of the sludge beds at the Water Pollution Control Plant contained thorium in a "ditch" area that was approximately 6 times background and a more generalized area that was up to 2 times background. Some form of remedial action may be warranted at the University and associated properties; however, from a radiological viewpoint, none of these areas has a significant impact on the health of the public. The radiological survey is being completed by Iowa State University under surveillance of the Chicago Operations Office.

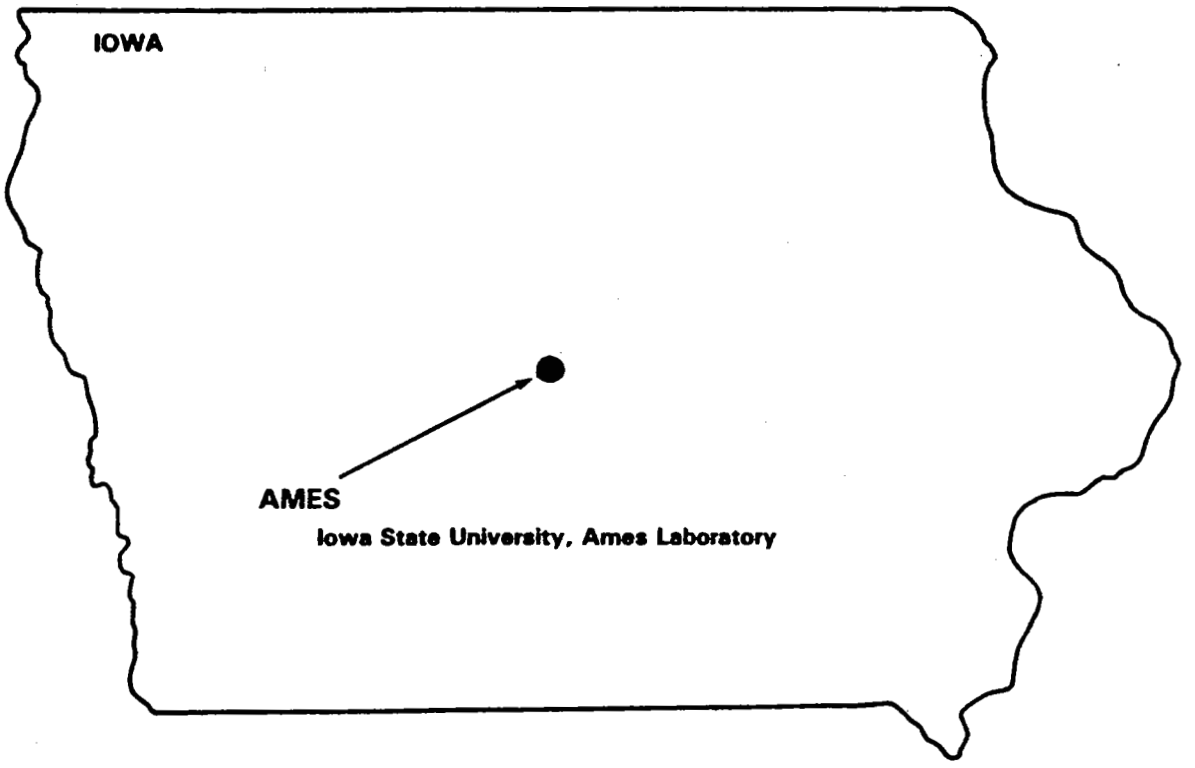

Figure 14. Formerly Utilized Sites in the State of Iowa

W. R. GRACE & COMPANY,
DAVISON CHEMICAL DIVISION
Curtis Bay, Maryland

Site Function

Developmental research and extraction of thorium from monazite ore was conducted at the W.R. Grace facility during 1956 and 1957. The ore was from Brazil, India, Asia, and Idaho and was owned by the Atomic Energy Commission. About 95 percent of the thorium in the monazite sand was recovered during processing and returned to the Commission. The unreacted material, or gangue, consisted primarily of silica, calcium sulfate, and diatomaceous earth as well as traces of unreacted monazite and thorium and uranium compounds. This gangue was retained by W.R. Grace for noncommercial disposition.

The processing plant used by W.R. Grace was never fully completed but operated for about 1 year. From May 1956 through late spring 1957, radioactive gangue was buried on the plant property at various depths up to 9 feet. Other contaminated material such as filter cloths and miscellaneous equipment were also disposed of in the same manner.

Site Description

The Atomic Energy Commission work was carried on at one building at the 260-acre facility, and the wastes were buried in a landfill-type area covering about 4 acres. The surrounding areas are industrial, and the nearest residence is about 1/2 mile away.

Owner History

The facility is owned by W.R. Grace & Company.

Radiological History and Status

The Atomic Energy Commission work at W.R. Grace concluded in 1957. In 1978, W.R. Grace contracted Radiation Management Corporation to perform a radiological survey of the site, including the waste area. Preliminary survey results indicate that the contaminated area covered about 4 acres and has a maximum depth of about 8 feet. The fill includes residue as well as some equipment. Radiation Management Corporation also indicated that there was no detectable contamination in the buildings resulting from the Atomic Energy Commission's activities.

W.R. Grace has maintained controlled access to the site. It is monitored by their security personnel and is about 1/2 mile from the nearest public access.

Based on a review of the W.R. Grace survey, it was determined that additional survey work will be required to characterize the radiological condition of the site. An aerial survey of the site was conducted in July 1979 for the Department of Energy. Results indicated that a comprehensive ground survey of the area is required. This survey has been assigned to Oak Ridge National Laboratory.

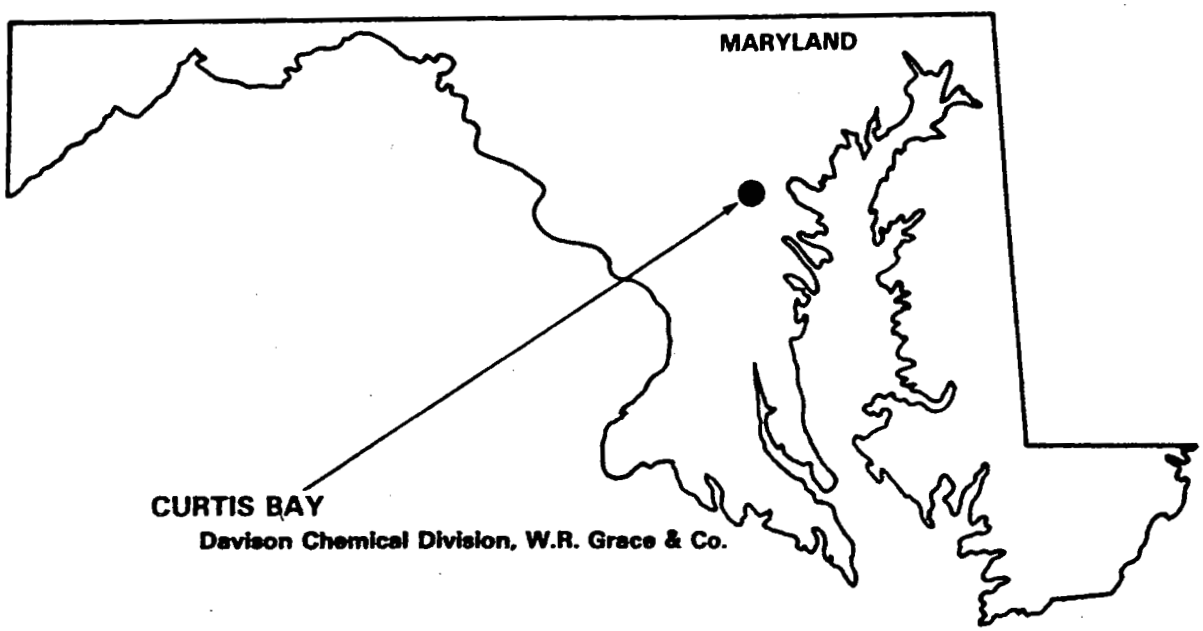

Figure 15. Formerly Utilized Sites in the State of Maryland

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
HOOD BUILDING
Cambridge, Massachusetts

Site Function

Massachusetts Institute of Technology was involved in numerous research and development efforts for the Manhattan Engineer District and the Atomic Energy Commission. Work included research in melting and casting uranium metal (started in 1942), uranium extraction from low-grade ores, and nuclear propulsion systems. Manhattan Engineer District contracts with the Massachusetts Institute of Technology included W-7405-Eng-40, W-7405-Eng-53, and W-7405-Eng-85. Under contract with the Atomic Energy Commission, other contractors took over the research operation at the Hood Building until 1958 when operations were terminated.

Site Description

The facility was located at 155 Massachusetts Avenue, Cambridge, Massachusetts, and was referred to as the Hood Building. Nuclear Metals Corporation, the last contractor to occupy the building, moved out of the facility in 1958, and the building remained unoccupied and sealed off for several years. It was decontaminated and demolished in 1963. In 1965, the Massachusetts Institute of Technology completed construction of a high-voltage research laboratory on this property.

Owner History

The Hood Building was owned by the Atomic Energy Commission and conveyed to the Massachusetts Institute of Technology on May 1, 1962.

Radiological History and Status

A representative of the Atomic Energy Commission visited the site of the Hood Building on July 3, 1963, to perform a final radiation survey of the site remains. The building had been completely demolished except for the basement walls and sections of the concrete floor. Disposal and removal of all building materials and debris associated with the demolition phase had been completed. The disposition of the building rubble is unknown. Radiological measurements indicated satisfactory decontamination. The Atomic Energy Commission then gave the Massachusetts Institute of Technology permission to "backfill" the basement.

Any subsequent activity at this site will be based on an evaluation of the adequacy of the 1963 survey; however, it appears that no further survey work will be required at this site.

THE FORMER SHPACK LANDFILL
Norton, Massachusetts

Site Function

The Shpack Landfill (now closed) was a private landfill that received wastes from local industrial operations. A Nuclear Regulatory Commission investigation determined that the former M&C Nuclear, Inc., Attleboro, Massachusetts (merged with Texas Instruments, Inc., in 1959), probably used the Shpack Landfill area for the disposal of trash and other material associated with nuclear fuel operations conducted at the facility from 1957 to 1966. M&C Nuclear, Inc., fabricated reactor fuel of various enrichments for the Federal Government and for private domestic and foreign concerns.

In once incident, documented by the Nuclear Regulatory Commission, about 1 ton of leftover uranium, which in powder form ignites spontaneously, was oxidized or burned in open trays outdoors to prevent it from igniting inside barrels that were to be shipped back to Argonne National Laboratory. The trays frequently spilled over or failed, thereby contaminating the surrounding soil. The contaminated soil may have been removed to the Shpack Landfill and is suspected of being a source of the radioactivity discovered there in 1978. Other possible sources of the residual radioactive material found at the landfill are being investigated.

Site Description

The Shpack Landfill is located in Norton, Massachusetts, along Union Road (State Route 123) near the corporate boundary of Norton and Attleboro. The area of concern comprises about five acres and is bounded on the north by Union Road, on the east by the Shpack residence, on the south by a swamp, and on the west by another private landfill. The surface presently contains metal, brick, concrete blocks, iron drums, plastics, and miscellaneous debris. The area is poorly drained and is covered by water part of the year. Drainage is toward the south and into Chartley Brook.

Owner History

The site is privately owned and has been owned by the same family since before the suspected date of contamination.

Radiological History and Status

On September 22, 1978, the Nuclear Regulatory Commission Region I Office was contacted by a concerned citizen who had detected elevated (above background) radiation levels at certain landfill/dump sites in the Norton/Attleboro area. A special investigation by the Nuclear Regulatory Commission from October through December 1978 verified the presence of radioactivity above background at the Shpack Landfill, Norton and Finberg Field*, Attleboro. The Nuclear Regulatory Commission survey and analysis

* Decontamination conducted by the state and local governments.

of water samples indicated that gross alpha measurements of well water from the owner's residence was found to be within the Environmental Protection Agency Drinking Water Standards.* An independent study conducted by Brown University students produced results that were orders of magnitude higher than the measurements of the Nuclear Regulatory Commission study and far in excess of the Environmental Protection Agency standards.* However, the Nuclear Regulatory Commission; in conjunction with the State of Massachusetts, collected a number of additional water samples and had them analyzed at a number of independent laboratories. The radionuclide concentrations of all well samples were below Environmental Protection Agency standards. As a result, the Nuclear Regulatory Commission determined that contamination at the landfill posed no immediate hazard to human health but that potential for exposure could exist if land use were to change.

As a result of a July 9, 1979, meeting held in Washington, D.C., between the Department of Energy, Nuclear Regulatory Commission, and other interested parties, it was decided that the Department of Energy would assume the lead responsibility in the landfill action under their formerly utilized sites program.

Representatives from Oak Ridge Operations Office and Oak Ridge National Laboratory visited the site and performed a preliminary ground survey and EG&G, Inc. (a Department of Energy contractor), performed an aerial radiological survey. The preliminary ground survey (July 24, 1979) concluded that the site was contaminated with uranium (primarily depleted) and radium. A full radiological survey was recommended. The aerial survey (August 8 and 9, 1979) did not observe any radiation levels significantly above those due to natural background.

On April 8, 1980, the Department of Energy, Oak Ridge National Laboratory, and the Commonwealth of Massachusetts participated in a public meeting in Norton to brief interested parties on the status of, and survey schedules for, the site. Oak Ridge National Laboratory completed a survey plan and initiated survey operations in July 1980.

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* Title 40, Code of Federal Regulations, Part 141, National Interim Primary Drinking Water Standards.

VENTRON CORPORATION
(The Former Metal Hydrides Corporation)
Beverly, Massachusetts

Site Function

From 1942 to 1948, Metal Hydrides Corporation was under contract to the Manhattan Engineer District and the Atomic Energy Commission to convert uranium oxide to uranium metal powder using calcium hydride, a method proven at Metal Hydrides Corporation in 1941. As better methods for production of uranium metal were developed, Metal Hydrides Corporation shifted its operations toward recovering uranium scrap and turnings from the slug fabrication plant at Hanford. Government contracts with Metal Hydrides included Contracts OEM-333, W-7405-Eng-8, and supplements.

Site Description

During Manhattan Engineer District and Atomic Energy Commission contract operations, three buildings were used for the uranium work. Two wooden buildings that contained the foundry facilities were demolished some time between 1948 and 1950. Two other buildings have been erected at these locations. The remaining original building contained furnace and leaching facilities, a mixing room, a drying room, and analytical laboratories.

Owner History

Metal Hydrides was incorporated in 1937. The name was changed to Ventron Corporation in 1965. Late in 1976, Thiokol Corporation acquired control of the company.

Radiological History and Status

The Atomic Energy Commission conducted a radiation survey in 1948, and the two foundry buildings and various pieces of equipment were listed as contaminated. As a result of that survey, it was recommended that painted surfaces be cleaned by sandblasting and contaminated concrete floor and platform materials be removed. Ocean dumping was recommended as the method for disposing of contaminated equipment and building rubble.

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site in January 1977 to conduct a screening survey. Based on the results of the exploratory measurements, it was determined that a complete radiological resurvey of the entire site is in order. Oak Ridge National Laboratory personnel visited the site again in April 1980 to collect information needed for the preparation of a survey plan. The survey is scheduled for 1980.

WATERTOWN ARSENAL
Watertown, Massachusetts

Site Function

The Massachusetts Institute of Technology operated a laboratory and a uranium ore testing facility in a now-demolished building at the Watertown Arsenal. The facility was operated for the Atomic Energy Commission under contract AT(30-1)-956. A modified ion-exchange technique for production of U_3O_8, which employed a fluidized bed system known as resin-in-pulp, was developed at this site. Initial research on African ores was conducted at the Massachusetts Institute of Technology in Cambridge. The activity was transferred to the Watertown Arsenal (Building 421) in 1946. The Massachusetts Institute of Technology conducted the research activities until 1950, at which time American Cyanamid took responsibility for the operations at the site. In 1951, the U.S. Army needed the space being used by the Atomic Energy Commission project. As a result, the Atomic Energy Commission initiated construction of a new laboratory in Winchester, Massachusetts. The Commission's activities at the Watertown Arsenal were transferred to the new facility when it was completed in 1953.

Site Description

The only building used by the Atomic Energy Commission for the development of the resin-in-pulp process was Building 421. The building was located in the south central part of the site along the Charles River. Only the concrete pad (about 22,630 square meters) from the building remains. The disposition of rubble from this building is unknown and will be investigated.

Owner History

The Watertown Arsenal ceased operations in the area of Building 421 in 1967. The site is now owned by the Watertown Redevelopment Corporation. Operations involving uranium are continuing in the Arsenal proper. This is the area west of the main gate and is not part of the area turned over to the Watertown Redevelopment Authority.

Radiological History and Status

In May 1977, Chicago Operations Office and Argonne National Laboratory personnel completed a comprehensive radiological survey of Building 421 and the surrounding area. Direct instrument surveys of the pad of Building 421 and the south wall of Building 331 (nearest building to the pad) identified three small spots on the pad that exceed the Nuclear Regulatory Commission guidelines.* Smears indicated that the contamination

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

was fixed, and the analysis of one sample identified the contamination to be from natural uranium. Other direct instrument measurements taken showed no readings above natural background. Analyses of soil and water samples and measurements of radon in the air gave no indication of radiation above background.

During the Argonne National Laboratory radiological assessment of the Building 421 site, it was discovered that several additional buildings and facilities were involved in uranium operations during the Manhattan Engineer District and Atomic Energy Commission era, including Buildings 34 and 41, which have been razed. Both building sites are within the confines of the Arsenal area, though they have been turned over to the Watertown Redevelopment Authority. There is no evidence of having performed a radiological survey for these two buildings. In addition, there is an area on the north side of Arsenal Street that had been utilized for uranium storage and as a burn area. These areas were used by the Army but no determination could be made as to whether they were part of the Manhattan Engineer District or Atomic Energy Commission work effort.

In 1973, Watertown Arsenal radiation safety personnel surveyed the concrete pad where the actual uranium burning occurred. Their investigation revealed a significant amount of contamination on the pad and a need for a more comprehensive survey of the area.

The survey report for Building 421 was published in February 1980. The Department of Energy plans to survey the area north of Arsenal Street and the pads of Buildings 34 and 41 during 1980.

WINCHESTER ENGINEERING AND ANALYTICAL CENTER
(Northeastern Radiological Health Laboratory)
Winchester, Massachusetts

Site Function

This facility, built in 1952 under sponsorship of the Atomic Energy Commission, was used to continue developmental work in the extraction of uranium from ore. The work was begun in 1942 by the Massachusetts Institute of Technology at Cambridge, Massachusetts, and continued at the Watertown Arsenal, Watertown, Massachusetts, from 1946 to 1950. This developmental work in the preparation of metal grade UF_4 was continued by the American Cyanamid Company at Watertown Arsenal until October 1952 and then at the Winchester facility until 1954. From 1954 until 1961, this development was continued at the Winchester facility by the National Lead Company under the Atomic Energy Commission Contract AT(49-6)-924. In 1961, the work was discontinued and the facility was transferred to the Department of Health, Education and Welfare for use as a low-level environmental radiation surveillance laboratory and for analysis of radiopharmaceuticals.

Site Description

The site property, approximately 5.8 acres, is located at 109 Holton Street in Winchester, Massachusetts. Original facilities included a one-story masonry building used for administration and laboratory space, a solvent storage building, and a corrugated metal building for pilot-scale projects. These are unchanged except for some renovation to facilitate the low-level radiation studies. Two metal frame warehouses were added to the property to accommodate Food and Drug Administration programs.

Owner History

The Winchester Engineering and Analytical Center, as the facility is now known, is Government-owned and is operated by the Food and Drug Administration, Public Health Service, Department of Health, Education and Welfare (now known as the Department of Health and Human Services).

Radiological History and Status

Cleanup operations were conducted in 1960, and in 1961, most of the equipment was removed from the site. When the site was transferred to the Department of Health, Education and Welfare in 1961, a survey was conducted by the Bureau of Radiological Health. All areas were decontaminated and radioactive materials were disposed of through commercial carrier.

On January 25, 1977, representatives of the Oak Ridge National Laboratory concluded that no personnel safety problems or limitations for present operation existed, and that further radiation surveys were not warranted. Oak Ridge National Laboratory recommended further measurements in the area where some minor quantities of pitchblende residues are believed to exist on the site if future plans for this facility involve this area.

It was determined that, at the time of the 1960 cleanup, approximately 50 drums of low-grade uranium-bearing ore removed from the site might have been disposed of at the Woburn landfill in Woburn, Massachusetts. The site was surveyed by the Department of Energy, state authorities, and Oak Ridge National Laboratory in October 1979. No radiation above background was detected.

The Winchester facility is currently operating under Nuclear Regulatory Commission licenses 20-08361-01 and SNM-688. Surveys are routinely conducted to ensure compliance with Nuclear Regulatory Commission regulations (Title 10, Code of Federal Regulations, Part 20).

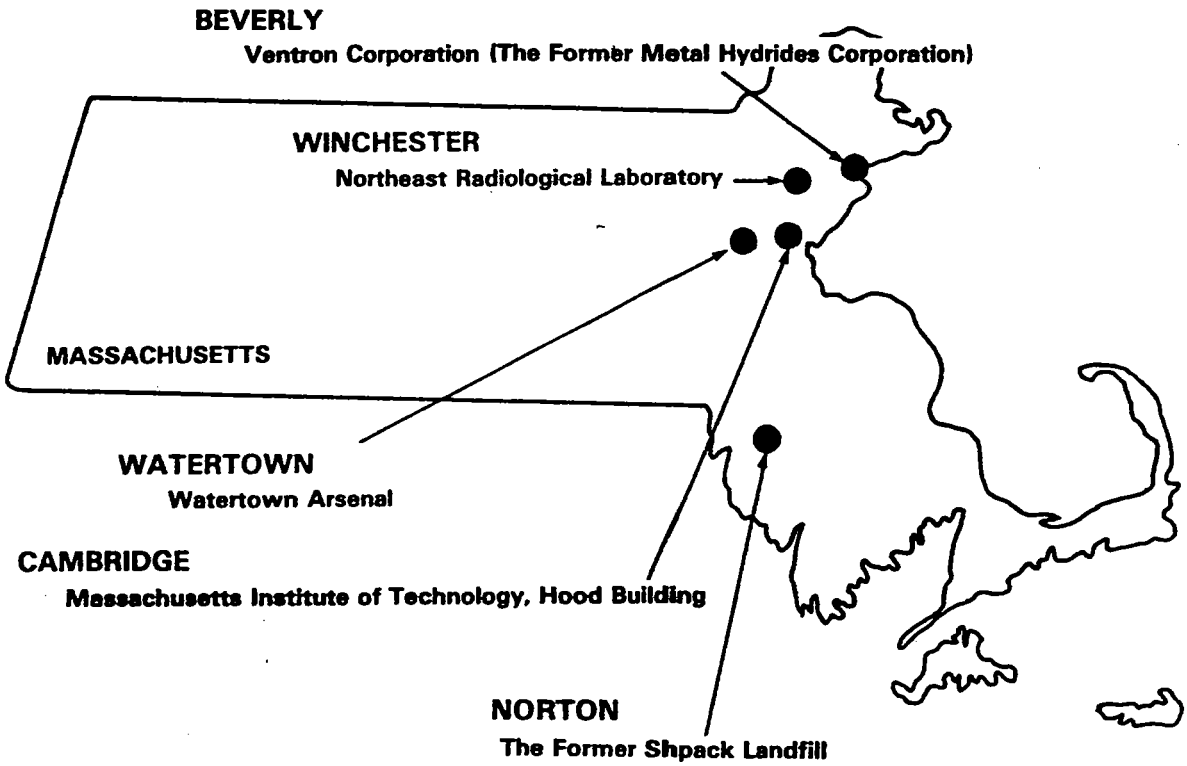

Figure 16. Formerly Utilized Sites in the State of Massachusetts

GENERAL MOTORS CORPORATION
(The Former Bridgeport Brass Company)
Adrian, Michigan

Site Function

From 1953 to 1962, the Bridgeport Brass Company operated a Special Metals Extrusion Plant in Adrian, Michigan, to produce material for fuel elements for production reactors at Hanford, Washington, and Savannah River, South Carolina. Uranium processed at the plant included depleted, natural, and up to 2.1 percent enriched uranium. The work was performed under Contract AT(30-1)-1405.

In 1962, the operation ceased in Adrian, and one of the two extrusion presses used was shipped to Reactive Metals, Inc.*, in Ashtabula, Ohio, and put into operation there. The other equipment was dismantled and scrapped. The disposition site of the material is unknown. At the present time, the facility is being used by General Motors, Chevrolet Manufacturing Division, for manufacturing operations.

Site Description

The complex covers 17.4 acres. Approximately 40,000 square feet of building plus surrounding land was subject to contamination.

Owner History

The plant was sold to Martin-Marietta following the completion of the Bridgeport Brass Atomic Energy Commission work. It was used by that company until 1974 when it was sold to General Motors.

Radiological History and Status

The building was first decontaminated in 1962. In May 1976, when General Motors Corporation learned of the plant's radiological history, it performed a radiological survey of the facility and found residual amounts of uranium in the areas originally devoted to the Atomic Energy Commission work. In July 1976, General Motors Corporation decontaminated the building by vacuuming dust, scraping and chipping floors, and removing contaminated stack ducts. In all, eight steel drums containing dust and solid debris and six stack ducts were shipped to National Lead Company of Ohio for disposal.

In August 1976, Oak Ridge National Laboratory surveyed the building and found some remaining contamination on the floor and the south wall. General Motors personnel subsequently decontaminated these areas and the

* Reactive Metals Inc., now called RMI Extrusion, uses the press under Nuclear Regulatory Commission License SMB-602.

site was resurveyed by Oak Ridge National Laboratory in March 1977. All areas except a sump were found to be decontaminated. General Motors Corporation scraped the sump and flushed it with water. Oil, water, and sludge from the sump were sampled and found to be below the limits specified by the Nuclear Regulatory Commission.* In March 1979, the Department of Energy expressed concern about uranium residue that might exist below floor level. The areas of concern were floor pits under two large extrusion presses. Upon removal of the presses, these pits and other subfloor level trenches were filled and covered with concrete. Based on information obtained by representatives from Oak Ridge National Laboratory who visited the Adrian plant in March 1979, it was recommended that core drillings be made through the existing concrete floor to the original surfaces of sumps, holding tanks, extrusion press pits, water troughs, and drain lines to measure radiation levels and obtain samples of scale, sediment, concrete, etc. The samples were obtained in April 1979. Preliminary results indicate that the samples were contaminated. General Motors was notified of these preliminary findings in June 1980. The determination regarding the need for additional decontamination will be made after the Department and General Motors have reviewed the analysis report.

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

Figure 17. Formerly Utilized Sites in the State of Michigan

MALLINCKRODT, INC.
(The Former Mallinckrodt Chemical Works)
St. Louis, Missouri

Site Function

In April 1942, the Army requested Mallinckrodt Chemical Works to set up an industrial-scale process to produce uranium dioxide and uranium trioxide. Mallinckrodt had the process operating by early summer 1942. The company was the sole source of purified natural uranium compounds until well into 1943 and processed all of the uranium used in the world's first self-sustaining nuclear reaction on December 2, 1942, at the University of Chicago. Mallinckrodt provided uranium compounds and uranium metal for use in the research, development, and production programs of the Atomic Energy Commission. Work also included (1) production of uranium tetrafluoride (UF_4), (2) production of uranium derby metal (subsequently vacuum recast to form purified ingot metal), (3) machining of uranium metal rods for reactor fuel slugs, (4) reversion of uranium tetrafluoride to UO_2 or U_3O_8, (5) recovery of scrap uranium metal, (6) production of UO_2F_2, (7) extraction and concentration of thorium-230 from pitchblende raffinate, and (8) experimental processing of very low enrichment UF_4. The St. Louis Airport Storage Site was used for storage and disposal of residues from Mallinckrodt's St. Louis operation. By the conclusion of Mallinckrodt's 24 years of uranium-processing work in 1966, the company had processed over 100,000 tons of purified natural uranium products at facilities in St. Louis and Weldon Spring, Missouri. Contracts with Mallinckrodt included W-14-108-Eng-8, AT-(23-2)-44, W-7405-Eng-1, W-7405-Eng-8, W-7405-Eng-13, and W-7405-Eng-29.

Site Description

Mallinckrodt leased portions of two locations (Broadway Street (main plant and Plant 4) and Destrehan Street) to the Manhattan Engineer District, primarily for the processing of uranium concentrate. From 1942 through 1945, uranium processing was done exclusively at the Broadway Street location, and some uranium metallurgical research continued at Plant 4 through 1956. From 1945 to 1957, uranium ore or concentrate was processed in buildings at the Destrehan location. In 1957, all operations at Destrehan were terminated and transferred to a new Atomic Energy Commission feed material processing center that Mallinckrodt operated in Weldon Spring, Missouri. About 20 existing buildings on the Mallinckrodt property at Broadway and Destrehan, plus their surroundings, were subject to radiological contamination. Figure 18 shows the general location of the facility in St. Louis.

Owner History

The subject property is owned and operated by Mallinckrodt, Inc. (formerly Mallinckrodt Chemical Works).

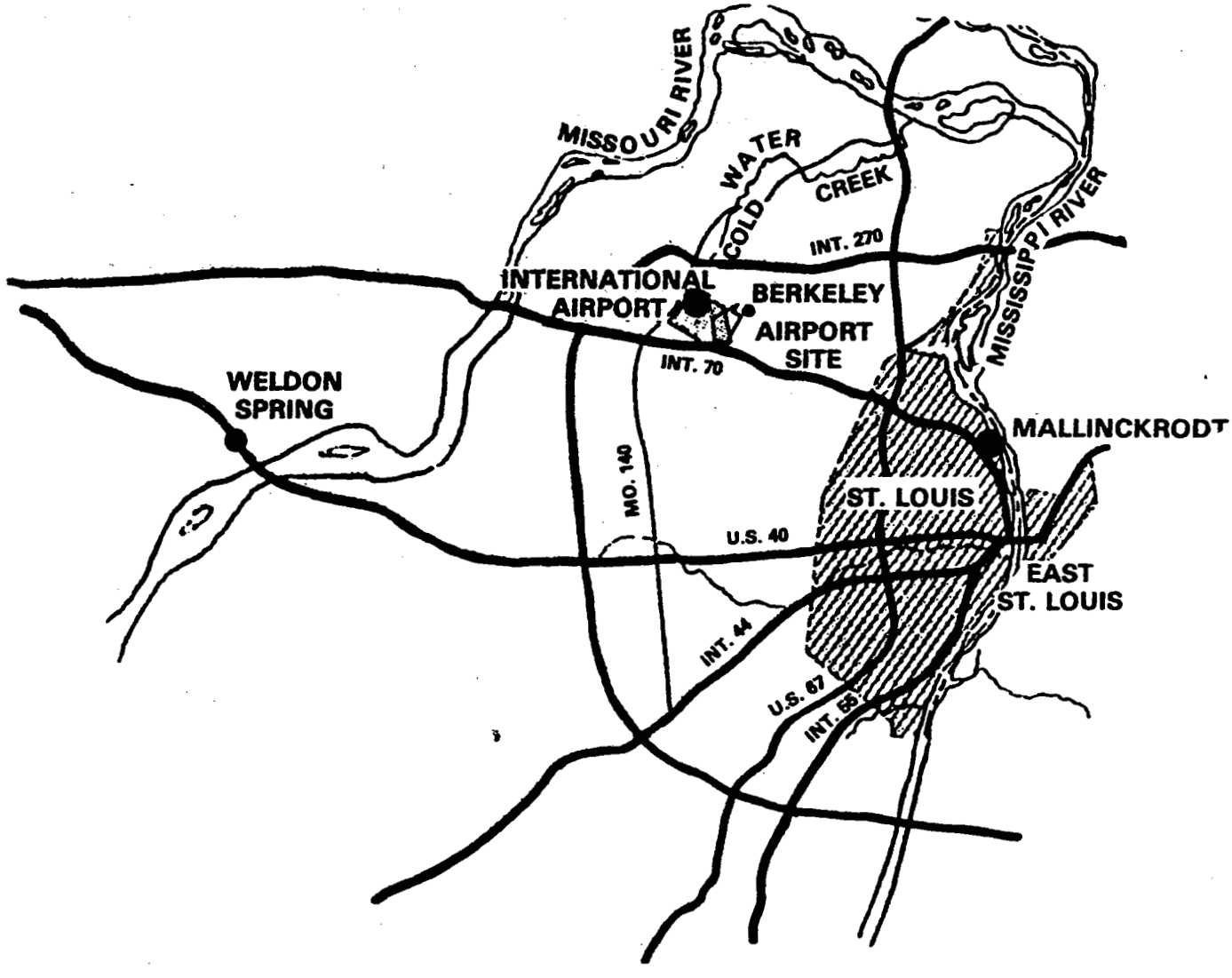

Figure 18. Location of Mallinckrodt Property

Radiological History and Status

From 1948 to 1950, the main plant property was decontaminated, and final decontamination surveys were performed. In 1951, the main plant property was returned to Mallinckrodt for unrestricted use. Between 1957 and 1962, the Destrehan properties and Plant 4 were also decontaminated, surveyed, and released for unrestricted use. In the process, some of the buildings were removed to the Atomic Energy Commission waste disposal sites. Contaminated earth was also removed and backfilled. Decontamination wastes, scrap, and rubble from these operations were buried at the west end of the St. Louis Airport Storage Site and also deposited in an abandoned quarry at Weldon Spring. Decontamination procedures were supervised by the New York Operations Office early in the program and by the Oak Ridge Operations Office during the Destrehan and Plant 4 decontamination. The Atomic Energy Commission decontamination activities did not reduce radioactivity levels to background but reduced them to prevailing permissible levels for unrestricted use.

Oak Ridge National Laboratory conducted a new radiological survey of the former uranium processing areas during the summer of 1977. Alpha and beta-gamma contamination levels inside and outside some of the buildings were above limits set by current Federal guidelines concerning the release of property for unrestricted use.* Elevated external gamma radiation levels were measured at some outdoor locations and in some of the buildings. Quantities of uranium in an amount that may require licensing were found in soil at some places, and the concentration of uranium in one water sample taken from an old waste pit was in excess of Federal standards.** Radon and radon-daughter concentrations in three buildings were in excess of current Federal guidelines for nonoccupational radiation exposure.

On February 15, 1980, the Office of Environment notified the Office of Nuclear Energy that the Mallinckrodt, Inc., site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

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* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

** Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

ST. LOUIS AIRPORT STORAGE SITE
St. Louis, Missouri

Site Function

The site was used as a storage area for waste generated by the Mallinckrodt Chemical Corporation during its uranium processing operations from 1946 to 1953. This waste or residue was stored at the site until 1967.

Site Description

The storage site is a 21.7-acre tract of land in St. Louis County, bordered on the north and east by Brown Road, on the south by the Norfolk and Western Railroad and the Airport, and on the west by Coldwater Creek.

Owner History

This site was acquired by the Manhattan Engineer District in 1946. Since 1965, access to the site has been controlled by the Airport Manager, thus barring casual entry. A permit, dated November 10, 1969, authorized the St. Louis Airport Authority to enter upon, use, and occupy the site for the purpose of undertaking certain decontamination work. The city of St. Louis Airport Authority acquired this site from the Atomic Energy Commission through General Services Administration (GSA) transfer (deed GS-06-DR-(5)-9-0085), effective June 8, 1973. The deed contains a restriction on the use of the property because residual radioactive materials remain onsite.

Radiological History and Status

The Atomic Energy Commission conducted a radiation survey of the Airport Site in 1965. Contamination was found on structures and at various locations and depths within the soil. During 1966 and 1967, residues were sold for processing and removed from the site. The removal of the residue resulted in decontamination of the site, restoring it to a condition where the radiation level at the ground surface was less than 1 mrad/hour except for an area where barium sulfate residue was located. This area was about 3 mrad/hour.

The St. Louis Airport Authority agreed to decontaminate this property as stated in the acquisition permit, dated November 10, 1969. An agreement with the Federal Government required that the barium sulfate residue be removed to an interim storage site at Weldon Spring, Missouri, and that all structures onsite except the fence be razed. Also, a minimum of 1 foot of clean fill was to be placed over the entire site. This work was performed during the period from January 1969 through December 1969 under procedures developed and monitored by the St. Louis Health Department as approved by the Atomic Energy Commission.

In January 1970, a radiation survey identified radiation levels above background at 11 points. Additional fill (2 to 3 feet) was placed over these areas to achieve acceptable radiation levels.

The Atomic Energy Commission conducted another radiation survey in November 1971 to document radiation levels over the entire site. Ground surface dose rates were generally less than 0.05 mrad/hour. Certain isolated areas were found to exceed 0.2 mrad/hour and were documented. No area was found to exceed 1 mrad/hour.

During the week of November 14, 1976, Oak Ridge National Laboratory performed a comprehensive survey of the site to characterize the existing radiological status of the property. The survey report indicated that the contaminated soil in the western section of the site represents a potential source of radiation exposure. At the time when some of the stored material was sold and removed, some remaining barium sulfate cake residue was covered with fill. At the present time, most of the contamination remains covered with earth in varying thicknesses; however, this earth cover has eroded up to 3 feet in some places. In one small area of the western section, above-background readings were obtained in numerous places. Samples of soil were collected from various points within the site and, at 26 points, a concentration of radium-226 was found to be in excess of the maximum level for background concentrations observed in Missouri. An analysis of groundwater revealed measurable quantities of several nuclides. Radionuclide analysis of surface water and sediment samples showed levels near background in most cases.

The St. Louis Police Department is planning to develop this site for use as a driver training course, with due consideration to the restrictions in the deed. The Nuclear Regulatory Commission has also proposed that contaminated material from the formerly licensed Latty Avenue* property located in Hazelwood, Missouri, be relocated to the airport site. The Department of Energy is evaluating the environmental and engineering impacts of this proposal.

On October 26, 1979, the Office of Environment notified the Office of Nuclear Energy that the St. Louis Airport site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

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* Latty Avenue is a former uranium processing site that is under the jurisdiction of the Nuclear Regulatory Commission.

WELDON SPRING SITE*
St. Charles County, Missouri

Site Function

The Department of Energy's Weldon Spring site consists of two separate properties. One of these properties is the raffinate pit area, which contains four pits constructed and used for the storage of wastes generated from the adjacent Atomic Energy Commission Uranium Feed Materials Plant (the plant area is now controlled by the U.S. Army). Mallinckrodt, Inc., operated this plant for the Atomic Energy Commission from 1957 until 1966. Some processing of thorium residues was also performed at the plant. The other property is an abandoned quarry located approximately 4 miles southwest of the raffinate pit area. The quarry was first used by the Atomic Energy Commission in 1959 when drummed residues containing about 3.8 percent thorium were dumped there. In 1963 to 1964, approximately 50,000 cubic yards of uranium- and radium-contaminated rubble from the demolition of the Destrehan Street plant were deposited in the quarry. Additional drummed thorium residues containing about 3 percent thorium were deposited in the quarry in 1966. During the decontamination of several of the buildings selected for herbicide production in 1967, the Army deposited approximately 6000 cubic yards of contaminated and unrecoverable material in the quarry. (The herbicide production proposal was later put aside.) Prior to the Atomic Energy Commission, the Army also used the quarry for disposition of trinitrotoluol-contaminated rubble during the operation of the Weldon Spring Ordnance Works Plant.

Site Description

The raffinate pit area occupies approximately 51 acres and is totally surrounded by Army property. Pits 1 and 2 are filled with residues within 3 feet of the top of the levees and Pit 3 is approximately 78-percent filled with residues. The residue fill in Pit 4 is quite irregular with about 10 percent of the total pit volume consumed. Approximately 70 percent of the residues discharged to Pits 1, 2, and 3 were neutralized raffinates from refinery operations. The remaining 30 percent of the residues consisted primarily of washed slag residues from the uranium metal production operation. In addition to some uranium residues similar to those in Pits 1, 2, and 3, Pit 4 contains raffinate solids from the processing of thorium recycle materials. Some minor amounts of thorium are also present in Pit 3. The raffinate pit area is fenced with standard 7-foot chain-link cyclone fence topped with three strands of barbed wire. Access to the pits is obtainable solely through the road system and security gates of the Army-owned areas.

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* This site is a DOE-owned Surplus Facility. It is included in this report because it was formerly utilized by the Atomic Energy Commission for processing activities.

The abandoned quarry consists of approximately 8 acres and is located between Missouri State Route 94 and the Femme Osage Creek in a relatively remote location. The main quarry hole area is about 2 acres with about 1/2 acre consisting of a pond or sump. The quarry is fenced with a 7-foot cyclone fence similar to the raffinate pit area, and signs are clearly posted indicating the presence of radiological material. The general location of Weldon Spring with respect to other Missouri sites is shown in Figures 18 and 19.

Owner History

In 1956, approximately 220 acres of the original Weldon Spring Ordnance Works Plant were acquired by the Atomic Energy Commission from the U.S. Army for use as a uranium feed materials plant. The Atomic Energy Commission acquired the abandoned quarry in 1958, also from the Army. After the Feed Materials Plant was shut down in 1966, the Army reacquired the land and facilities, except for the 51-acre raffinate pit area and the quarry, to use portions of the plant facilities for the production of herbicide orange. However, the project was never implemented and the property was declared excess in 1970. The General Services Administration determined that the land could not be released because of the degree of radioactive contamination. Both the raffinate pit area and the quarry are under the control of the Department of Energy, but the remainder of the property is still under Army control.

Radiological History and Status

Since about 1967, the National Lead Company of Ohio, under contract with Oak Ridge Operations Office, makes periodic visits to the raffinate pit area for environmental control sampling. Necessary security and maintenance such as fence repair and grass-cutting is performed, under agreement, by the Army personnel located onsite. The pits are uncovered and represent a potential quicksand hazard; however, access is restricted by the 7-foot fence and the area is completely enclosed within the boundary of a U.S. Army facility. Beta-gamma radiation measurements at a point about 1 foot above the sludge were above background. Air samples taken around the pits have shown no short- or long-lived airborne activity that could be attributed to the pits. Test holes drilled in the area have shown neither lateral seepage of effluents nor selective migration of radionuclides from the raffinate pits. Data obtained from the analyses of samples of effluents and storm drainage from the pit area indicate that uranium and other radiological contaminate concentrations are within Nuclear Regulatory Commission concentration guides for uncontrolled areas.*

The Department of Energy is currently negotiating with the Cotter Corporation of Canon City, Colorado, for the removal of the raffinates from the pits. An Environmental Assessment, DOE/EA-0031, has been prepared

* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

covering the transfer of title of the raffinates to the Cotter Corporation. The Department is also investigating other alternatives for disposition of the raffinates and pits.

Data obtained from samples collected by National Lead of Ohio at the quarry in 1975 and 1976 indicate that uranium and thorium concentrations in the quarry pond are above background but within Federal guidelines for water in controlled areas.* Water in the Femme Osage Slough, although at lower levels, is also above background, and this appears to confirm the existence of a hydraulic connection between the quarry and the Slough. Samples of incoming water to the St. Charles waterworks well field indicate that no contamination of the well field exists; however, due to the proximity of the well field to the quarry and the Femme Osage Slough, contamination could be a matter of potential concern.

Some form of remedial action is required at this site. Removal of the raffinate from the pits (possibly by Cotter Corporation for reprocessing) is required and may be followed by decontamination of the pits themselves. The disposition of the quarry must also be addressed. Meanwhile, monitoring of the site will continue, and a radiometric aerial survey is planned for fiscal year 1980.

The Department of the Army has requested that the Department of Energy accept the transfer of the 169-acre Weldon Spring Chemical Plant as they have neither the funds nor the expertise to decontaminate the property. The Department of Energy is evaluating the proposal along with other options.

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

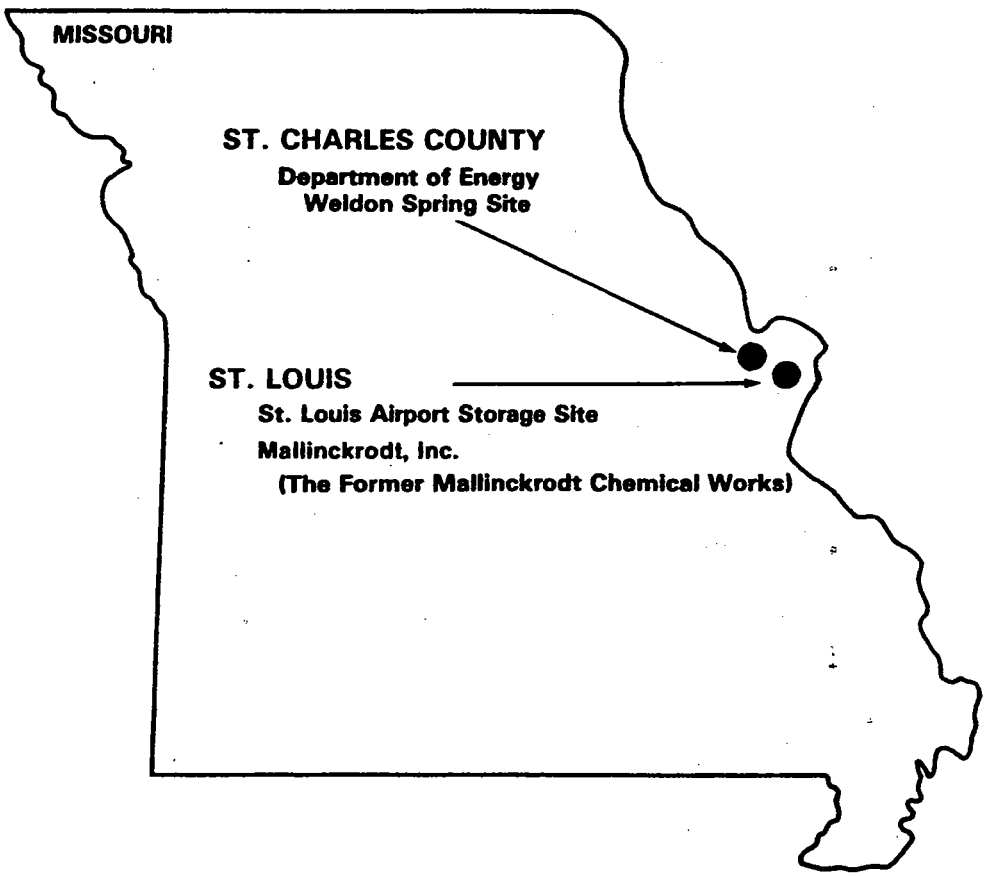

Figure 19. Formerly Utilized Sites in the State of Missouri

UNIVERSITY OF NEVADA,
MACKEY SCHOOL OF MINES
Reno, Nevada

Site Function

The University of Nevada conducted developmental studies involving beneficiation of low-grade uranium ore and extractive metallurgy for recovery of uranium on laboratory and unit process scales. The work was conducted under Contract AT(49-1)-624.

Site Description

Room 12, in the Mackey School of Mines building was apparently the primary facility used in conducting the developmental studies. This facility is now used as a chemical engineering instructional laboratory. The disposition of the low-grade uranium ore studied is unknown.

Owner History

The area utilized under this contract was, and still is, part of the University of Nevada.

Radiological History and Status

Chicago Operations Office and Argonne National Laboratory personnel visited this facility to conduct a screening survey. No contamination resulting from Manhattan Engineer District or Atomic Energy Commission activities was identified. The site is currently operated under license. A final determination regarding any subsequent activity at the site is pending; however, based on the data collected to date and the fact that this site is under license, no further Department of Energy action at this facility is likely.

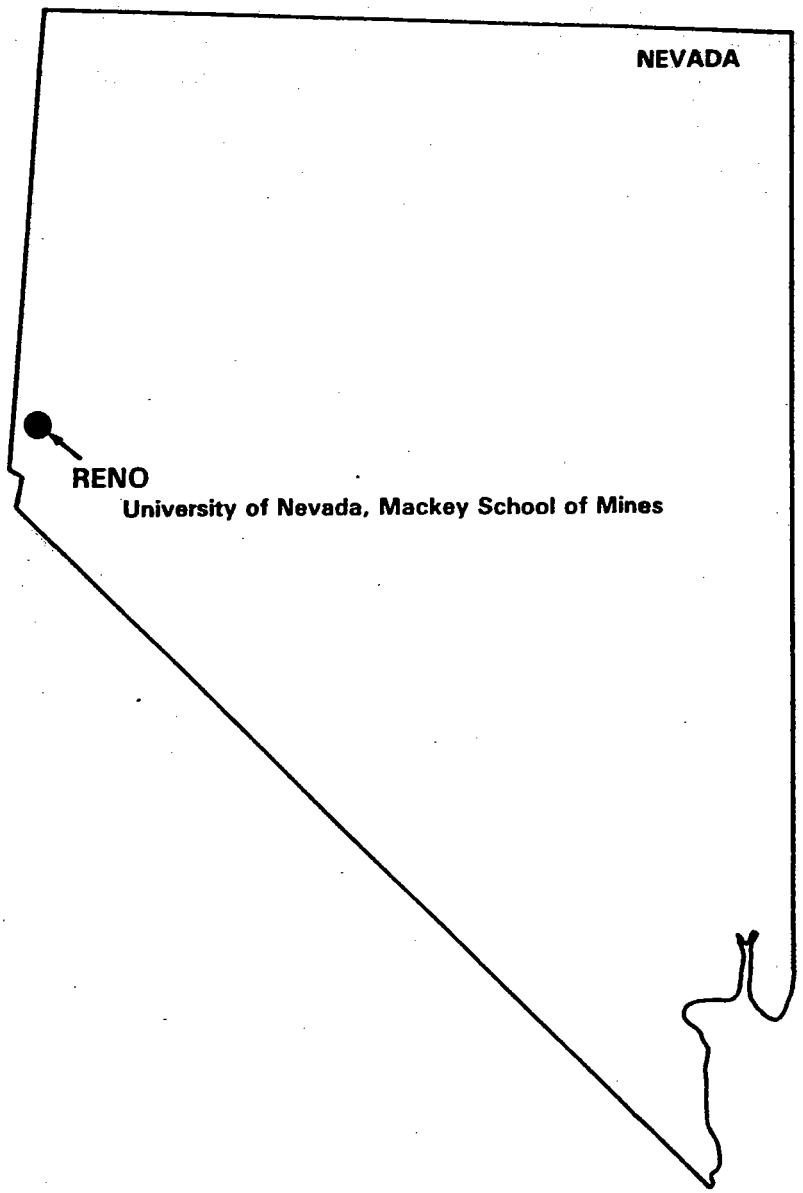

Figure 20. Formerly Utilized Sites in the State of Nevada

E.I. duPONT de NEMOURS AND COMPANY
Deepwater, New Jersey

Site Function

Early in 1942, prior to the establishment of the Manhattan Engineer District, DuPont was experimenting with uranium hexafluoride under contract to the Office of Scientific Research and Development. When the Manhattan Engineer District was chartered, it took over the Office of Scientific Research and Development contracts. The records indicate that DuPont operations for the Manhattan Engineer District included development of a process for converting uranium oxide to uranium tetrafluoride, production of uranium peroxide from Manhattan Engineer District scrap, production of uranium tetrafluoride, production of uranium metal, production of uranium hexafluoride, and various related research activities. Contracts with the Manhattan Engineer District under which this work was performed included W-7412-Eng-3, W-7412-Eng-10, W-7412-Eng-22, and W-7412-Eng-151. Uranium production ceased late in 1947, and decontamination and radiological survey activities for the site were conducted in 1948 and early 1949.

Site Description

This site is referred to as the Chambers Works of DuPont. The Chambers Works covers 700 acres and is in both Pennsville and Penns Grove Townships. It is located on the north shore of the Delaware River near the Delaware Memorial Bridge and is adjacent to the residential community of Deepwater. The Manhattan Engineer District activities took place on the Pennsville portion of the property. Three buildings were involved in the Manhattan Engineer District activities: Buildings J-16, 708, and 845.

After its release to DuPont, Building J-16 was demolished and several feet of earth were removed. A new building, designated J-26, now stands at this location.

A portion of Building 708 was demolished and removed from the site in 1945, and the remainder was removed along with several feet of earth in 1953. Since the demolition and removal of this building, a parking facility has been constructed at this location.

Building 845 is a four-story structure and is currently used as a warehouse. A portion of the Chambers Works is used as a low-level radioactive material burial facility possibly containing a few pieces of equipment from the demolished buildings used for the Manhattan Engineer District operations. The burial facility was approved by the State of New Jersey. Material from the demolished buildings is stored at the burial site.

Owner History

The site is owned by the E.I. duPont de Nemours and Company.

Radiological History and Status

The last portion of the site used for the Manhattan Engineer District was released to the contractor in November or December 1948. Oak Ridge National Laboratory indicated that all contaminated equipment was removed and taken to the Atomic Energy Commission's portion of the Lake Ontario Ordnance Works, Lewiston, New York. Building decontamination was conducted under the direction of the Atomic Energy Commission and included sandblasting, vacuuming, and washing of all building surfaces. A radiation survey was made by the Atomic Energy Commission and the buildings were subsequently released to DuPont.

A radiological resurvey of the Chambers Works site was conducted by Oak Ridge National Laboratory in March 1977. The final radiological report was completed in December 1978. Elevated concentrations of uranium were found in residues from the operations building and in some surface and subsurface soil samples. Alpha and beta-gamma contamination levels in some areas of the operations buildings were above the limits of Nuclear Regulatory Commission surface contamination guidelines* for the release of property for unrestricted use. Under current use conditions, the radiation levels measured will not cause employees to receive exposures appreciably different from those due to background radiation. On February 7, 1980, the Office of Environment notified the Office of Nuclear Energy that the Deepwater, New Jersey, DuPont site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

THE FORMER KELLEX CORPORATION
Jersey City, New Jersey

Site Function

The M.W. Kellogg Company established the Kellex Corporation in 1943 for the purpose of designing and constructing the first gaseous diffusion uranium enrichment plant (K-25 and later K-27) under a 1942 Manhattan Engineer District contract (W-7405-Eng-23). The work continued to July 1952 and included research and development of PUREX fuel reprocessing and component testing with uranium hexafluoride. Other contracts included W-28-094-Eng-73 (technical services), AT-30-1-GEN-169 (solvent extraction process for recovery of uranium and other byproducts from the wastes in storage at Richland, Washington; effective June 1, 1947), AT(30-1)-848 (application of new solvent processing techniques to pitchblende ore and/or other uranium feeds or residues; recovery of uranium from various low-grade wastes; effective January 31, 1950), AT(30-1)-850 (gas decontamination studies and decontamination of waste streams; effective February 6, 1950), and AT(30-1)-812 (no information available). In August 1951, the Vitro Corporation of America assumed all the rights and obligations of the Kellex Corporation. Apparently, any work related to uranium was discontinued at the Jersey City site late in July 1952.

Site Description

The Kellogg Company site was located at the intersection of New Jersey Route 440 and Kellogg Street. This site consisted of approximately 43 acres with more than 20 buildings. Apparently, all of Kellex's operations were conducted in Building 11. The building contained laboratories, offices, weighing facilities, toilets, change rooms, and a shielded counting room. In 1953, Building 11 was demolished, leaving only the concrete pad. All of the original buildings have since been demolished, and some of the Building 11 concrete pad has been covered with fill dirt. The disposition of the rubble from these demolished buildings is unknown.

A shopping center is under construction on a part of the site that has already been decontaminated. There are plans to use the remainder of the site for a housing project scheduled to begin in March 1981.

Owner History

Some acreage of the Kellogg site has been sold and portions of the site are occupied by various businesses. A Pathmark supermarket is located near the south end of the property, and new buildings are under construction in the central portion of the site. The site where the Kellex Corporation research facility was located is currently owned partially by Delco-Levco and partially by Pierpont Associates, Inc.

Radiological History and Status

On June 25, 1953, the Vitro Corporation of America prepared a contamination status report that detailed the findings of a radiation survey of Building 11 undertaken by the Kellex Laboratory. This report identified external gamma radiation readings that were above background, but no transferable alpha or beta-gamma contamination was observed in any of the accessible areas.

Representatives from Oak Ridge Operations Office and Oak Ridge National Laboratory conducted a site visit and screening survey on October 21, 1976. The survey revealed gamma ray readings in the background range. However, due to the size of the property and uncertainty as to the exact location and extent of Kellex operations, it was decided that a formal survey should be conducted.

Oak Ridge National Laboratory personnel performed the formal survey on March 28 to 30, 1977. The survey indicated that levels of radioactivity were indistinguishable from background with the exception of a few isolated and well defined spots on or near the site of the former Kellex Laboratory (Building 11). On October 15, 1979, the Office of Environment notified the Office of Nuclear Energy that the former Kellex Research Laboratory site required consideration for remedial action. At the request of the Department of Energy, an environmental evaluation and an engineering plan were prepared by the Envirosphere Company.

Efforts to decontaminate the site were begun in July 1979 and, in the process of the remedial action, some additional contamination was discovered. Decontamination efforts were extended to cover the additional areas. Remedial action has been completed at the Delco-Levco portion of the property. Efforts are continuing at the Pierpont portion of the property.

THE FORMER MIDDLESEX MUNICIPAL LANDFILL SITE
Middlesex, New Jersey

Site Function

This area is a former landfill for the Borough of Middlesex. The landfill was used for disposal of nonradioactive wastes from the Middlesex Sampling Plant. However, during the operation of the Sampling Plant, some contaminated wastes were shipped to the landfill. There is no documented material to indicate when the residual radioactive material was transported to the landfill; however, a review of operating files from 1946 to 1966 indicates that the most probable time frame was between November 1947 and October 1948. Construction of a drainage ditch and paved storage area took place during this period. It is believed that the material may have been deposited at the landfill by a contractor during this construction effort. It has been estimated that about 6000 cubic yards of material were involved.

Site Description

The contaminated area consists of approximately 3 acres of a 37-acre unimproved landfill. The Middlesex Presbyterian Church is the closest building to the contaminated area and is more than 200 feet away. Figure 21 shows the location of this facility in Middlesex.

Owner History

Five acres of the landfill were bought by the Middlesex Presbyterian Church after the 1961 Atomic Energy Commission cleanup action. The rest of the landfill site remains the property of the Borough of Middlesex. The contaminated portion is approximately half on Church property and half on Borough property.

Radiological History and Status

In May 1960, during a local civil defense exercise, monitors detected elevated radiation levels in the landfill. Upon analytical confirmation of the presence of pitchblende, a further survey of the area was made. Readings taken at that time confirmed gamma radiation levels 20 to 50 times background over an area of less than 1/2 acre.

Following meetings with local officials in November 1960 to discuss the significance of survey findings and to offer remedial assistance, the Atomic Energy Commission removed the part of the material nearest the surface (about 650 cubic yards). The area was covered with about 2 feet of clean dirt sufficient to shield surface radiation levels to about 50 microroentgens/hour. The contaminated soil was removed to the Atomic Energy Commission New Brunswick Laboratory site. Upon receiving assurance by the Atomic Energy Commission that no health hazard existed,

Borough officials agreed that the situation was satisfactory. No official record of the original deposition of the residues at the landfill exists in available Borough records. On January 30, 1974, another meeting was held with Borough officials to request permission to resurvey the involved area to permit re-evaluation of current conditions. Location of the suspect area was confirmed by survey data.

As a result of the survey findings, the following conclusions were made:

(1) The contaminated area in its present configuration and use presents no significant radiation exposure potential to the public. This should be the case as long as the area is undisturbed by excavation or the construction of habitable enclosures.

(2) The exposure of individuals to levels at or exceeding Nuclear Regulatory Commission guide levels is possible under circumstances that could exist if the area were developed in the future with residences or other habitable structures.

The Oak Ridge National Laboratory conducted additional survey and assessment work during 1978. That survey supported the earlier conclusion that no radiological hazard exists under present conditions of usage.

During the period May 20 to 27, 1978, EG&G, Inc., under contract to the Department of Energy performed an aerial survey of Middlesex. The survey revealed no new contaminated areas related to the landfill. In April 1978, Ford, Bacon & Davis Utah Inc. completed an engineering evaluation and environmental analysis of options for various remedial actions at this site. The options range from stabilization of the contaminated material onsite to removal of all contaminated material until background radiation levels are achieved and backfilling to present topography with clean fill is completed.

Over the years, the contaminated soil from the Sampling Plant has become mixed with other soil and landfill debris. Based upon the engineering evaluation, the contaminated portion involves a volume of between 34,000 to 69,000 cubic yards of soil. There has been additional sanitary landfill activity since the radioactivity was dispersed in the landfill. An estimated 16,000 to 21,000 cubic yards of nonradioactive soil and debris currently covers the contaminated soils. In terms of weight, this amounts to 46,000 to 93,000 tons of contaminated soil or debris and 22,000 to 28,000 tons of uncontaminated overburden.

The Office of Environment notified the Office of Nuclear Energy that this site requires consideration for remedial action. The Office of Nuclear Energy is currently evaluating the remedial action options presented in the engineering evaluation.

THE FORMER MIDDLESEX SAMPLING PLANT
(Perry Warehouse)
Middlesex, New Jersey

Site Function

This facility, also known as the Perry Warehouse, was used for sampling, weighing, assaying, and storing uranium and thorium ores. The uranium sampling operations were conducted between November 1943 and February 1955. The bulk of the Belgian Congo uranium ores and other uranium ores used by the United States was handled at this site. The residue from the processing of these ores was temporarily stored at Middlesex prior to its return to the vendor.* The site was also used as an interim holding site for disposition of various research-related and decontamination wastes. Following the termination of the uranium sampling operations, the primary Atomic Energy Commission activities at the plant involved the sampling and storage of thorium materials and residue. All Atomic Energy Commission operations were terminated in September 1967 with the conclusion of the decontamination activities, performed under Contract AT(40-1)3637 and certification of the site for unrestricted use.

Site Description

The Middlesex Sampling Plant facility includes six buildings on 9.6 acres. The area is protected by a 6- to 7-foot-high chain-link fence. The underground storm drainage for the plant runs north to south emptying into a 20-foot-wide (0.345-acre) easement leading to a drainage ditch and marsh area. The sewage system for the warehouse, process building, and office building consists of a sediment tank and septic tank. The east side of the facility borders on fields and some garden areas. The west side borders an industrial site. The property to the south is marshy land and fields. The main entrance to the facility (Mountain Avenue) is on the north side. The north side also borders the Lehigh Valley Railroad right-of-way property. Figure 21 shows the location of this site in Middlesex.

The soil of some portions of the adjacent and nearby properties, especially along the south border, contains residual radioactive material. Two nonadjacent private properties have also been identified as having soil contaminated with radioactive ore from the former Middlesex Sampling Plant:

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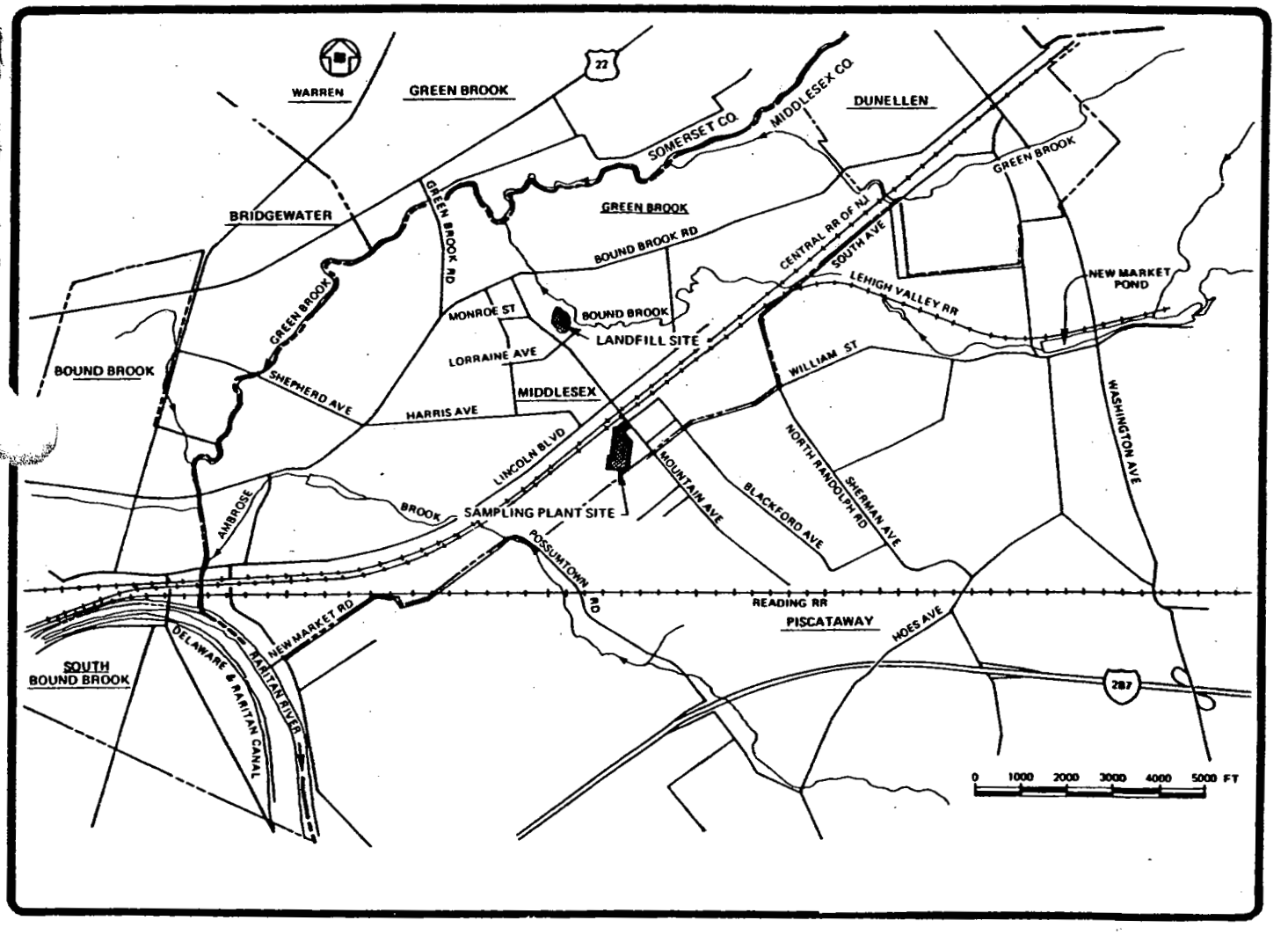
*According to the terms of the contract, the residue containing radium and other precious metals still belonged to the vendor (African Metals, Inc.). In many cases, this residue was shipped to other Federal facilities such as the Atomic Energy Commission portion of the former Lake Ontario Ordnance Works (now the Department of Energy Niagara Falls Storage Site) for long-term storage.



Source: Ford, Bacon & Davis Utah Inc.

Figure 21. Location of the Middlesex Municipal Landfill Site

- A region in the vicinity of the rectory of the Our Lady of Mount Virgin Catholic Church at 650 Harris Avenue, Middlesex, New Jersey.

- The private residence at 432 Williams Street, Piscataway, New Jersey.

It was also determined that the Middlesex Municipal Landfill contains residual radioactive material from the sampling plant; however, it is being treated as a separate site.

Owner History

At the request of the Manhattan Engineer District, the North Atlantic Division Engineers leased the first portion of the Sampling Plant property from American Marietta Company on November 1, 1943. Supplements to the lease were issued on May 15, 1945, and June 27, 1945, to include additional properties. Procedures for Government purchase of the property were initiated on March 8, 1946, and the judgment of stipulation filed on June 15, 1950, made the Sampling Plant the property of the Federal Government. Easement rights for required drainage were obtained following the judgment. The property was transferred to the Atomic Energy Commission after its formation in 1946. On February 12, 1968, the Atomic Energy Commission officially reported the property as excess real property. The General Services Administration transferred the property to the Department of the Navy, U.S. Marine Corps, on January 3, 1969. The Marine Corps formerly used the property for their 6th Motor Transport Battalion reserve training. Through an agreement established in 1978, the Department of Energy agreed to be custodian of the site and contracted National Lead Company of Ohio to maintain it.

As a result of sampling plant operations, several private properties became contaminated. To date, all but two (those at Harris Avenue and Williams Street) are contiguous with the site property.

Radiological History and Status

Prior to transfer of the site to the General Services Administration as excess property, the Atomic Energy Commission contracted with Isotopes, Inc., to decontaminate the site. The Atomic Energy Commission conducted a follow-up survey and additional decontamination was performed. This included sandblasting, vacuuming, detergent and acid washing, concrete chipping, equipment removal, and, in cases of severe contamination, building member removal. Waste was transported by rail to the Nuclear Fuel Services licensed burial site at West Valley, New York. On September 2, 1967, upon completion of decontamination, Oak Ridge Operations Office certified the site for unrestricted release.

Oak Ridge National Laboratory resurveyed the site in April 1976 and offsite areas subject to contamination due to wind and water transport in May 1976. The radiological surveys included measurements of residual alpha

and beta-gamma contamination levels, radon, and radon-daughter concentrations in buildings, external gamma radiation levels, and radium concentrations in the soil.

Surface contamination levels on the former plant site exceeded the Nuclear Regulatory Commission guidelines*, and radon concentration levels exceeded the nonoccupational maximum permissible concentration** in some structures. These results indicate the possible need for extensive radon and radon-daughter measurements in structures both onsite and offsite.

An aerial survey was conducted for the Department by EG&G, Inc., between May 20 and May 27, 1978, and followup ground surveys were performed by Oak Ridge National Laboratory. The two additional properties that are not contiguous with the sampling plant were identified (see Site Description section) as having been contaminated by material handled at the Sampling Plant.

Ford, Bacon & Davis Utah Inc. prepared an engineering evaluation to determine options and costs for remedial action at the Sampling Plant and associated properties. The evaluation indicated that remedial actions at the sampling plant and associated properties might require removal of 54,000 to 77,000 cubic yards (81,000 to 113,000 tons) of soil and building materials. This estimate includes soils from adjacent and nearby private properties including the Williams Street lot and the Harris Avenue lot but does not include the material in the Municipal Landfill site.

On September 28, 1979, the Office of Environment notified the Office of Nuclear Energy that the Former Middlesex Sampling Plant site required consideration for remedial action. The Department of Energy has proposed a two-stage remedial action at this site. The plan would entail the cleanup of all offsite contaminated property and interim storage of the contaminated material onsite until a disposal site is identified at which time the entire site would be decontaminated. The Office of Nuclear Energy has drafted preliminary plans that schedule the remedial action to begin in 1980 and prepared, in conjunction with New Jersey, a cooperative agreement between the Department of Energy, New Jersey, and the Borough of Middlesex. The agreement was signed in December 1979. The National Environmental Policy Act process has been completed (September 1979) for remedial actions at the Williams Street and Catholic Church properties, and remedial actions are scheduled to begin in 1980. A National Environmental Policy Act review is in progress for the other associated properties.

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* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

** Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

NEW BRUNSWICK LABORATORY*
New Brunswick, New Jersey

Site Function

This facility was originally established in 1948 for official assay of nuclear material for the Government and development of methods for this work. The laboratory analyzed small samples of uranium ores and concentrates, nuclear fuels, thorium, uranium oxide, uranium fluorides, uranium metals, plutonium, and other materials.

Initially, this facility was located in a relatively isolated part of New Brunswick. However, industrial expansion into the area limited the possibility for expansion of the laboratory, and the increased population and traffic made security more difficult to maintain. As a result, the New Brunswick Laboratory functions were transferred to the Argonne National Laboratory, Argonne, Illinois, which offered the facilities required for expanded activities and the necessary safeguards.

The plutonium operations at the New Brunswick Laboratory facility were terminated in July 1972. The remaining uranium operations were transferred to Argonne in the spring of 1977.

Site Description

The New Brunswick Laboratory facility proper was a 44,000-square-foot area located on 4.7 acres of land south of Jersey Avenue about 1.5 miles from the center of New Brunswick, New Jersey (population about 40,000). There were essentially four separate complexes of buildings at the site.

Owner History

This facility has been the property of the Department of Energy or the Atomic Energy Commission since its establishment in 1948.

Radiological History and Status

The New Brunswick Laboratory has been operated with adequate safeguards throughout its operation; however, portions of the buildings have become contaminated and, as a result, require decontamination and, in some cases, demolition. Excavation of a portion of the land at the railroad spur will also be required during the decontamination effort. This is necessary to remove the 650 cubic yards of contaminated soil deposited at the New

*This site is a surplus facility owned by the Department of Energy. It is included in this report because it was used for Atomic Energy Commission activities.

Brunswick Laboratory site following a decontamination effort at the Middlesex Municipal Landfill Site in late 1960 and early 1961. Argonne National Laboratory conducted subsurface investigations and surveys at this site from May to June 1980. Preliminary survey data indicates that the volume of contaminated soil is substantively greater than the amount of residue deposited at the site, probably due to dispersion and mixing.

This facility is scheduled for decontamination and decommissioning pending identification of suitable disposal sites for residue from remedial actions and completion of the radiological characterization of the site.

PRINCETON UNIVERSITY,
PALMER PHYSICAL LABORATORY
Princeton, New Jersey

Site Function

During the 1940s, scientists at Princeton performed several functions for the Manhattan Engineer District and the Atomic Energy Commission. The basement of Palmer Physical Laboratory housed experiments on uranium isotope separation. One project used a machine known as the "isotron" and involved very small research quantities (gram amounts) of natural uranium. Another used a cyclotron and involved approximately 20 to 30 pounds of natural uranium, mostly in the form of uranium oxide, and a small amount in the form of uranium metal. In Frick Chemical Laboratory, also on the Princeton campus, experiments were aimed at development of diffusion barrier material for the gaseous diffusion enrichment process. This work did not involve uranium. Frick personnel also sampled and assayed African uranium ore for the Federal Government. However, available records do not specify whether this work was performed in Frick Lab, Palmer Lab, or the Middlesex Sampling Plant.

Site Description

The site consists of the basement of Palmer Hall (23 rooms, cyclotron area, and corridors) and the Frick Chemical Laboratory.

Owner History

The site is owned and operated by Princeton University.

Radiological History and Status

Following an initial site visit by Chicago Operations Office and Argonne National Laboratory personnel on September 28, 1976, Princeton's Health Physics Officer conducted probe and smear surveys on three floors of Frick Laboratory. All results were negative. Palmer Laboratory was surveyed from January 6 through February 11, 1977. Low-level contamination was found in five areas of the basement, concentrated along pipe trenches, floor joints, and cracks. Removable contamination was found in only one area; this contamination was verified by spectral analysis as uranium. The levels encountered did not represent a radiation hazard to occupants of the rooms. However, Princeton expressed concern that a hazard could arise if substantial renovations of the building were undertaken in the future.

In 1977, in order to unequivocally eliminate any concern with a potential radiation problem, Princeton contracted with ATCOR, Inc., Park Hill, Peekskill, New York, to conduct a survey and perform any required decontamination of the facility. The work was completed in August 1977, and a final radiological survey was performed and completed on August 29, 1977, by the Bureau of Radiation Protection of the New Jersey State Department of Environmental Protection. The Bureau reported that the site was adequately decontaminated.

THE FORMER VITRO LABORATORIES, VITRO CORPORATION
West Orange, New Jersey

Site Function

At this site, Vitro performed work that involved conversion of low enrichment uranium dioxide to uranium carbide spheres. Apparently, there were two contracts involving two levels of enrichment, 3.68 percent and 4.9 percent. Vitro also conducted work under contract to the Oak Ridge Operations Office for the separation of fission products. The facility was operated in the late 1950s and early 1960s.

Site Description

The original site covered approximately 3 acres. The radiological operations were carried out on the second floor of the Vitro building. The building was destroyed, and a tennis club occupies the site.

Owner History

The site was initially owned and operated by Vitro Laboratories, Division of the Vitro Corporation. It is now owned by the West Orange Tennis Club, Inc.

Radiological History and Status

On November 30, 1977, personnel from Oak Ridge National Laboratory and Oak Ridge Operations Office visited the site. Onsite measurements and samples collected showed only background levels except for one soil sample having an elevated thorium-232 concentration. Because of the nature of the Vitro operations, it is unlikely that their work was the cause of the reading. Thus, no residual radioactivity traceable to Atomic Energy Commission operations was detected at the site. There is no indication of where the demolition wastes were stored.

Oak Ridge National Laboratory has prepared a letter report on this site and has concluded that although radiation levels onsite are within background levels, an effort should be made to locate operational records, building rubble, and equipment associated with the site project. Any subsequent Department of Energy activity at the site will be based on a review of the findings to date.

WESTINGHOUSE ELECTRIC CORPORATION
Building 7
Bloomfield, New Jersey

Site Function

From 1941 to 1943 at its Bloomfield, New Jersey, facility, Westinghouse developed a photochemical technique to produce uranium metal using uranium oxide or nitrate and potassium fluoride. The process was used to produce limited quantities of uranium. (Under the best weather conditions with good sunlight, the process could produce 1 ton/month.) The green salt produced by the reaction was electrolyzed to yield uranium metal that was subsequently cast into discs, Tuballoy, pellets, and ingots. Five Westinghouse/Manhattan Engineer District contracts were identified and include W-7407-Eng-2 (LYTMET, August 1, 1942); W-7407-Eng-132 (equipment, December 18, 1943); W-7409-Eng-31 (thorium metal, August 8, 1944); W-7405-Eng-312 (chemistry of uranium, date unknown); and W-7505-Eng-312(2) (Micronex-development of high speed X-ray tubes and circuits, date unknown). LYTMET presumably refers to the photochemical uranium production. It is unknown whether the other contracts pertain to work performed at the Bloomfield facility.

Site Description

Only Building 7 was used in the Manhattan Engineer District work. Uranium processed on the roof was pipe fed to the basement laboratory for purification. The pipe was stripped from the facility, along with other process equipment, at the conclusion of the Manhattan Engineer District work. The disposition of this material has not yet been determined.

Owner History

The facility is owned and operated by the Westinghouse Electric Corporation.

Radiological History and Status

The known or suspected areas involved in the Manhattan Engineer District work were surveyed by Oak Ridge Operations Office and Oak Ridge National Laboratory personnel on October 21, 1976. Several surface areas were found to be contaminated slightly in excess of Nuclear Regulatory Commission guidelines.* Subsequently, Westinghouse decontaminated these areas at their own expense and resurveyed the area. Although radioactivity levels reported showed no health hazards, certain basement and connecting sub-floor piping plus some loading dock support members were still

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

contaminated above the guidelines. Long-term control of the contaminated components in case of future demolition was recommended. Either the Nuclear Regulatory Commission or the State of New Jersey, or both, may implement the necessary long-range controls. Westinghouse indicated that, upon its formal request, the Nuclear Regulatory Commission will amend the existing license covering thorium research to include the Manhattan Engineer District contaminated areas of Building 7.

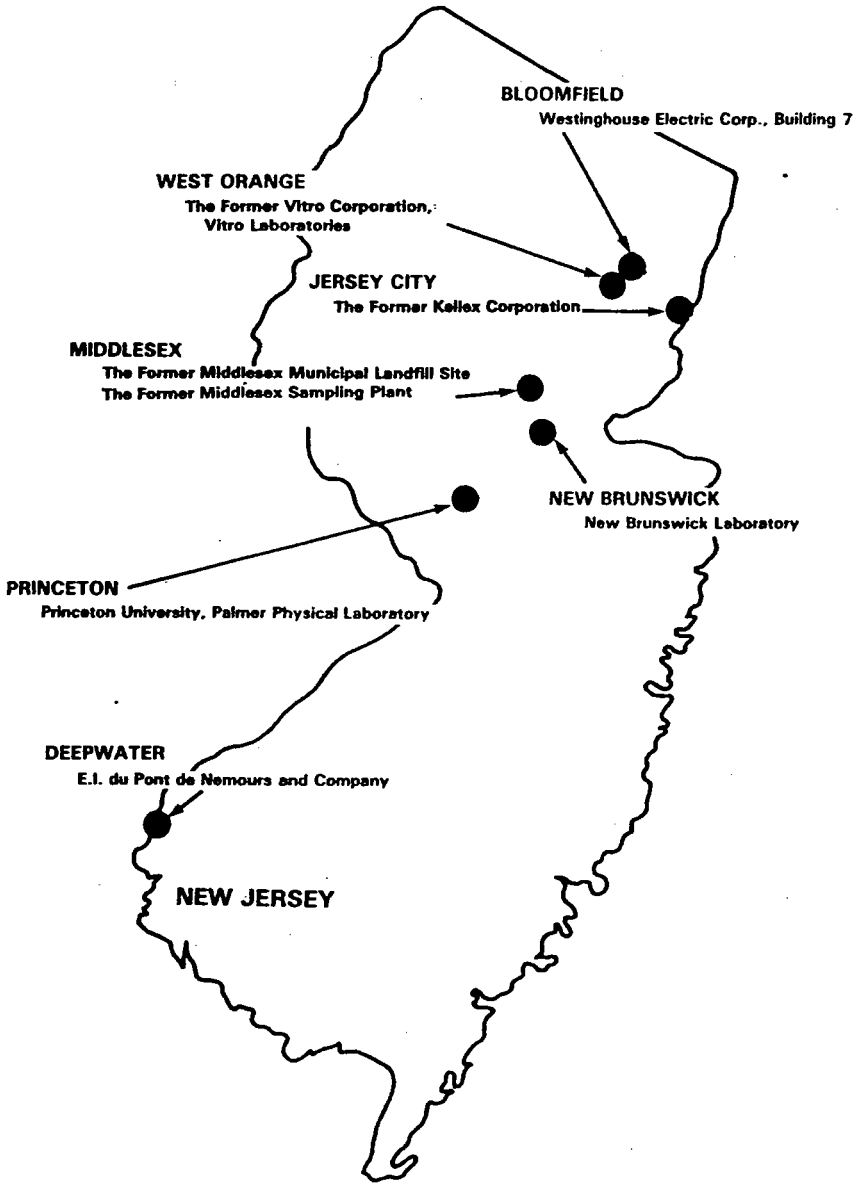

Figure 22. Formerly Utilized Sites in the State of New Jersey

ACID AND PUEBLO CANYONS
Los Alamos, New Mexico

Site Function

These deep canyons were the discharge area for untreated radioactive liquid wastes resulting from research and processing at the Los Alamos Scientific Laboratory between 1943 and 1951. Starting in 1951, treated radioactive effluents were discharged into the canyon from Technical Area 45, the liquid waste treatment facility that operated until 1964.

Site Description

The Technical Area 45 waste treatment plant was sited on the mesa forming the south side of Acid Canyon. Acid Canyon is a deep canyon cut into soft volcanic rock and is a tributary to Pueblo Canyon. Intermittent streams ultimately flow into the Rio Grande.

Acid Canyon is located in Tract L and Parcel I, Eastern Area No. 3. Pueblo Canyon is located in Parcel I, Eastern Area No. 3 and Pueblo Canyon Parcel, Eastern Los Alamos County Tracts and Parcels.

Owner History

Acid Canyon and Pueblo Canyon were transferred to the incorporated county of Los Alamos, subject to recognition of an easement with the Atomic Energy Commission. This easement was generally a 100-foot-wide strip along the stream channel. The right of access was to permit the construction and operation of test wells and to permit the collection of earth and water samples. The property was transferred by a Quitclaim Deed on July 1, 1967.

Radiological History and Status

Liquid effluents discharged into the canyons from 1943 to 1964 contained plutonium, americium, and fission products. The first survey of Acid Canyon, for purposes of cleanup, was made on August 31, 1965. In October 1966, work commenced on removing the Technical Area 45 structures (waste treatment facility). Five hundred truckloads of demolition debris and dirt from this location were removed to the contaminated waste dump within the currently operational Los Alamos Scientific Laboratory site. Ninety-four loads of debris from Acid Canyon were also placed in the contaminated waste disposal area. This decontamination activity included the removal of all drain pipes, wires, rocks, tuff, and other debris found contaminated in Acid and Pueblo Canyons. This work was completed in 1967, and it was reported that a small amount of contamination remained in inaccessible places.

Some radioecological and environmental surveillance evaluations have been completed and documented for Pueblo Canyon. Several hundred soil and sediment samples were collected for the most recent radiological survey

conducted in 1977. Data showed that some limited areas at the Technical Area 45 site and in the canyons exceed the Environmental Protection Agency proposed soil screening guides for plutonium concentrations. Measurements of penetrating radiation showed no areas that exceed radiation protection standards. A radiological survey report and an engineering evaluation are being prepared.

BAYO CANYON AREA
Los Alamos, New Mexico

Site Function

The Bayo Canyon site, or Technical Area 10, was used by the Los Alamos Scientific Laboratory between 1944 and 1961. Technical Area 10 was a firing site for experiments using conventional high explosives and radioactive sources in conjunction with nuclear weapons development. A radiochemical separations laboratory was also located at the site.

Site Description

This site now includes unexcavated portions of a solid waste disposal pit and sump for liquid wastes. A number of buildings were located in this canyon but all physical facilities were removed or demolished by the end of 1963.

Owner History

The Bayo Canyon site was transferred to the incorporated county of Los Alamos by Quitclaim Deed on July 1, 1967, for unconditional use.

Radiological History and Status

There were numerous high explosives detonations at this site. Many of the explosive assemblies contained a lanthanum-140 source. The source frequently amounted to several thousand curies. Although lanthanum has a relatively short life, all of the sources contained a small but unavoidable amount of strontium-90 contamination, and therefore much of the canyon area became contaminated with this beta-emitting material. The source preparation building and several surrounding buildings, much of the plumbing, and waste pits were contaminated with strontium-90. Some of the first structures to be cleared in Bayo Canyon were released on February 8, 1960. On March 13, 1960, seven structures were burned at four different locations in the canyon with the residue removed for burial. The small solid waste disposal pit and a sump for liquid wastes were excavated. Material from the waste disposal pits and underground pipes were removed to the contaminated burial area on Mesita Del Buey (also located on the Los Alamos Scientific Laboratory site). These were dug out to a depth of approximately 15 feet at which level the radiation reading was still above background. The holes were filled with clean dirt resulting in the surface's being left at background radiation levels. All contaminated objects on the surface of the canyon were picked up, and an intensive search was made for material throughout the area. This entire area was inspected and a final report, dated August 19, 1963, stated that the area was free of significant radioactive contamination and did not present a health hazard.

The Bayo Canyon area was resurveyed periodically using portable radiation survey instruments. No positive readings were encountered. Samples that were collected as part of the routine environmental surveillance program and other special studies showed no hazardous conditions.

A field radiological survey and evaluation of this area was conducted during 1976-1977, including collection of more than 1200 samples of surface and subsurface soils. Results showed that there was strontium-90 contamination at levels higher than could be attributed to worldwide fallout. Subsurface soil samples revealed high gross beta activity with the highest levels being several meters below the surface. Measurements and theoretical evaluations show that no exposures in excess of Federal radiation protection standards* are being received by the public under present or projected land use.

A radiological survey report has been published and an engineering evaluation is being prepared. On February 7, 1980, the Office of Environment notified the Office of Nuclear Energy that the Bayo Canyon site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

CHUPADERA MESA
White Sands Missile Range, New Mexico

Site Function

This site is near the location of the Trinity Site atomic bomb test (White Sands Missile Range, New Mexico) conducted in 1945.

Site Description

This area is a portion of the fallout zone of the explosion outside the boundaries of White Sands Missile Range. Much of Chupadera Mesa is being used as grazing land; further north the land is primarily used for growing alfalfa and assorted row crops.

Owner History

The site was and continues to be primarily private lands with multiple ownership.

Radiological History and Status

The University of California, Los Angeles, conducted the first radiological survey during 1947 to 1950. Thousands of soil and biological samples were obtained. From 1972 to 1976, the Los Alamos Scientific Laboratory collected additional samples. In 1977, the Laboratory obtained more data around Trinity ground zero and the outlying fallout zones.

A radiological survey report (scheduled for 1980) and engineering evaluation are being prepared.

LOS ALAMOS COUNTY
(Underground Manhattan Engineer District Pipelines)
Los Alamos, New Mexico

Site Function

From 1952 to 1965, underground pipeline or industrial waste lines were used at the Los Alamos Scientific Laboratory to transport liquid wastes from Technical Area 1, Technical Area 3, Technical Area 48, and Technical Area 43 to a chemical waste treatment plant (Technical Area 45). Starting in 1963, liquid wastes from Technical Area 3 and Technical Area 48 were diverted through new underground pipes to an improved and currently operating facility at Technical Area 50. The wastes from Technical Area 43 were so diluted that they could be directed to a sanitary sewer system. Technical Area 1 was decommissioned in 1965. Thus, the need for the industrial waste lines connecting these facilities to Technical Area 45 was eliminated.

Site Description

The abandoned underground pipelines located in Los Alamos were removed by 1967 except for certain sections: (1) approximately 2250 feet of 3- and 4-inch line running from Building 700 to the northwest of the Medical Center, some of which is on government land; (2) approximately 850 feet of 6-inch line from the Health Research Laboratory Building to an old manhole on Trinity Drive (this line runs under the present west wing of the Medical Center); (3) approximately 175 feet of 4-inch line in three sections -- under Trinity Drive, along Diamond Drive, and across Canyon Road; and (4) approximately 165 feet of 8-inch line in three sections where they cross under Central Avenue, Rose Street, and Canyon Road.

Owner History

The property associated with Central Avenue, Canyon Road, and Diamond Drive was unconditionally transferred to the incorporated county of Los Alamos on July 1, 1967. The small section of acid waste line under and across from the hospital property is owned by Lutheran Hospitals and Homes Society, Inc.

Radiological History and Status

With the exception of the sections noted above, the contaminated pipelines or sewers were all dug up prior to 1967. Soil surrounding the pipe was monitored and, if contaminated, removed. The soil and presumably the pipes themselves were disposed of in the Los Alamos Scientific Laboratory contaminated waste dump. The remaining sections of pipe were capped and plugged at each end with concrete.

The pipe remaining under the west wing of the Medical Center is approximately 20 feet under the surface. When the west wing addition was built (approximately 1969), it was decided to leave this section of pipe because it was not highly contaminated and construction work on the addition did not extend to the sewer.

In 1974, Los Alamos Scientific Laboratory indicated that plans for the eventual removal of the remaining pipe sections would be made when all of the results of the surveys were available. However, it was decided in 1976 that the level of radiological contamination of the sections of the pipe could be established without a further physical survey. Therefore, in early 1977 and prior to roadwork by Los Alamos County, the Energy Research and Development Administration removed about 1100 feet of the main industrial waste lines from near the Health Research Laboratory to Canyon Road, 195 feet of the 6-inch line from the Health Research Labortory to Trinity Drive, and two manholes. A report, completed in April 1979, documents the 1977 industrial waste line removal and discusses the present contamination status. The four sections of industrial waste lines still under Los Alamos County roads (Rose, Central, and two under Canyon) are to be removed as part of a funded project to replace the entire industrial waste lines system at Los Alamos Scientific Laboratory.

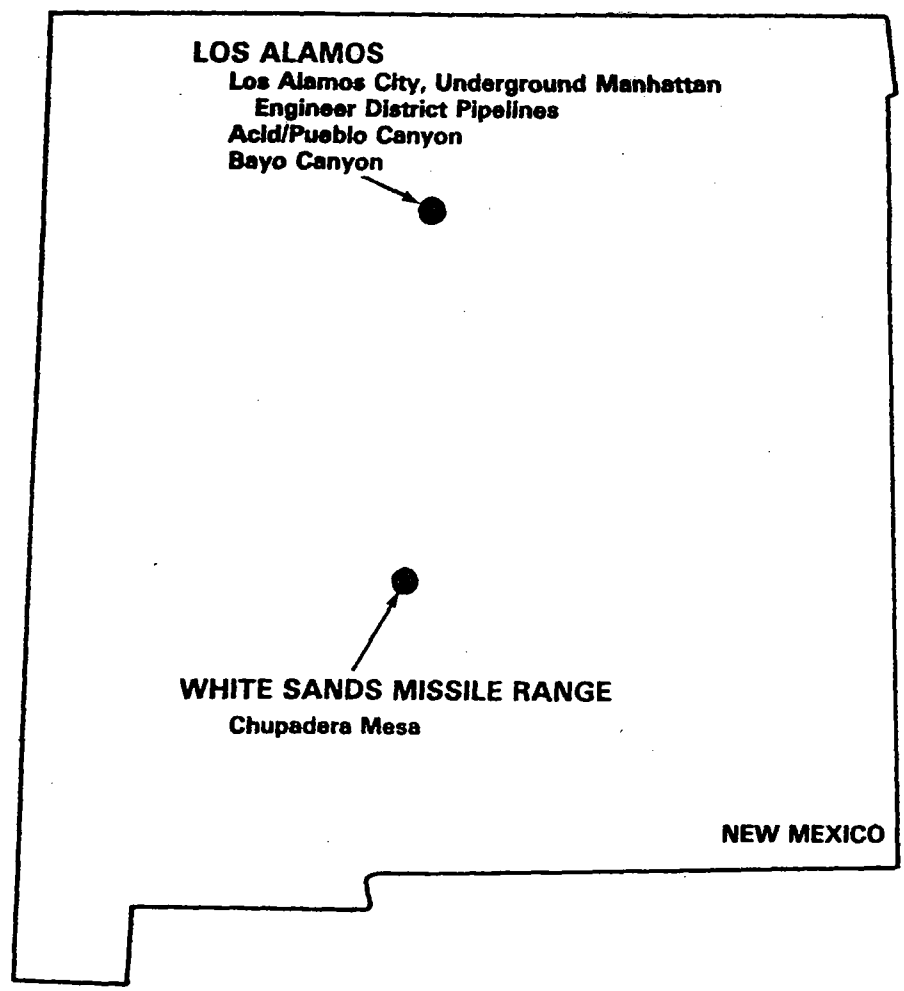

Figure 23. Formerly Utilized Sites in the State of New Mexico

AL-TECH SPECIALTY STEEL CORPORATION
(The Former Allegheny-Ludlum Steel Corporation)
Spring Street Road, Watervliet, New York

Site Function

The Al-Tech Watervliet plant was used briefly in 1950 and 1951 for the processing of uranium metal for the Atomic Energy Commission. The company, known as Allegheny-Ludlum at the time of the contract, rolled uranium billets into solid rods. The operation was on a developmental rather than a production scale. The contract called for return to the Atomic Energy Commission of all uranium-bearing material and any scrap generated in the operation. More definitive information on quantities of uranium processed is not available. The uranium operations were limited to the 14-inch rolling mill and an annealing furnace and were conducted only on weekends. Atomic Energy Commission personnel were on hand during the rolling operations and carefully vacuumed areas surrounding the rolling mill and made radiation measurements. However, no records are presently available. The primary purpose of the contract was to develop design criteria for the planned Fernald rolling mill. The 14-inch mill was removed in 1960 to a Dunkirk, New York, plant. The area where the mill operated in 1950 through 1951 is now used for metal and roller storage. The annealing furnace is still in use but could be any one of four electric furnaces. Furnace liner material was replaced several times in the interim. This material is believed to have been buried in the company disposal yard. The building housing the operation has been rearranged and expanded significantly since 1951.

Site Description

The site used for uranium processing consists of a building and surrounding property.

Owner History

The facilities are owned and operated by Al-Tech Specialty Steel Corporation, formerly Allegheny-Ludlum Steel Corporation.

Radiological History and Status

On August 19, 1976, alpha and beta-gamma survey measurements were made by Oak Ridge National Laboratory and Oak Ridge Operations Office personnel on surfaces in the involved areas. Measurements were also made in the company disposal yard. Since 1973, Al-Tech has mined the yard for metal recovery. This resulted in the resurrection of materials previously covered by many years of waste disposal, i.e., furnace liner bricks. All radiation levels measured at the plant were indistinguishable from the natural background. Because no elevated radioactivity was detected and only

uranium was handled, in a relatively nondispersible form and on a limited developmental scale, Oak Ridge National Laboratory concluded that any radioactive residue from the Atomic Energy Commission contract operation was insignificant and further surveys were not required. Although the equipment was only used for a short period of time, an effort has been made to locate the machinery used, and an equipment survey has been scheduled. A final determination regarding any subsequent activity at this site is pending; however, based on the findings to date, no further Department of Energy actions are anticipated.

ASHLAND OIL COMPANY
(Former Haist Property)
Tonawanda, New York

Site Function

The former Haist property site was used by the Manhattan Engineer District from 1943 to 1946 for uranium residue storage. The property served as a disposal site for refinery residues generated by Linde Air Products (Division of Union Carbide Corporation). Linde Air Products participated in the refinery program of the Manhattan Engineer District project.

Site Description

The former Haist property, consisting of about 10 acres, is located in a large industrial area and is several hundred yards from the nearest dwellings. There is one building, the National Fuel Gas building, located in the northeast corner of the site. This building is occupied no more than a few hours a week. Surface water normally drains from the Haist property in small streams that merge and run off onto the Seaway Industrial Park, continues north for nearly a mile through an industrial zone, and then drains into the Niagara River.

Owner History

On June 25, 1943, 10 acres known as the Haist property were leased for the Federal Government by the Manhattan Engineer District. The District purchased the property from L.H. Wood, K.F. Russell, E. Haist, R. Haist, and H. Haist on August 21, 1944. A perpetual easement for access (4.6 acres) was also purchased with the land. After the Atomic Energy Commission excessed this property in 1949, it was under the control of the General Services Administration until 1960. The property remained undeveloped until it was sold by the Government to Ashland Oil in June 1960. Ashland Oil subsequently built storage tanks on the site, which is adjacent to the company's petroleum refinery.

Radiological History and Status

The residues deposited on the Haist property consisted essentially of low-grade uranium residues. About 16 million pounds in dry weight of residues containing approximately 0.54 percent uranium were spread out over roughly two-thirds of the site to a depth of 1 to 5 feet.

A radiological survey of the Haist property was conducted by the Atomic Energy Commission in 1958. As a result of this survey, the property was released for unrestricted use. In 1974, Ashland transported approximately 6000 cubic yards of the residue at this site to the Seaway Industrial Park.

During the period from July 7, 1976, through August 6, 1976, Oak Ridge National Laboratory conducted a survey to characterize the existing radiological status of the Haist property. The results of this survey indicated that the residues on the site "do not pose an immediate health hazard assuming that the residues remain in place . . . and that the site continues to be used in the manner in which it is presently used." Measurement showed that the radon-daughter concentration, in the onsite building, was close to background level, and that only small quantities of radium or uranium were carried from the site in surface runoff. Because the property is located in an industrial area, the population density surrounding the site is very low, and thus, the potential for exposure in excess of Federal guidelines* is low. If the site use were changed or buildings constructed onsite, there could be an increase in exposure and a potential health hazard could result. New York State officials have been notified of these findings and have taken appropriate measures to control use in the near term.

EG&G, Inc., conducted an aerial survey of this site for the Department of Energy in September 1979. Oak Ridge National Laboratory will perform any supporting ground surveys indicated necessary by the aerial survey.

On October 29, 1979, the Office of Environment notified the Office of Nuclear Energy that the Former Haist Property site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

BETHLEHEM STEEL
Lackawanna, New York

Site Function

In 1949, in order to develop mill pass schedules for the rolling of natural uranium billets into 1½-inch rods (to be used for reactor fuel rods), the Atomic Energy Commission awarded a contract to Bethlehem Steel. The project was completed in 1951. The data developed were used in the design of a rolling mill at the Feed Materials Production Center in Fernald, Ohio. All work at Lackawanna was limited to weekends and involved only the 10-inch bar mill and associated billet preparation and handling equipment. Material accountability procedures required collection of scale, residues, and cropped ends and vacuuming of fine debris for return to the Atomic Energy Commission. Shipments were received from Mallinckrodt during the week and stored at the mill in rail cars. Following rolling, the material was bundled and shipped to the Atomic Energy Commission. The Atomic Energy Commission personnel were present during all rolling operations and apparently made radiological surveys, although no records are presently available.

Site Description

The 10-inch mill was in use for metal rolling operations during the time of the August 1976 screening survey, but has since been taken out of service and dismantled. Ancillary equipment, other than some rolls thought to have been used for uranium work, could not be located.

Owner History

Facilities are owned and operated by Bethlehem Steel.

Radiological History and Status

An alpha and beta-gamma smear survey conducted by Bethlehem Steel during May 1976 included the 10-inch bar mill and building surfaces in the area of uranium operations. No removable radioactivity was detected. On August 26, 1976, personnel from Oak Ridge Operations Office and Oak Ridge National Laboratory visited the site. They performed a screening survey while the mill was in operation. The survey included direct measurement of alpha and beta-gamma radiation levels, and no radioactivity above background levels was detected. Because no elevated radioactivity levels were detected and operations were on a limited developmental scale, they concluded that no significant radioactive residual from Atomic Energy Commission contract operations exists at the site; however, the Department of Energy has scheduled an additional screening survey of the equipment now that it is nonoperational. A final determination regarding any subsequent activity at the site depends on the results of the second survey.

COLUMBIA UNIVERSITY
New York, New York

Site Function

Columbia University was involved in nuclear research prior to the establishment of the Manhattan Engineer District. Absorption experiments to determine the feasibility of nuclear chain reactions began in 1939. In November 1940, the National Research Defense Committee contracted Columbia for additional research in this area. Columbia was a major contributor to research and development efforts throughout the early years of nuclear development under the Manhattan Engineer District and later under the Atomic Energy Commission. Research included work on isotope separation (centrifuge and gaseous diffusion), the nuclear chain reaction, and an atomic pile.

Site Description

Buildings utilized for the Manhattan Engineer District and the Atomic Energy Commission work at Columbia were Pupin, Schermerhorn, Havemeyer, Nash, and possibly Prentiss.

Owner History

All buildings are owned by the University except Nash, which was leased for Manhattan Engineer District work reportedly involving uranium hexafluoride from 1943 to 1944.

Radiological History and Status

All buildings used by the Manhattan Engineer District and the Atomic Energy Commission except Nash, are currently involved in radioactive work, licensed by the Nuclear Regulatory Commission and the City of New York, and are under continuing surveillance by the University Health Physics Office. The Environmental and Safety Engineering Division has notified the Columbia University Health Physics Office that, based upon available data and the findings of a visit by Oak Ridge Operations Office personnel, the buildings were adequately decontaminated and no radiological survey was warranted. Five buildings were investigated:

Pupin -- Used for nuclear research and storage of research quantities of radioactive material.

Schermerhorn -- Used for early "pile" research and gaseous diffusion research and development and operations of a barrier production pilot plant. There was no detectable contamination remaining.

Havemeyer -- Contains much of the University's present radiation chemistry work. Any residual contamination attributable to the Manhattan Engineer District work would be insignificant compared to the ongoing work.

Nash -- Very small scale gaseous diffusion test cascade work. No significant potential for residual contamination exists.

Prentiss -- No evidence of Manhattan Engineer District or Atomic Energy Commission experimental work being performed in this building was found. Columbia's Radiation Safety Officer made a detailed gamma survey of the building in preparation for installation of two 25-curie cesium-137 sources and observed no abnormal levels.

From the site visit and screening survey, it was concluded that contamination caused by the Manhattan Engineer District was decontaminated by the University and no additional Department of Energy actions are warranted.

DEPARTMENT OF ENERGY NIAGARA FALLS STORAGE SITE*
(Lake Ontario Ordnance Works)
Lewiston, New York

Site Function

This site was a portion of the former Lake Ontario Ordnance Works and was first used by the Manhattan Engineer District in 1944 for the storage of radioactive low-grade pitchblende residues (L-30, L-50, and R-10) from the nearby Linde refinery in Tonawanda. Following World War II, contaminated materials from wartime plants and some post-wartime operations were stored at the site. After April 1, 1949, part of the high-grade pitchblende residues (K-65) from the St. Louis refinery were stored at the site in drums and subsequently transferred to the 165-foot-high concrete silo. In the early 1950s, the site was used as an interim storage site for incoming and outgoing uranium billets. In addition, radioactive materials from the University of Rochester** and Knolls Atomic Power Laboratory** were transferred to this storage site. The Knolls' wastes were later transferred to the Oak Ridge National Laboratory burial grounds.

In about 1953, the Atomic Energy Commission operated a boron isotope separation plant at the site. The plant was placed on standby in 1958 and was restarted in 1964 and again put on standby in July 1974.

In 1958, at the termination of ore procurement contracts, 25-year storage lease agreements were negotiated with African Metals Corporation (Afrimet), the American subsidiary of Union Miniere du Haut Katanga of Brussels, Belgium (owner and supplier of Belgian Congo Ore), for the storage of its residues in four concrete structures on the site. Approximately 60 percent (12,000 tons) of the radioactive residues stored at the site belong to Afrimet. The storage lease agreements expire on July 1, 1983.

Site Description

The Department of Energy storage site currently consists of 191 acres and is located about 3 miles southeast of Youngstown, 3 miles northeast of Lewiston, and 7 miles north of the city of Niagara Falls in the county of

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* The Department of Energy still controls 191 acres of the Atomic Energy Commission portion of the ordnance work (originally 1511 acres) known as the Department of Energy Niagara Falls Storage Site.

** These facilities are currently active in nuclear research. The University of Rochester was involved in the biological effects of radiation and conducts animal research. The Knolls Atomic Power Laboratory is involved in research and development related to nuclear energy.

Niagara Falls, New York. The county has a population of over 235,000 and an area of 532 square miles. The population per square mile in the county is approximately 446. The site is dormant and the National Lead Company of Ohio is under contract to act as caretaker. The site area is very flat and poorly drained. The former Lake Ontario Ordnance Works and the area controlled by the Department of Energy (191 acres) are shown in Figure 24.

Owner History

In 1948, the Atomic Energy Commission acquired approximately 1511 acres of the former Lake Ontario Ordnance Works from the Army. In 1955, the Atomic Energy Commission declared 1298 acres excess, and, as of 1968, this acreage had been acquired by the town of Lewiston (89 acres), Fort Conti Corporation (642 acres), Mr. M.W. Frank (199 acres), Niagara Mohawk Power Company (5 acres), The Somerset Group Inc. (133 acres), and the Air Force (230 acres). In 1975, the Energy Research and Development Administration (the predecessor agency to the Department of Energy) declared a 22-acre sewage plant excess and transferred this plot to the town of Lewiston, New York, leaving the present 191-acre Department of Energy site. Since 1968, the properties of M.W. Frank were sold to S. Washuta (for proposed use as a landfill) and portions of the Fort Conti Corporation properties have been sold to Chem-Trol and subsequently to Services Corporation of America. (This property is being used for treatment and disposal of hazardous wastes.)

Radiological History and Status

In October 1970 and June 1971, radioactive surveys of the 1298 acres formerly held by the Atomic Energy Commission showed that about 6.5 acres exceeded the Atomic Energy Commission criterion of 50 microroentgens/hour including background. Decontamination was carried out in 1972 and involved the removal of about 15,000 to 20,000 cubic yards of radioactive soil and debris. This contaminated material was piled on the remaining 191-acre Atomic Energy Commission site. A final radiation survey conducted in June 1972 indicated that only a few portions of the central drainage ditch and Sixmile Creek exceeded the accepted criterion, and beta-gamma levels measured at contact were less than 0.2 mrad/hour. However, New York State did not agree that the decontamination criterion was sufficient to allow unrestricted use of the properties. As a result, the State has placed restrictions on the use of these lands.

For a number of years, National Lead Company of Ohio has periodically sampled and analyzed the groundwaters and surface waters on and around the site. No significant radioactivity has been found in surface waters, and radium-226 and uranium concentrations in well samples are substantially below levels specified in guidelines for water in uncontrolled areas. In August 1978, the Department of Energy began offsite radon monitoring, both indoors and outdoors, to supplement the site fence-line monitoring conducted by National Lead Company of Ohio. To date, the

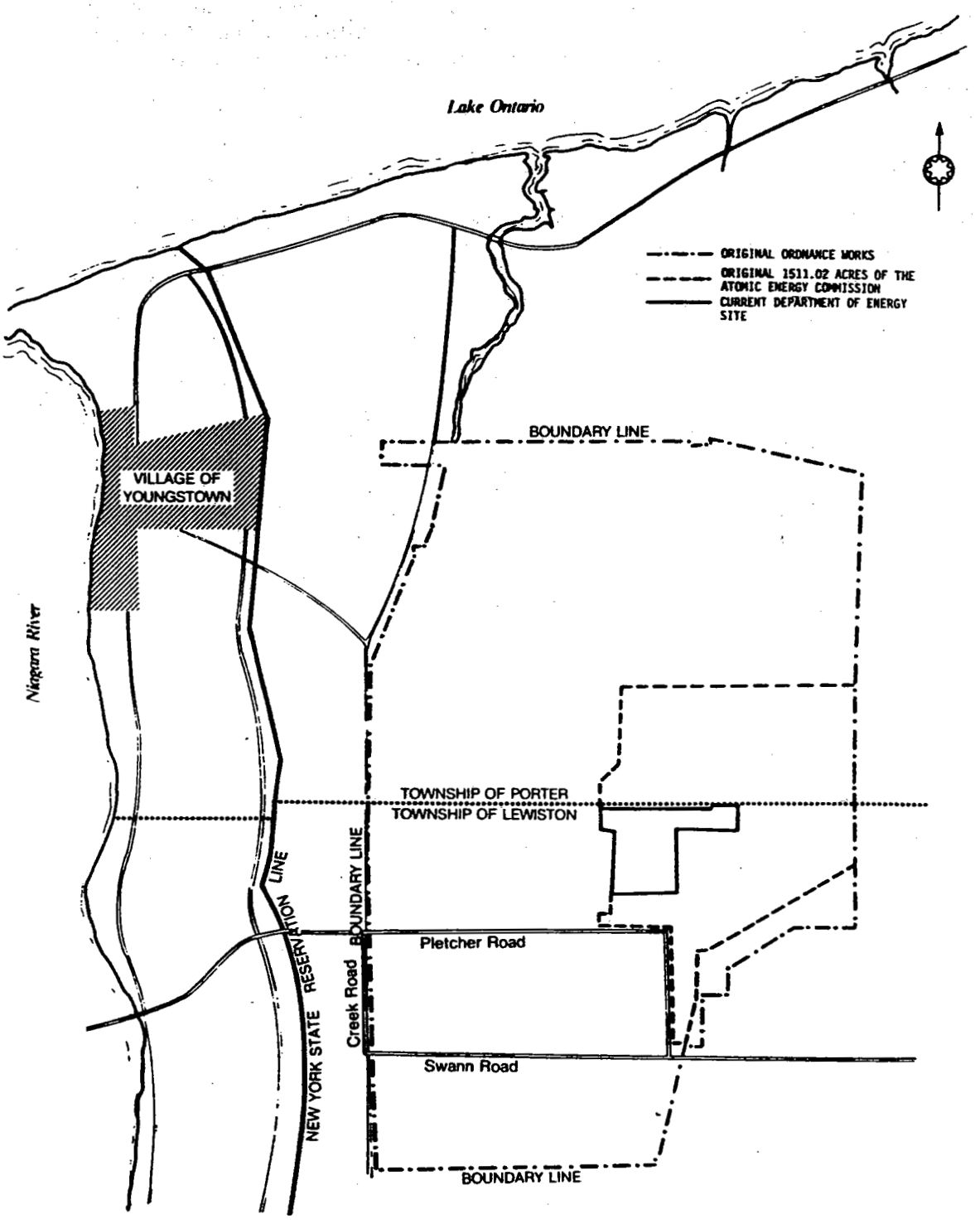

Figure 24. Former Lake Ontario Ordnance Works and the Area Controlled by the Department of Energy

average concentrations in residences neighboring the Department of Energy site are within the range of indoor concentrations found in New York City and its suburbs. The Department of Energy conducted a survey of the site in 1979 and found contamination in several locations. The Department is now evaluating a number of options for long-term disposition of the residue at this site. In the interim, remedial measures to minimize emanation of radon from the residues are being instituted and the monitoring program is being expanded. Efforts are underway to survey the ditches and decontaminate them to prevent recontamination by impounding residual radioactive material stored outside the buildings and to locate any contaminated material buried within the original Atomic Energy Commission site boundaries.

HOOKER SPECIALTY CHEMICAL DIVISION,
HOOKER CHEMICAL & PLASTICS CORPORATION
Niagara Falls, New York

Site Function

During the 1940s, Hooker entered into a contract with the Manhattan Engineer District to provide chemical processing (slag recovery) of uranium-bearing materials as a precursor to uranium recovery. These materials included furnace liners and were thought to contain enough uranium to warrant uranium recovery. The material to be processed came in wooden barrels by rail. It was deposited on a concrete pad and transported by bucket conveyor into tanks containing byproduct acid from the Manhattan Engineer District chlorinations. This reaction removed carbonates and oxides. The latter were then transferred into wooden barrels and shipped out by rail. The work was performed under Manhattan Engineer District Contract W-7405-Eng-28, dated January 4, 1943, and continued until shortly after World War II. The Manhattan Engineer District program also included the manufacture of xylene hexafluoride, xylene hexachloride, and Miller's Fluorolubricant. Five buildings were utilized for this project.

Site Description

The Hooker Chemical Company, Niagara Falls, New York, is located in an industrial area on the north bank of the Niagara River, approximately 2 miles east of Niagara Falls. All uranium operations were confined to 5.5 acres adjacent to the New York Central Railroad. Five buildings were under the Manhattan Engineer District program; however, except for the laboratory that was used for uranium analysis purposes, all of the uranium handling was done outdoors in an area adjacent to the railroad siding located north of the Manhattan Engineer District buildings. The equipment used for the uranium operations has been removed, and four of the five buildings have been outfitted for new processes. The fifth building was destroyed. Hooker plans to demolish the four remaining buildings.

Owner History

The site is owned by the Hooker Chemical and Plastics Corporation, a subsidiary to Occidental Petroleum Corporation, and was known as Hooker Electrochemical Company during the time of the Manhattan Engineer District contract.

Radiological History and Status

Oak Ridge National Laboratory personnel conducted a radiological survey of all involved areas of the Hooker plant in October 1976. The residual radioactivity levels documented in the final survey report, published in January 1977, are within current Federal and state guidelines for unrestricted use. The site was cleared for unrestricted use on September 22, 1977.

LINDE AIR PRODUCTS DIVISION,
UNION CARBIDE CORPORATION
Tonawanda, New York

Site Function

The Linde Division was under contract with the Manhattan Engineer District from 1942 through approximately 1948. Uranium and nickel production was carried out under Contract W-7401-Eng-14 (November 16, 1942) at a facility known as the Ceramics Plant (Building 30). During the first 3 years, pitchblende ore from the Belgian Congo and concentrates from the Colorado Plateau ore were converted to U_3O_8. Residues from the pitchblende processing were stored at a portion of the former Lake Ontario Ordnance Works, now known as the Department of Energy Niagara Falls Storage Site. The refinery residues from the domestic ore were moved to the nearby Haist property (now owned by Ashland Oil Company). Some liquid wastes for the refinery operation were disposed of in onsite wells. A second process yielding UO_2 was operated at the Ceramics Plant for about 1 year. A separate building (38) housed a third process for converting the UO_2 to green salt (UF_4). This process was used in conjunction with the Electromet Niagara Falls operation during World War II and for the following 2 years.

Under Contract W-26-121-Eng-46, Linde also developed and produced barrier material for the Oak Ridge gaseous diffusion plant. Other contracts have been identified, but the exact nature of the work involved is unknown: W-7401-Eng-15 (black oxide, October 17, 1942), W-17-028-Eng-29 (ore concentrate, May 4, 1945), and At-(30-1)-GEN-165 (type of material and date unknown).

Site Description

The Linde Division property is bordered on the north and east by other industries; on the south by small businesses, industries, and undeveloped land; and on the west by a golf course. Five buildings (Buildings 14, 30, 31, 37, and 38) were involved in the uranium separation process. Building 14 (now fabrication facilities, offices, and storage area) was used for small-scale development of the separation process carried out in Building 30 (now a shipping and receiving warehouse). The product from Building 30 was then transferred to Building 38 (presently a warehouse) where fluorination resulted in an end product of uranium tetrafluoride. Buildings 31 and 37 were also used in these operations. Building 37 is not being used at present. During normal working hours, there are generally 20 to 30 employees in each of Buildings 14 and 30, and 12 to 20 employees in Building 31.

Owner History

This facility is owned by the Linde Air Products Division of the Union Carbide Corporation. The Manhattan Engineer District constructed four

buildings (30, 31, 37, and 38) on land owned by Union Carbide Corporation. Union Carbide constructed Building 14 in the mid-1930s. The buildings were transferred to Linde upon termination of the Atomic Energy Commission contract.

Radiological History and Status

To determine the radiological status of the portions of the Linde facility used for Government operations, a survey was performed by Oak Ridge National Laboratory personnel from October 18 through November 5, 1976. A radiological survey report was published by the Department of Energy in May 1978. The results of the survey showed that surface contamination was present in Buildings 14, 30, 37, and 38. As part of this survey, onsite soil samples were collected. Some of the samples contained concentrations of uranium-238 and concentrations of actinium-227 exceeding background. Oak Ridge National Laboratory made attempts to obtain samples from the wells used for waste disposal; however, the wells were plugged below the surface. Alternate methods of determining the contents of the wells are being investigated.

On July 27, 1977, the Energy Research and Development Administration held a meeting at the Linde Plant to discuss the findings of the radiological survey of the Linde site with company and state regulatory officials. As a result of the meeting, the Linde Air Products Division made application for amendment to its New York State license 1983-0143 to cover the contaminated buildings. The amendment was approved by New York State.

On February 29, 1980, the Office of Environment notified the Office of Nuclear Energy that the Linde site required consideration for remedial action. Following additional investigation, the Office of Nuclear Energy indicated that the New York State license held by Linde presently provides control of the residual radioactivity on the site and requires decontamination of the facility as a condition of license termination. As a result, the Department of Energy currently has no plans for conducting remedial actions at this site in the immediate future; however, the ultimate disposition of the residual radioactive material is being evaluated.

NL INDUSTRIES, INC.
(Former National Lead Company,
Nuclear Metals Division)
Albany, New York

Site Function

In 1960, a plant at the National Lead Company, Nuclear Metals Division, was primarily devoted to the fabrication of shielding components from depleted uranium (0.2 percent uranium-235). This work was under contract to the Lockland Aircraft Reactors Operations Office. In 1961, Atomic Energy Commission contracts were in effect for the fabrication of 3.6 percent enriched uranium fuel elements for the Hallam reactor (Chicago Operations Office) and for the chemical processing of unirradiated, enriched uranium scrap (New York Operations Office).

Site Description

This site consists of a plant with process equipment that was set up to perform a variety of operations on uranium materials.

Owner History

The plant is owned and operated by NL Industries, Inc.

Radiological History and Status

Representatives of the Chicago Operations Office and the Argonne National Laboratory survey team visited the site on May 19, 1977. At that time, NL Industries personnel informed the Energy Research and Development Administration representatives that the present operations of the facility had not changed since the early 1960s except for termination of the Atomic Energy Commission work. The work at the plant is devoted mainly to fabrication of shielding components and ballast weights from depleted uranium. This work is performed under New York State license 235-0482 and is reviewed by the state agency for compliance with their license. In addition, the plant has not undergone any modification resulting in a previous radioactive area's being converted to general work areas. Any radioactivity of Manhattan Engineer District origin would be indistinguishable from the present day activities, which are regulated by New York State. Therefore, no radiological survey of the facility was performed.

SEAWAY INDUSTRIAL PARK
Tonawanda, New York

Site Function

Most of the Seaway Industrial Park has been used as a landfill for a number of years. In 1974, contaminated residue from Ashland Oil Company property was transferred to the site.

Site Description

The Seaway Industrial Park covers nearly 100 acres. This site is in an industrial area and is bounded by Ashland Oil, Inc.; Agway Fuel, Inc.; River Road; Murphy Trucking, Inc.; Leffler Auto Parts; and property owned by Niagara Mohawk Power Corporation. There are no buildings and little vegetation on the Seaway property. Most of the drainage from Seaway flows north or northeast into drainage ditches or a creek and eventually to the nearby Niagara River.

Owner History

This site is owned by the Seaway Industrial Park Development Company, Inc.

Radiological History and Status

In 1974, approximately 6000 cubic yards of residue, consisting essentially of low-grade uranium ore tailings, was transported by Ashland Oil, Inc., from the former Haist property (now owned by Ashland Oil, Inc.) to the Seaway property. This residue was dumped in three separate areas. One area covers approximately 10 acres and the other two areas together cover approximately 2 acres. In the 10-acre area, the residue was spread to a depth of less than 2 feet in most mounds. While much of the residue is not covered, it has become partially mixed with clean soil due to the moving and spreading it has undergone in recent years.

Oak Ridge National Laboratory conducted a survey of this site in August 1976, to determine radiation levels and the extent of movement of radioactive residues by natural means such as surface runoff. The results indicated that the residues on the site do not pose any immediate health hazards under conditions of present use. However, if buildings were to be built in certain areas on the site, significant concentrations of radon-daughters could develop in these structures. Should the use of this site under present conditions be considered for purposes other than a landfill site, an assessment would be required to determine whether the proposed use would result in radiation exposure. New York State officials have been notified of these findings and have taken appropriate measures to control use of the property.

On October 26, 1979, the Office of Environment notified the Office of Nuclear Energy that the Seaway Industrial Park site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

SENECA ARMY DEPOT
Romulus, New York

Site Function

About 2000 barrels of pitchblende ore were stored in 11 munitions bunkers during a short period in the 1940s.

Site Description

The depot covers about 10,000 acres and is west of the town of Romulus, New York. The area where the ore was stored consists of 11 munitions bunkers and the surrounding area includes a rail spur over which the ore was transported.

Owner History

The site is owned and operated by the U.S. Army.

Radiological History and Status

In September 1976, Oak Ridge National Laboratory surveyed the 11 munitions bunkers and their surroundings. Residual radioactivity appeared to be confined almost entirely to the interiors of eight of the bunkers and to the outdoor areas near the entrances to these bunkers. The levels measured did not appear to represent a radiation safety problem to personnel under present conditions of use and limited occupancy. The nature of the radionuclides present, however, requires their long-term control in the event of significantly altered use or demolition and disposal of these structures in the future. An additional radiological survey performed by personnel from the U.S. Army Environmental Hygiene Agency in 1978 resulted in readings similar to the Department of Energy survey (±10 percent).

The Department of Energy's final survey report was published in February 1979. On February 7, 1980, the Office of Environment notified the Office of Nuclear Energy that the Seneca Army Depot required consideration for remedial action. The Army is currently conducting tests to determine maximum possible exposures from contamination in the bunkers and plans to conduct core sampling to better define the extent of contamination outside the bunkers. The Department of Energy is assisting the Army in their analysis of the site conditions.

SIMONDS STEEL DIVISION,
GUTERL SPECIAL STEEL CORPORATION
(The Former Simonds Saw & Steel Company)
Lockport, New York

Site Function

From 1948 through 1956, Simonds Saw & Steel handled large quantities of uranium metal and lesser quantities of thorium metal in rolling mill operations. Simonds rolled between 25 million and 35 million pounds of uranium for the Atomic Energy Commission under contract to National Lead of Ohio. About 30,000 to 40,000 pounds of thorium were also rolled. Over 99 percent of all Simonds uranium work was done on the 16-inch rolling mill. Several small lots of bars were run through the 10-inch rolling mill, and 15 or 20 ingots were processed in the hammer forge shop, which is in the adjacent building. No uranium or thorium has been processed at this facility since 1956. Atomic Energy Commission operations were initiated in May 1948 under Contract AT-30-1-Gen-339 and extended by modification of the contract to June 1952. Subcontract number S-4 with National Lead of Ohio carried the activities through December 1956.

Site Description

The area subjected to contamination consists of the rolling mill building, the forging shop, and general vicinity.

Owner History

The facility is owned and operated by Simonds Steel Division, Guterl Special Steel Corporation, formerly Simonds Saw & Steel Company.

Radiological History and Status

During all operations from 1948 through 1956, Atomic Energy Commission was responsible for radiological monitoring and safety. Residue from the operation was returned to the Atomic Energy Commission or National Lead of Ohio. The Department of Energy's Niagara Falls Storage Site (formerly Lake Ontario Ordnance Works) was used for interim storage of the materials between processing operations and use. Protective measures included the use of hoods and dust collection equipment over the 16-inch rolling mill stands and pans in the mill pits to collect material from every working turn. The mill area was vacuumed after every batch of 16 ingots, and the shipping area was vaccumed daily.

A radiological survey, conducted by Nuclear Science and Engineering Corporation and Carborundum Metals in November 1958, indicated radiation levels were highest in the quench tank area. Appropriate decontamination measures were taken, and a second radiation survey conducted by Carborundum Metals in December 1958 verified the decontamination.

The Oak Ridge National Laboratory personnel performed another radiological survey in October 1976, to characterize the radiological status of the property. The survey results showed acceptable levels of residual alpha radiation throughout the site. However, the beta-gamma radiation levels in some areas exceeded the maximum allowable for unrestricted use specified in the Nuclear Regulatory Commission guidelines.* Soil sample data indicated that uranium in the soil was in excess of concentrations requiring a source material license (a license is required for certain quantities of material having an excess of 0.05 percent uranium) and that radium concentrations were equivalent to background in the area. Water samples from site drainage were radiologically clean. Under current conditions of use, the radiation levels measured will not cause the public or employees to receive radiation exposures appreciably different from those due to background radiation.

The final radiological survey report was published in November 1979. On February 7, 1980, the Office of Environment notified the Office of Nuclear Energy that the Simonds Steel Division site required consideration for remedial action. In the interim, New York State has been notified of these findings and has taken steps to ensure that the site is adequately controlled.

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

STATEN ISLAND WAREHOUSE
(The Former Archer-Daniels Midland Company)
Richmond Terrace
Port Richmond, New York

Site Function

A warehouse located at Richmond Terrace was used for uranium ore storage from 1939 to 1942. The storage site was also known as the Archer-Daniels Midland Company warehouse. In 1942, 2007 drums containing 1072 long tons of Belgian Congo uranium ore were stored here. The ore contained about 660 tons of U_3O_8 and 170 grams of radium.

Site Description

No permanent buildings currently exist. The site is used as a truck/trailer parking lot.

Owner History

At the time of use for uranium ore storage, the warehouse was owned by Archer-Daniels Midland Company. The current owner of the property is RHS Realty Corporation.

Radiological History and Status

A visual inspection was performed by Oak Ridge Operations Office personnel on August 18, 1976. All buildings have been destroyed, and at that time, the site was being used as a truck/trailer parking lot. The Department of Energy's Environmental and Safety Engineering Division determined that additional data needed to be acquired and therefore instituted an owner search and scheduled a site visit. Oak Ridge National Laboratory personnel conducted the scheduled screening survey in July 1980. A determination regarding subsequent activity at the site will be made following a review of the screening survey results; however, preliminary data indicate that a more comprehensive radiological survey of the site is necessary.

THE FORMER SYLVANIA-CORNING NUCLEAR CORPORATION, INC., METALLURGICAL LABORATORY
Bayside, New York

Site Function

The site was used in the 1950s under an Atomic Energy Commission contract for research and development with radioactive materials, principally uranium and thorium. The Atomic Energy Commission work included UO_2 wafer production and uranium pipe cutting operations. The facility was also licensed by the Atomic Energy Commission to process and use uranium. The regulatory responsibility for the license was transferred from the Commission to the New York State Department of Labor in 1962.

Site Description

The site is located at 208 to 220 Willetts Point Boulevard, Bayside, New York. Atomic Energy Commission work was conducted at the metallurgical laboratory of Sylvania-Corning. The site now consists of about 28 acres strewn with concrete and other building debris. Only a garage and boiler house remain.

Owner History

The site was identified as the Sylvania-Corning Nuclear Corporation, Inc., Metallurgical Laboratory. The site was owned by Sylvania Electric Company (Syl-Cor) and later by General Telephone & Electronics but is now controlled by the National Bank of North America. Present plans include the sale of the property and development of the site.

Radiological History and Status

New York State terminated the General Telephone & Electronics license at this site in 1973 following verification of decontamination by the New York Labor Department. However, because no records were available at the time, the site was visited for survey screening by Oak Ridge Operations Office and Oak Ridge National Laboratory personnel on November 29, 1977, to determine its radiological condition. During the site visit and exploratory survey, which included onsite measurements and collection of soil samples, no radioactivity above background was detected. However, Oak Ridge National Laboratory has prepared a draft letter report and recommends that an effort be made to locate operational records that might indicate the disposition of process wastes, building rubble, and equipment associated with the project. Preliminary findings indicate that much of this material was transferred to the General Telephone & Electronics Laboratories in Waltham, Massachusetts,* or the former Sylvania-Corning facility in Hicksville, New York,* and additional investigations are being conducted to resolve these questions.

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* Both facilites were licensed for nuclear operations.

UNION CARBIDE CORPORATION, METALS DIVISION
(Electro Metallurgical "Electromet" Company)
Niagara Falls, New York

Site Function

This facility received uranium tetrafluoride (UF_4) from the Linde plant at Tonawanda, reacted it in induction furnaces to convert it to uranium metal, and then recast it into 110- to 135-kilogram ingots. Contract W-7405-Eng-14 was initiated with Electromet on November 14, 1942, and W-7405-Eng-227 and W-7403-Eng-255 were initiated on March 1, 1943. Contract W-7405-Eng-14 closed out with Amendment 28 on November 27, 1953. Process residues (dolomite slag, uranium chips, and crucible dross) were shipped to other sites for uranium recovery. The specific sites are not known. Other waste from the operation was sent to the Atomic Energy Commission portion of the Lake Ontario Ordnance Works (now known as the Department of Energy Niagara Falls Storage Site).

The uranium tetrafluoride building was also used for zirconium processing and later, just prior to demolition, for titanium processing. In addition, following the termination of the Atomic Energy Commission contracts, uranium and thorium ores were processed for commercial use under New York State Radioactive Material license 950-0139. From August 1965 through April 1972, Union Carbide produced 505 tons of slag bearing 9212 pounds of thorium dioxide and 1293 pounds of uranium oxide. This slag material was placed in 55-gallon drums and buried in a designated area on plant property in a hole 20 feet deep with 4 to 5 feet of soil cover.

Site Description

The Electromet site is located south of Pine Avenue and east of its intersection with Packard Road. The Manhattan Engineer District and Atomic Energy Commission operations took place in only one building, a cinder block and wood structure that was demolished in 1957. It was located in an area now occupied by the south end of a building designated as Building 166.

Owner History

This facility was part of what is now known as the Metals Division of the Union Carbide Corporation. During the Manhattan Engineer District and Atomic Energy Commission period, the facility was called the Electro Metallurgical Company, a Division of Union Carbide and Carbon Corporation.

Radiological History and Status

At the end of the Atomic Energy Commission and Electromet contract, the facilities were sold to the contractor. The plant and equipment were decontaminated through washing, vacuuming, and, in some locations,

removing concrete floors and wood platforms. Final radiological certification of the condition of the plant and a recommendation to release the facility were made on September 28, 1953. The building was later demolished. Demolition debris and uranium processing wastes were transferred to the Atomic Energy Commission portion of the Lake Ontario Ordnance Works, now known as the Department of Energy Niagara Falls Storage Site. In the late 1950s, the wastes from uranium processing were subsequently sent to Oak Ridge National Laboratory for permanent disposal. However, some of the rubble may have been deposited in the old Union Carbide dump (200 to 300 acres located north of Pine Avenue and owned by Newco, now CECOS International, Inc.). Additional investigations are being performed to verify the disposition of this waste.

On August 24, 1976, personnel from Oak Ridge National Laboratory and Oak Ridge Operations Office conducted a screening survey of the site and the old dump. Due to the near background radiation levels encountered, a comprehensive formal survey was not recommended. Further measurements and soil samples will be taken between Buildings 163 and 166 to ensure that no significant residual radioactive material remains in this area. An aerial radiological survey of the Niagara Falls area was conducted by EG&G, Inc., in November 1978. This survey did not identify any radiation levels above guidelines* in the area of the Electromet facility. Any subsequent activity at this site will be based on an evaluation of the findings collected to date and the results of the planned measurements.

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

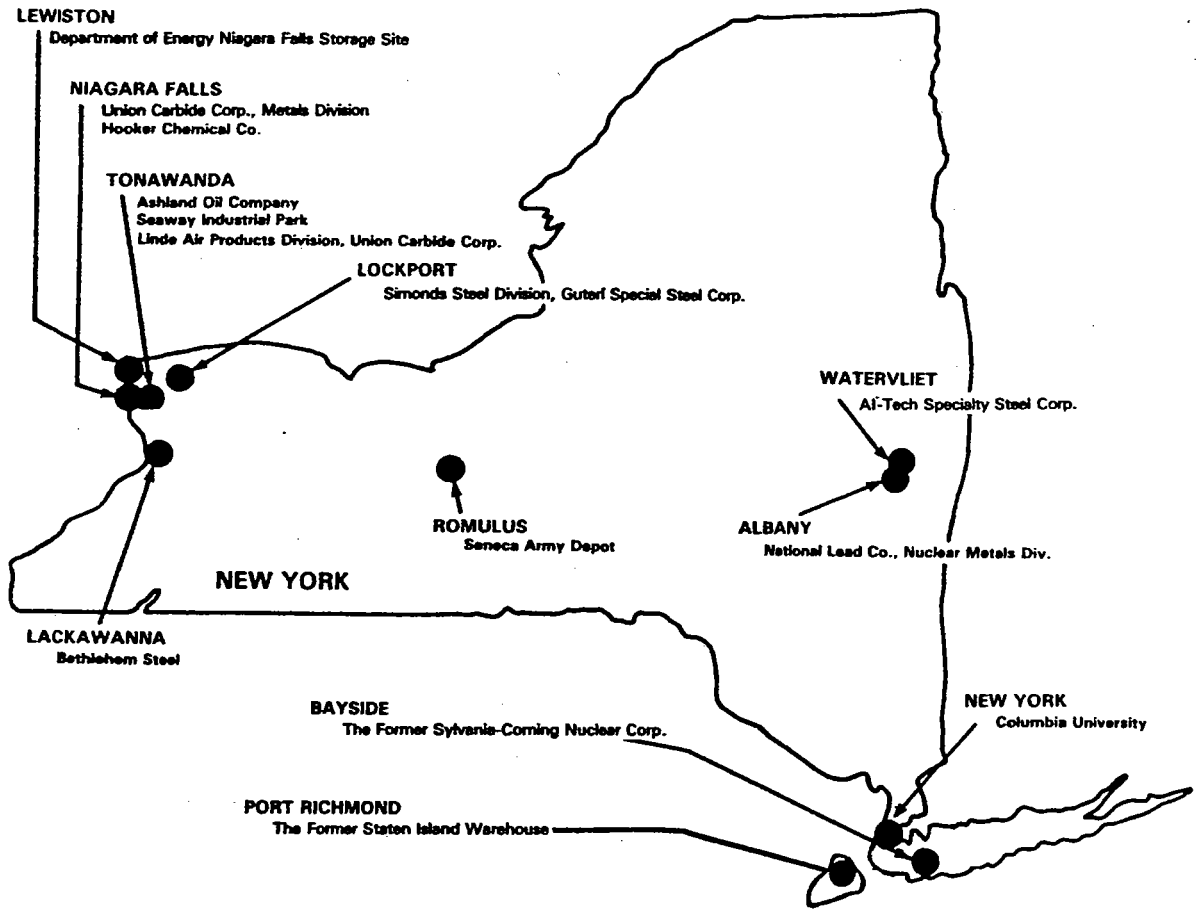

Figure 25. Formerly Utilized Sites in the State of New York

BATTELLE MEMORIAL INSTITUTE,
BATTELLE COLUMBUS DIVISION
King Avenue, Columbus, Ohio

Site Function

Two buildings were used at Battelle in Columbus for processing ores from early 1940 to mid-1950 under Contract W-7405-Eng-92. The principal operation in Building A was a thorium solvent extraction pilot plant. Some metallurgical studies of uranium were also carried on in this building. In Building 1, natural uranium and thorium were extracted from ores.

Site Description

The buildings are located on a plot within the city limits of Columbus and are designated the King Avenue site of Battelle Columbus Laboratories. Building A is a steel, concrete, and brick U-shaped structure. The west wing and north end contain three floors plus basement and attic levels. The east wing contains four floors plus a basement level. Building A houses the main library, a small auditorium, creep laboratory, nondestructive testing laboratory that includes small radioactive sources for use in radiography, general offices, and document storage. Access to the building is controlled. Building 1 is a four-story concrete, steel, and brick structure connected to Building 4 on the east and Building 11 on the north. The building contains ore laboratories, miscellaneous laboratories, offices, and a foundry occasionally used for processing natural or depleted uranium or natural thorium.

Owner History

Facilities are owned and operated by Battelle Memorial Institute, Battelle Columbus Division.

Radiological History and Status

Chicago Operations Office and Argonne National Laboratory personnel visited the site in January 1977 and confirmed the need for a full survey and decontamination. A radiological survey of Battelle Columbus Division facilities involved in the Manhattan Engineer District projects was completed by members of the Battelle Columbus Division staff. Rooms 17 and 53 through 55, and Room Complexes 6, 57, 163, and 219 (all in Building A) were determined to have radioactive levels consistent with natural background radioactivity of the structural materials of the facilities.

The Room 58 complex (Building A) and the Room 1223 complex (Building 1) do contain residual activity in excess of background. These levels do not constitute a radiological hazard. Smear sample data showed that there was no removable radioactivity. Dose rate data indicated only a slight increase in dose rate with the exception of one very small area. Air

sample data were in the ranges of natural radioactivity. The radiological conditon of the Room 1219 complex in Building 1 was not reported because it is still used as an ore laboratory.

These areas of elevated activity have been monitored and decontaminated by Battelle Columbus Division except for one small lab room and an exhaust duct. The latter areas have been reconstructed for continued laboratory use, and none of these areas are freely accessible to the public. The Department of Energy will make the final determination regarding certification of these facilities following a Chicago Operations Office and Argonne National Laboratory certification survey scheduled for late 1980.

THE FORMER BRUSH BERYLLIUM COMPANY
Cleveland, Ohio

Site Function

Brush Beryllium Company (now Brush Wellman, Inc.) conducted thorium metal machining and extruding at two sites in the Cleveland area under Contract W-7405-Eng-3, effective October 14, 1942.

Site Description

One site was located at 4201 Perkins Avenue, and the other was located at 3714 Chester Street. The buildings that were leased by Brush Beryllium were completely demolished at both sites. The location of the debris has not yet been determined. A new facility has been built on the Perkins Avenue site and is occupied by S.S Kemp and Company. The Chester Street site is presently a vacant lot.

Owner History

During the term of the Atomic Energy Commission contract, the buildings were leased by Brush Beryllium Company. The present owner of the Perkins Avenue site is Cleveland Commerce Center, Inc.; the owner of the Chester Street site is the Dyment Howe Company.

Radiological History and Status

Personnel from the Chicago Operations Office and Argonne National Laboratory performed a beta-gamma survey of the Chester Street site on May 17, 1977. The survey did not show any levels above background. Because of the new building covering the site of the former laboratory at Perkins Avenue, that location was not surveyed. A final determination regarding any subsequent activity at this site is pending; however, based on the findings to date, no further Department of Energy actions are anticipated.

CLECON METALS, INC.
(The Former Horizons, Inc.)
Cleveland, Ohio

Site Function

During the 1940s and early 1950s, two buildings at the Horizons metal handling facility were used for the production of granular thorium metal. The feed material, thorium nitrate tetrahydrate, was processed through a number of steps and ultimately converted to thorium metal by use of an electrolytic process.

Site Description

This site is located at 2905 East 79th Street in Cleveland, Ohio. There are three buildings on this site, two of which (B and C) were used for the production of granular thorium metal. Building B is presently used for storage of nonradioactive material. Building C is used for receiving and storing nonradioactive material and also contains several offices. Much of the potentially contaminated material associated with these buildings has been removed or covered as a result of substantial construction modifications since the thorium operations. Building C has been extended over what was formerly a contaminated alley. Also, sections of walk, floors, and ceilings in Buildings B and C have been repaired or replaced. This material is probably untraceable.

These buildings are located in an industrial area that is presently sparsely populated. A few buildings are located on property adjacent to this site.

Owner History

The buildings at this site are presently occupied by Clecon Metals, Inc. This firm employs approximately 60 workers (mostly in Building C) for the production of gaskets and for the lamination of various materials.

Radiological History and Status

An air hygiene survey performed in December 1954 by the Atomic Energy Commission detected concentrations of airborne thorium above background in both Buildings B and C. The survey results indicated a potential for contamination of overhead and upper wall surfaces due to airborne thorium, and contamination of floors and lower walls was possible from the routine handling of thorium.

Because the radiological records of the Atomic Energy Commission contract termination remaining in the files were inadequate to evaluate the status of this facility, Oak Ridge National Laboratory conducted a radiological resurvey during February 7 to 18 and March 21 to 22, 1977.

The results showed that alpha and beta-gamma contamination levels exceeded applicable guideline limits in some areas of Buildings B and C. External gamma radiation levels approximately 10 times the average background level were measured at isolated points in and near Building B. Lead-212 concentrations in the air in Building B were near the radioactivity concentration guide level.* Most of the elevated radiation levels were found indoors in areas presently used for storage. Outdoors, above-background radiation levels were found only near the east wall of Building B.

The radiological survey report was completed in February 1979. On December 19, 1979, The Office of Environment notified the Office of Nuclear Energy that the former Horizons, Inc., site required consideration for remedial action. The Office of Nuclear Energy is currently in the process of determining and reviewing remedial action options.

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

THE FORMER E.I. duPONT de NEMOURS & COMPANY GRASSELLI PLANT
Cleveland, Ohio

Site Function

For several years prior to 1945, DuPont handled natural uranium slugs (1- by 6-inch cylindrical forms) in the Research Building of its Grasselli facility. The material was delivered to Cleveland from Battelle Columbus Laboratory and, after chemical treatment, slugs were shipped to the University of Chicago. After the conclusion of the program (about 1945), the area was cleaned and the remaining slugs of uranium were returned to the University of Chicago. There was never any radioactive material other than natural uranium on the site and none of the natural uranium was buried or otherwise disposed of at the site. The following Manhattan Engineer District contracts with DuPont were identified: W-7412-Eng-3 (November 20, 1942), W-7412-Eng-5 (July 25, 1942), W-7412-Eng-22 (December 30, 1942), and W-7412-Eng-151 (September 5, 1944). It is unknown which, if any, related to the Grasselli work.

Site Description

The Manhattan Engineer District work performed at the Grasselli facility was conducted in the three-story section at the east end of the Research Building.

Owner History

The facility was owned and operated by E.I. duPont de Nemours and Company until 1950. It was then sold to the present owner, the Standard Oil Company of Ohio. The facility is currently leased to the Cleveland Regional Sewer District.

Radiological History and Status

On October 27, 1976, personnel from Oak Ridge Operations Office and Oak Ridge National Laboratory visited the Sohio operations at the old Grasselli location and conducted a screening survey. Results from an exploratory survey of the Grasselli Research Laboratory indicated that there was no radioactivity above background in the areas utilized for the Manhattan Engineer District and Atomic Energy Commission activities with the exception of one small area of a wall in the hallway area that had slightly elevated (but below guideline*) levels. Paint was chipped from the

* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Materials," U.S. Nuclear Regulatory Commission, November 1976.

surface and reanalysis did not indicate levels significantly above background. Other areas checked included drains, floor cracks, separations in the linoleum, and air ducts. Oak Ridge National Laboratory has prepared a draft letter report that documents the visit and recommends that no additional Department of Energy survey be performed. A final determination regarding any subsequent activity at this site is pending; however, based on findings to date, no further Department of Energy action is anticipated.

HARSHAW CHEMICAL COMPANY
Cleveland, Ohio

Site Function

In September 1942, the Manhattan Engineer District contracted with Harshaw for the production of green salt (UF_4). This work was a continuation of smaller scale work performed for the Office of Scientific Research and Development. In 1943, Harshaw also began production of uranium hexafluoride, an operation that was substantially expanded in 1947. Other Manhattan Engineer District and Atomic Energy Commission contracts involved the production of uranium tetrachloride and uranium oxyfluoride. Contracts identified include W-7405-Eng-2, W-7405-Eng-37, W-7405-Eng-43, W-7405-Eng-276, and W-26-021-Eng-4.

Site Description

The main portion of the Harshaw facility includes over 30 buildings on about 16 acres of land. The total facility is over 40 acres. Building G1 (Plant C) was used for the UF_6 production and the foundry building was used for the UF_4 production. Analytical work was performed in Building K1. Equipment and material from the Manhattan Engineer District and Atomic Energy Commission operations were apparently stored in those and other buildings at the site.

Owner History

The facility was released from Atomic Energy Commission controls to the Harshaw Chemical Company in 1960.

Radiological History and Status

AEC personnel visited this site on October 27 and 28, 1953, to survey the equipment and buildings for contamination and to provide the recommended actions necessary prior to the return of the building to the contractor. A meeting with representatives from the Harshaw Chemical Company was held, and a decontamination program was agreed to.

Another survey was conducted on November 21, 1957, by the Oak Ridge Operations Office. The purpose of this survey was to locate any areas where residual contamination was of such magnitude that it might represent a potential radiation or contamination control problem that would require restrictions on the use of the building. At the time, all equipment had been removed except for the Rockwell furnace, two denitration pots, and some process vessels in the recovery area. The location of this material has not been determined. This survey report identified contaminated areas and recommended methods for decontamination. It was made a part of Contract W-7405-Eng-276 by Modification 85, Supplemental Agreement, June 25, 1958. This supplemental agreement assigned to the contractor responsibility

for decontaminating all equipment transferred to it and for decontaminating its own premises used in the performance of the contract. Furthermore, the decontamination effort was to be accomplished in accordance with the recommendations contained in the survey report. The building was released from further Atomic Energy Commission control in 1960.

As a result of the 1974 survey program initiated by the Atomic Energy Commission to identify previously utilized Manhattan Engineer District and Atomic Energy Commission sites, a radiation survey of the building at Harshaw was performed from May 12 to 20, 1976, by Argonne National Laboratory and the Chicago Operations Office. During this survey, three soil samples taken in the area adjacent to the building showed the presence of residual radioactive material. The survey also showed that residual contamination remained in Building G1. If modifications, remodeling, cleanup, or other structural changes were to be undertaken, radioactive material now fixed in the structure could be released and lead to airborne contamination. Following the receipt of preliminary results of this survey, Harshaw indicated that they would contact the Department of Energy prior to any remodeling, destruction, etc., in this area surveyed.

In November 1976, Argonne National Laboratory personnel collected coring samples at selected locations around the Harshaw complex. Based upon this data, additional survey work, including an aerial radiometric survey, was performed between August and September 1979. Detailed surveys were conducted over the 16 acres of the main facility and the associated buildings. A screening survey was also conducted over the remainder of the complex. Preliminary results indicate that there is contamination at a number of locations throughout the site. Additional survey work is scheduled in 1980. A survey report is in preparation.

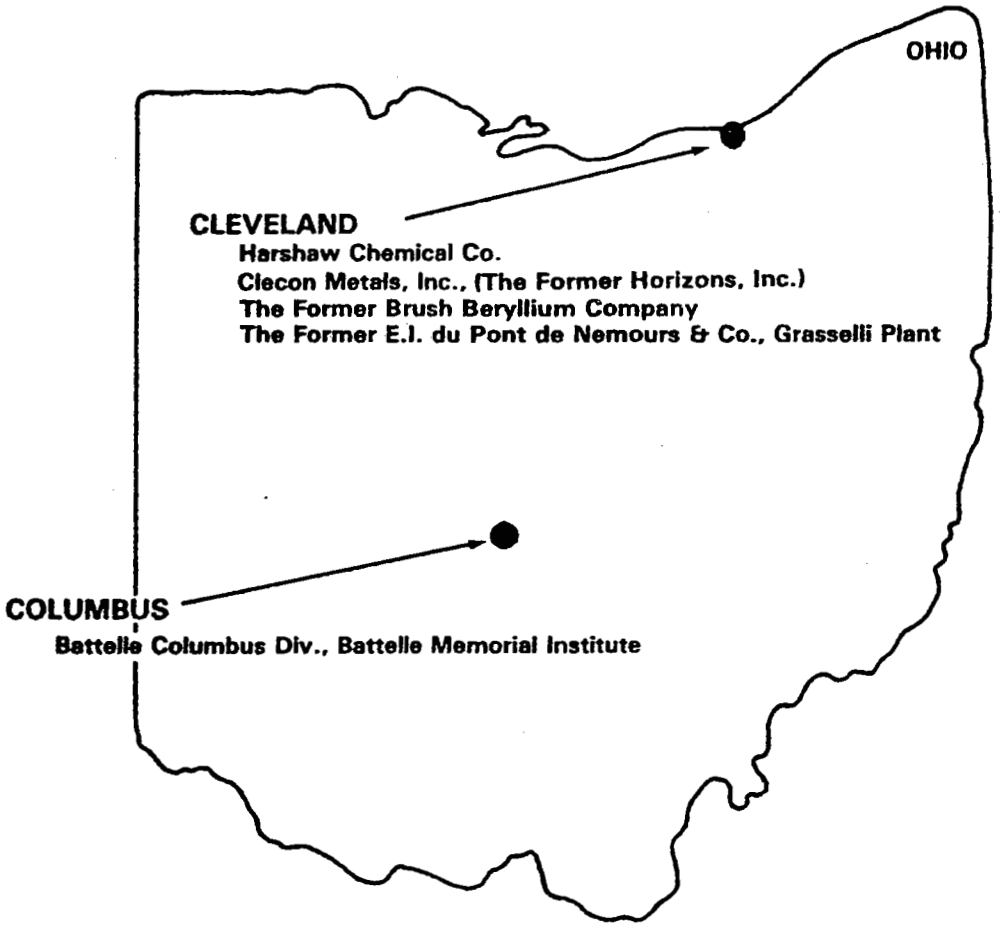

Figure 26. Formerly Utilized Sites in the State of Ohio

ALBANY METALLURGICAL RESEARCH CENTER
U.S. Bureau of Mines
Albany, Oregon

Site Function

From 1954 to 1956, the Albany Metallurgical Research Center, Bureau of Mines, U.S. Department of the Interior, was engaged in metallurgical operations involving thorium. Operations under the Atomic Energy Commission Contract AT(07-2)-1 and others included reducing, melting, machining, welding, and alloying. Metallurgical operations on thorium were also performed from 1960 to 1971 for the Pittsburgh Naval Reactors Office under Contract AT(11-1)-599. Research on alloys of uranium and thorium started in 1955 and continued to 1978 under Contract E(04-3)-906.

Site Description

Eight buildings on the 45-acre site were subject to possible contamination. None of these buildings is currently in use for uranium or thorium alloy research.

Owner History

The buildings are owned by the Federal Government and controlled by the Albany Metallurgical Research Center, Bureau of Mines.

Radiological History and Status

At the time that the work initiated under the Atomic Energy Commission was terminated (1978), these buildings were decontaminated to the general guidelines provided by the Atomic Energy Commission to the Bureau of Mines.

Contaminated materials, equipment, or wastes generated under the Atomic Energy Commission contracts were removed from the site for disposal by one of the following:

- Lawrence Livermore Laboratory (Atomic Energy Commission) contract disposal at Richland, Washington;
- Idaho Operations Office (Atomic Energy Commission), Idaho Falls, Idaho; or
- Nuclear Engineering Company, Richland, Washington.

To verify the conditions of the site, Argonne National Laboratory conducted a radiological survey of these buildings and grounds in 1978 and found contamination on surfaces that exceeds current guidelines for unrestricted use. Some areas of soil are also contaminated with uranium and thorium. As an interim measure, the Bureau of Mines has fenced in areas of contaminated soil to restrict access. Some additional survey work was

conducted in September through November 1979, and Argonne National Laboratory is preparing a radiological survey report to document all survey activities. An aerial survey covering 8 square miles around the facility was conducted in February 1980, and additional work, including subsurface investigations, will be conducted in 1980.

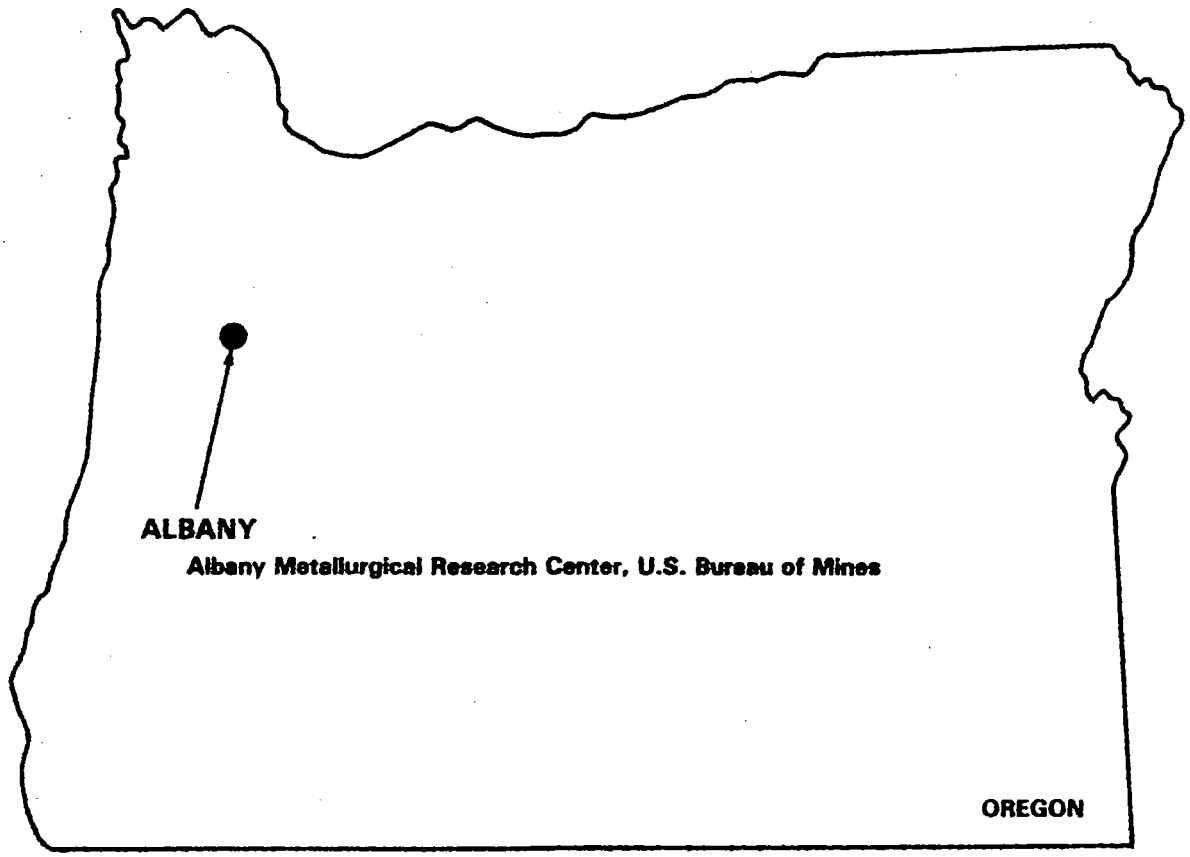

Figure 27. Formerly Utilized Sites in the State of Oregon

CANONSBURG INDUSTRIAL PARK*
(The Former Vitro Rare Metals Plant)
Canonsburg, Pennsylvania

Site Function

The plant was operated by Standard Chemical Company, and, some time after 1911, Standard Chemical began extracting radium as bromide or sulfate from carnotite ore at this site. The property was purchased by Vitro Rare Metals Company in 1922. From 1930 to 1942, Vitro extracted radium and uranium salts from onsite residues and carnotite ore. From 1942 to 1957, operations turned to the recovery of uranium from various ores, concentrates, and scrap materials under the Manhattan Engineer District and Atomic Energy Commission contracts. During the early years of World War II, the Vitro Plant processed a substantial portion of the high-grade Congo uranium ore and nearly all of the Vandium Corporation of America's 50-percent sludge. The last Atomic Energy Commission contract with Vitro was terminated in 1957. Since then, property has changed owners and been leased to tenant companies for light industrial use.

Site Description

The 18-acre site is located on Strabane Avenue. It is bounded by Chartiers Creek, the CONRAIL right-of-way, privately owned property formerly known as George's Pottery Company, and the Washington-Canonsburg Street Railway right-of-way (Figure 28). Approximately 20 buildings presently stand on the site, and these are leased to tenant companies with a total of nearly 100 employees. Historically, the site is divided into three separate sections: the section northeast of Ward Street containing the buildings, the section southwest of Ward Street containing fill dirt plus dredgings from Chartiers Creek, and the section southeast of Strabane Avenue that is a swamp or lagoon. A railroad spur and access streets service the site.

During plant operation, liquid wastes were discharged into an open drain that went under Strabane Avenue and emptied into the swamp southeast of the Avenue. The swamp ultimately drains into Chartiers Creek, which flows into the Ohio River west of Pittsburgh.

Solid wastes were accumulated in mounds located away from the site buildings. Early survey work indicated that adjacent roads and fields showed above background radiation levels, suggesting that waste material had eroded from its original position or was used for fill.

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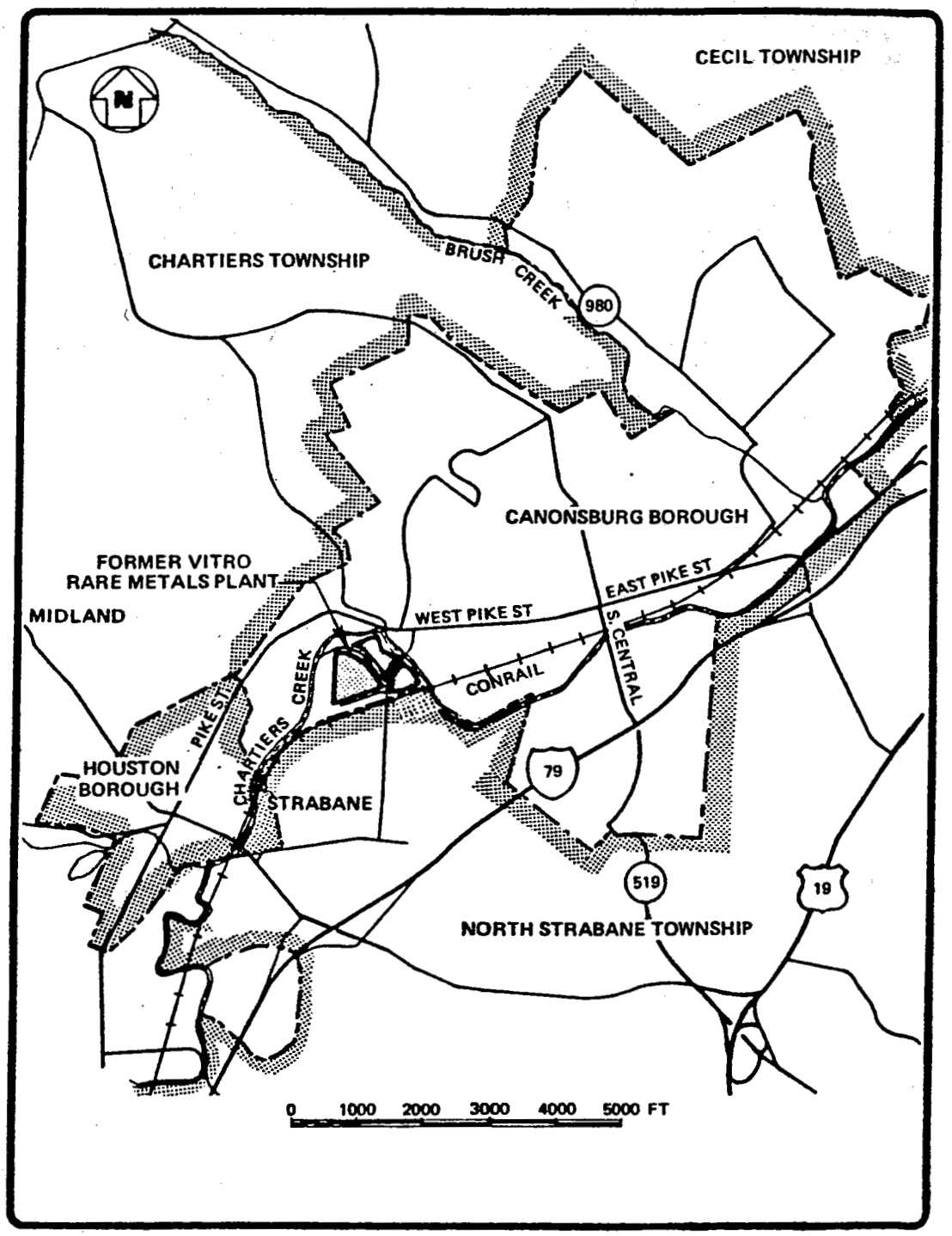
* Authority for remedial action has been granted under the Uranium Mill Tailings Radiation Control Act of 1978 (Public Law 95-604) and the site is now included in the Department of Energy's Inactive Uranium Mill Tailings Remedial Action Program.



Source: Ford, Bacon & Davis Utah Inc.

Figure 28. Location of the Cannonsburg, Pennsylvania, Site

Owner History

The site was owned by the Standard Chemical Company until 1922 when the Vitro Manufacturing Company (now the Vitro Corporation of America) acquired the plant. On December 31, 1962, the property was purchased by a group of individuals, and since 1963, the property has been owned by the Canon Development Company.

Radiological History and Status

Between October 1956 and January 1957, about 6000 tons of waste residue containing 0.097 percent U_3O_8 were removed for disposal from the Vitro site with the approval of the Oak Ridge Operations Office. This waste residue was dumped into a landfill on Pennsylvania Railroad property in Burrell Township, Pennsylvania.

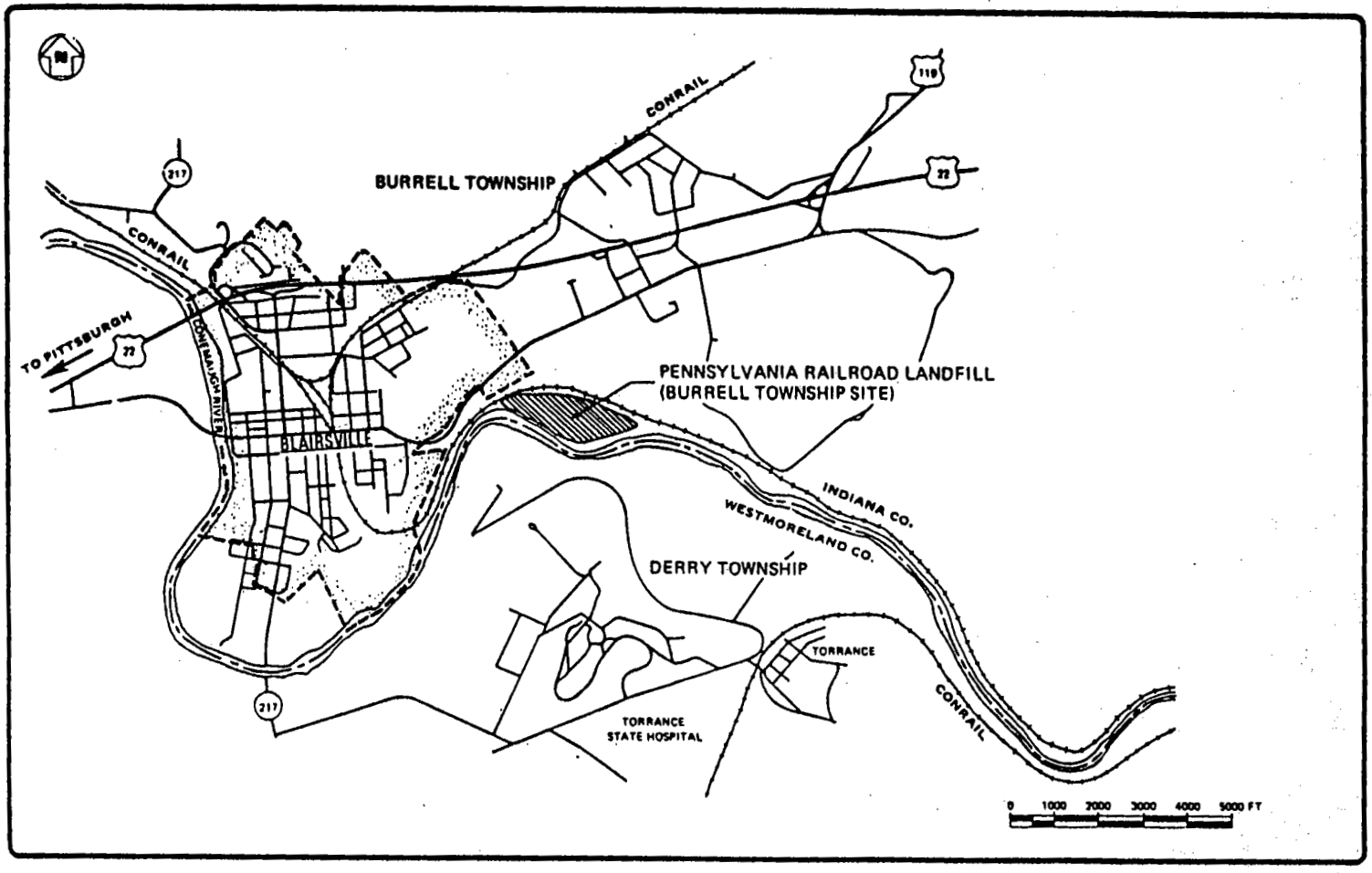
Vitro ceased operations at Canonsburg in 1957, and in 1961, a "storage only" license was issued to Vitro for source material onsite. The 1962 agreement of sale provided that the uranium-bearing residues stored onsite would remain the property of Vitro. Following discussions and correspondence with the Atomic Energy Commission and the Commonwealth of Pennsylvania Department of Health, Vitro decontaminated and stabilized the residue and requested on January 12, 1966, that the source material license be terminated. The Atomic Energy Commission approved the request on February 14, 1966.

A subsequent review of the Canonsburg records under the Atomic Energy Commission and the Energy Research and Development Administration site survey program indicated that insufficient data existed to ensure that conditions at the site were radiologically acceptable. Oak Ridge National Laboratory personnel conducted a radiological survey of the Canonsburg Industrial Park from March through July 1977. The program measured radon and radon-daughter concentrations in the air in the buildings, surface and subsurface contamination levels on and near the site, radiation levels above the surface on and near the site, and radon concentrations near the site.

The survey indicated that large quantities of radioactive wastes still remain, contaminating almost the entire site. Radon and radon-daughter levels in buildings exceeded the pertinent standards.* Alpha contamination levels, beta-gamma dose rates, and external gamma radiation levels in some areas of the buildings and outdoors on the site were above current Federal guidelines for unrestricted use.** Concentrations of radium-226 in water

* Federal Register, "Interim Cleanup Standards for Inactive Uranium Processing Sites," Environmental Protection Agency, April 22, 1980.

** "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.



Source: Ford, Bacon & Davis Utah Inc.

Figure 29. Location of the Pennsylvania Railroad Landfill Site

Radiological History and Status

Representatives of the Commonwealth of Pennsylvania conducted a radiological survey of the site on April 17, 1963. Area monitoring indicated that radiation levels were in excess of background at several locations. The survey also indicated that the radioactive residue was not uniformly distributed below the surface.

The Oak Ridge National Laboratory surveyed the property during the period of November 11 through December 9, 1977. Their report summarizes the radiological status and survey operations. Oak Ridge National Laboratory was able to establish the general location of the material and found that more than 75 percent of the residue lies at least 10 feet beneath the surface. Measurements of certain localized areas of the surface soil indicated radium-226 concentrations of several thousand picocuries/gram; external gamma radiation levels and beta-gamma dose rates exceed guidelines* at some locations. However, at most sampling points, radionuclide concentrations in surface soil and radiation levels both at the surface and at 1 meter above the surface are less than 10 times background levels.

Some samples analyzed contained licensable concentrations of natural uranium (that is, the samples are greater than 0.05 percent uranium by weight). While sediment filtered from some water samples taken in drainage areas on and near the site contained elevated concentrations of lead-210 and thorium-230, all water samples had concentrations of radium-226, thorium-230, uranium-238, and lead-210 below the concentration guides stated in the Federal Regulations.* The data also indicated that there is no significant atmospheric transport of radon-222 from the site.

It is estimated that for complete cleanup between 52,000 and 57,000 cubic yards of contaminated soil and debris located under about 35,000 cubic yards of clean landfill material would require removal.

An aerial radiometric survey of the landfill was completed by EG&G, Inc., on April 14, 1978. No abnormalities other than those noted by the radiological survey were found.

Some form of remedial action is warranted at this site. The site will be designated as part of the Canonsburg Vitro Site under Public Law 95-604.

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* Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation; and "Guidelines for Decontamination of Facilites and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, and Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

ROHM & HAAS COMPANY
Philadelphia, Pennsylvania

Site Function

This facility was used in the early 1950s for research and development on methods for analyzing and processing uranium ores under Atomic Energy Commission Contract AT-(49-1)-535.

Site Description

The plant is located at 5000 Richmond Street, Philadelphia. The portions of the facility used under the Atomic Energy Commission contract included an area of Building 60 (research area) for laboratory scale work and Building 49c semiworks area or pilot process area. The two rooms in Building 60 used for the Atomic Energy Commission work are still used as laboratories and remain very much as they were at the time of the project, except for the removal of equipment in 1968 (disposition unknown). The semiworks area of Building 49c is now used primarily for storage.

Owner History

The plant is owned and operated by Rohm & Haas Company.

Radiological History and Status

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site on December 1, 1977, and surveyed Rooms 22 and 24, a wing of Building 60; and the semiworks area of Building 49c. Gamma-ray exposure-rate measurements ranged from 6 to 8 microroentgens/hour (essentially background). Direct measurements of alpha radiation were at background levels, and the maximum beta-gamma dose rate was far below the Nuclear Regulatory Commission guideline value.* Oak Ridge National Laboratory recommended that no remedial action is indicated. A final determination regarding any subsequent activity at this site is pending; however, based on the findings to date, no further Department of Energy actions are anticipated.

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* "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," U.S. Nuclear Regulatory Commission, November 1976.

UNIVERSAL CYCLOPS, INC.
(The Former Vulcan Crucible Steel Company)
Aliquippa, Pennsylvania

Site Function

The contractor at this site worked uranium billets furnished by the Government into rods. This work was performed on an "as required basis" under Contract AT-(30-1)-407.

Site Description

This site consisted of a rolling mill, two furnaces for heating, and cutting and extruding equipment. The finished rods were stored in boxcars after being transferred to the receiving and shipping room for weighing. The building used is one story over 30 feet high with part concrete, part dirt, and part metal floor.

Owner History

During the Atomic Energy Commission contract period, the site was owned by the Vulcan Crucible Steel Company. In 1955, the facility became Vulcan Crucible Steel of H.K. Porter, and in about 1960, American Iron and Steel Institute records indicate that the name was changed to Vulcan-Kidd Steel of H.K. Porter. The present owner (since 1966) is Universal Cyclops, Inc. Portions of the building are leased for storage by Heritage Box Company and Precision-Kidd Company.

Radiological History and Status

During the period of February 15 to 16, 1949, dust samples at the mill were collected by representatives of the New York Operations Office, Atomic Energy Commission. From these samples, it was apparent that alpha-emitting dust was a problem. Corrective actions were recommended to the Vulcan Crucible Steel Company.

Representatives from the Atomic Energy Commission again visited the plant on July 21, 1949, and made radiation and airborne dust measurements. Government-owned property disposition was discussed and required decontamination work was defined. The major portion of the decontamination work was completed by January 19, 1950, and the time period of the contract was extended to February 28, 1950, to cover the final cleaning operation.

Argonne National Laboratory conducted a radiological survey to verify the condition of this site in 1978 and prepared a draft survey report. Preliminary results indicate the presence of some residual radioactive material from the former Atomic Energy Commission operations at the site. The final radiological survey report is in preparation. It is anticipated that the Office of Environment will designate this site as a site requiring consideration for remedial action.

WESTINGHOUSE ATOMIC POWER DEVELOPMENT PLANT
East Pittsburgh Plant
Forest Hills
Pittsburgh, Pennsylvania

Site Function

Westinghouse Manhattan Engineer District and Atomic Energy Commission contract work performed at this facility prepared the uranium metal for Enrico Fermi's Stagg Field experiment and research and development on and pilot scale production of uranium oxide fuel elements. The process involved uranium separation using a laboratory-scale magnetron. The numbers of three Manhattan Engineer District contracts with Westinghouse were identified: W-7407-Eng-2 (August 1, 1941), W-7407-Eng-31 (August 7, 1944), and W-7407-Eng-132 (December 18, 1943). Based on available data, it is not clear whether all of these contracts applied to the work performed at this facility.

Site Description

The facility is located near Route 30 in East Pittsburgh (Forest Hills). The area used in the project was located in "L" Building and was designated Lab 2L. Renovations to the lab were underway at the time of the survey visit in October 1976 and included the dismantling of a partition.

Owner History

The plant is owned and operated by Westinghouse Electric Corporation.

Radiological History and Status

Westinghouse personnel indicated that the area used was cleaned, and tools and equipment had been decontaminated, sealed in drums, and shipped to other locations when the project ended. At the time of the cleanup, an Atomic Energy Commission industrial hygiene group surveyed and cleared the site, but no records are available. On October 22, 1976, Oak Ridge National Laboratory personnel surveyed "L" Building, including the original brick and wooden floors and brick wall. The survey indicated alpha and beta measurements were about background and gamma measurements were about 5 to 6 microroentgens/hour. Oak Ridge National Laboratory has prepared a draft letter report that recommends no additional radiological measurements. A final determination regarding any subsequent activity at this site is pending; however, based on the findings to date, no further Department of Energy action is anticipated.

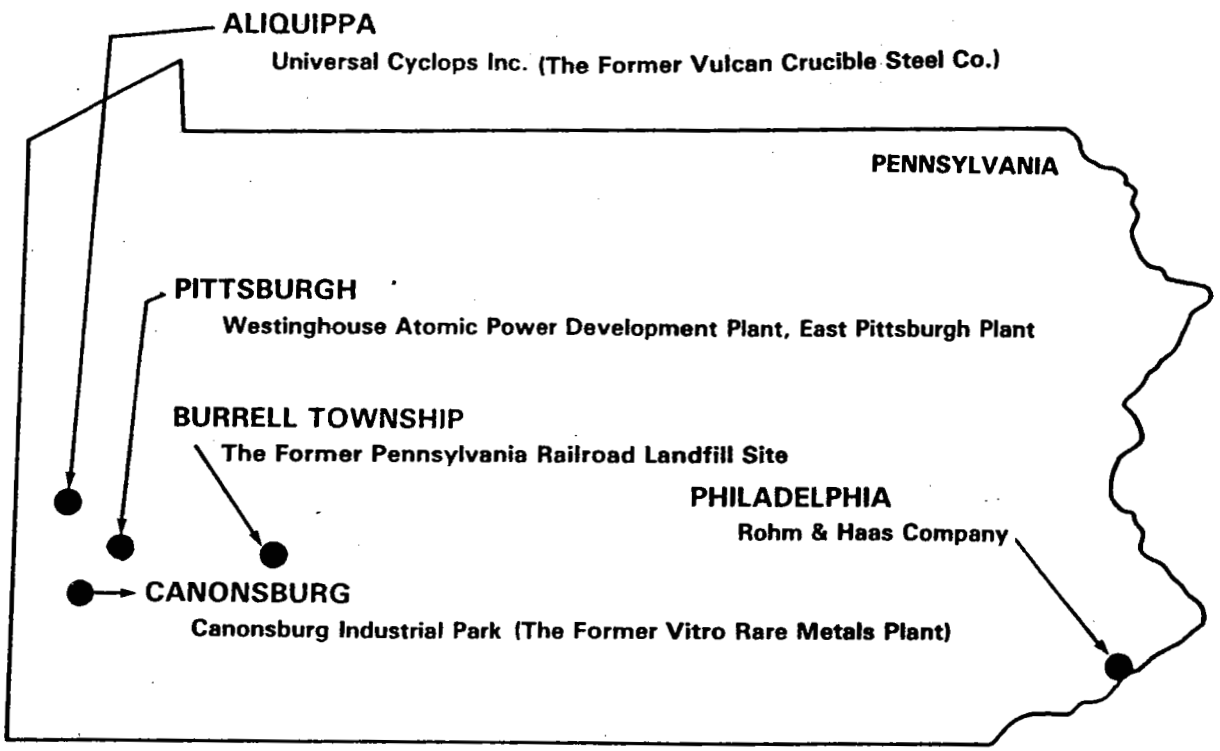

Figure 30. Formerly Utilized Sites in the State of Pennsylvania

AMERICAN OIL COMPANY
(The Former Texas City Chemicals, Inc.)
Texas City, Texas

Site Function

Under Contracts AT(49-1)-616 (February 14, 1952, extended by amendments to June 1, 1958), AT(49-1)-647 (May 12, 1953), AT(49-6)-910 (through September 10, 1955), and AT(05-1)-481 (date unknown), Texas City Chemicals produced uranium by recovery of U_3O_8 from a phosphate fertilizer production plant. Atomic Energy Commission work ceased about 1956, when Texas City Chemicals went bankrupt.

Site Description

The facility used under the Atomic Energy Commission contract consisted of a recovery plant attached to the phosphate fertilizer plant. Only a concrete pad (approximately 19 x 36 yards) remains from the initial recovery plant. The location of the building debris has not yet been determined. The pad has since been used to store gypsum from phosphate rock processing that occurred after the uranium production ceased.

Owner History

Texas City Chemicals, Inc., became part of the Smith-Douglass Company in about 1956 and was later sold to the Borden Chemical Division of Borden, Inc. With the phaseout of fertilizer production in September 1977, all the remaining facilities and property were sold by Borden to the American Oil Company on December 15, 1977.

Radiological History and Status

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site on November 17, 1977. Measurements revealed radiation levels above normal background in this area of Texas. Although the maximum gamma-ray exposure rates at this site are similar to those at other phosphate products plants where uranium recovery is not performed, the maximum observed radon-226 concentration is higher than that typically observed at other phosphate product plants. Oak Ridge National Laboratory has prepared a draft letter report recommending that further radiological measurements may be required. However, because of the level of background radiation resulting from the phosphate operations, it is unlikely that additional data will result from another survey. This site is considered low-priority, and if it is determined that additional survey efforts will supply useful data, the Department of Energy will schedule the survey work.

PASADENA CHEMICAL CORPORATION
(The Former Mathieson Chemical Company)
Pilot Plant
Pasadena, Texas

Site Function

This site was used to operate a small pilot plant that extracted uranium from wet process phosphoric acid produced for fertilizer manufacture. The facility was operated by Mathieson Chemical Company from mid-1951 through mid-1953 under an Atomic Energy Commission contract.

Site Description

The site is located on the Houston Ship Channel near Pasadena, Texas. The pilot plant was located in a single room in a one-story building used as a process development facility and analysis laboratory. The equipment was removed after the project was completed (about 1955). The location of this material has not yet been determined. The room currently contains an L-shaped laboratory bench (with sink) running along two walls and a chemical hood located on a third wall. The room is now being used for storage of jantorial equipment.

Owner History

Mathieson Chemical Company became Olin Mathieson Chemical Corporation in August 1954. In September 1969, the name changed to Olin Corporation. The site is now owned by Pasadena Chemical Corporation.

Radiological History and Status

Oak Ridge Operations Office and Oak Ridge National Laboratory personnel visited the site on November 18, 1977. Results of this preliminary survey indicated the presence of low-level contamination in the sink and drain. Although no real potential for exposure to persons under present use exists, it was recommended that these structures, when removed, be handled as contaminated material, and disposed of at an approved burial site. Oak Ridge National Laboratory has prepared a draft letter report on this site.

The Texas Department of Health conducted a gamma ray radiation survey of the old Atomic Energy Commission pilot plant area on September 20, 1978. No contamination was found that could be attributed to the pilot plant operation.

The current owner of the facility has indicated to the Department of Energy that the contaminated structures will be disposed of in the appropriate manner if the structure is modified. The Department of Energy has notified the State of Texas of the findings at this site. A final determination regarding any subsequent activity at this site is pending; however, no further Department of Energy actions are anticipated unless it is requested by Texas, following a decontamination of the site.

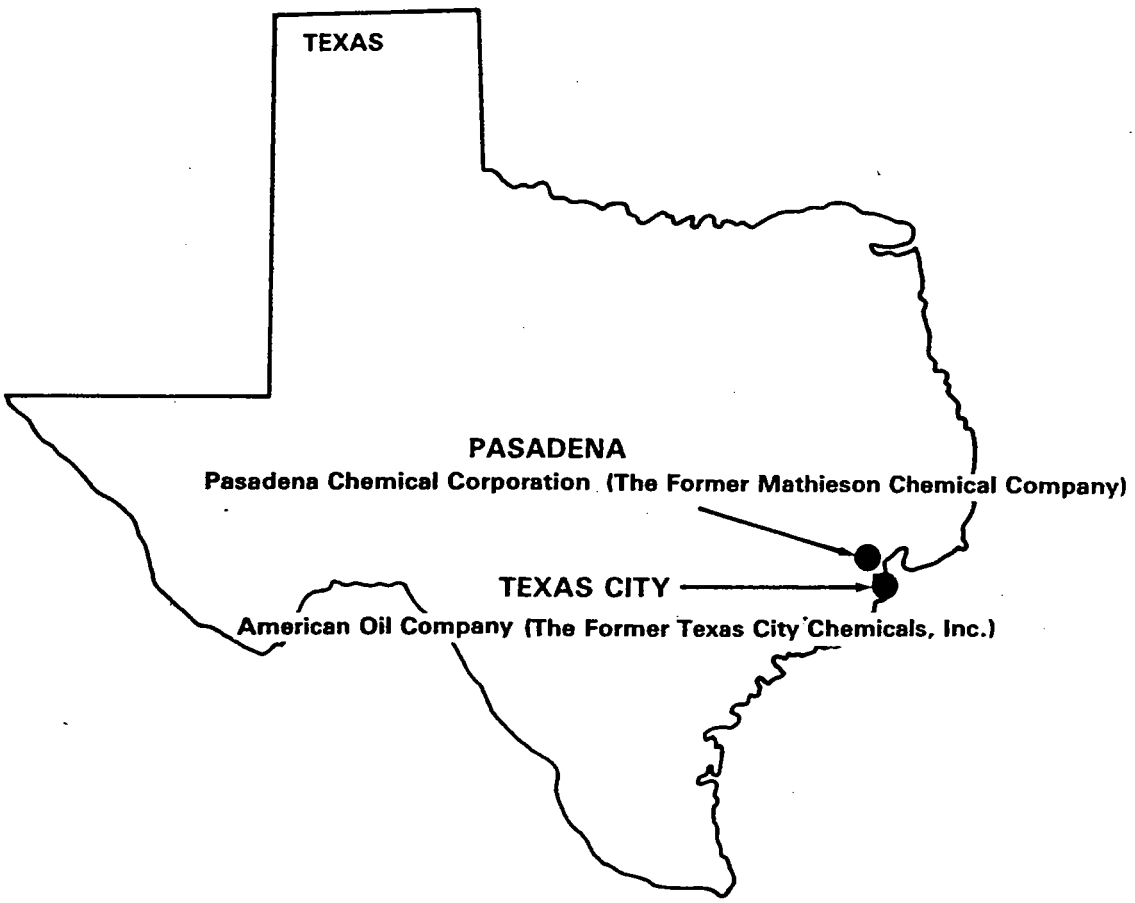

Figure 31. Formerly Utilized Sites in the State of Texas

UNIVERSITY OF UTAH
Salt Lake City, Utah

Site Function

The work at the University of Utah's Medical Research Center consisted of animal inhalation studies involving uranium dust. Work was also performed in the old Mines Building of the School of Mines involving studies on processing of uranium ores and thorium research.

Site Description

The animal inhalation studies were conducted in a small basement area of the hospital. Three laboratory rooms (109, 201, and 221) in the old Mines Building were used for conducting the studies on processing of uranium ores and the thorium research.

Owner History

The facilities are owned and occupied by the University of Utah.

Radiological History and Status

The work at this site was conducted under an Atomic Energy Commission contract during the early 1950s. Representatives from the Chicago Operations Office and Argonne National Laboratory visited the site on November 29, 1977, and surveyed the small basement area in the Medical Research Center. They found no detectable activity above background except in a small room used to store radioactive material. This area is presently used for radiation therapy and contains several radiation-producing devices. Rooms 201 and 202 were also surveyed, and no activity above background was detected. Because Room 109 was not accessible during the one-day visit, the University's Radiation Survey Officer surveyed this room on December 1, 1977. A final determination regarding any subsequent activity at this site is pending; however, based on the findings of the survey, no further Department of Energy action is anticipated.

U.S. BUREAU OF MINES
Salt Lake City, Utah

Site Function

The work performed at this site began in 1948 and involved the development of processes for uranium recovery from various types of ore. In addition, a small pilot plant was operated at this site. Currently, it is a metallurgical research center.

Site Description

The site is located adjacent to the University of Utah, Salt Lake City, and consists of a multiple-story concrete building. The building contains offices, analytical laboratories, and a pilot plant for uranium recovery.

Owner History

The facility is still an active research facility using uranium and is owned and operated by the U.S. Bureau of Mines.

Radiological History and Status

Since the termination of the Atomic Energy Commission work, the research on uranium recovery by the Bureau of Mines has continued. The work is presently being performed under the general licensing authority of Title 10, Code of Federal Regulations 40.22, which limits the volume of material to less than 150 pounds per year with a maximum of 15 pounds per shipment. Similar quantities were sent during the Atomic Energy Commission contract work. On November 28, 1977, representatives from the Chicago Operations Office and Argonne National Laboratory performed a screening survey of various parts of the facility, used in the Atomic Energy Commission work. Some small areas of the facility with observable levels of contamination were found. However, this facility is still an active research facility using uranium under a general licensing authority and is being monitored by a radiation protection officer. No detailed Department of Energy radiological survey is considered necessary because any contamination due to Manhattan Engineer District or Atomic Energy Commission work would be indistinguishable from contamination resulting from present activities.

The facility is to be turned over to the University of Utah in mid-1980 for use as an energy research laboratory when the Bureau of Mines occupies a new research facility presently under construction. In anticipation of this event, the Bureau of Mines recently performed a comprehensive radiological survey to identify specific areas of contamination for the purpose of defining the scope of work for a contract to survey and decontaminate those areas.

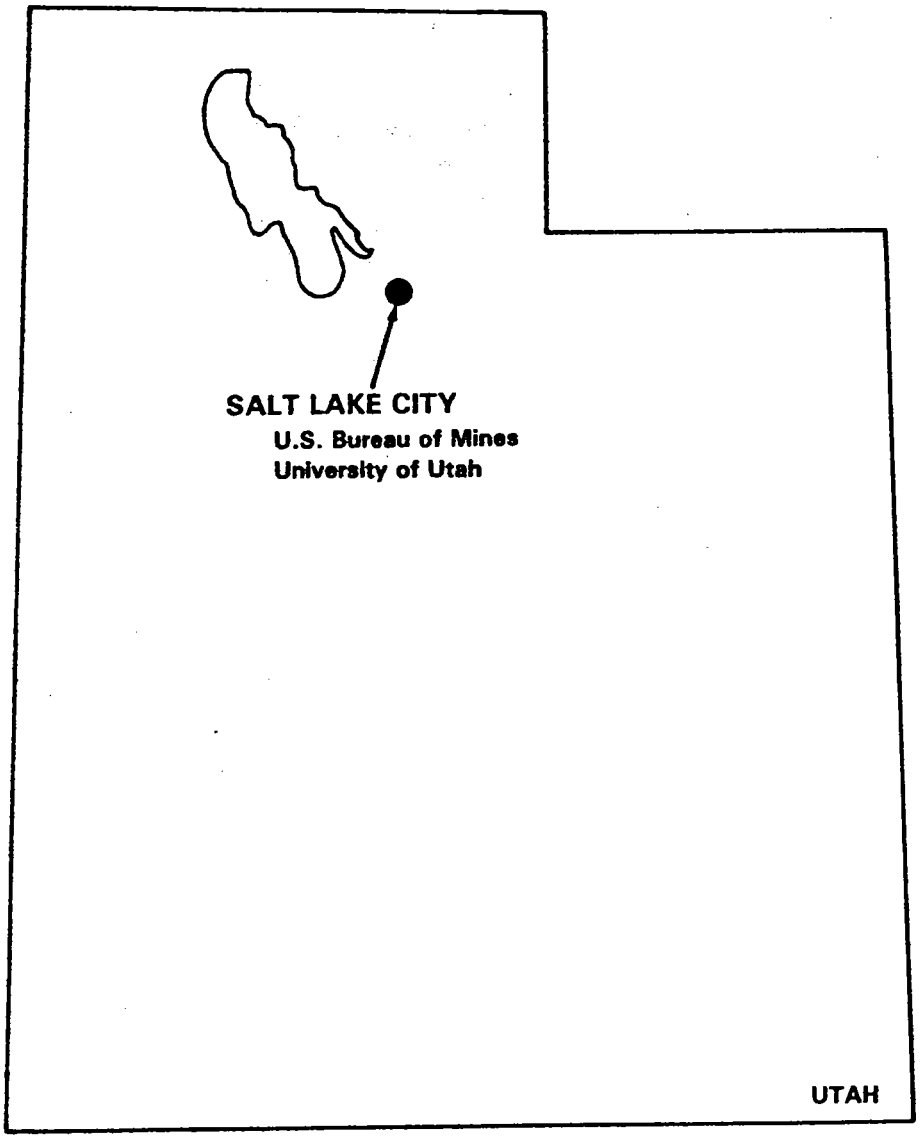

Figure 32. Formerly Utilized Sites in the State of Utah

THE FORMER VIRGINIA-CAROLINA CHEMICAL CORPORATION
818 Perry Street
Richmond, Virginia

Site Function

This facility was used in the early 1950s for research and development to recover uranium as a byproduct of phosphate production. The operations were conducted on a "lab bench scale" and involved no more than gram quantities of separated uranium. Uranium recovery work lasted only about 6 months. The laboratory was dismantled and all equipment removed prior to sale of the building in 1965 for use as a warehouse. The location of the equipment probably cannot be traced. The Atomic Energy Commission activities were conducted under Contract AT-(49-6)-905.

Site Description

The site consists of a warehouse plus surrounding land. Site dimensions are 162.66 feet by 340 feet (irregular).

Owner History

The facility was first owned by the Virginia-Carolina Chemical Corporation and was subsequently acquired by Mobil Oil Corporation. The property is now under private ownership.

Radiological History and Status

No radiological survey was made of the site to date. Based on the small quantities of uranium processed, as well as the short duration of the contract, the Oak Ridge Operations Office concluded that the potential for uranium contamination was small. Furthermore, the laboratory equipment used under the contract has been removed. Although there is little possibility of any residual radioactive material remaining at this site, the Department is planning to conduct a screening survey of the facility to verify the site's radiological status.

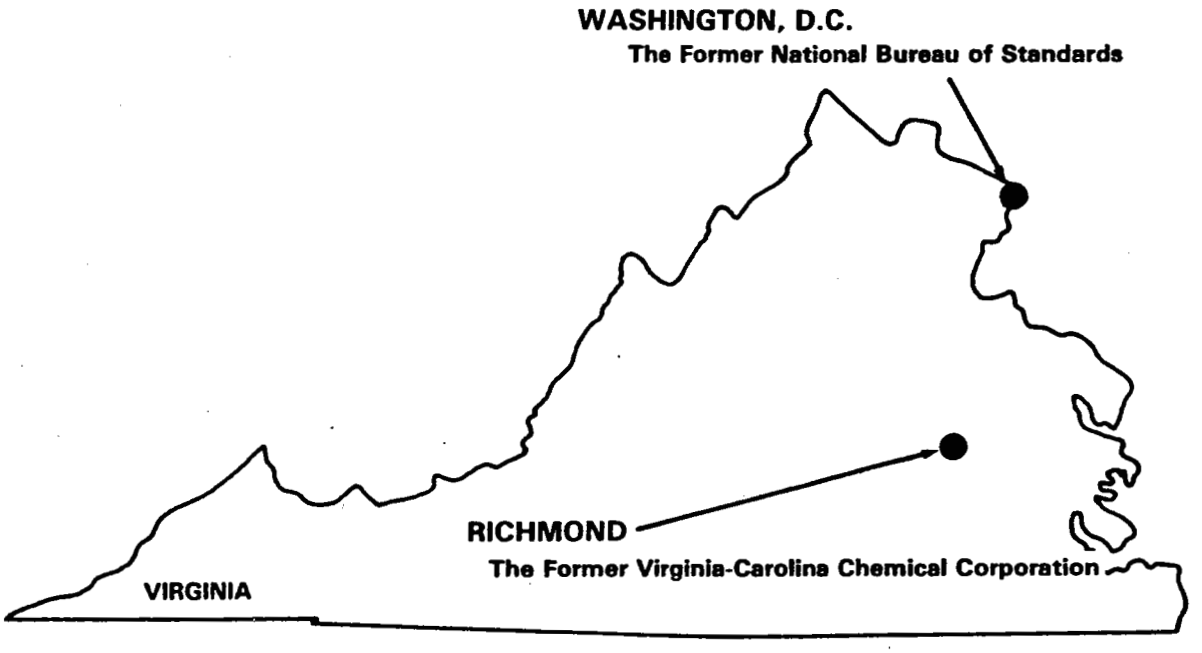

Figure 33. Formerly Utilized Sites in the State of Virginia

THE FORMER NATIONAL BUREAU OF STANDARDS BUILDINGS
Van Ness Street
Washington, D.C.

Site Function

The National Bureau of Standards occupied this site prior to moving to Gaithersburg, Maryland. A radioactivity laboratory at the site was used from the early 1920s until 1952 for measuring all radium samples used in this country for medical purposes. In the early 1940s, the National Bureau of Standards also performed quality control analysis for the Manhattan Engineer District.

Site Description

This site contained a number of buildings. The radioactivity laboratory was located in the East Building, also referred to as Building 2.

Owner History

Subsequent to National Bureau of Standards occupancy, the buildings on this site were turned over to the General Services Administration. On February 5, 1968, six of the buildings at this site, including Building 2, were occupied by the District of Columbia for use by the Washington Technical Institute under a permit agreement with General Services Administration.

In 1977, the entire site was turned over to the Department of State for use as an International Center. The area where Building 2 was located is planned for use as an open area or a street.

Radiological History and Status

During the occupancy of Building 2 by the Radiological Laboratory, many rooms, hallways, and the attic became contaminated. In 1952 and after the National Bureau of Standards moved to Gaithersburg, decontamination work was completed with the exception of three rooms, which were sealed and posted with signs indicating the presence of radioactive material. In 1968, when the buildings at the Van Ness Street site were leased to the District of Columbia, a survey of the facility was performed, and extensive decontamination of Building 2 was accomplished. Following another reevaluation of all areas, it was determined that although small amounts of radioactivity remained in isolated areas, the levels were within safe limits as defined by the recommended guidelines of the U.S. Public Health Service. Building 2 was demolished during September and October 1976.

GLOSSARY

Activity -- Radioactivity, the spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nuclei of an unstable nuclide. As a result of this emission, the radioactive isotope is converted (or decays) into the isotope of a different (daughter) nuclide, which may or may not be radioactive. Ultimately, as a result of one or more stages of radioactive decay, a stable (nonradioactive) nuclide is formed.

Aerial survey -- A search for sources of radiation by means of sensitive instruments mounted in a helicopter or airplane. Generally, the instrumentation records the intensity, location, and spectral analysis of the radiation.

Agreement state -- A state granted licensing authority over nuclear facilities within its borders by entering into an agreement with the Nuclear Regulatory Commission (formerly, the Atomic Energy Commission) under subsection 274b of the Atomic Energy Act of 1954, as amended by Public Law 86-373 in 1959.

Airborne activity -- Radioactivity resulting from unstable nuclides in the air.

Alpha particle -- (Symbol α (alpha)) A positively charged particle emitted by certain radioactive materials. It is made up of two neutrons and two protons bound together, and hence is identical with the nucleus of a helium atom. It is the least penetrating of the three common types of radiation (alpha, beta, gamma) emitted by radioactive material, and can be stopped by a sheet of paper. It is not dangerous to plants, animals, or man unless the alpha-emitting substance has entered the body.

Alpha ray -- A stream of alpha particles. Loosely, a synonym for an alpha particle.

Americium -- (Symbol Am) A manmade transuranic element with atomic number 95.

Associated property -- A real property in the vicinity of a radioactive materials processing site that has become contaminated by radioactive materials emanating from the site; also called a vicinity property.

Background -- Background radiation.

Background radiation -- The radiation in man's natural environment, including cosmic rays and radiation from the naturally radioactive elements. It is also called natural radiation. The term may also mean radiation that is unrelated to a specific experiment. Levels vary, depending on location.

Becquerel -- (Symbol Bq) The international system unit of activity of a radionuclide, equal to the activity of a quantity of a radionuclide having one spontaneous nuclear transition per second.

Beneficiation -- Treatment of ore in a way that improves its properties, e.g., to upgrade uranium-bearing ore so that it has a higher uranium content.

Beta particle -- (Symbol β (beta)) An elementary particle emitted from a nucleus during radioactive decay, with a single electrical charge and a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation may cause skin burns, and beta-emitters are harmful if they enter the body.

Beta ray -- Loosely, a synonym for a beta particle.

BFC-6 -- A code name for a residue stored at the Pennsylvania Railroad Landfill Site.

Billet -- A semifinished, short, thick bar of metal in the form of a cylinder or rectangular prism produced from an ingot.

Black oxide -- A U_3O_8 (uranium oxide) concentrate produced during a step in uranium refining.

Brown oxide -- A UO_2 (uranium dioxide) concentrate produced during a step in uranium refining.

Byproduct material -- As defined in Public Law 95-604, Section 201, any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

Carnotite -- (Symbol $K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$) A mineral consisting of a hydrous radioactive vanadate of uranium and potassium that is a source of radium and uranium.

Certification survey -- A comprehensive radiological survey performed to verify that the levels of residual radioactive material meet criteria for the intended use of the site.

Contamination -- (See radioactive contamination).

Cooperative agreement -- An agreement entered into between the United States of America, acting through the Department of Energy, and States (hosts of designated radioactive materials processing sites) to establish a program of assessment and remedial action.

Creep -- A time-dependent strain of solids caused by stress.

Curie -- (Symbol Ci or c) The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any nuclide having 1 curie of radioactivity.

Daughter -- The product of radioactive decay of a nuclide such as uranium; radioactive decay product.

Decay, radioactive -- The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in a decrease, with time, of the number of original radioactive nuclides in a sample. It involves the emission from the nucleus of alpha particles, beta particles (or electrons), or gamma rays; or the nuclear capture or ejection of orbital electrons; or fission. Also called radioactive disintegration.

Decontamination -- The removal of chemical, biological, or radiological contaminants from, or their neutralization on, a person, object, or area to within levels established by the Environmental Protection Agency.

Depleted uranium -- Uranium having a smaller percentage of uranium-235 than the 0.7 percent found in natural uranium. It is obtained from the spent (used) fuel elements or as byproduct tails, or residues, of uranium isotope separation.

Derby -- Crude uranium metal produced by reacting uranium tetrafluoride (UF_4) with magnesium metal at high temperature.

Designated sites -- Inactive uranium mill tailings sites designated as candidates for remedial action in accordance with the Inactive Uranium Mill Tailings Control Act of 1978 (Public Law 95-604).

Diffusion plant -- (See gaseous diffusion.)

Disintegrate -- Decay.

Dynapak -- A process for forging metal, or the associated machinery.

Dyne -- The absolute centimeter-gram-second unit of force; that force which will impart to a free mass of 1 gram an acceleration of 1 centimeter per second per second.

Electron -- (Symbol e^-) An elementary particle with a unit negative electrical charge and a mass 1/1837 that of the proton. Electrons surround the positively charged nucleus and determine the chemical properties of the atom. Positive electrons, or positrons, also exist.

Element -- A substance that cannot be divided into simpler substances by chemical means. A substance whose atoms all have the same atomic number. Examples: hydrogen, lead, uranium. (Not to be confused with fuel element.)

Enriched uranium -- Uranium in which the percentage of the fissionable uranium-235 isotope present has been artificially increased, so that it is higher than the percentage found in natural uranium (0.7 percent).

Erg -- The unit of energy that can exert a force of 1 dyne through a distance of 1 centimeter.

Feed materials -- Refined uranium or thorium metal or their pure compounds in a form suitable for use in nuclear reactor fuel elements or as feed for uranium enrichment processes.

Fission -- The splitting of a heavy nucleus into two approximately equal parts (which are nuclei of lighter nuclides), accompanied by the release of a relatively large amount of energy and generally one or more neutrons. Fission can occur spontaneously but usually is caused by nuclear absorption of gamma rays, neutrons, or other particles.

Fixed contamination -- Residual radioactive materials embedded in a rough or porous surface that cannot be easily removed by wiping the area.

Food chain -- The pathways by which any material passes from the first absorbing organism through plants and animals to man.

Formerly utilized site -- A site once used by or under contract to the Manhattan Engineer District or the Atomic Energy Commission to conduct research with, process, or store uranium or thorium ore or metals derived therefrom.

Fuel -- Fissionable material used or usable for producing energy in a nuclear reactor. Also applied to a mixture, such as natural uranium, in which only part of the atoms are readily fissionable, if the mixture can be made to sustain a chain reaction.

Fuel cycle -- The series of steps involved in supplying fuel for nuclear power reactors. It includes mining, refining, the original fabrication of fuel elements, their use in a reactor, chemical processing to recover the fissionable material remaining in the spent fuel, reenrichment of the fuel material, and refabrication into new fuel elements.

Fuel element -- A rod, tube, plate, or other mechanical shape or form into which nuclear fuel is fabricated for use in a reactor. (Not to be confused with element.)

Fuel reprocessing -- The processing of reactor fuel to recover the unused fissionable material.

Gamma radiation -- (Symbol γ (gamma)) High-energy, short-wavelength electromagnetic radiation of nuclear origin (radioactive decay). Gamma rays are the highest penetrating of the three common types of radioactive decay (alpha, beta, and gamma) and are best stopped or shielded against by dense materials, such as lead or depleted uranium.

Gas centrifuge process -- A method of isotopic separation in which heavy gaseous atoms or molecules are separated from light ones by centrifugal force.

Gaseous diffusion (plant) -- A method of isotopic separation based on the fact that gas atoms or molecules with different masses will diffuse through a porous barrier (or membrane) at different rates. The method is used to separate uranium-235 from uranium-238; it requires large gaseous-diffusion plants and enormous amounts of electric power.

Green salt -- Uranium tetrafluoride (UF_4).

Green sludge -- A product of vanadium tailings containing 5 to 10 percent uranium oxide.

Half-life -- The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years.

Health physics -- The science concerned with recognition, evaluation, and control of health hazards from ionizing radiation.

Heavy water -- (Symbol D_2O) Water containing significantly more than the natural proportion (one in 6500) of heavy hydrogen (deuterium) atoms to ordinary hydrogen atoms. Heavy water is used as a moderator in some reactors because it slows down neutrons effectively and also has a low probability for absorption of neutrons.

Heavy-water-moderated reactor -- A reactor that uses heavy water as its moderator. Heavy water is an excellent moderator and thus permits the use of inexpensive natural (unenriched) uranium as a fuel.

Hot -- Highly radioactive.

Hot spot -- A surface area of higher-than-average radioactivity.

Intensity -- The amount of energy passing through a unit area per unit time.

Ion -- An atom or molecule that has lost or gained one or more electrons. By this ionization, it becomes electrically charged.

Ion exchange -- A chemical process involving the reversible interchange of various ions between a solution and a solid material, usually a plastic or a resin. It is used to separate and purify chemicals, such as fission products, rare earths, etc., in solutions.

Ionization -- The process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, or nuclear radiations can cause ionization.

Ionizing event -- Any occurrence in which an ion or group of ions is produced; for example, by the passage of a charged particle through matter.

Ionizing radiation -- Any radiation displacing electrons from atoms or molecules, thereby producing ions. Examples: alpha, beta, and gamma radiation; short-wave ultraviolet light.

Isointensity contours -- Imaginary lines on the surface of the ground or water, or lines drawn on a map, joining points in a radiation field that have the same radiation intensity at a given time.

Isopleth -- A line on a map connecting points at which a given variable (e.g., radiation intensity) has a specified constant value.

Isotope -- One of two or more atoms with the same atomic number (the same chemical element) but with different atomic weights. An equivalent statement is that the nuclei of isotopes have the same number of protons but different numbers of neutrons. Thus, $^{12}_{6}C$, $^{13}_{6}C$, and $^{14}_{6}C$ are isotopes of the element carbon, the subscripts denoting their common atomic numbers, the superscripts denoting the differing mass numbers, or approximate atomic weights. Isotopes usually have very nearly the same chemical properties but somewhat different physical properties.

Isotope separation -- The process of separating isotopes from one another, or changing their relative abundances, as by gaseous diffusion or electromagnetic separation. All systems are based on the mass differences of the isotopes. Isotope separation is a step in the isotopic enrichment process.

Isotopic enrichment -- A process by which the relative abundances of the isotopes of a given element are altered, thus producing a form of the element that has been enriched in one particular isotope. Example: enriching natural uranium in the uranium-235 isotope.

K-25 process -- A gaseous diffusion process.

K-27 process -- A gaseous diffusion process.

K-65 -- A code name for residue from the Mallinckrodt Chemical Works stored at the Niagara Falls Storage Site and the Feed Materials Production Center in Fernald, Ohio.

L-30 -- A code name for residue from Linde Air Products stored at the Niagara Falls Storage Site.

L-50 -- A code name for residue from Linde Air Products stored at the Niagara Falls Storage Site.

Leach -- To dissolve out by the action of a percolating fluid.

Leachate -- Solution or product obtained by leaching.

Licensed material -- Source material, special nuclear material, or byproduct material received, possessed, used, or transferred under a general or special license issued by the Nuclear Regulatory Commission or an agreement state.

Lockland Aircraft Reactors Operation Office -- Former Atomic Energy Commission office located at Lockland, Ohio.

Low-level radiation -- Radiation that is of such intensity or concentration that it poses a minimal health hazard (less than 1 μcurie per gallon or cubic foot).

Manhattan Engineer District -- The code name for the group in the Department of the Army that was responsible for the World War II nuclear energy project.

Manhattan Project -- The War Department program during World War II that produced the first nuclear bombs. The term originated in the code-name, "Manhattan Engineer District," which was used to conceal the nature of the secret work underway. The Atomic Energy Commission, a civilian agency, succeeded the military unit on January 1, 1947.

Mass spectrograph, mass spectrometer -- Two related devices for detecting and analyzing isotopes. They separate nuclei that have different charge-to-mass ratios by passing the nuclei through electrical and magnetic fields.

Maximum Concentration Guide -- (See Radiactivity Concentration Guide.)

Maximum permissible concentration -- (Symbol MPC) The amount of radioactive material in air, water, or food which might be expected to result in a maximum permissible dose to persons consuming them at a standard rate of intake. An obsolescent term. (See Radioactivity Concentration Guide.)

Maximum permissible dose (maximum permissible exposure) -- (Symbol MPD) That dose of ionizing radiation established by competent authorities as an amount below which there is no reasonable expectation of risk to human health, and which at the same time is somewhat below the lowest level at which a definite hazard is believed to exist. An obsolescent term. (See Radioactivity Concentration Guide.)

Mesothorium I -- Radium-228, a daughter of thorium-232.

Mesothorium II -- Actinium-228, a daughter of thorium-232.

Microroentgen -- (Symbol μR) One millionth (10^{-6}) of a roentgen.

Mill tailings -- (See tailings.)

Millirad -- (Symbol mrad) One-thousandth (10^{-3}) of a rad.

Milliroentgen -- (Symbol mR) One thousandth (10^{-3}) of a roentgen.

Monazite -- A mineral that is a yellow, red, or brown phosphate of the rare earths and thorium found often in sand and gravel deposits.

Monitor -- An instrument that measures the level of ionizing radiation in an area. Also, to use an instrument to detect ionizing radiation. More generally, to perform an overview of an activity.

Nanocurie -- (Symbol nCi) One-billionth (10^{-9}) of a curie.

Natural uranium -- Uranium as found in nature, containing 0.7 percent of uranium-235, 99.3 percent of uranium-238. It is also called normal uranium.

Neutron -- (Symbol n) An elementary particle of neutral charge with a mass slightly greater than that of the proton and found in the nucleus of every atom heavier than hydrogen. A free neutron is unstable and decays with a half-life of about 13 minutes into an electron, proton, and neutrino.

Noble gas -- Any of a group of rare gases that include helium, neon, argon, krypton, xenon, and sometimes radon and exhibit great chemical stability and extremely low reaction rates. Also known as an inert gas.

Nuclear energy -- The energy liberated by a nuclear reaction (fission or fusion) or by radioactive decay.

Nuclear powerplant -- Any device, machine, or assembly that converts nuclear energy into some form of useful power, such as mechanical or electrical power. In a nuclear electric powerplant, heat produced by a reactor is generally used to make steam to drive a turbine that in turn drives an electric generator.

Nuclear reaction -- A reaction involving a change in an atomic nucleus, such as fission, fusion, neutron capture, or radioactive decay, as distinct from a chemical reaction, which is limited to changes in the electron structure surrounding the nucleus.

Nuclear reactor -- A device in which a fission chain reaction can be initiated, maintained, and controlled. Its essential component is a core with fissionable fuel. It usually has a moderator, a reflector, shielding, coolant, and control mechanisms.

Nuclear weapons -- A collective term for atomic bombs and hydrogen bombs. Any weapons based on a nuclear explosive.

Nuclei -- Plural of nucleus.

Nucleon -- A constituent of an atomic nucleus, that is, a proton or a neutron.

Nucleus -- The positively charged core of an atom. It is only about 1/10,000 the diameter of the atom but contains nearly all the atom's mass. All nuclei contain both protons and neutrons, except the nucleus of ordinary hydrogen, which consists of a single proton.

Nuclide -- A general term applicable to all atomic forms of the elements. The term is often erroneously used as a synonym for "isotope," which properly has a more limited definition. Whereas isotopes are the various forms of a single element (a family of nuclides) and all have the same atomic number and number of protons, nuclides comprise all the isotopic forms of all the elements. Nuclides are distinguished by their atomic number, atomic mass, and energy state.

Orange oxide -- A UO_3 (uranium trioxide) concentrate produced in a step during the refining of uranium.

Overburden -- Material overlying a deposit of useful geological materials.

Parent -- A radionuclide that upon radioactive decay or disintegration yields a specific nuclide (the daughter), either directly or as a later member of a radioactive series.

Particle -- A minute constituent of matter, generally one with a measurable mass. The primary particles involved in radioactivity are alpha particles, beta particles, neutrons, and protons.

Picocurie -- (Symbol pCi) One-trillionth (10^{-12}) of a curie.

Pile -- Old term for nuclear reactor. This name was used because the first reactor was built by piling up graphite blocks and natural uranium.

Pitchblende -- A massive, brown to black, fine-grained, amorphous, microcrystalline variety of the mineral uraninite, which has a pitchy to dull luster and contains uranium.

Pittsburgh Naval Reactors Office -- Former Atomic Energy Commission office in Pittsburgh, Pennsylvania.

Plutonium -- (Symbol Pu) A heavy, radioactive, manmade, metallic element with atomic number 94. Its most important isotope is fissionable plutonium-239, produced by neutron irradiation of uranium-238. It is used for reactor fuel and in weapons.

Positron -- (Symbol β^+ (beta-plus)) An elementary particle with the mass of an electron but positively charged. It is emitted in some radioactive disintegrations and is formed in pair production by the interaction of high-energy gamma rays with matter.

Prime contractor -- A contractor having a direct contract for an entire project and who may in turn assign portions of the work to subcontractors.

Processing site -- As defined in Public Law 95-604, Section 101(6), means (A) any site, including the mill, containing residual radioactive materials, at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless (i) such site was owned or controlled as of January 1, 1978, or is thereafter owned or controlled by any Federal agency, or (ii) a license (issued by the Nuclear Regulatory Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under Section 274 of such Act) for the production at such site of any uranium or thorium product derived from ores was in effect on January 1, 1978, or was issued or renewed after such date; and (B) any other real property or improvement thereon which (i) is in the vicinity of such site, and (ii) is determined by the Secretary of Energy, in consultation with the Nuclear Regulatory Commission, to be contaminated with residual radioactive materials derived from such site.

Progeny -- Descendants; used to mean the product of radioactive decay of an element; a nuclide remaining after radioactive decay which may itself be radioactive.

Protection -- Provisions to reduce exposure of persons to radiation. For example, protective barriers to reduce external radiation or measures to prevent inhalation of radioactive materials.

Protective Action Guide -- (Symbol PAG) The absorbed dose of ionizing radiation to individuals in the general population that would warrant protective action following a contaminating event.

Proton -- An elementary particle with a single positive electrical charge and a mass approximately 1837 times that of the electron. The nucleus of an ordinary or light hydrogen atom. Protons are constituents of all nuclei. The atomic number (Z) of an atom is equal to the number of protons in its nucleus.

PUREX process -- A method developed by the Kellex Corporation to separate uranium and plutonium from spent fuel.

Q-55 -- A code name for residue stored at the Pennsylvania Railroad Landfill Site.

R-10 -- A code name for a residue stored at the Niagara Falls Storage Site.

Rad -- (Acronym for radiation absorbed dose.) The basic unit of absorbed dose of ionizing radiation, equal to the absorption of 100 ergs of radiation energy per gram of absorbing material.

Radiation -- The emission and propagation of energy through matter or space by means of electromagnetic disturbances which display both wave-like and particle-like behavior; in this context, the "particles" are known as photons. Also, refers to the energy so propagated. The term has been extended to include streams of fast-moving particles (alpha and beta particles, free neutrons, cosmic radiation, etc.). Nuclear radiation is that which is emitted from atomic nuclei in various nuclear reactions, including alpha, beta, and gamma radiation and neutrons.

Radiation damage -- A general term for the harmful effects of radiation on matter.

Radiation detection instruments -- Devices that detect and record the characteristics of ionizing radiation.

Radiation dosimetry -- The measurement of the amount of radiation delivered to a specific place or the amount of radiation that was absorbed there.

Radiation monitoring -- Continuous or periodic determination of the amount of radiation present in a given area.

Radiation protection -- Legislation and regulations to protect the public and laboratory or industrial workers against radiation. Also, measures to reduce exposure to radiation.

Radiation Protection Guide -- The officially determined radiation doses that should not be exceeded without careful consideration of the reasons for doing so. These standards, established by the Federal Radiation Council, are equivalent to what was formerly called the maximum permissible dose or maximum permissible exposure.

Radiation shielding -- Reduction of radiation by interposing a shield of absorbing material between any radioactive source and a person, laboratory area, or radiation-sensitive device.

Radiation source -- Usually a manmade, sealed source of radioactivity used in teletherapy, radiography, as a power source for batteries, or in various types of industrial gauges. Machines such as accelerators, and radioisotopic generators and natural radionuclides may also be considered as sources.

Radiation standards -- Exposure standards, permissible concentrations, rules for safe handling, regulations for transportation, regulations for industrial control of radiation, and control of radiation exposure by legislative means.

Radiation warning symbol -- An officially prescribed symbol (a magenta trefoil on a yellow background) which should always be displayed when a radiation hazard exists.

Radioactive -- Exhibiting radioactivity or pertaining to radioactivity.

Radioactive contamination -- Deposition of radioactive material in any place where it may harm persons, spoil experiments, or make products or equipment unsuitable or unsafe for some specific use. The presence of unwanted radioactive matter. Often referred to only as contamination.

Radioactive chain -- A radioactive series.

Radioactive decay (disintegration) -- (See decay, radioactive.)

Radioactive half-life -- (See half-life.)

Radioactive isotope -- A radioisotope.

Radioactive series -- A succession of nuclides, each of which transforms by radioactive disintegration into the next until a stable nuclide results. The first member is called the parent, the intermediate members are called daughters, and the final stable member is called the end product.

Radioactive source -- A radiation source.

Radioactive standard -- A sample of radioactive material, usually with a long half-life, in which the number and type of radioactive atoms at a definite reference time is known. These are used in calibrating radiation-measuring equipment or for comparing measurements in different laboratories.

Radioactive waste -- (See waste, radioactive.)

Radioactivity -- The spontaneous decay or disintegration of an unstable atomic nucleus, usually accompanied by the emission of ionizing radiation. (Often shortened to "activity.")

Radioactivity Concentration Guide -- The concentration of radioactive material in an environment that would result in doses equal, over a period of time, to those in the Radiation Protection Guide. This Federal Radiation Council term replaces the former maximum permissible concentration.

Radiography -- The use of ionizing radiation for the production of shadow images on a photographic emulsion. Some of the rays (gamma rays or X-rays) pass through the subject, while others are partially or completely absorbed by the more opaque parts of the subject and thus cast a shadow on the photographic film.

Radioisotope -- A radioactive isotope. An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. More than 1300 natural and artificial radioisotopes have been identified.

Radiological hazard -- A condition in which radiation may cause health effects due to long-term exposure.

Radiological survey -- A comprehensive survey of the surface contamination, groundwater contamination, radiation levels, radon working levels, and other measurements as appropriate to characterize the type of radioactive material at a site and to evaluate the degree of radiological hazard that may exist.

Radiometric -- Relating to, using, or measured by a radiometer (an instrument for measuring the intensity of radiant energy).

Radionuclide -- A radioactive nuclide.

Radium -- (Symbol Ra) A radioactive metallic element with atomic number 88. As found in nature, the most common isotope has an atomic weight of 226. It occurs in minute quantities associated with uranium in pitchblende, carnotite, and other minerals; the uranium decays to radium in a series of alpha and beta emissions. By virtue of being an alpha- and gamma-emitter, radium is used as a source of luminescence and as a radiation source in medicine and radiography.

Radon -- (Symbol Rn) The heaviest element of the noble gas group, produced as a gaseous emanation from the radioactive decay of radium. Its atomic number is 86. All isotopes are radioactive. Rn-222 is an isotope with a half-life of 3.82 days.

Radon breath analysis -- Examination of exhaled air for the presence of radon to determine the presence and quantity of radium in the human body.

Raffinate -- A liquid product resulting from the extraction of a liquid with a solvent, e.g., the radionuclide-containing liquid waste produced during the refining of uranium ore.

Rare earths -- A group of 15 chemically similar metallic elements, including elements 57 through 71 on the Periodic Table of the Elements, also known as the Lanthanide Series.

Recycling -- The reuse of fissionable material, after it has been recovered by chemical processing from spent or depleted reactor fuel, reenriched, and then refabricated into new fuel elements.

Relative biological effectiveness -- (Symbol RBE) A factor used to compare the biological effectiveness of different types of ionizing radiation. It is the inverse ratio of the amount of absorbed radiation required to produce a given effect to a standard (or reference) radiation required to produce the same effect.

Rem -- (Acronym for roentgen equivalent, man.) The unit of ionizing radiation that produces the same biological damage to man as a unit of absorbed dose (1 roentgen) of high-voltage X-rays.

Remedial action -- As defined in the proposed Residual Radioactive Material Control Act, means action that is necessary for (1) the removal from a remedial action site of residual radioactive material to a disposal site and subsequent control of that material, or (2) stabilization and subsequent control of residual radioactive material at the remedial action site, or (3) both (1) and (2), to comply with standards established under Section 276 of the Atomic Energy Act of 1954, as amended.

Remedial action site -- As defined in the proposed Residual Radioactive Material Control Act, means (1) a site at which remedial action is required and which was used under a contract with any predecessor of the Department of Energy, including the Manhattan Engineer District and Atomic Energy Commission for researching, developing, manufacturing, fabricating, testing, processing, sampling, or storing radioactive material, except a site (a) for which a license (issued by the Nuclear Regulatory Commission or its predecessor agency under the Atomic Energy Act of 1954, or by a State under Section 274 of that Act) for the production or possession at the site of uranium or thorium, or their daughter products, including radium, is in effect on the date of enactment of the Residual Radioactive Material Control Act, or is issued or renewed after that date, or (b) owned or leased by the Federal Government on or after the date of enactment of the Residual Radioactive Material Control Act and (2) any other location the Secretary of Energy or his designee determines to require remedial action due to contamination with residual radioactive material derived from a site meeting the criteria of part (1) of this definition.

Removable contamination -- Residual radioactive materials that are easily removed by wiping a surface. Sometimes referred to as transferrable contamination.

Rep -- (Acronym for roentgen equivalent, physical.) An obsolete unit of absorbed dose of any ionizing radiation, with a magnitude of 93 ergs per gram. It has been superseded by the rad.

Reprocessing -- Remilling of residual radioactive materials to extract mineral content.

Research reactor -- A reactor primarily designed to supply neutrons or other ionizing radiation for experimental purposes. It may also be used for training, materials testing, and production of radioisotopes.

Residual radioactive material -- As defined in the proposed Residual Radioactive Material Control Act, means any radioactive material present at a site that results in radiation levels that exceed background levels, including but not limited to waste material, soils, rock, plants, shrubs, personal property, and building materials.

Residue -- The material that remains after some is removed.

Restricted use -- A designation following remedial action that requires some control on the activities at a site containing residual radioactive material.

Roentgen -- (Symbol R) A unit of exposure to ionizing radiation. It is that amount of gamma or X-rays required to produce ions carrying 1 electrostatic unit of electrical charge (either positive or negative) in 1 cubic centimeter of dry air under standard conditions.

Roentgen equivalent, man -- (See rem.)

S-50 process -- The thermal diffusion process.

S-109 -- A code name for residue stored at the Pennsylvania Railroad Landfill Site.

Sands -- A granular residue.

Screening survey -- A preliminary survey conducted at a site to determine whether a radiological hazard may exist or whether the site warrants a more comprehensive radiological survey due to the presence of residual radioactive materials that produce radiometric readings above background.

Shield (shielding) -- A body of material used to reduce the passage of radiation.

Slime -- Moist clay-like mud produced in refining carnotite ore.

Sludge -- Muddy sediment produced in refining carnotite ores.

Slug -- A short, usually cylindrical fuel element.

Soda salt -- (Symbol $Na_2U_2O_7$) Sodium uranate, a concentrate produced during a step in uranium refining.

Sodium diuranate -- (Symbol $Na_2U_2O_7$) Also referred to as sodium uranate, a concentrate produced during a step in uranium refining, commonly called yellow cake.

Sodium uranate --(See sodium diuranate.)

Source -- (See radiation source.)

Source material -- In atomic energy law, any material, except special nuclear material, which contains 0.05 percent or more of uranium, thorium, or any combination of the two.

Special nuclear material -- In atomic energy law, this term refers to plutonium-239, uranium-233, uranium containing more than the natural abundance of uranium-235, or any material artificially enriched in any of these substances.

Specific activity -- The radioactivity of a radioisotope of an element per unit weight of the element in a sample. The activity per unit mass of a pure radionuclide. The activity per unit weight of any sample of radioactive material.

Specific ionization -- The number of ion pairs formed per unit of distance along the track of an ion passing through matter.

Spectrum -- A visual display, a photographic record, or a plot of the distribution of the intensity of a given type of radiation as a function of its wavelength, energy, frequency, momentum, mass, or any related quantity.

Spent (depleted) fuel -- Nuclear reactor fuel that has been irradiated (used) to the extent that it can no longer effectively sustain a chain reaction.

Spill -- The accidental release of radioactive material.

Stable -- Incapable of spontaneous change. Not radioactive.

Stable isotope -- An isotope that does not undergo radioactive decay.

Stabilization -- The activities or measures taken to contain radioactive materials and prevent them from migrating from a site.

Subcontractor -- A manufacturer or organization that receives a contract from a prime contractor for a portion of the work on a project.

Surface contamination -- Radioactive materials attached to or deposited on a surface.

Surplus facility -- A potentially radioactive contaminated property under the control of the Department of Energy (including cribs, ponds, trenches, buildings, reactors, and equipment) that has become obsolete in terms of current and future program needs.

Survey -- An evaluation of the radiation hazards incidental to the production, use, or existence of radioactive materials or other sources of radiation under a specific set of conditions.

Survey meter -- Any portable radiation detection instrument especially adapted for surveying or inspecting an area to establish the existence and amount of radioactive material present.

Tailings -- As defined in Public Law 95-604, Section 101(8), the term "tailings" means the remaining portion of a metal-bearing ore after some or all of such metal, such as uranium, has been extracted.

Thermal diffusion -- A method of separating isotopes by forcing heated gas through barriers.

Thermoluminescent dosimeter -- (Symbol TLD) A device that records the radiation dose to which it is exposed; the device is read by an instrument that records the amount of light emitted when the crystal is heated.

Thorium -- (Symbol Th) A naturally radioactive element with atomic number 90 and, as found in nature, an atomic weight of approximately 232. The thorium-232 isotope is abundant and can be transmuted to fissionable uranium-233 by neutron irradiation.

Thorium series (sequence) -- The series of nuclides resulting from the radioactive decay of thorium-232. Many manmade nuclides decay into this sequence. The end product of the sequence in nature is lead-208.

Thoron -- Radon-220, a daughter of thorium-232 and radium-224.

Threshold dose -- The minimum dose of radiation that will produce a detectable biological effect.

Total contamination -- The combination of fixed and removable contamination, usually measured as beta-gamma (in millirads at one centimeter) and alpha (in counts per minute per 100 cm^2 at contact).

Transuranic element (isotope) -- An element above uranium in the periodic table, that is, with an atomic number greater than 92. All 11 transuranic elements are produced artificially and are radioactive. They are neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium.

Tritium -- A radioactive isotope of hydrogen with two neutrons and one proton in the nucleus. It is manmade and is heavier than deuterium (heavy hydrogen). Tritium is used in industrial thickness gauges and as a label in experiments in chemistry and biology. Its nucleus is a triton.

Tuballoy -- A metallic form of uranium.

U-235 -- Uranium-235. (See uranium.)

Unrestricted use -- As defined in the proposed Residual Radioactive Material Control Act, means any use without restraint on ownership, occupancy, or land development.

Unstable isotope -- A radioisotope. (Compare stable isotope.)

Uranium -- (Symbol U) A radioactive element with the atomic number 92 and, as found in natural ores, an average atomic weight of approximately 238. The two principal natural isotopes are uranium-235 (0.7 percent of natural uranium) and uranium-238 (99.3 percent of natural uranium). Natural uranium also includes a minute amount of uranium-234. Uranium is the basic raw material of nuclear energy.

Uranium dioxide -- (Symbol UO_2) A solid compound called brown oxide produced during a step in uranium refining.

Uranium enrichment -- (See isotopic enrichment.)

Uranium hexafluoride -- (Symbol UF_6) A volatile compound of uranium and fluorine. UF_6 gas is the process fluid in the gaseous diffusion process. (See isotope separation.)

Uranium oxide -- (Symbol U_3O_8) A solid compound called black oxide. An intermediate product in the refining of uranium.

Uranium peroxide -- (Symbol $UO_4 \cdot 2H_2O$) An intermediate substance produced in the refining of uranium.

Uranium series (sequence) -- The series of nuclides resulting from the radioactive decay of uranium-238, also known as the uranium-radium series. The end product of the series is lead-206. Many manmade nuclides decay into this sequence.

Uranium tetrafluoride -- (Symbol UF_4) A solid green compound called green salt. An intermediate product in the production of uranium hexafluoride.

Uranium trioxide -- (Symbol UO_3) An intermediate product in the refining of uranium, also called orange oxide.

Vanadium -- (Symbol V) A metal in group Vb; soluble in strong acids and alkalis; silver-white in color, ductile, resistant to corrosion, used in alloy steels and as an X-ray target.

Vanadium pentoxide -- (Symbol V_2O_5) A concentrate produced during the refinement of natural vanadium ore.

Vicinity property -- A real property in the vicinity of a radioactive materials processing site that has become contaminated by radioactive materials emanating from the site; also called an associated property.

Waste, radioactive -- Equipment and materials (from nuclear operations) that are radioactive and for which there is no further use. Wastes are generally classified as high level (having radioactivity concentrations of hundreds to thousands of curies per gallon or cubic foot), low level (in the range of 1 microcurie per gallon or cubic foot), or intermediate (between these extremes).

Whole body counter -- A device used to identify and measure the radiation in the body (body burden) of human beings and animals; it uses heavy shielding to keep out background radiation and ultrasensitive scintillation detectors and electronic equipment.

Working level --(Symbol WL) A unit of radon daughter exposure equal to any combination of short-lived radon daughters in 1 liter of air that will result in the ultimate emission of 130,000 million-electric-volts. Equivalent working levels inside structures are determined from the radon concentration, assuming a 50-percent equilibrium condition.

X-10 process -- A method of producing plutonium from natural uranium used at Hanford, Washington.

Y-12 process -- A method used to enrich uranium using electromagnetic fields.

Yellow cake -- A concentrate of uranium produced at uranium mills; the common name for sodium or ammonium diuranate.

Yellow sludge -- A concentrate containing 10 to 15 percent U_3O_8 (uranium oxide).

130-H -- A code name for a pitchblende residue stored at the Pennsylvania Railroad Landfill Site.

306 -- A code name for residue stored at the Pennsylvania Railroad Landfill Site.

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