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M-609

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for Maywood, New Jersey

U.S. Department of Energy

0489-0613.1

147161

ornl

ORNL/RASA-96/5

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Results of the Independent Radiological Verification Survey of the Final Remediation at 90 Avenue C, Lodi, New Jersey (LJ079V)

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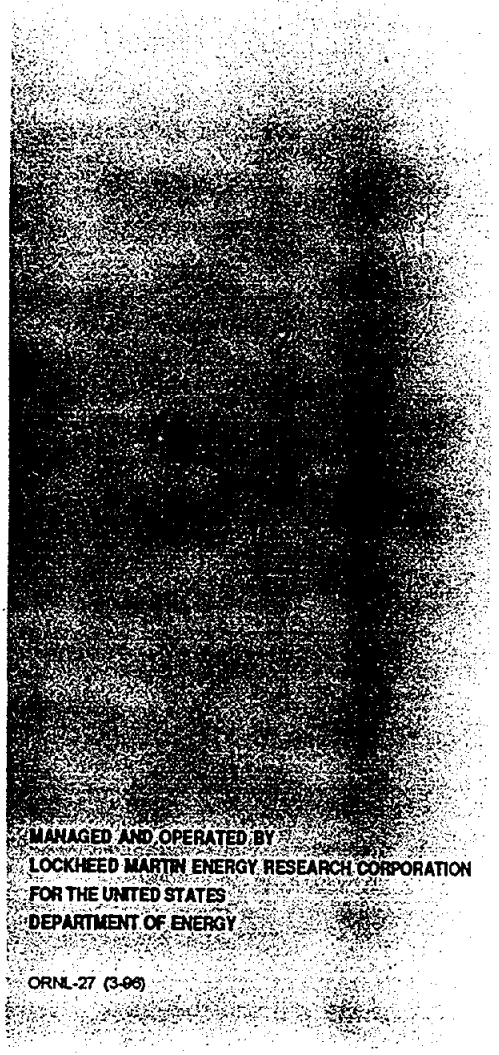

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DEPARTMENT OF ENERGY

ORNL-27 (3-96)

ORNL/RASA-96/5

HEALTH SCIENCES RESEARCH DIVISION

Environmental Restoration and Waste Management Non-Defense Programs
(Activity No. EX 20 20 01 0; ADS1310AA)

Results of the Independent Radiological Verification Survey of the Final Remediation at 90 Avenue C, Lodi, New Jersey (LJ079V)

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Date Issued - September 1996

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for the
U. S. DEPARTMENT OF ENERGY
under contract DE-AC05-96OR22464

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ACKNOWLEDGMENTS

This project was sponsored by the Office of Environmental Restoration, U.S. Department of Energy, under contract DE-AC05-84OR21400 with Lockheed Marietta Energy Systems, Inc., and contract DE-AC05-96OR22464 with Lockheed Marietta Energy Research Corp. The authors wish to acknowledge the contributions of D. A. Rose and D. A. Roberts of the Measurement Applications and Development Group, Oak Ridge National Laboratory, for sample preparation and analysis. The authors also wish to thank Bechtel National, Inc., and Thermo NuTech for their cooperation and assistance.

ABSTRACT

Prior to the final remediation, radionuclide residues in excess of DOE applicable guidelines were found outdoors on the rear half of the property at 90 Avenue C, Lodi, New Jersey. (The front half of the property outdoors and areas indoors had previously been remediated and verified.) Decontamination, which consisted of excavation and removal of contaminated soil, was performed by subcontractors under the direction of Bechtel National, Inc. The independent radiological verification survey described in this report was performed by the Measurement Applications and Development Group at Oak Ridge National Laboratory (ORNL) to verify that the final remedial action had reduced contamination levels to within authorized limits.

The property at 90 Avenue C, Lodi, New Jersey, was thoroughly investigated outdoors for radionuclide residues. Surface gamma exposure rates were below guideline levels and comparable to typical background values for the area. The results of soil radionuclide analysis for ^{238}U, ^{226}Ra, and ^{232}Th indicated that all soil concentration measurements were below limits prescribed by DOE applicable guidelines for protection against radiation.

Analysis of data contained in the post-remedial action report (DOE/OR/21949-405) and results of this final independent radiological verification survey by ORNL confirm that all radiological measurements fall below the limits prescribed by DOE guidelines established for this site. The property at 90 Avenue C successfully meets the DOE remedial action objectives.

Results of the Independent Radiological Verification Survey of the Final Remediation at 90 Avenue C, Lodi, New Jersey (LJ079V)*

INTRODUCTION

Thorium ores were processed by the Maywood Chemical Works (MCW),[1] Maywood, New Jersey, between 1916 and 1959. The MCW ceased thorium processing in 1959, and the 30-acre property was sold that same year to Stepan Chemical Company. During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities, now called the Maywood Interim Storage Site. Subsequently, residuals containing radioactive materials migrated off-site to the surrounding area, and the Stepan property and several vicinity properties, along with other sites, were designated by Congress for remedial action as a result of the 1984 Energy and Water Development Appropriations Act.

The waste produced by the thorium extraction process was a sand-like material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. Because some of the wastes had been carried downstream by Lodi Brook, and some area residents had also used the sand-like wastes as mulch in their yards, the properties in the vicinity of the MCW were included as a decontamination research and development project under the Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP).

At the request of the DOE, the Measurement Applications and Development Group at Oak Ridge National Laboratory (ORNL) conducted investigative radiological surveys of properties surrounding the former processing plant. In May 1988, a radiological survey was conducted on the private, residential property at 90 Avenue C, Lodi, New Jersey.[2] The location of the Stepan property and the DOE-owned Maywood Interim Storage Site relative to 90 Avenue C in Lodi, New Jersey, is shown in Fig. 1.

The survey consisted of complete indoor and outdoor gamma scans of the property, both at the surface and 1 m above the surface, and collection of surface and subsurface soil samples. Survey results, published in June 1989,[2] reported elevated gamma exposure rates in the strip of yard between the sidewalk and the street, at ground level on the eastern wall of the garage, and at 8 ft above ground level on the eastern side of the house. Surface and 1-m gamma levels were elevated west of the garage and south and west of the house. Indoors, elevated gamma exposure rates were found in the kitchen, near the back door, the basement steps, and the basement area beneath the eastern kitchen wall. Soil sample analyses indicated that the property contained radioactive contamination primarily from the ^{232}Th and ^{238}U decay chains, with some contamination from ^{226}Ra. Both the concentration and extent of ^{232}Th on the property were in excess of the applicable DOE criteria, and the property was scheduled for remedial action.

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*The survey was performed by members of the Measurement Applications and Development Group of the Health Sciences Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

In the fall of 1990, Bechtel National, Inc. (BNI), the project management contractor designated by DOE, conducted a remediation investigation of this property,[3] which confirmed earlier findings of contamination and identified additional contamination in an upstairs bedroom. In July 1991, BNI performed a partial remedial action consisting of demolition of the entire kitchen and basement walls and floor and excavation and removal of contaminated soil around the foundation.[4] The garage was also remediated at this time. Soil in one location in front of the house and at the curb adjacent to the street had been remediated earlier and was not part of this remediation. Contaminated soil in the rear half of the lot was left for remediation at a later date.

A verification survey of the 1991 remedial action by BNI was conducted by the Measurement Applications and Development Group of ORNL, the independent verification contractor. The DOE's policy to assign an independent verification contractor ensures the effectiveness of remedial actions performed within FUSRAP and confirms the site's compliance with DOE guidelines. Results of the independent verification survey were reported in February 1994.[5] All radiological measurements in the portion of the site that had been remediated fell within limits prescribed by DOE radiological guidelines.

Decontamination of the rear half of the property to current guidelines was conducted by subcontractor personnel in the fall of 1995 under the direction of BNI. Thermo NuTech was the radiological support subcontractor. At that time, soils samples from four locations beneath the garage floor contained no ^{238}U, ^{226}Ra, or ^{232}Th above guideline levels.

An independent radiological verification survey of the final remediation was conducted in October 1995 by the Measurement Applications and Development Group at ORNL, at the request of DOE's Office of Environmental Restoration. This report describes that survey. The property at 90 Avenue C, Lodi, New Jersey, is a residential lot with a single family dwelling, asphalt driveway, and concrete walkway. A diagram of the property is shown in Fig. 2.

SCOPE OF THE SURVEY

Objectives

The objectives of the verification activities were to confirm (1) that available documentation adequately and accurately describes the post-remedial action status of the property that is to be verified, and (2) that the final remedial action reduced contamination levels to within authorized limits. Applicable DOE guidelines for protection against radiation are shown in Table 1.

Survey Methods

A comprehensive description of the survey methods and instrumentation used in this survey is given in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (April 1987)[6] and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).[7]

The radiological verification survey of this property included (1) a complete surface gamma scan of the property outdoors, (2) a cursory beta-gamma scan of the exposed foundation on the house and garage, (3) the collection of surface soil samples for analysis, and (4) the examination of additional data collected by BNI and Thermo NuTech. Gamma radiation levels were determined using a portable sodium iodide (NaI) gamma scintillation probe connected to a Victoreen Model 490 Thyac III ratemeter. Measurements were recorded in counts per minute (cpm) and converted to microroentgen per hour (μR/h). A Bicron miniscaler/ratemeter with a Geiger-Mueller (GM) pancake detector was used for the beta-gamma scan.

Surface (0 to 15 cm) soil samples were collected at various locations over the property. Systematic soil samples (VS9, VS10, and VS11) were taken irrespective of gamma exposure rates. One biased sample (VB6) was collected at the point of the highest surface gamma exposure rates in the remediated area. All soil samples were collected after excavation was completed and before a remediated area was backfilled with clean soil. Concentrations of ^{226}Ra, ^{232}Th, and ^{238}U were determined in soil samples using gamma spectrometry.

VERIFICATION SURVEY RESULTS

DOE guidelines are summarized in Table 1. Typical background radiation levels for the northern New Jersey area are presented in Table 2. These data are provided for comparison with survey results presented in this section. All direct-measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in soil.

Gamma Exposure Rate Measurements

Surface gamma exposure rates (see Fig. 2) on the property generally ranged from 7 to 10 μR/h in the front yard and 7 to 13 μR/h in the backyard. Gamma levels in the ash pit in the backyard ranged from 10 to 14 μR/h. Gamma levels in four test holes drilled through the asphalt driveway north of the excavated area ranged from 10 to 13 μR/h. All gamma exposure rates are comparable to typical background radiation levels of 3 to 13 μR/h found in the northern New Jersey area (Table 2).

Beta-Gamma Exposure Rate Measurements

All beta-gamma measurements along the exposed foundation of the house and garage were within typical background beta-gamma levels.

Soil Samples

Soil sample locations are shown in Fig. 2, and results of radionuclide analyses are listed in Table 3. Systematic and biased samples contained ^{226}Ra in concentrations ranging from 0.66 to 1.1 pCi/g, similar to the typical background concentrations found in the northern New Jersey area (Table 2). Systematic and biased samples contained ^{238}U in concentrations

ranging from 0.63 to 2.1 pCi/g and ^{232}Th in concentrations ranging from 0.95 to 4.1 pCi/g. Three samples were above typical background concentrations found in the northern New Jersey area (Table 2), but all are well below the DOE applicable guideline of 5 pCi/g (Table 1) with background concentrations subtracted.*

CONCLUSIONS

Prior to the final remediation, radionuclide residues in excess of DOE applicable guidelines were found outdoors on the rear half of the property at 90 Avenue C, Lodi, New Jersey. (The front half of the property outdoors and areas indoors had previously been remediated and verified.[4,5]) Decontamination, which consisted of excavation and removal of contaminated soil, was performed by subcontractors under the direction of BNI. This independent radiological verification survey was performed to verify that the final remedial action had reduced contamination levels to within authorized limits.

The property was thoroughly investigated outdoors for radionuclide residues. Surface gamma exposure rates were below guideline levels and comparable to typical background values for the area. The results of soil radionuclide analysis for ^{238}U, ^{226}Ra, and ^{232}Th indicated that all soil concentration measurements were below limits prescribed by DOE applicable guidelines for protection against radiation.

Analysis of data contained in the post-remedial action report (DOE/OR/21949-405)[8] and results of this final independent radiological verification survey by ORNL confirm that all radiological measurements fall below the limits prescribed by DOE guidelines established for this site. The property at 90 Avenue C successfully meets the DOE remedial action objectives.

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2. R. D. Foley and L. M. Floyd, *Results of the Radiological Survey at 90 C Avenue, Lodi, New Jersey (LJ079)*, ORNL/RASA-88/67, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., June 1989.

*For residential properties in the Lodi, New Jersey, area, the guideline for ^{232}Th is 5 pCi/g above background levels, averaged over a 100-m^2 area, for both surface and subsurface soil. *Source*: W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, correspondence to J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, March 1994, and J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, correspondence to W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, April 1995.

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8. *Post-Remedial Action Report for the Maywood Site Vicinity Properties at 79 Avenue B, 90 Avenue C, 108 Avenue E, 112 Avenue E, and 113 Avenue E, Maywood, New Jersey*, DOE/OR/21949-405, Bechtel National, Inc., Oak Ridge, Tennessee, September 1996.

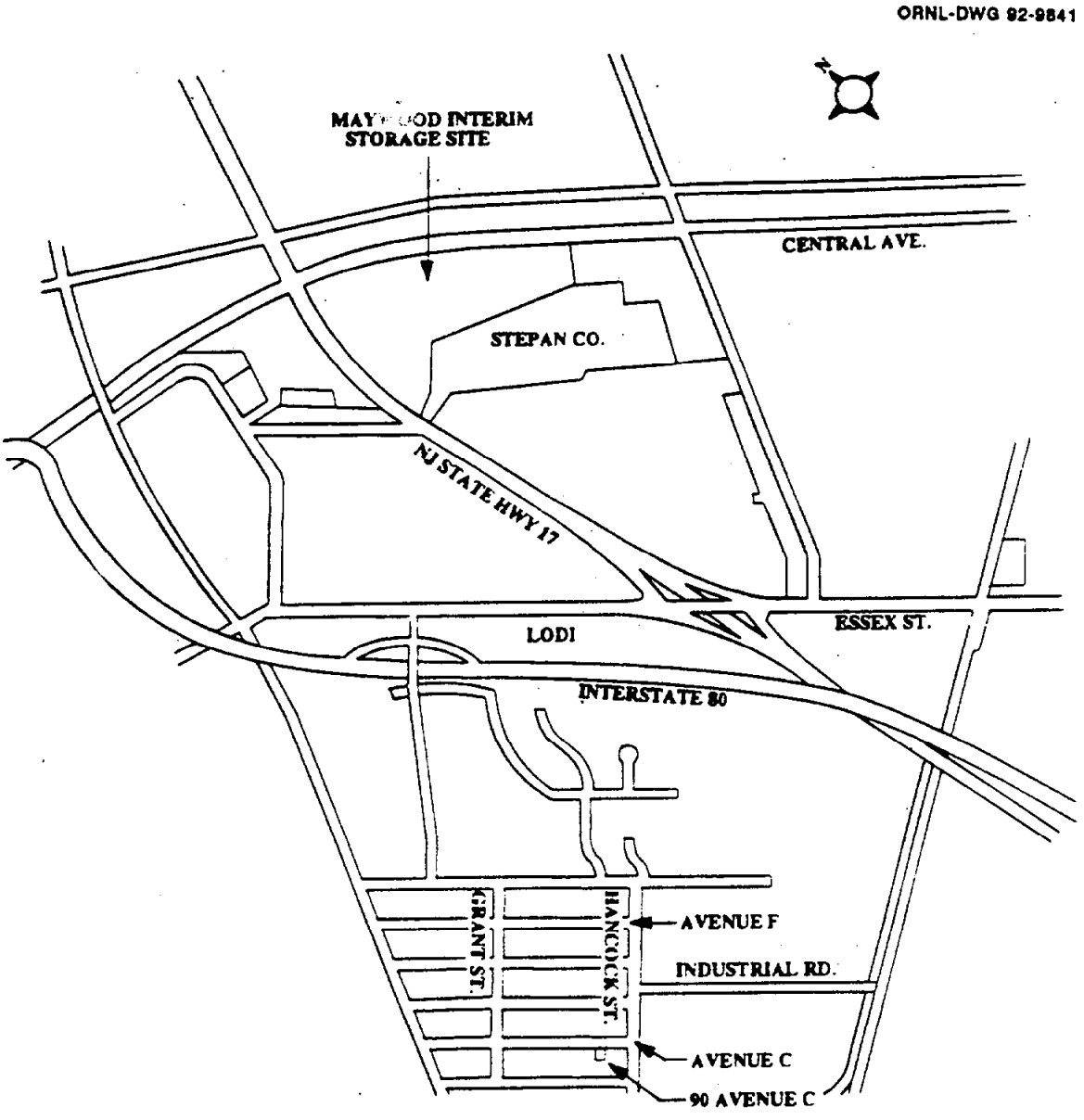

Fig. 1. Diagram showing general location of the Stepan property and the Maywood Interim Storage Site in relation to 90 Avenue C, Lodi, New Jersey.

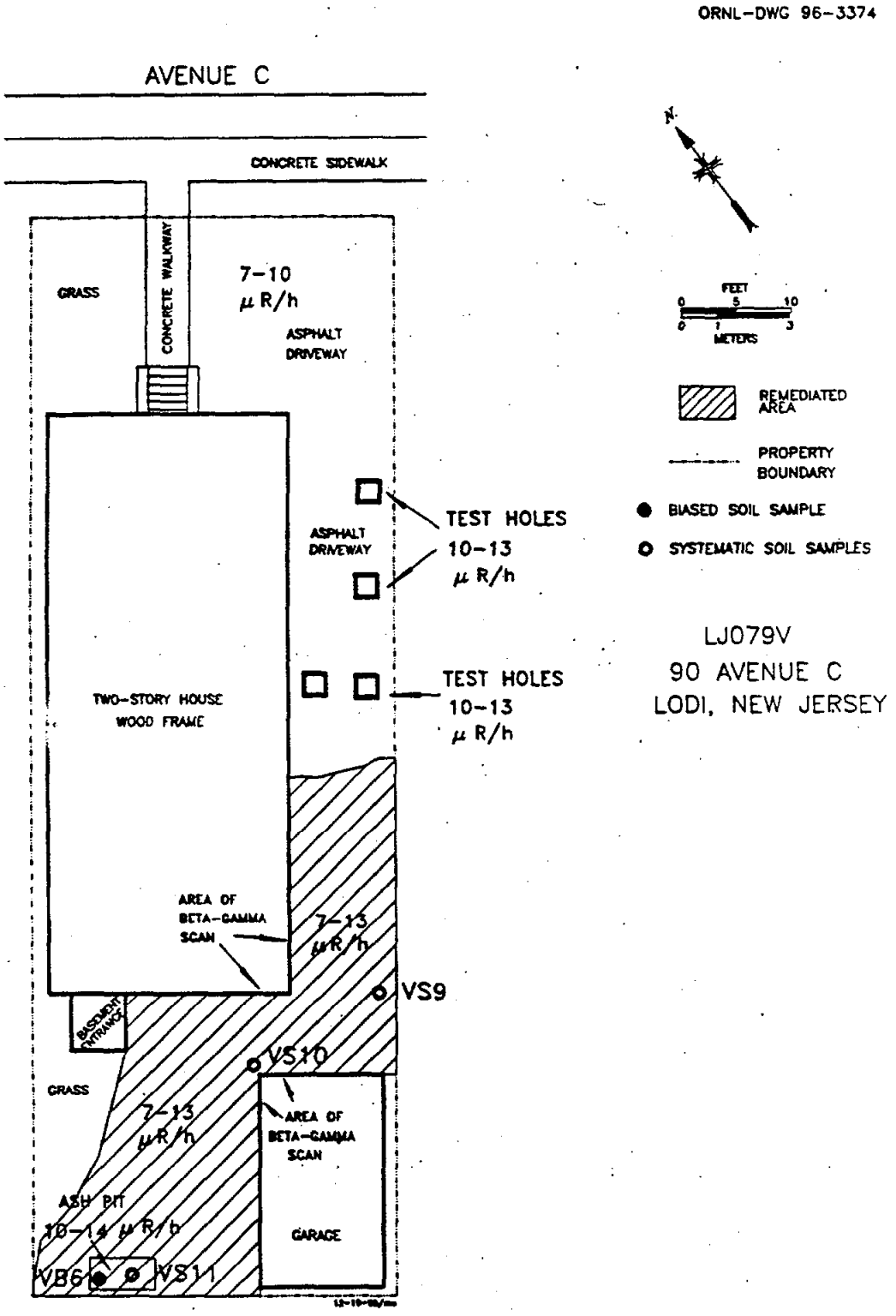

Fig. 2. Diagram of the property at 90 Avenue C, Lodi, New Jersey, showing surface gamma exposure rates and soil sampling locations.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h[a]
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m^2 area ^{226}Ra ^{232}Th ^{230}Th	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface[b,c]
Derived concentrations	Total uranium	100 pCi/g[d]
Guideline for nonhomogeneous contamination (used in addition to the 100-m^2 guideline)[e]	Applicable to locations with an area $\leq$25 m^2, with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{1/2}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m^2 area

[a]The 20 μR/h shall comply with the basic dose limit (100 mrem/year) when an appropriate-use scenario is considered.

[b]For residential properties in the Lodi, New Jersey, area, the guideline for ^{232}Th is 5 pCi/g above background levels, averaged over a 100-m^2 area, for both surface and subsurface soil. *Source*: W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, correspondence to J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, March 1994, and J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, correspondence to W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, April 1995.

[c]The concentration of any single radionuclide above normal background levels shall not exceed the guideline value. If more than one radionuclide is present, the sum of the ratios of the measured soil concentration of each radionuclide to its corresponding guideline value shall not exceed unity.

[d]DOE guidelines for uranium are derived on a site-specific basis. A guideline of 100 pCi/g for total uranium above background levels has been approved for this site. *Source*: J. W. Wagoner II, Director, Division of Off-Site Programs, Office of Eastern Areas Programs, Office of Environmental Restoration, Department of Energy, memorandum to L. Price, Oak Ridge Operations Office, Department of Energy, April 1995.

[e]DOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area. *Source*: Adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987.

Sources: Adapted from U.S. Department of Energy, DOE Order 5400.5, April 1990; U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987; and U.S. Department of Energy, *Radiological Control Manual*, DOE/EH-0256T (DOE N 5480.6), June 1992.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil, northern New Jersey area

Type of radiation measurement or sample	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at 1 m above ground surface (μR/h)	3–13[a]	8[b]
Concentration of radionuclides in soil (pCi/g)[c]		
^{226}Ra	0.55–1.4	1.0
^{232}Th	0.53–1.5	1.0
^{238}U	0.46–1.4	1.0

[a]Values obtained from 14 locations in the northern New Jersey area. *Source:* T. E. Myrick and B. A. Berven, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., November 1981.

[b]U.S. Department of Energy, *Radiological Survey of the Middlesex Municipal Landfill, Middlesex, New Jersey*, DOE/EV-00005/20, April 1980.

[c]Values obtained from 15 locations in northern New Jersey area. *Source:* T. E. Myrick and B. A. Berven, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., November 1981.

Table 3. Concentrations of radionuclides in soil at 90 Avenue C, Lodi, New Jersey (LJ079)

Sample number[a]	Grid location[b]	Depth[c] (cm)	Radionuclide concentration (pCi/g)[d]		
			^{226}Ra	^{232}Th	^{238}U
		Systematic samples[e]			
VS9	N747910 E2162664	0–15	0.66±0.09	0.95±0.09	0.63±0.3
VS10	N747911 E2162653	0–15	0.76±0.05	1.2±0.05	0.88±0.2
VS11	N747907 E2162634	0–15	1.0 ±0.1	2.2±0.1	1.2±0.2
		Biased sample[f]			
VB6	N747907 E2162629	0–15	1.1±0.1	4.1±0.2	2.1±0.2

[a]Sample locations are shown on Fig. 2.

[b]Grid location based on state plane.

[c]Samples taken after excavation completed and before a remediated area was backfilled with clean soil.

[d]Indicated counting error is at the 95% confidence level ($\pm 2\sigma$). Background concentrations (see Table 2) have not been subtracted.

[e]Systematic samples are taken at locations irrespective of gamma exposure rates.

[f]Biased sample taken from area with very slightly elevated surface gamma exposure rates.

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