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**Results of the Independent  
Radiological Verification  
Survey at 112 Avenue E,  
Lodi, New Jersey  
(LJ082V)**

R. E. Rodriguez  
C. A. Johnson

**MASTER**

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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 at 112 Avenue E, Lodi, New Jersey (LJ082V)**

R. E. Rodriguez and C. A. Johnson

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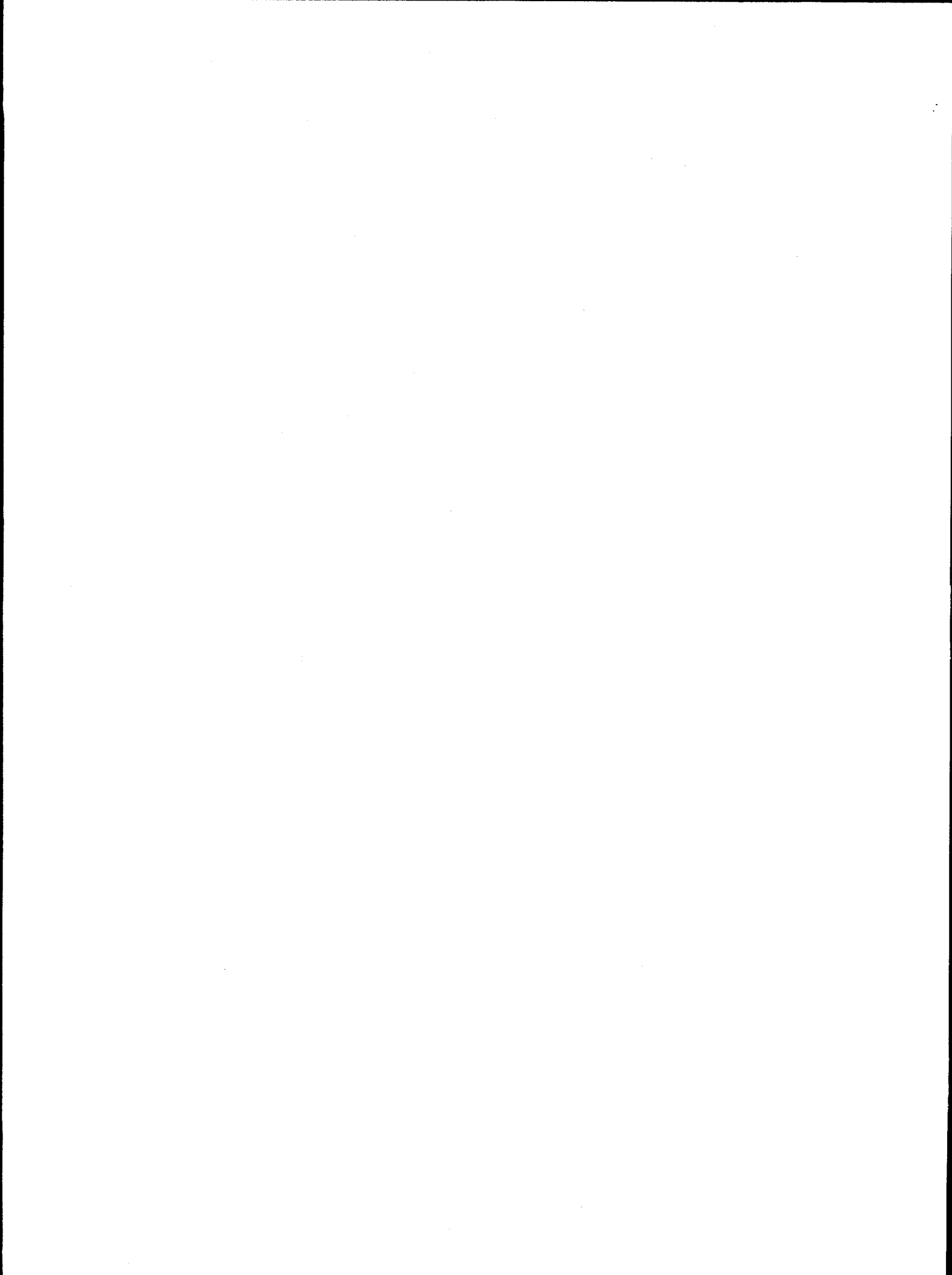
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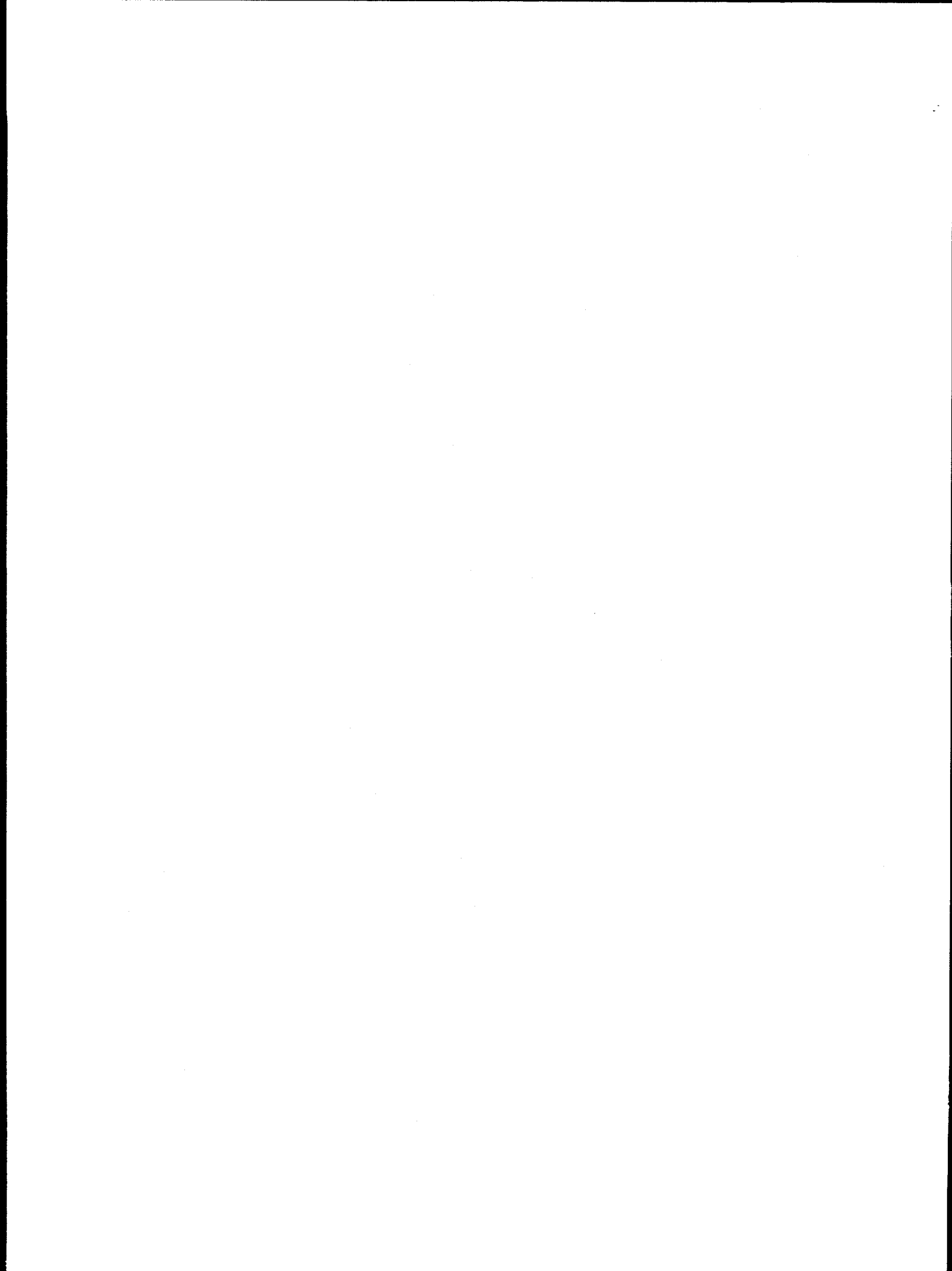
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## ABSTRACT

Thorium ores were processed by the Maywood Chemical Works until the property was sold to Stepan Chemical Company in 1959. Wastes were stored at what is now called the Maywood Interim Storage Site (MISS), owned by the U. S. Department of Energy (DOE). Because of the migration of residuals off site into the surrounding areas, the Stepan property and several vicinity properties were designated for remedial action under the 1984 Energy and Water Development Appropriations Act.

The DOE conducted radiological surveys of these sites to evaluate current radiological conditions as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). In 1988, radiological surveys of some private residential properties on Avenue E in Lodi, New Jersey were conducted by members of an ORNL radiological survey team. Results of this survey indicated radiological contamination in excess of the DOE criteria for surface contamination at this vicinity property (112 Avenue E), and it was recommended for remediation.

In the fall of 1995, a verification survey of this vicinity property was conducted by ORNL, the independent verification contractor for this effort, in conjunction with decontamination operations conducted under the supervision of Bechtel National Incorporated. The verification survey included complete surface gamma scans of the grounds and the collection of soil samples for radionuclide analysis. This report describes the radiological verification survey of this residential property.

Based on the remedial action and verification survey data reported in this document, all radiological measurements fall below the limits prescribed by DOE radiological guidelines established for this site, and the property at 112 Avenue E, Lodi, New Jersey successfully meets the DOE radiological guidelines for unrestricted use.

# **Results of the Independent Radiological Verification Survey at 112 Avenue E, Lodi, New Jersey (LJ082V)\***

## **INTRODUCTION**

Thorium ores were processed by the Maywood Chemical Works (MCW)<sup>1</sup>, 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 (MISS). Subsequently, residuals containing radioactive materials migrated off-site to the surrounding area, and the Stepan property and several vicinity properties at this and 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).

The location of Lodi, New Jersey, relative to the Stepan property and the DOE-owned Maywood Interim Storage Site is shown in Fig. 1.

At the request of the DOE, the Measurement Applications and Development (MAD) Group from 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 112 Avenue E., Lodi, New Jersey by members of the MAD Group of ORNL.<sup>2</sup>

The survey consisted of a complete gamma scan of the entire property outdoors and the collection of systematic and biased soil samples. The survey report, published in 1989, concluded that areas of elevated gamma were scattered about the front, back, and side yards, and soil analysis from these areas indicated that the property contained residual radioactive material primarily from the <sup>232</sup>Th decay chain.<sup>2</sup> Additionally, both the concentration and extent of <sup>232</sup>Th found 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 of Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

Decontamination of the facility to current guidelines was conducted by subcontractor personnel in conjunction with the verification survey in the fall of 1995 under the direction of Bechtel National Incorporated (BNI), the project management contractor for FUSRAP. Thermo NUtech was the radiological support subcontractor.

The independent radiological verification survey detailed in this report was performed in March and November 1995 under the FUSRAP program by members of the Measurement Applications and Development Group at ORNL, the independent verification contractor for this property. 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.

This report describes the radiological verification survey of the private, residential property at 112 Avenue E, Lodi, New Jersey, conducted by ORNL at the request of the DOE's Office of Environmental Restoration. The property, a single family dwelling with concrete walks and asphalt driveway, was marked in 25-ft grids for the survey. A diagram of the property is shown in Fig. 2.

## SCOPE OF THE SURVEY

### Objectives

The objective of the verification activities was to confirm (1) that available documentation adequately and accurately describes the post-remedial action of the facility that is to be verified, and (2) that the remedial action reduced contamination levels to within authorized limits. Applicable DOE residual radioactivity guidelines for protection of the general public are summarized in Table 1. Typical background radiation levels for the New Jersey area are presented in Table 2.

### 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), and Measurement Applications and Development Group Guidelines, ORNL-6782 (January 1995).<sup>3,4</sup>

The radiological verification survey of this property included: (1) a complete surface gamma scan of the grounds and (2) the collection of surface and subsurface soil samples for analysis.

Gamma radiation levels were determined using a portable sodium iodide (NaI) gamma scintillation detector connected to a Victoreen ratemeter. Measurements were recorded in counts per minute (cpm) and converted to microroentgens per hour ( $\mu\text{R/h}$ ).

Confirmatory surface (0-15 cm, or 0 to 6 in) and subsurface (15-30 cm, or 6 to 12 in) soil samples were collected from under the basement floor and at various locations over the property. Samples taken where elevated gamma levels were found are referred to as biased samples and are labeled VB1 through VB6. Systematic samples (VS1 to VS9)

were taken from locations irrespective of gamma levels. Two samples (VS1 and VS2) were taken from under the concrete floor in the basement, and two (VB6 and VS9) were taken from under the concrete sidewalk along the east side of the house. Locations of the samples are shown in Fig. 2, and results of the radionuclide analysis are shown in Table 3.

Tables 1 and 2, summarizing current guidelines for sites included within FUSRAP and typical background radiation levels for the New Jersey area, provide comparison with the survey results presented in this section. Gamma measurements presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil.

## VERIFICATION SURVEY AND ANALYSIS

Applicable DOE guidelines and typical background radiation levels for the northern New Jersey area are presented in Tables 1 and 2. These data are provided for comparison with the survey results presented in this section. All measurements presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil samples.

### Gamma Exposure Rates

Gamma measurements generally ranged from 7-18  $\mu\text{R/h}$  at the surface over the property, and up to 25  $\mu\text{R/h}$  on the east corner of the house. Two soil samples were taken from this area. These measurements are comparable to the natural background levels for this area. Elevated gamma levels ranging from 12 to 80  $\mu\text{R/h}$  were measured in a small area around the tree in the backyard, indicating spotty contamination. Two biased samples and four systematic soil samples were taken close to and around the tree in the backyard.

### Soil Samples

Surface and subsurface soil samples were collected indoors from underneath the basement floor and from outside in the front, side, and back yards. Biased samples were taken from excavated areas (before backfilling) and from areas of elevated gamma. Although gamma levels were elevated around the tree in the southern end of the back yard, the owner did not want the tree removed, so extensive soil sampling was done around the tree. Six soil samples were taken in close proximity to each other and to the tree. All samples were analyzed for radium ( $^{226}\text{Ra}$ ), thorium ( $^{232}\text{Th}$ ), and uranium ( $^{238}\text{U}$ ).

Results of the soil analyses are in picocuries per gram (pCi/g) and are shown in Table 3. Radionuclide concentrations of  $^{226}\text{Ra}$  and  $^{232}\text{Th}$  in systematic samples ranged from 0.49 to 1.0 pCi/g and 0.72 to 2.5 pCi/g, respectively. Concentrations of  $^{226}\text{Ra}$  and  $^{232}\text{Th}$  in biased samples ranged from 0.96 to 2.3 and from 2.3 to 20 pCi/g, respectively. The DOE guideline for these radionuclides in soil is 5 pCi/g above background averaged over 100  $\text{m}^2$  for surface and subsurface soil in this area.<sup>5</sup>

The maximum of 20 and 11 pCi/g  $^{232}\text{Th}$  (VB4 and VB5, Table 3) were found in close proximity to each other in a small area as shown on Fig. 2. The area was no more

than 5 m<sup>2</sup> as delineated by sampling and gamma radiation measurements. The resulting average of 14.5 pCi/g (when background is subtracted) falls below the DOE "hot spot" criteria for this size area (Table 1). All other values are well below the DOE guidelines.

Concentrations of <sup>238</sup>U in soil ranged from 0.56 to 2.3 pCi/g in systematic samples, and from 1.1 to 10 pCi/g in biased samples. These values are well below the site specific guidelines of 100 pCi/g for total uranium ( 50 pCi/g for <sup>238</sup>U) averaged over 100 m<sup>2</sup> for uranium in soil (Table 1).<sup>6</sup>

## CONCLUSIONS

Prior to remedial efforts, thorium residuals exceeding guidelines were found in scattered small areas outdoors on the property at 112 Avenue E, Lodi, New Jersey. Decontamination of these areas was performed by subcontractors under the direction of BNI.

The remediated areas on the grounds of the property, including the area around the tree in the back yard were thoroughly investigated for radionuclide residues. The results of soil radionuclide analysis for <sup>238</sup>U, <sup>226</sup>Ra, and <sup>232</sup>Th (Table 3) indicate that all soil concentration measurements are within the limits prescribed by DOE radiological guidelines. Gamma exposure rates were all below guideline levels and comparable to the average background values for the area.

Results of the independent radiological verification survey of this property by ORNL confirm that residual radionuclide contaminations have been remediated to levels below DOE guidelines for FUSRAP sites.

Based on the results of the post remedial action data (*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., September 1996) and confirmed by the verification survey data, all radiological measurements fall below the limits prescribed by DOE radiological guidelines established for this site, and the property at 112 Avenue E successfully meets the DOE remedial action objectives.

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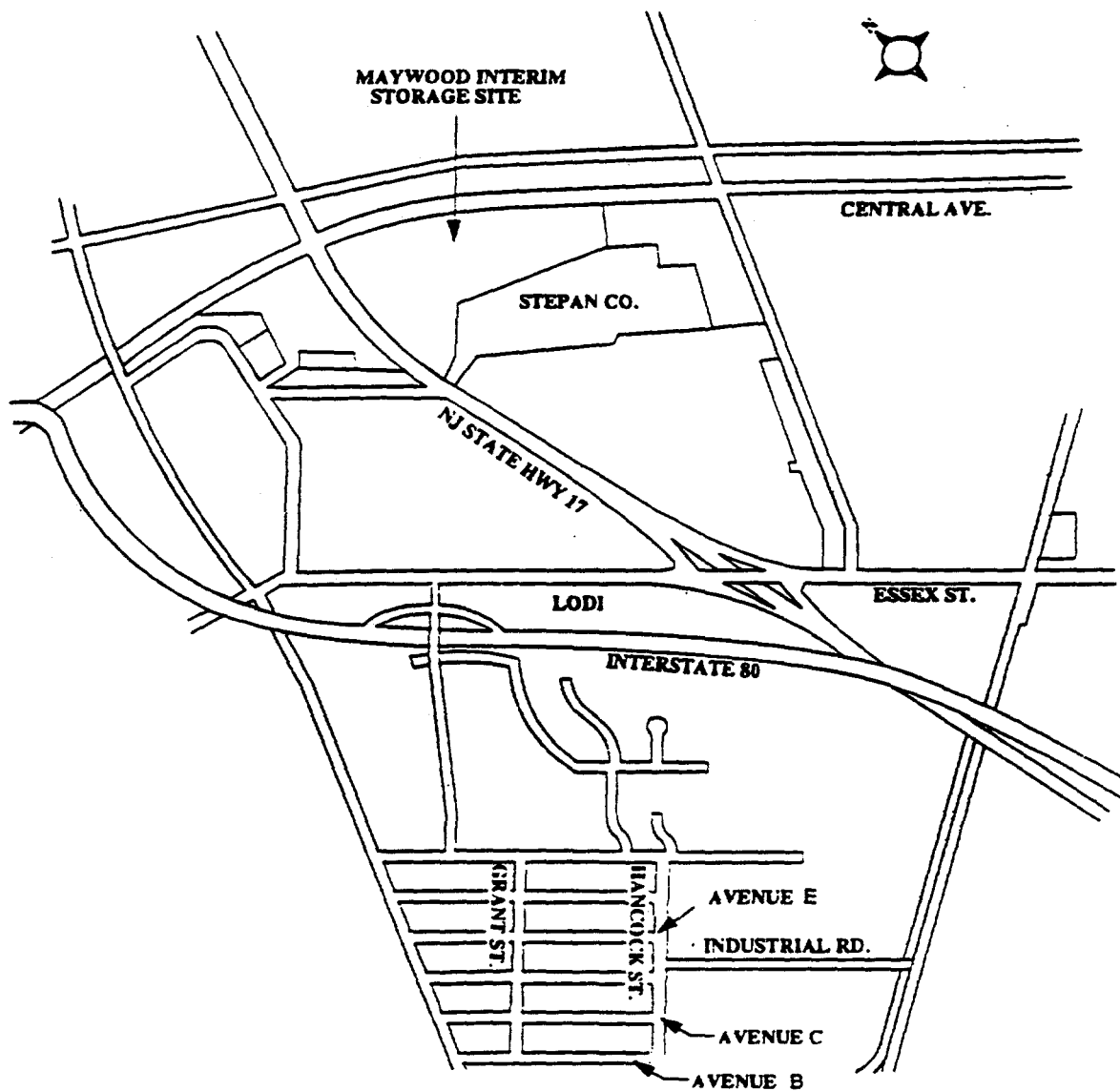
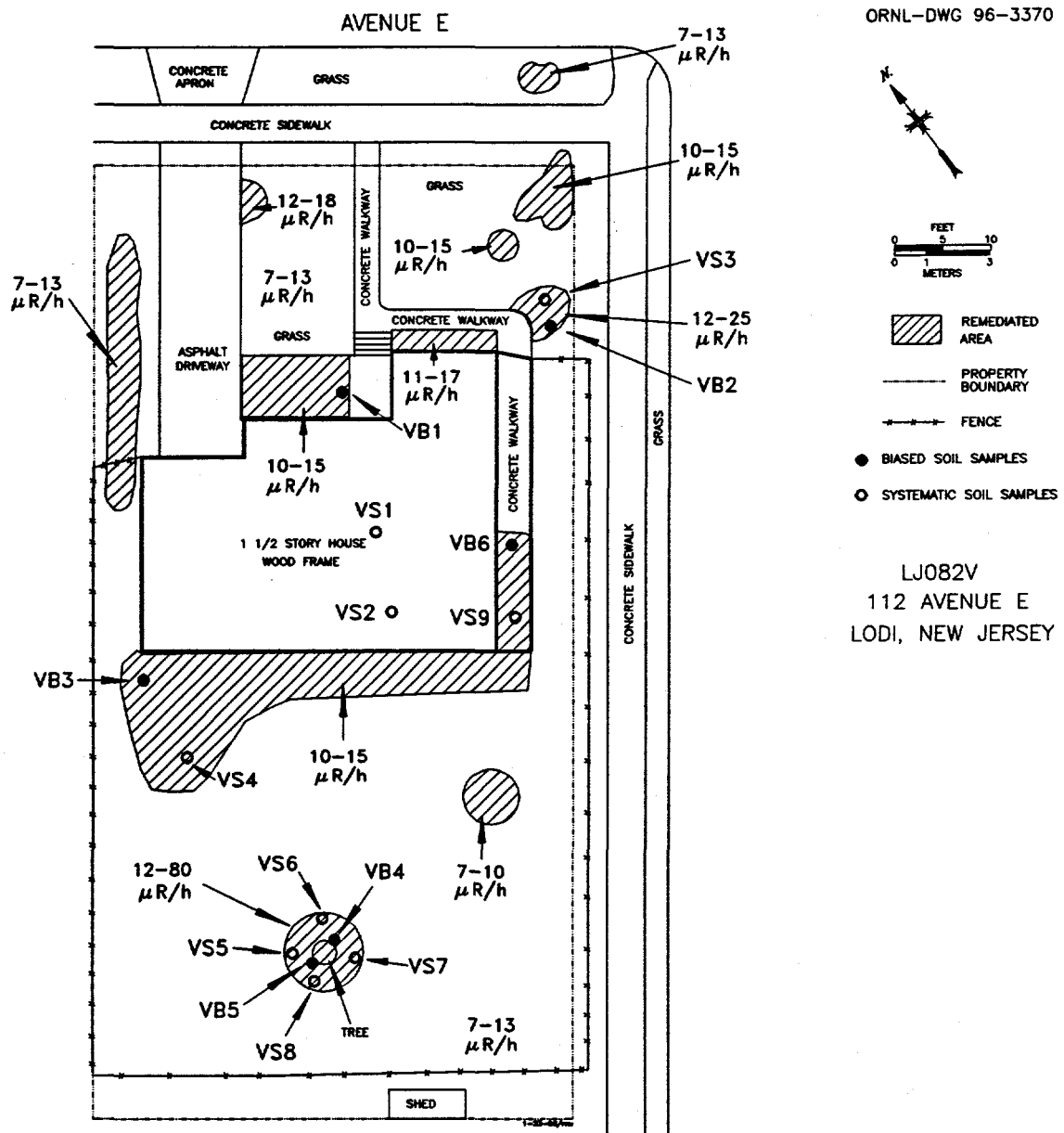


Fig. 1. Diagram showing the general location of vicinity properties in Lodi, New Jersey relative to the Maywood Interim Storage Site (MISS).





**Fig. 2. Diagram showing gamma measurements and soil sampling locations at 112 Ave. E, Lodi, New Jersey.**

**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 $\mu\text{R/h}^a$
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m <sup>2</sup> area  $^{226}\text{Ra}$ $^{232}\text{Th}$ $^{230}\text{Th}$	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 over 15 cm below the surface <sup>b,c</sup>
Derived concentrations	Total uranium	100 pCi/g <sup>d</sup>
Guideline for non-homogeneous contamination (used in addition to the 100-m <sup>2</sup> guideline) <sup>e</sup>	Applicable to locations with an area $\leq 25$ m <sup>2</sup> , 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 <sup>2</sup> area

<sup>a</sup>The 20  $\mu\text{R/h}$  shall comply with the basic dose limit (100 mrem/yr) when an appropriate-use scenario is considered.

<sup>b</sup>For residential properties in the Lodi, New Jersey, area, the guideline for  $^{232}\text{Th}$  is 5 pCi/g for both surface and subsurface soil.<sup>5</sup>

<sup>c</sup>The concentration of any single radionuclide above normal background levels shall not exceed the concentration guidelines. If more than one radionuclide is present, the sum of the ratios of the measured soil concentrations of each radionuclide to its corresponding guideline shall not exceed unity.

<sup>d</sup>DOE guidelines for uranium are derived on a site-specific basis. Guidelines of 100 pCi/g have been applied at this FUSRAP site. Source: Memo, J. W. Wagoner II, U.S. DOE, *Uranium Guideline for the Maywood, New Jersey Site*, to L. K. Price, Oak Ridge Field Office, U.S. DOE, April 1994.<sup>6</sup>

<sup>e</sup>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. Adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987.

Sources: Adapted from U.S. Department of Energy, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, April 1990, and 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 N 5480.6 (DOE/EH-256T), June 1992.

**Table 2. Background radiation levels and concentrations of selected radionuclides in soil in the 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 ( $\mu\text{R/h}$ )	3-13 <sup>a</sup>	8 <sup>b</sup>
Concentration of radionuclides in soil (pCi/g) <sup>c</sup>		
<sup>226</sup> Ra	0.55-1.4	1.0
<sup>232</sup> Th	0.53-1.5	1.0
<sup>238</sup> U	0.46-1.4	1.0

<sup>a</sup>Values obtained from 14 locations in the northern New Jersey, area.

Source: T. E. Myrick, B. A. Berven, and F. F. Haywood, *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.

<sup>b</sup>U. S. Department of Energy, *Radiological Survey of the Middlesex Municipal Landfill, Middlesex, New Jersey*, DOE/EV-0005/20, April 1980.

<sup>c</sup>Values obtained from 15 Locations in the northern New Jersey area.

Source: T. E. Myrick, B. A. Berven, and F. F. Haywood, *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 112 Avenue E, Lodi, New Jersey (LJ082V)**

Sample number <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g) <sup>b</sup>		
		<sup>226</sup> Ra	<sup>232</sup> Th	<sup>238</sup> U
<i>Systematic soil samples<sup>c</sup></i>				
VS1 <sup>d</sup>	61-76	0.49 ±0.05	0.73±0.09	1.1 ±0.6
VS2A <sup>e</sup>	0-15	1.0 ±0.08	1.2 ±0.1	1.4 ±1.0
VS2B	30-45	0.82 ±0.06	0.98±0.1	0.56±0.4
VS2C	76-91	0.53 ±0.08	0.72±0.09	1.6 ±0.6
VS3	0-15	0.94 ±0.1	2.5 ±0.2	2.3 ±0.5
VS4	0-15	0.67 ±0.04	0.80±0.05	0.84 ±0.3
VS5	0-15	0.65 ±0.09	1.1 ±0.1	0.66 ±0.3
VS6	0-15	0.59 ±0.09	2.2 ±0.2	1.6 ±0.4
VS7	0-15	0.72 ±0.1	1.7 ±0.1	1.3 ±0.4
VS8	0-15	0.69 ±0.1	1.3 ±0.1	1.2 ±0.4
VS9	0-15	0.84 ±0.1	1.6 ±0.1	1.2 ±0.4
<i>Biased samples<sup>f</sup></i>				
VB1	0-15	1.2 ±0.2	4.0 ±0.3	2.6 ±0.5
VB2	0-15	1.2 ±0.1	4.9 ±0.2	2.6 ±0.5
VB3	0-15	0.99±0.1	2.3 ±0.1	1.1 ±0.2
VB4 <sup>g</sup>	0-15	2.3 ±0.2	20 ±0.6	7.3 ±0.8
VB5 <sup>g</sup>	0-15	1.8 ±0.1	11 ±0.2	10 ±1.0
VB6A	0-15	0.96±0.1	2.4 ±0.2	2.0 ±0.4
VB6B	15-30	1.3 ±0.1	4.7 ±0.2	3.5 ±0.5

<sup>a</sup>Locations of soil samples are shown on Fig. 2. Radionuclide concentrations are gross values; background concentrations have not been subtracted.

<sup>b</sup>Indicated counting error is at the 95% confidence level ( $\pm 2\sigma$ ).

<sup>c</sup>Systematic samples are taken at locations irrespective of gamma exposure rates.

<sup>d</sup>Sample taken ~2.5 ft below surface of concrete floor of basement.

<sup>e</sup>VS2 samples taken from surface to ~2.5 - 3 ft below surface of concrete floor of basement.

<sup>f</sup>Biased samples are taken from areas with elevated gamma exposure rates.

<sup>g</sup>Samples VB4 and VB5 were bounded by samples VS5-VS8.

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