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**RESULTS OF THE  
RADIOLOGICAL SURVEY  
AT  
112 AVENUE E, LODI,  
NEW JERSEY (LJ082)**

**R. D. Foley  
L. M. Floyd**

PREPARED BY  
MARTIN MARIETTA ENERGY SYSTEMS, INC.  
FOR THE UNITED STATES  
DEPARTMENT OF ENERGY

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**HEALTH AND SAFETY RESEARCH DIVISION**

**Nuclear and Chemical Waste Programs  
(Activity No. AH 10 05 00 0; ONLWCO1)**

**RESULTS OF THE RADIOLOGICAL  
SURVEY AT 112 AVENUE E,  
LODI, NEW JERSEY  
(LJ082)**

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## ABSTRACT

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sandlike waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally  $^{232}\text{Th}$ , derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 112 Avenue E, Lodi, New Jersey (LJ082), was conducted during 1988.

Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

**RESULTS OF THE RADIOLOGICAL  
SURVEY AT 112 AVENUE E,  
LODI, NEW JERSEY  
(LJ082)\***

**INTRODUCTION**

From 1916 to 1956, process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores were generated by the Maywood Chemical Works (MCW), Maywood, New Jersey. During the latter part of this period, MCW supplied rare earth metals and thorium compounds to various government agencies. In the 1940s and 1950s, MCW produced thorium and lithium, under contract, for the Atomic Energy Commission (AEC). These activities ceased in 1956, and, approximately three years later, the 30-acre real estate was purchased by the Stepan Company. The property is located at 100 Hunter Avenue in a highly developed area in Maywood and Rochelle Park, Bergen County, New Jersey.

During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities. In the early 1930s, these areas were separated from the rest of the property by the construction of New Jersey State Highway 17. The Stepan property, the interim storage facility, and several vicinity properties have been designated for remedial action by the U.S. Department of Energy (DOE).

The waste produced by the thorium extraction process was a sandlike material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. During the years 1928 and 1944 to 1946, area residents used these process wastes mixed with tea and cocoa leaves as mulch in their lawns and gardens. In addition, some of the contaminated wastes were apparently eroded from the site into Lodi Brook and carried downstream.

Lodi Brook is a small stream flowing south from Maywood with its headwaters near the Stepan waste storage site. Approximately 150 ft after passing under State Route 17, the stream has been diverted underground through concrete or steel culverts until it merges with the Saddle River in Lodi, New Jersey. Only a small section near Interstate 80 remains uncovered. From the 1940s to the 1970s when the stream was being diverted underground, its course was altered several times. Some of these changes resulted in the movement of contaminated soil to the surface of a few properties, where it is still in evidence. In other instances, the contaminated soil was covered over or mixed with clean fill, leaving no immediate evidence on the surface. Therefore, properties in question may be drilled in search of former stream bed material, even in the absence of surface contamination.

As a result of the Energy and Water Appropriations Act of Fiscal Year 1984, the property discussed in this report and properties in its vicinity contaminated

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

with residues from the former MCW were included as a decontamination research and development project under the DOE Formerly Utilized Sites Remedial Action Program. As part of this project, DOE is conducting radiological surveys in the vicinity of the site to identify properties contaminated with residues derived from the MCW. The principal radionuclide of concern is thorium-232. The radiological surveys discussed in this report are part of that effort and were conducted, at the request of DOE, by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory.

A radiological survey of the private, residential property at 112 Avenue E, Lodi, New Jersey, was conducted during 1988. The survey and sampling of the ground surface were carried out on May 7, 1988.

## SURVEY METHODS

The radiological survey of the property included: (1) a gamma scan of the entire property outdoors, both at the surface and one meter above the surface and (2) collection of soil samples. No indoor survey measurements were performed.

Using a portable gamma scintillation meter, ranges of measurements were recorded for areas of the property surface and one meter above the surface. If the gamma readings were elevated, a biased soil sample was taken at the point showing the highest gamma radiation level. Systematic soil samples were taken at various locations on the property, irrespective of gamma radiation levels. These survey methods followed the plan outlined in Reference 1. A comprehensive description of the survey methods and instrumentation has been presented in another report.<sup>2</sup>

## SURVEY RESULTS

Applicable federal guidelines are summarized in Table 1.<sup>3</sup> The normal 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 environmental samples.

### Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan of the surface of the property are given in Fig. 1, with corresponding measurements one meter above the surface where indicated. Gamma exposure rates over the major portion of the property surface ranged from 8 to 19  $\mu\text{R}/\text{h}$ . One-meter readings were between 8 and 15  $\mu\text{R}/\text{h}$ , all above the normal background level of 8  $\mu\text{R}/\text{h}$  at one meter for the northern New Jersey area (Table 2). The highest readings were next to the house, 19 to 78  $\mu\text{R}/\text{h}$  on the south side, 12 to 78  $\mu\text{R}/\text{h}$  on the west side, 13 to 32  $\mu\text{R}/\text{h}$  on the eastern corner, and 17 to 37  $\mu\text{R}/\text{h}$  in the front flower beds. Around the tree

farthest to the south, levels ranged from 13 to 32  $\mu\text{R}/\text{h}$ . The four highest elevated areas in the front yard ranged from 13 to 31  $\mu\text{R}/\text{h}$ .

### Systematic and Biased Soil Samples

Systematic and biased soil samples were taken from various locations on the property for radionuclide analyses. Locations of the systematic (S) and biased (B) samples are shown in Fig. 2, with results of laboratory analyses provided in Table 3. Concentrations of radium, thorium, and uranium in the biased samples ranged from 1.1 to 3.6 pCi/g, 4.6 to 28 pCi/g, and 2.6 to 23 pCi/g, respectively. Biased samples B1A, B2A, B3A&B, and B4A were above DOE guidelines for  $^{232}\text{Th}$  (Table 1). Radium-226 biased samples were all near or above background values for the northern New Jersey area (Table 2).

### SIGNIFICANCE OF FINDINGS

Measurements taken at 112 Avenue E indicate that the property contained residual radioactive material primarily from the  $^{232}\text{Th}$  and  $^{238}\text{U}$  decay chains, with slight contamination from  $^{226}\text{Ra}$ . These radionuclide distributions are typical of the type of material originating from the MCW site. The concentration and extent of  $^{232}\text{Th}$  on this property were in excess of the applicable DOE criteria (Table 1). This material was found at sample locations B1, B2, B3, and B4, shown in Fig. 2. Results of this radiological assessment indicate that the property contains residual radioactivity derived from MCW in concentrations that exceed remedial action guidelines.

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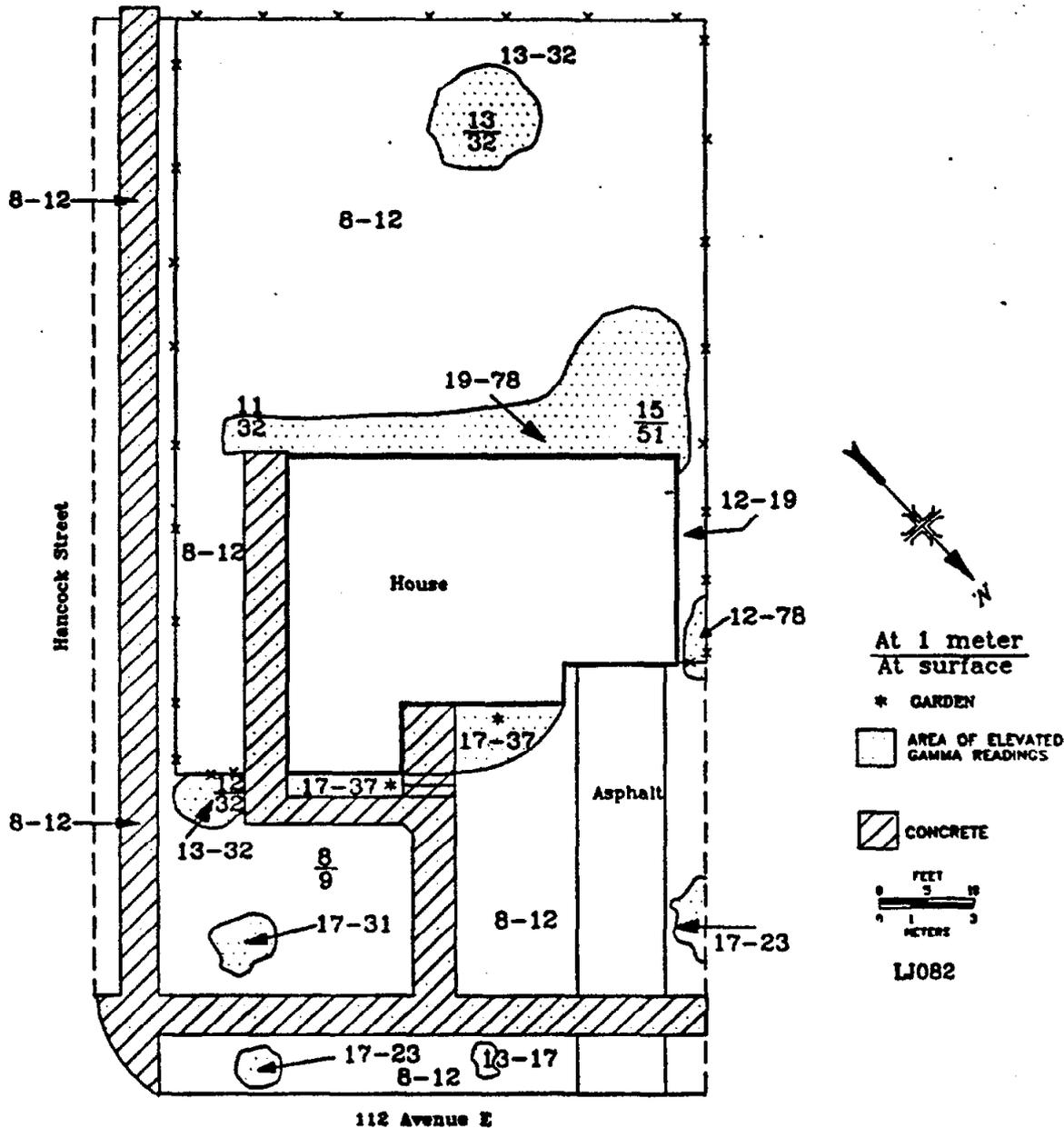


Fig. 1. Gamma radiation levels ( $\mu\text{R}/\text{h}$ ) measured on the surface at 112 Avenue E, Lodi, New Jersey (LJ082), with corresponding measurements one meter above the surface where indicated.

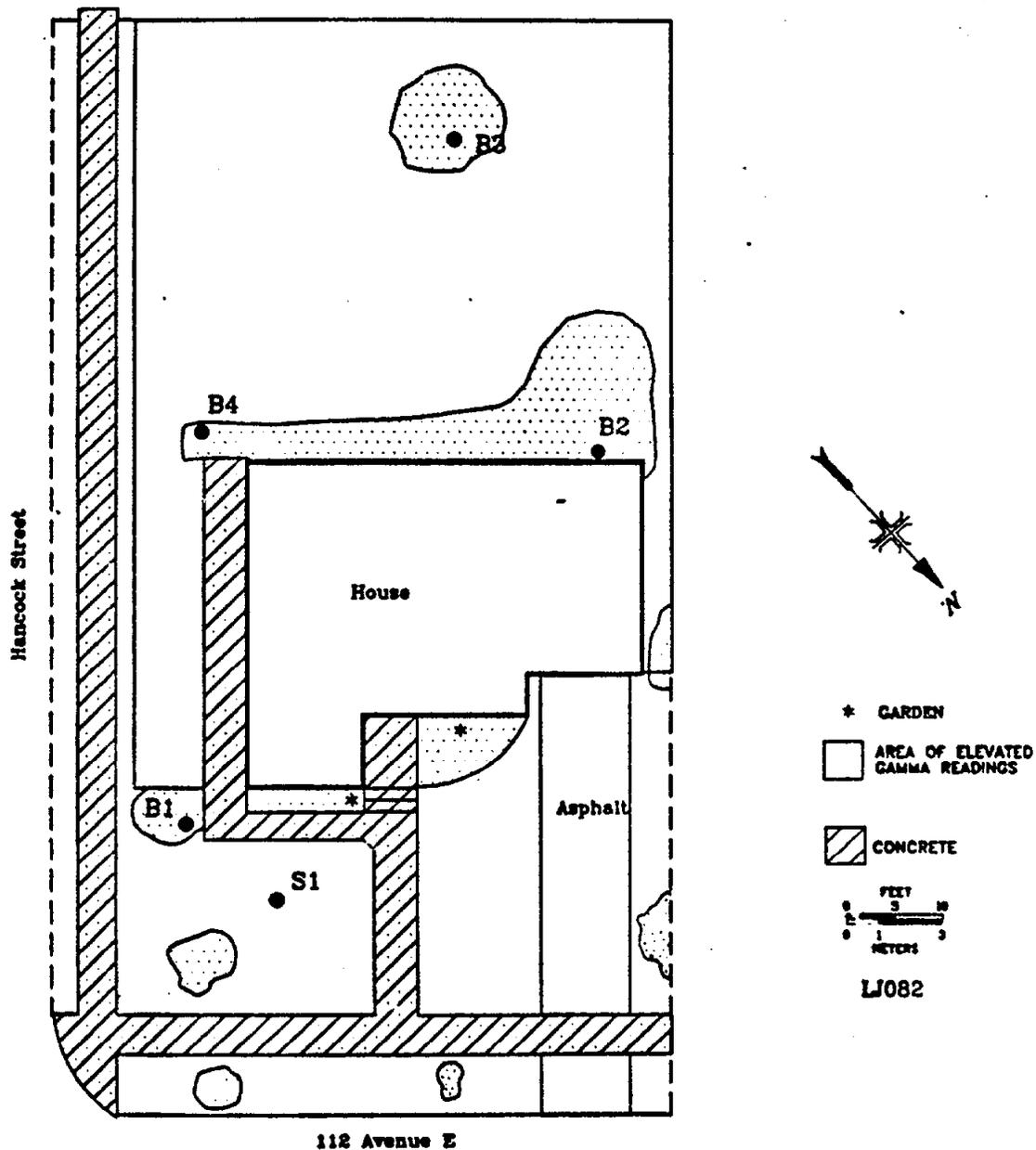


Fig. 2. Diagram showing locations of soil samples taken at 112 Avenue E, Lodi, New Jersey (LJ082).

**Table 1. Applicable guidelines for protection against radiation<sup>a</sup>**

Mode of exposure	Exposure conditions	Guideline value
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over 100 m <sup>2</sup> area <sup>232</sup> Th <sup>230</sup> Th <sup>228</sup> Ra <sup>226</sup> Ra	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

<sup>a</sup>Reference 3.**Table 2. Background radiation levels for the northern New Jersey area**

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure at 1 m above ground surface ( $\mu$ R/h)	8 <sup>a</sup>
Concentration of radionuclides in soil (pCi/g)	
<sup>232</sup> Th	0.9 <sup>b</sup>
<sup>238</sup> U	0.9 <sup>b</sup>
<sup>226</sup> Ra	0.9 <sup>b</sup>

<sup>a</sup>Reference 4.<sup>b</sup>Reference 5.

**Table 3. Concentrations of radionuclides in soil at  
112 Avenue E, Lodi, New Jersey (LJ082)**

Sample <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g)		
		<sup>226</sup> Ra <sup>b</sup>	<sup>232</sup> Th <sup>b</sup>	<sup>238</sup> U <sup>b</sup>
<i>Systematic samples<sup>c</sup></i>				
S1A	0-15	0.70±0.2	1.4 ±0.09	1.6±0.05
S1B	15-30	0.59±0.006	0.91±0.1	1.1±0.2
<i>Biased samples<sup>d</sup></i>				
B1A	0-15	3.6 ±0.08	28 ±0.2	23 ±3
B1B	15-30	1.8 ±0.1	11 ±0.3	6.8±0.4
B1C	30-45	1.2 ±0.04	4.6 ±0.07	2.6±0.8
B2A	0-15	3.0 ±0.3	23 ±1	16 ±6
B2B	15-30	1.3 ±0.1	6.0 ±0.1	5.5±0.08
B3A	0-15	2.6 ±0.2	22 ±0.7	17 ±2
B3B	15-25	2.7 ±0.3	23 ±1	13 ±2
B4A	0-15	2.9 ±0.06	19 ±0.1	13 ±3
B4B	15-30	1.1 ±0.06	4.6 ±0.1	4.3±0.3

<sup>a</sup>Locations of soil samples are shown on Fig. 2.

<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.

<sup>d</sup>Biased samples are taken from areas shown to have elevated gamma exposure rates.

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