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**RESULTS OF THE RADIOLOGICAL  
SURVEY AT KENNEDY PARK,  
MONEY AND SIDNEY STREETS,  
LODI, NEW JERSEY (LJ062)**

R. D. Foley  
W. D. Cottrell  
L. M. Floyd

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

ORNL/RASA-88/55

**HEALTH AND SAFETY RESEARCH DIVISION**

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LODI, NEW JERSEY (LJ062)**

R. D. Foley, W. D. Cottrell, and L. M. Floyd

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**Investigation Team**

R. E. Swaja - Measurement Applications and Development Manager  
W. D. Cottrell - FUSRAP Project Director  
R. D. Foley - Field Survey Supervisor

**Survey Team Members**

A. C. Butler*	R. A. Mathis
K. S. Dickerson	C. A. Muhr
C. A. Johnson	E. M. Pilz
A. K. Klitz	W. Winton
J. A. Rice (ORAU)	
W. H. Shinpaugh (Stone Associates)	

\*Former Employee of Martin Marietta Energy Systems, Inc.

Work performed by the  
**MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP**

Prepared by the  
**OAK RIDGE NATIONAL LABORATORY**  
Oak Ridge, Tennessee 37831-6285  
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## CONTENTS

LIST OF FIGURES .....	v
LIST OF TABLES .....	vii
ACKNOWLEDGMENTS .....	ix
ABSTRACT .....	xi
INTRODUCTION .....	1
SURVEY METHODS .....	2
SURVEY RESULTS .....	3
Surface Gamma Radiation Levels .....	3
Systematic and Biased Soil Samples .....	3
Auger Soil Samples .....	3
SIGNIFICANCE OF FINDINGS .....	4
REFERENCES .....	4

063990

### LIST OF FIGURES

1	Gamma radiation levels measured on the surface at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062) .....	5
2	Diagram showing locations of soil samples taken at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062).....	6
3	Gamma profile for auger hole 1 at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey .....	7
4	Gamma profile for auger hole 2 at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey .....	8

063990

### LIST OF TABLES

1	Applicable guidelines for protection against radiation .....	9
2	Background radiation levels for the northern New Jersey area .....	9
3	Concentrations of radionuclides in soil at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062) .....	10

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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, Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062), was conducted during 1986 and 1987.

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  
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**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

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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 U.S. DOE contract DE-AC05-84OR21400.



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 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 public property at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey, was conducted during 1986 and 1987. The survey and sampling of the ground surface was carried out on November 14-20, 1986, and the follow-up subsurface investigation was performed on June 5, 1987.

### SURVEY METHODS

The radiological survey of the property included: (1) a gamma scan of the entire property outdoors, (2) collection of surface and subsurface soil samples, and (3) gamma profiles of auger holes. No indoor survey measurements were performed.

Using a portable gamma scintillation meter, ranges of measurements were recorded for areas of the property surface. If the gamma exposure rates 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.

To define the extent of possible subsurface soil contamination, the auger holes were drilled to depths of approximately 2.7 m. A plastic pipe was placed in each hole, and a NaI scintillation probe was lowered inside the pipe. The probe was encased in a lead shield with a horizontal row of collimating slits on the side. This collimation allows measurement of gamma radiation intensities resulting from contamination within small fractions of the hole depth. Measurements were usually made at 15- or 30-cm intervals. If the gamma readings in the hole were elevated, a soil sample was scraped from the wall of the auger hole at the point showing the highest gamma radiation level. The auger hole loggings were used to select locations where further soil sampling would be useful. A split-spoon sampler was used to collect subsurface samples at known depths. In some auger holes, a combination of split-spoon sampling and side-wall scraping was used to collect samples. 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.<sup>4</sup> 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.

### Surface Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan of the property surface are given in Fig. 1. Gamma exposure rates over the major portion of the property ranged from 8-15  $\mu\text{R/h}$ . The basketball court, in the eastern corner of the park, ranged from 10-14  $\mu\text{R/h}$ . The highest measurements found in this corner of the park were 11-24  $\mu\text{R/h}$  and were taken near the brick building adjacent to this ball court at the intersection of two brick walls. The other side of this court measured 8 and 11  $\mu\text{R/h}$ , as indicated in Fig. 1. The dugouts in the two baseball courts gave slightly higher readings than these, but the survey indicated that such readings were probably due to the block walls and brick floors. The highest gamma levels found in the park altogether were 11-36  $\mu\text{R/h}$ , from a strip of ground bordering Money Street on the western corner of the park. This area is indicated in Fig. 1 by crosshatching.

### 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 and thorium in the biased samples ranged from 0.71 to 7.8 pCi/g and 2.4 to 91 pCi/g, respectively. All thorium levels at biased sample location B1 were above DOE criteria (Table 1). Radium levels continued to rise with depth in both biased samples, and thorium levels increased at lower depths in sample B2.

### Auger Soil Samples

Varying thicknesses of subsurface soil were sampled from depths of 45 to 275 cm in auger holes (A) which were drilled at 2 separate locations indicated in Fig. 2. Auger hole A1 was drilled and logged, in the manner described above, to determine if the location was in the old creek bed. The gamma log of this auger hole indicated an area of possible contamination. The drilling rig was therefore moved one foot west, and the hole redrilled. Samples were taken from the new hole using the split spoon method. Due to the close proximity of the two holes, the second hole was not logged, and both holes were assigned the same hole location and number. The results of analyses of these samples are given in Table 3. Concentrations of  $^{226}\text{Ra}$  and  $^{232}\text{Th}$  in soil samples from both auger holes ranged from 0.56 to 2.2 and 0.80 to 17 pCi/g, respectively. Radionuclide concentrations in sample A2D (17 pCi/g) were above DOE criteria (Table 1) for thorium; all other values were near or below criteria.

Gamma logging was performed in each of the 2 auger holes to characterize and further define the extent of possible contamination. The logging technique used here is not radionuclide specific. However, logging data, in conjunction with soil analyses data, may be used to estimate regions of elevated radionuclide concentrations in auger holes when compared with background levels for the area. Following a comparison of these data, it appears that any shielded scintillator readings of 1000 counts per minute (cpm) or greater generally indicate the presence of elevated concentrations of  $^{226}\text{Ra}$  and/or  $^{232}\text{Th}$ . Data from the gamma profiles of the logged auger holes are graphically represented in Fig. 3 and Fig. 4. Readings at depths from 1.5 to 2.1 m were greater than 1000 cpm in auger hole A2, with a maximum reading of 3053 cpm at 1.8 m. Readings in auger hole A1 were above 1000 cpm from 1.5 m down, with a maximum reading of 6701 cpm at 2.4 m.

### SIGNIFICANCE OF FINDINGS

Measurements taken at Kennedy Park indicate that the property contained radioactive contamination primarily from the  $^{232}\text{Th}$  decay chain. These radionuclide distributions are typical of the type of material originating from the processing operations at the MCW site. The concentration and extent of  $^{232}\text{Th}$  on this property was in excess of the applicable DOE criteria (Table 1). This material was found at sample locations B1, A1, and A2 shown in Fig. 2. Based on the results of this radiological assessment, it is recommended that this site be considered for inclusion in the DOE remedial action program.

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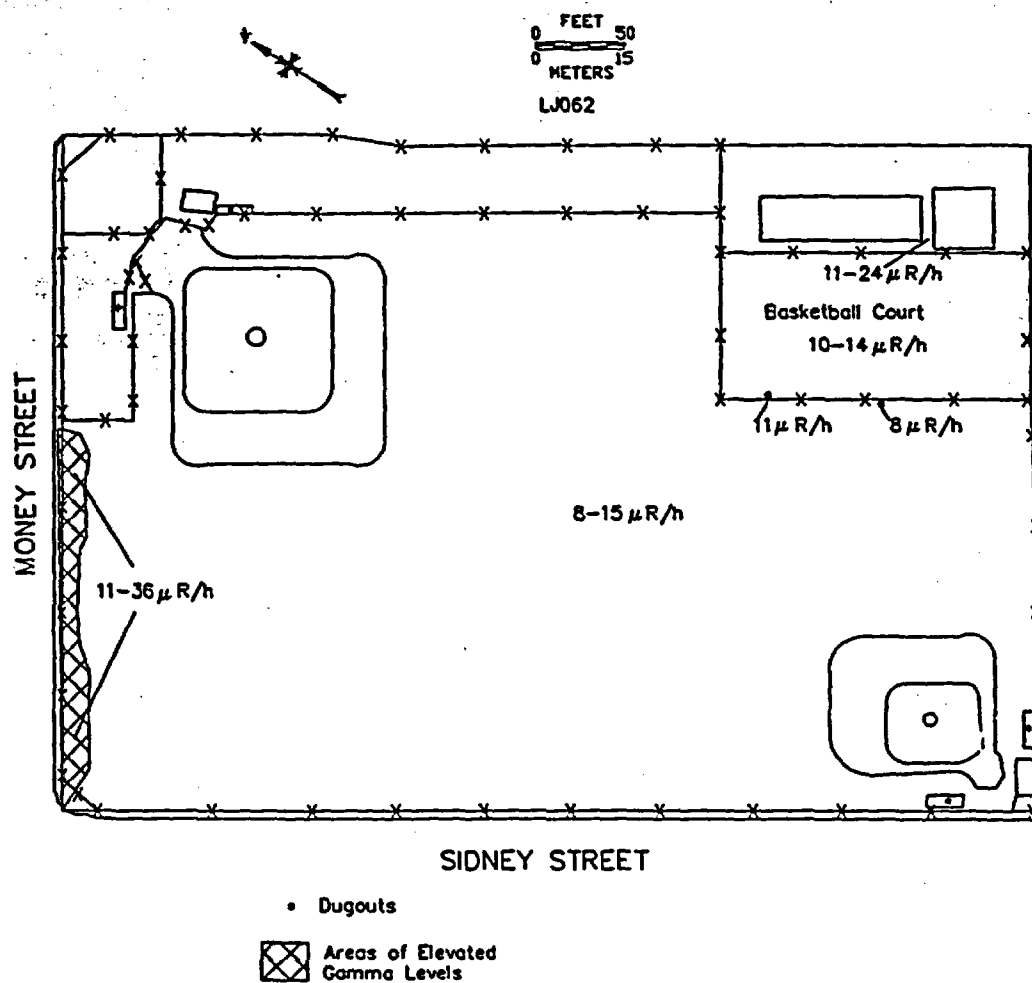


Fig. 1. Gamma radiation levels ( $\mu$ R/h) measured on the surface at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062).

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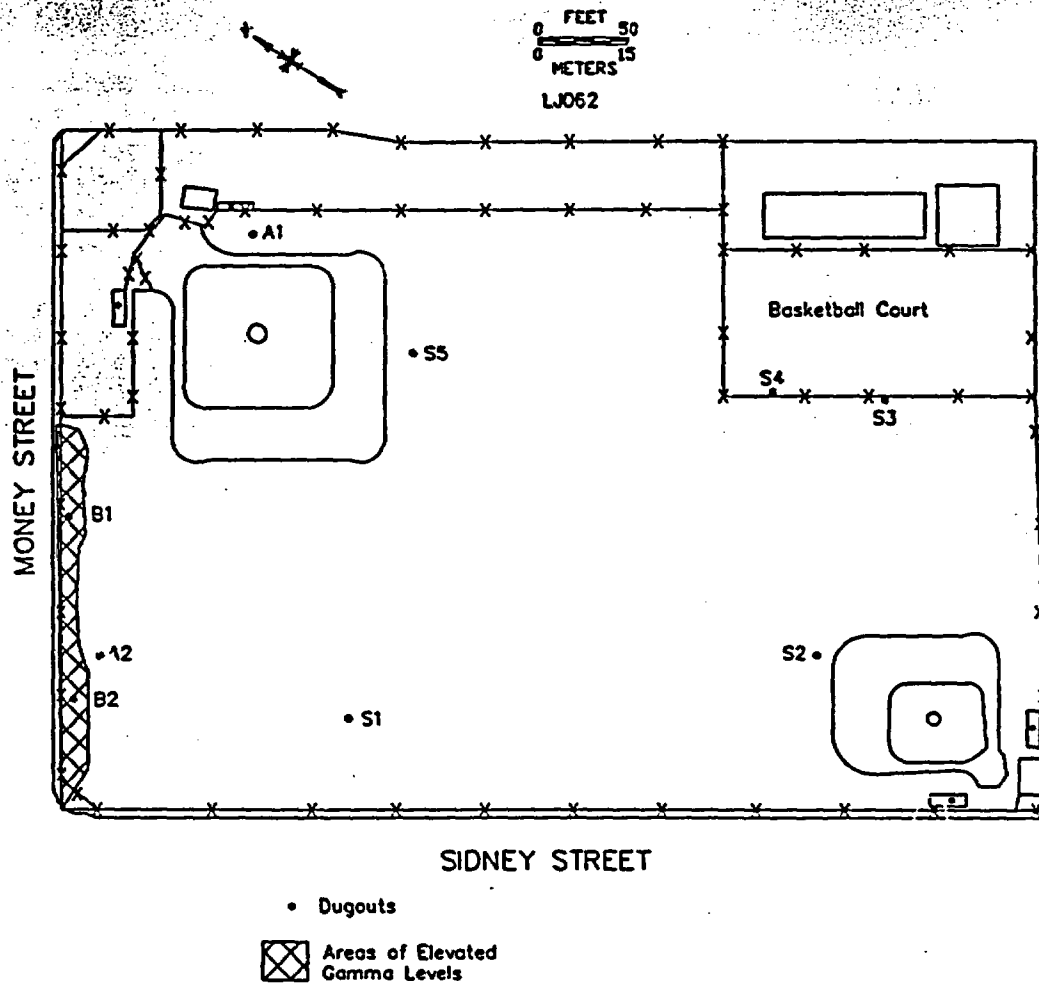
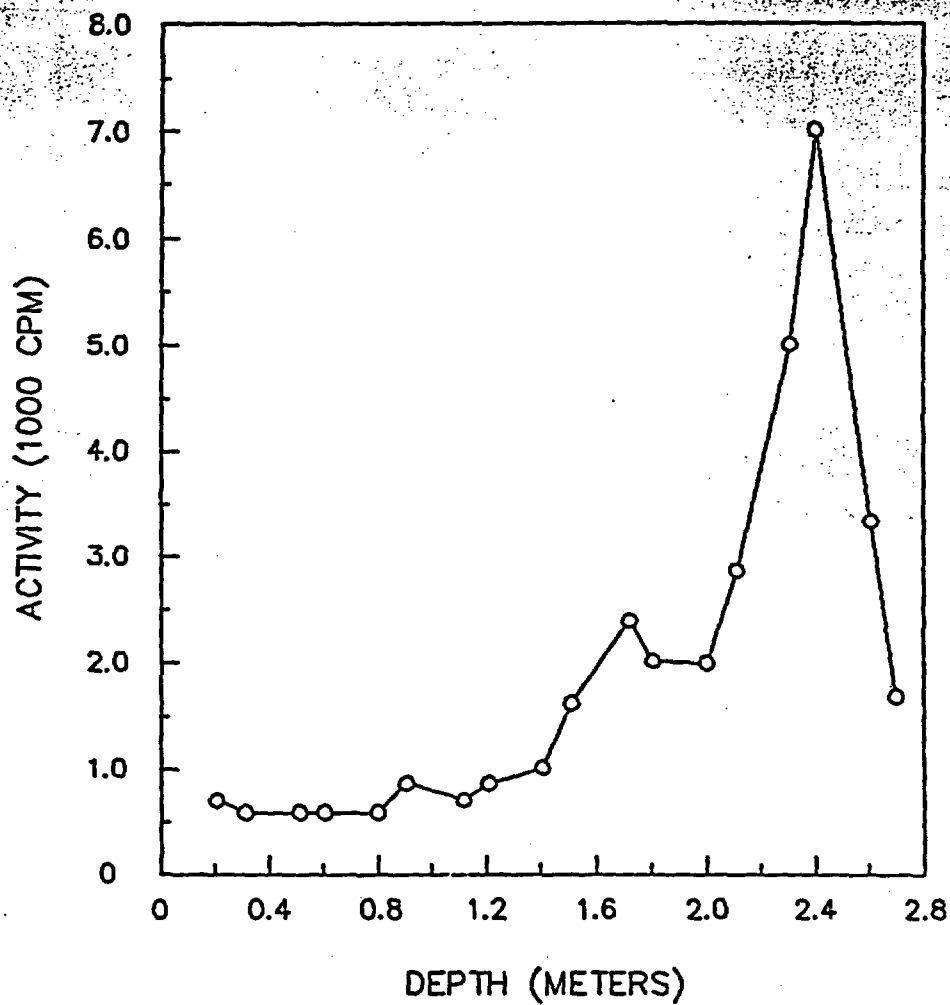


Fig. 2. Diagram showing locations of soil samples taken at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062).

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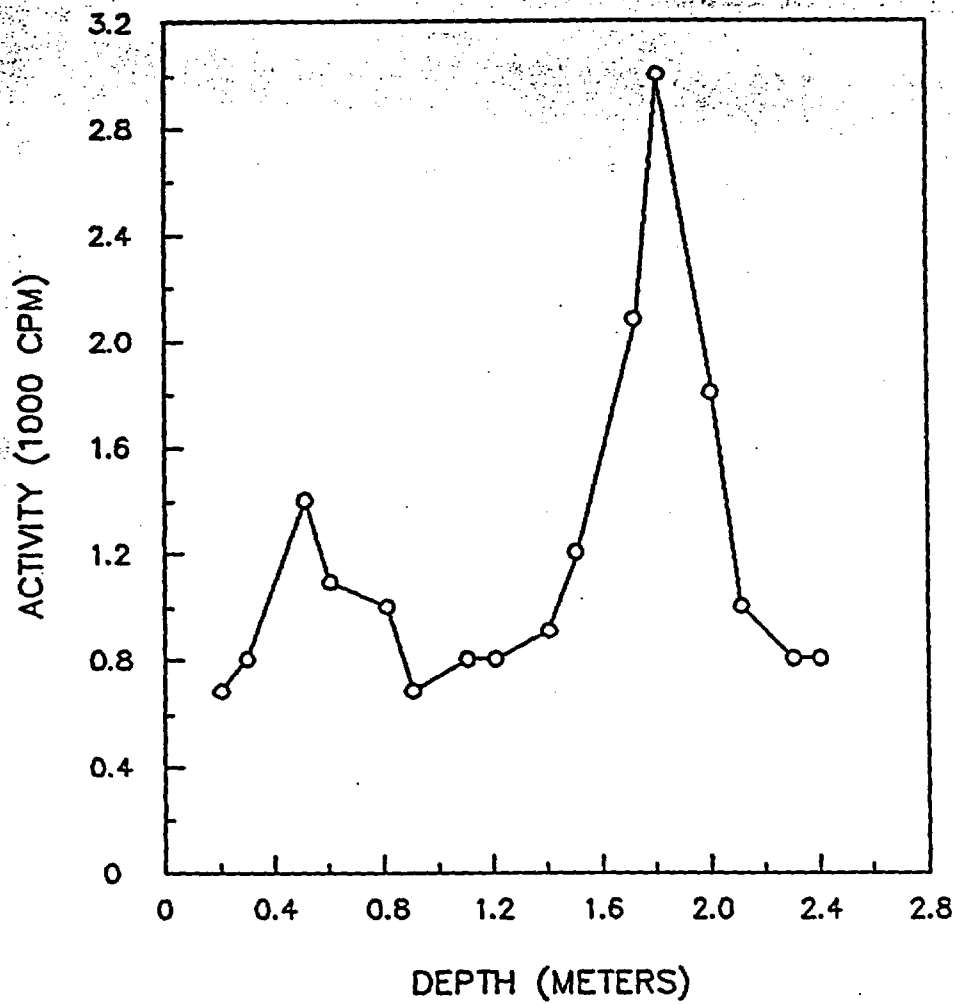
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Fig. 3. Gamma profile for auger hole 1 at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey.

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Fig. 4. Gamma profile for auger hole 2 at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey.

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
Concentration of radionuclides in soil (pCi/g)	
<sup>232</sup> Th	0.9 <sup>a</sup>
<sup>238</sup> U	0.9 <sup>a</sup>
<sup>226</sup> Ra	0.9 <sup>a</sup>

<sup>a</sup>Reference 4.



Table 3. Concentrations of radionuclides in soil at Kennedy Park, Money and Sidney Streets, Lodi, New Jersey (LJ062)

Sample <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g)	
		<sup>226</sup> Ra <sup>b</sup>	<sup>232</sup> Th <sup>b</sup>
Systematic Samples <sup>c</sup>			
S1	0-15	0.56 ± 0.02	1.2 ± 0.2
S2	0-15	0.58 ± 0.09	0.73 ± 0.06
S3	0-15	0.63 ± 0.07	0.73 ± 0.1
S4	0-15	0.61 ± 0.1	0.68 ± 0.04
S5	0-15	0.60 ± 0.06	0.58 ± 0.08
Biased Samples <sup>d</sup>			
B1A	0-15	1.8 ± 0.3	15 ± 2
B1B	15-30	2.0 ± 0.2	17 ± 0.6
B1C	30-45	3.6 ± 0.3	36 ± 2
B1D	45-60	4.3 ± 0.3	45 ± 5
B1E	60-75	6.8 ± 0.6	91 ± 6
B1F	75-90	7.8 ± 0.2	46 ± 3
B2A	0-15	0.71 ± 0.03	2.4 ± 0.3
B2B	15-30	0.83 ± 0.1	3.4 ± 0.4
B2C	30-45	1.5 ± 0.1	9.3 ± 0.8
Auger Samples <sup>e</sup>			
A1A	90-105	0.58 ± 0.08	0.80 ± 0.2
A1B	105-120	0.60 ± 0.04	0.92 ± 0.1
A1C	135-150	0.72 ± 0.05	1.4 ± 0.03
A1D	150-165	1.2 ± 0.1	5.5 ± 0.3
A1E	165-185	1.6 ± 0.2	7.7 ± 0.45
A1F	185-195	1.1 ± 0.08	3.9 ± 0.08
A1G	195-215	1.4 ± 0.8	12 ± 0.5
A1H	215-225	1.6 ± 0.4	15 ± 0.6
A1I	225-245	0.80 ± 0.1	1.9 ± 0.2
A1J	245-255	0.78 ± 0.1	1.2 ± 0.2
A1K	255-275	0.87 ± 0.1	1.1 ± 0.6
A2A	45-60	0.85 ± 0.9	3.7 ± 0.05
A2B	135-150	0.66 ± 0.06	1.3 ± 0.07
A2C	150-165	0.56 ± 0.1	0.99 ± 0.2
A2D	165-185	2.2 ± 0.4	17 ± 1.2
A2E	185-195	0.80 ± 0.03	1.5 ± 0.06
A2F	195-215	0.77 ± 0.1	1.1 ± 0.1
A2G	215-225	0.91 ± 0.05	1.3 ± 0.4

<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 rates.

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

<sup>e</sup>Auger samples are taken from holes drilled to further define the depth and extent of radioactive material. Holes are drilled where the surface may or may not be contaminated.

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