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HEALTH AND SAFETY RESEARCH DIVISION

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

ORNL/RASA--88/84

DE89 017340

RESULTS OF THE RADIOLOGICAL SURVEY AT 142 WEST CENTRAL AVENUE, MAYWOOD, NEW JERSEY (MJ041)

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Date Published – June 1989

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MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U. S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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ACKNOWLEDGMENTS

Research for this project was sponsored by the Division of Facility and Site Decommissioning Projects, U.S. Department of Energy, under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc. The authors wish to acknowledge the support of J. E. Baublitz, Acting Director, Office of Remedial Action and Waste Technology; J. J. Fiore, Director, Division of Facility and Site Decommissioning Projects; and members of their staffs. The authors also appreciate the contributions of D. A. Roberts and T. R. Stewart of the Measurement Applications and Development Group; A. C. Butler and B. S. Ellis, former employees of Martin Marietta Energy Systems, Inc.; and W. H. Shinpaugh and M. E. Ward of Don Stone and Associates, Inc., for participation in the collection, analyses, and reporting of data for this survey.

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}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, 142 West Central Avenue, Maywood, New Jersey (MJ041), was conducted during 1988.

Results of the survey indicated scattered radiation or "shine" from a storage pile, located off the property, containing residual radioactive material. Lead-shielded measurements showed radioactivity in the range of normal background for the northern New Jersey area. Radiological assessments of soil samples from the site demonstrate no radionuclide concentrations in excess of DOE Formerly Utilized Sites Remedial Action Program criteria.

RESULTS OF THE RADIOLOGICAL SURVEY AT 142 WEST CENTRAL AVENUE MAYWOOD, NEW JERSEY (MJ041)*

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.

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 Oak Ridge National Laboratory.

A radiological survey of the private, residential property at 142 West Central, Maywood, New Jersey, was conducted during 1988. The survey and sampling of the ground surface were carried out on May 11, 1988, and the follow-up subsurface investigation was performed on June 2, 1988.

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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.

SURVEY METHODS

The radiological survey of the property included: (1) a gamma scan of the entire property outdoors at the soil surface, and measurements 1 m above the surface, (2) collection of surface and subsurface soil samples, and (3) gamma profiles of auger holes. The survey methods followed the plan outlined in Reference 1. No indoor survey measurements were performed.

Using a portable gamma scintillation meter, ranges of measurements were recorded for areas of the property surface and 1 m 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.

To define the extent of possible subsurface soil contamination, auger holes were drilled to depths of approximately 3 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-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.[2]

SURVEY RESULTS

Applicable federal guidelines are summarized in Table 1.[3] 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 scan of the surface of the property are given in Fig. 1. Gamma exposure rates were 9 to 14 μR/h in the front yard and 6 to 20 μR/h in the back yard. Using a lead shielded probe, gamma measurements were taken at one location in the front yard and at three locations in the back yard. Surface gamma measurements were 4 μR/h and 4 to 6 μR/h, respectively. Corresponding measurements at 1 m were 2 μR/h and 2 to 3 μR/h, respectively. Under certain conditions, extraneous radiation emanating from a source outside the area of concern will confound measurements. For this reason, shielded readings were taken at several locations to verify that the elevated levels were due to scattered radiation from the storage pile and not from the ground surface. The source of scattered radiation, or "shine," at this site is a storage pile containing significant

amounts of residual radioactive material, located across the railroad tracks from the back of the property.

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 ^{226}Ra and ^{232}Th in these samples ranged from 0.67 to 1.3 pCi/g and 0.76 to 4.9 pCi/g, respectively. It should be noted that samples E, F, and G from systematic soil sample S5 (Table 3) contained a large percentage of coal ash. These values are within applicable DOE guidelines (Table 1). Determinable values for concentration of ^{238}U ranged from 1.0 to 3.7 pCi/g. Radionuclide concentrations ranged from below to slightly above normal background levels for the northern New Jersey area (Table 2).

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 30 to 165 cm in two of the seven auger holes (A) drilled at seven separate locations indicated in Fig. 2. The results of analyses of these samples are given in Table 3. Concentrations of ^{226}Ra and ^{232}Th in soil samples ranged from 0.94 to 2.9 pCi/g and 1.6 to 3.1 pCi/g, respectively. All of these values are within applicable DOE guidelines. Determinable values for concentration of ^{238}U ranged from 1.6 to 3.9 pCi/g.

Gamma logging was performed in six of the seven auger holes to characterize and further define the extent of possible contamination. Rock was encountered in two holes (A1 and A2) at depths of approximately 0.8 m. 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}Ra and/or ^{232}Th. Data from the gamma profiles of the logged auger holes are graphically represented in Figs. 3 through 8. Rock was struck in auger hole 1, and only two gamma readings were taken (1028 cpm at 0.6 m and 1016 cpm at 0.7 m). It was not graphed. Readings greater than 1000 cpm occurred in auger hole 3 from 0.6 to 0.8 m, in auger hole 4 from 0.3 to 1.4 m, and in auger hole 5 from 0.6 to 0.8 m. The maximum reading (1429 cpm) occurred in auger hole 4 at a depth of approximately 0.6 m. All other readings were below 1000 cpm. The greatest concentrations of radionuclides shown in Table 3 correspond to the higher gamma readings in auger hole 4. Coal ashes were observed in auger hole 4 at the depths coincident with the elevated readings. The analysis results are consistent with other samples containing ash that have been collected in the Maywood/Lodi area. The slight elevation in radionuclide concentration in the coal ash is due to the naturally occurring radioactive elements in coal.

SIGNIFICANCE OF FINDINGS

Measurements taken at 142 West Central Avenue indicate scattered radiation, or "shine," at this site from a storage pile containing significant amounts of residual

radioactive contamination, located across the railroad tracks from the back of the property. Lead-shielded measurements taken on the property show radioactivity in the range of normal background for the northern New Jersey area. Radiological assessments of soil samples from the site demonstrate no radionuclide concentrations in excess of applicable DOE guidelines.

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2. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, Oak Ridge National Laboratory, ORNL/TM-8600 (April 1987).
3. 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).
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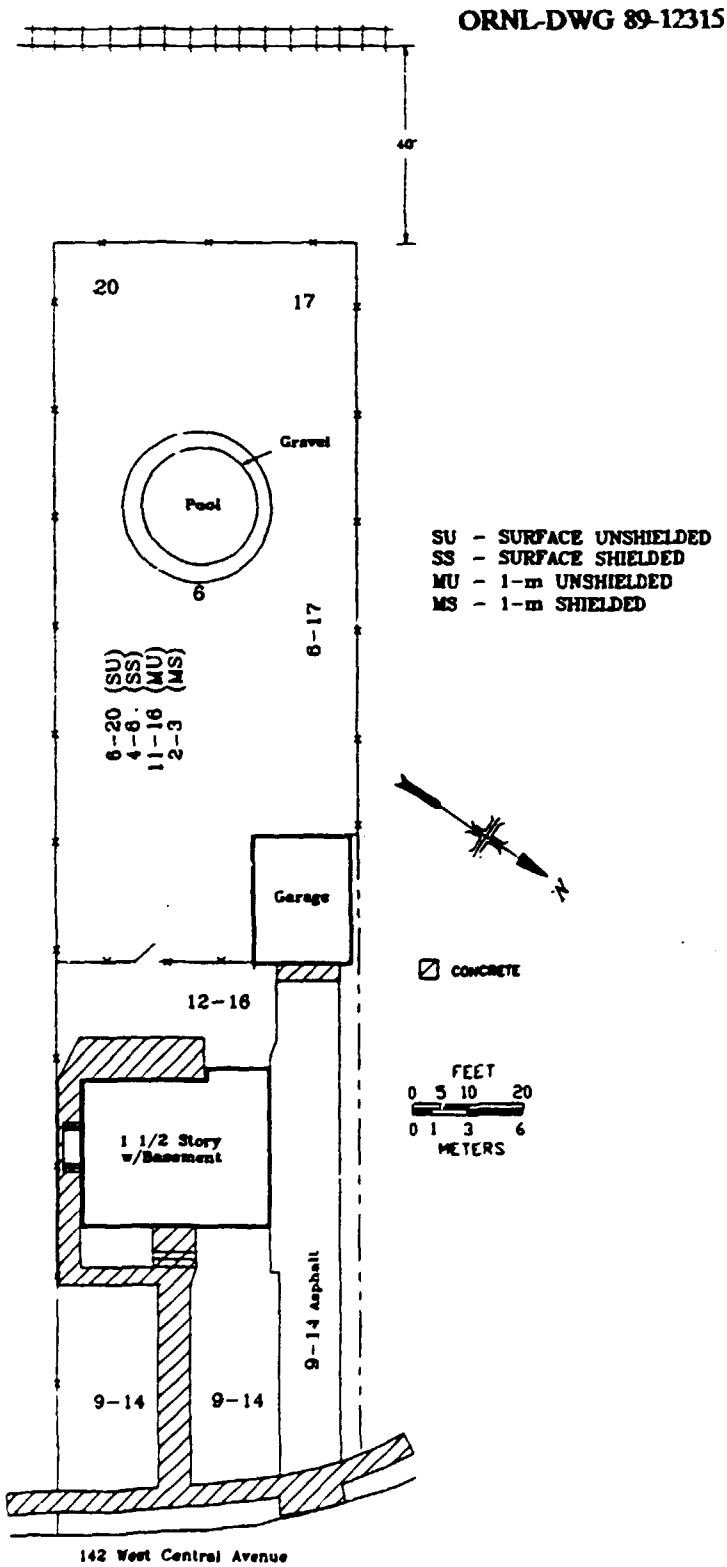

Fig. 1. Gamma radiation levels (μR/h) measured on the surface at 142 West Central Avenue, Maywood, New Jersey (MJ041).

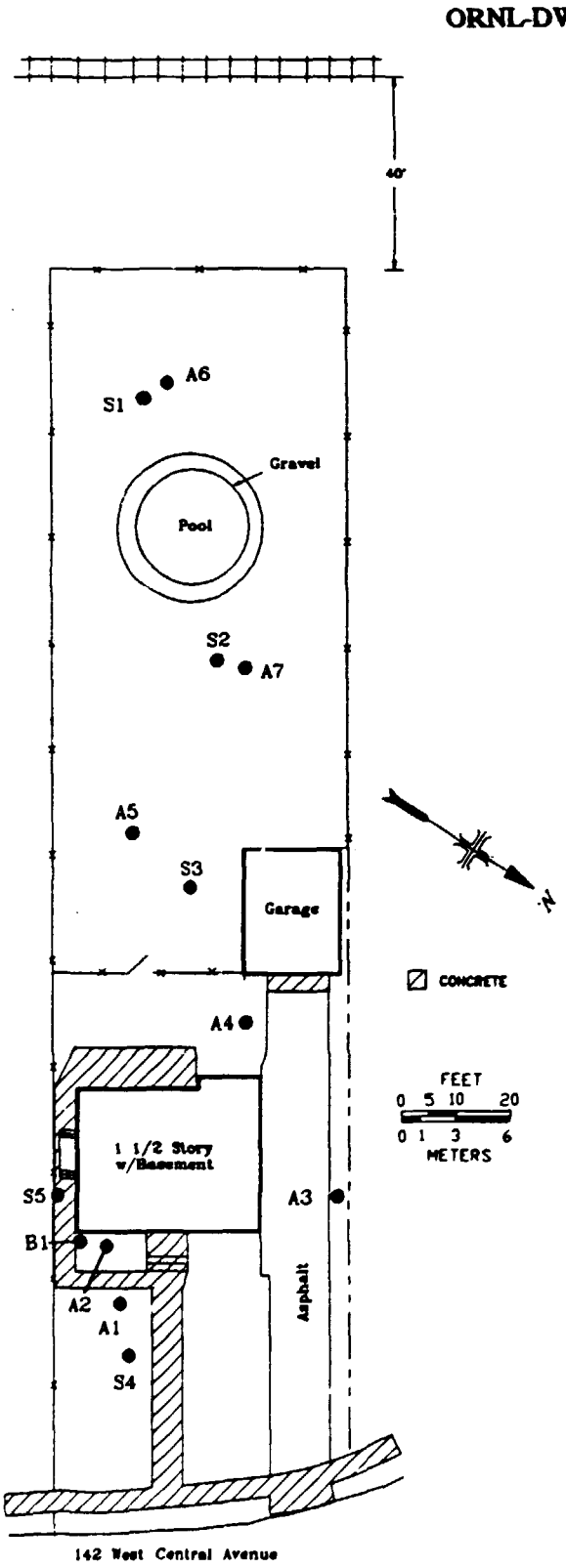

Fig. 2. Diagram showing locations of soil samples taken at 142 West Central Avenue, Maywood, New Jersey (MJ041).

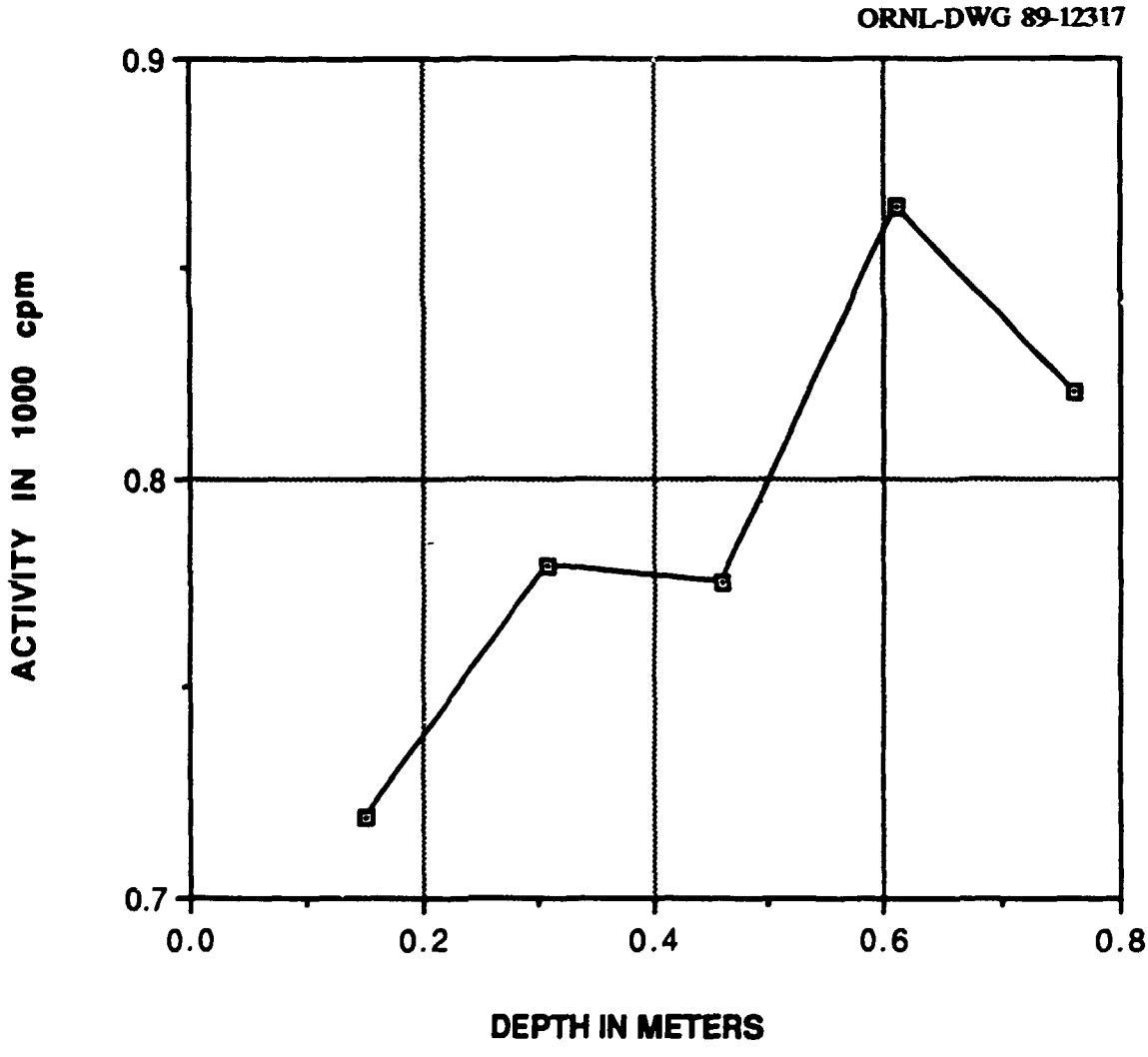

Fig. 3. Gamma profile for auger hole 2 (MJ041A2) at 142 West Central Avenue, Maywood, New Jersey.

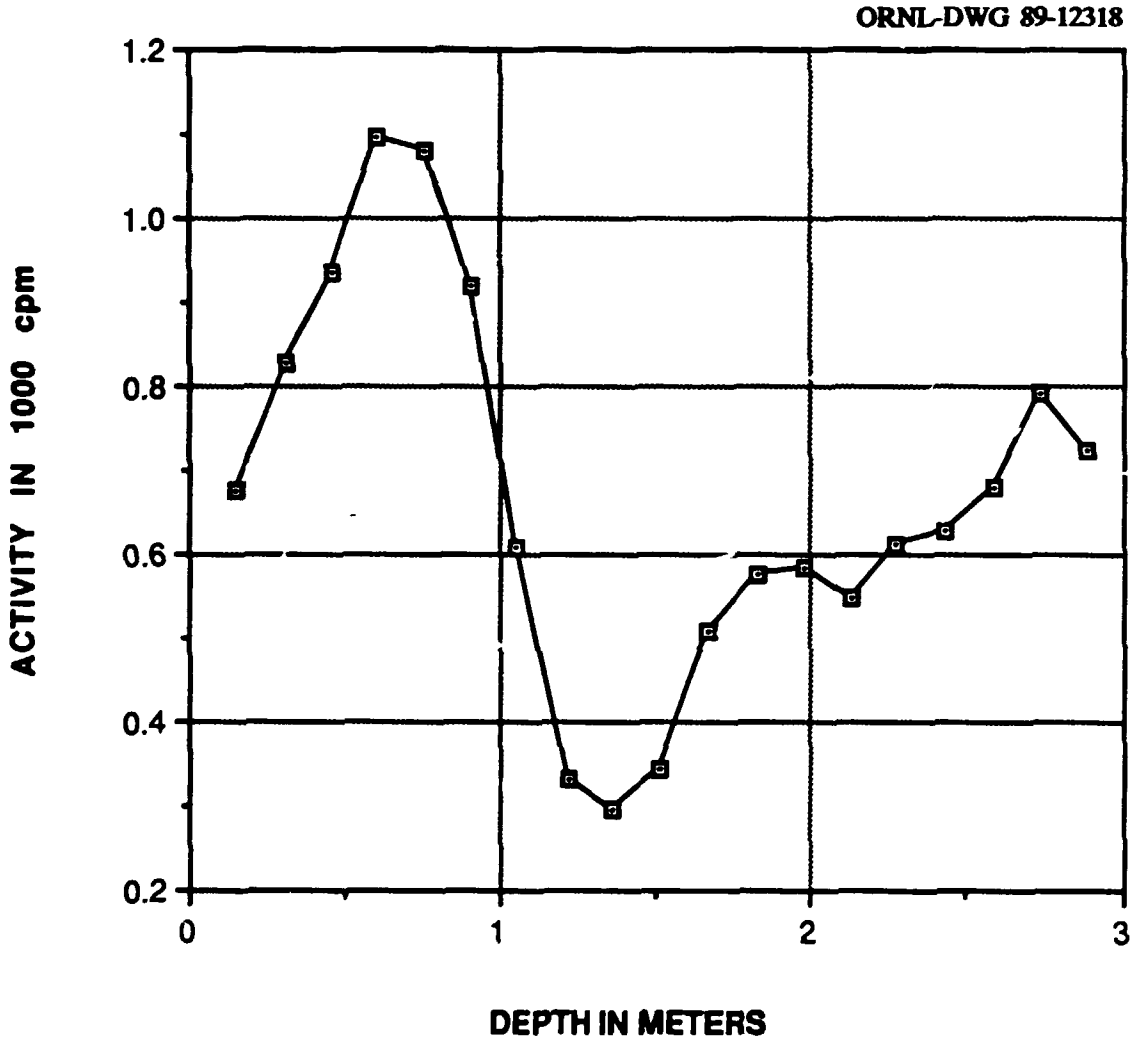

Fig. 4. Gamma profile for auger hole 3 (MJ041A3) at 142 West Central Avenue, Maywood, New Jersey.

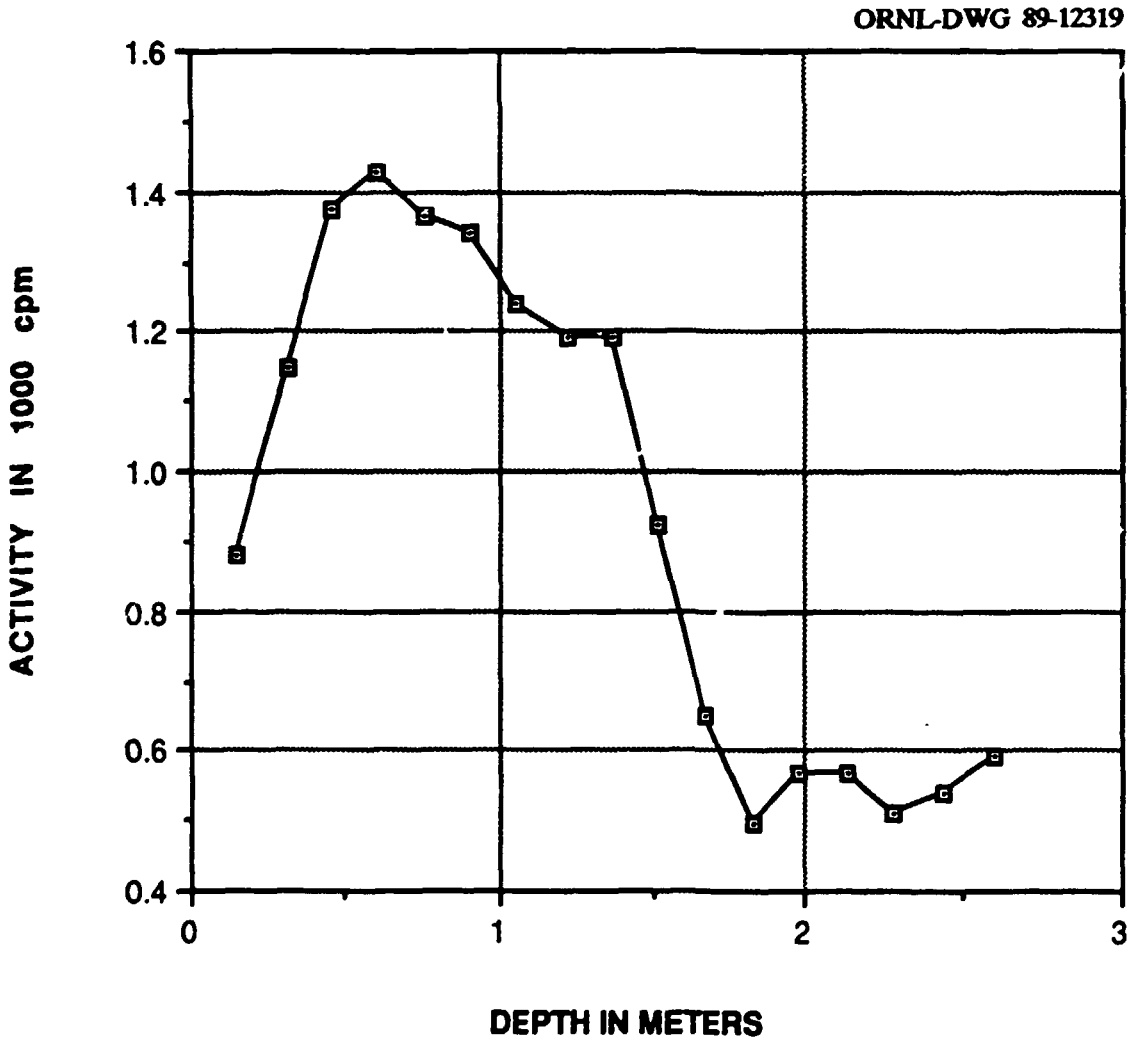

Fig. 5. Gamma profile for auger hole 4 (MJ041A4) at 142 West Central Avenue, Maywood, New Jersey.

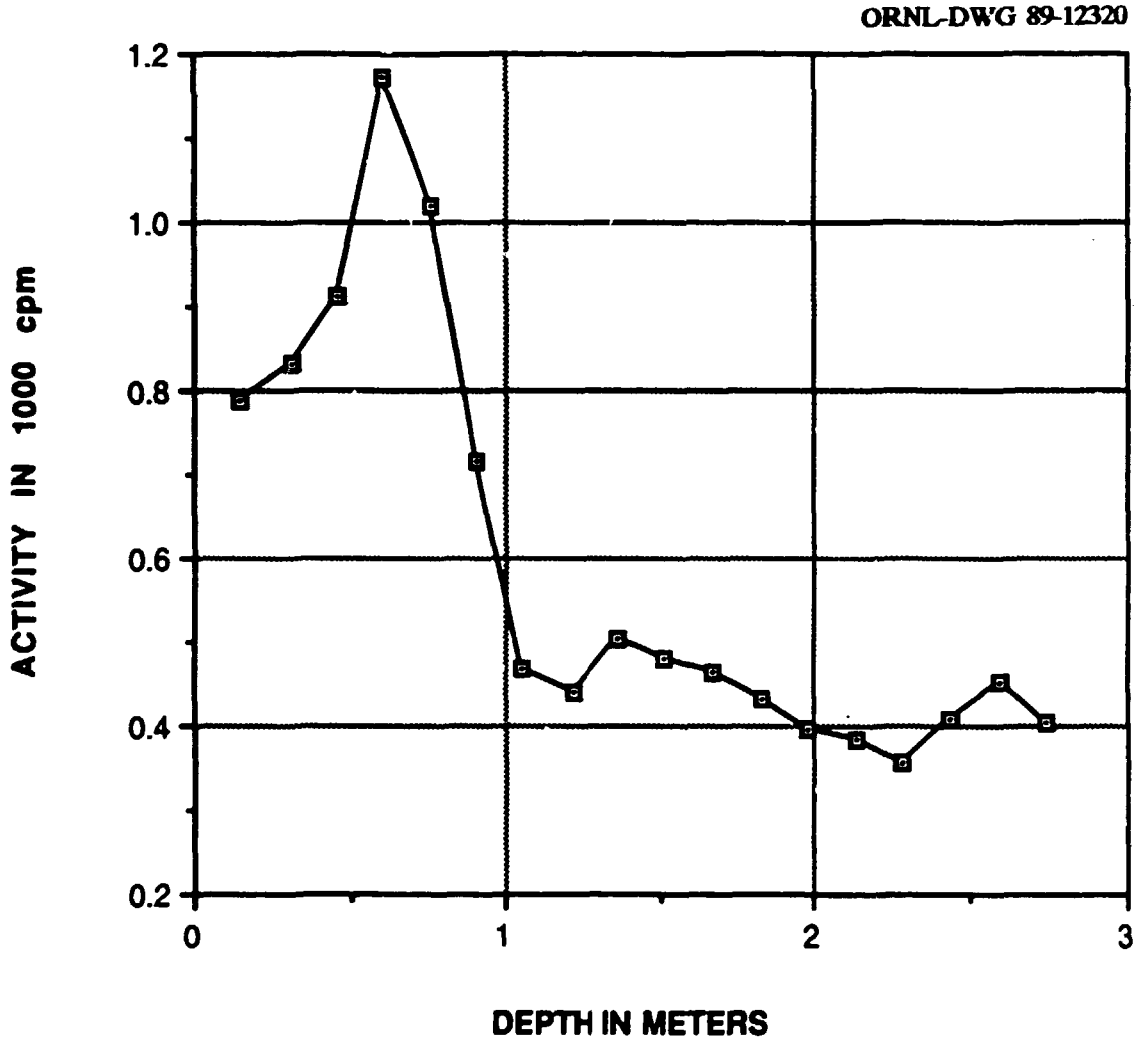

Fig. 6. Gamma profile for auger hole 5 (MJ041A5) at 142 West Central Avenue, Maywood, New Jersey.

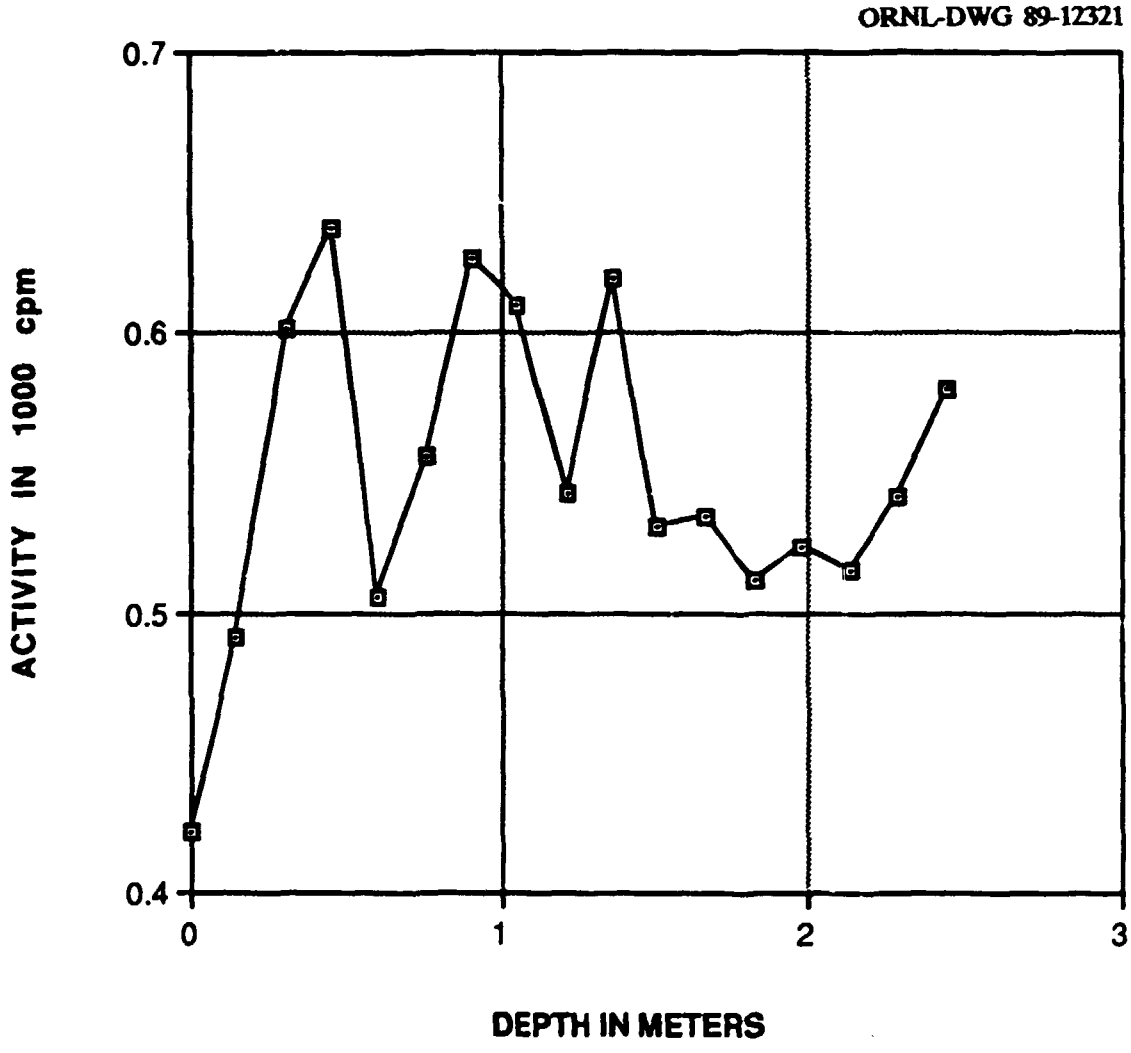

Fig. 7. Gamma profile for auger hole 6 (MJ041A6) at 142 West Central Avenue, Maywood, New Jersey.

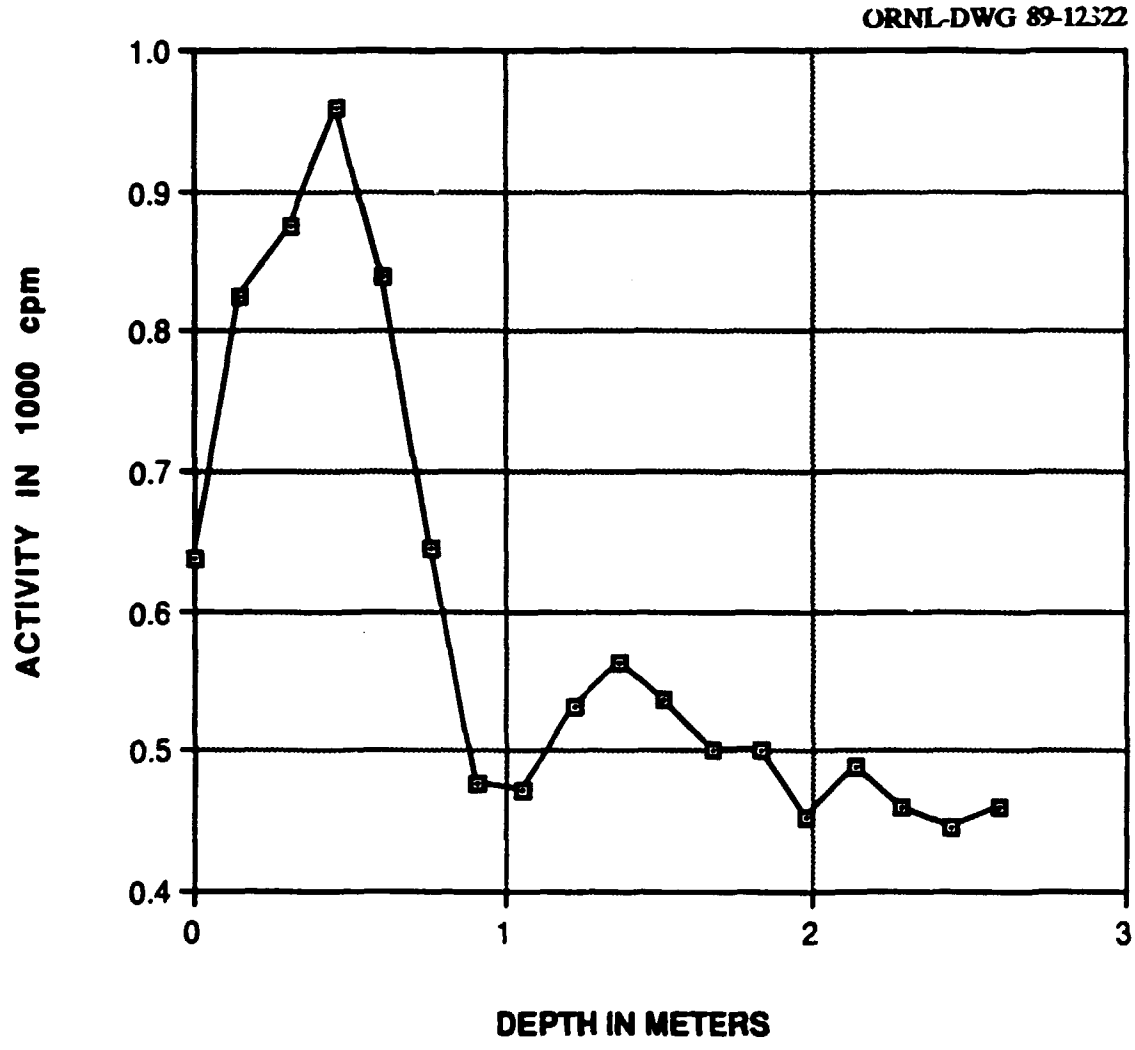

Fig. 8. Gamma profile for auger hole 7 (MJ041A7) at 142 West Central Avenue, Maywood, New Jersey.

Table 1. Applicable guidelines for protection against radiation[a]

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^2 area ^{232}Th ^{230}Th ^{228}Ra ^{226}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

[a]Reference 3.

Table 2. Background radiation levels for the northern New Jersey area

Type of radiation measurement or sample	Radiation level or radionuclide concentration[a]
Gamma exposure at 1 m above ground surface (μR/h)	8
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9
^{238}U	0.9
^{226}Ra	0.9

[a]Reference 4.

Table 3. Concentrations of radionuclides in soil at 142 West Central Avenue, Maywood, New Jersey (MJ041)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
		^{226}Ra[b]	^{232}Th[b]	^{238}U[b]
		Systematic samples[c]		
S1A	0–15	0.75±0.02	0.81±0.03	1.1±0.5
S1B	15–30	0.67±0.02	0.76±0.03	1.0±6
S2A	0–15	1.1 ±0.05	1.8 ±0.04	1.8±2
S2B	15–30	1.2 ±0.01	1.6 ±0.02	1.0±0.3
S3A	0–15	0.80±0.03	1.1 ±0.1	1.1±0.4
S3B	15–30	0.88±0.02	1.2 ±0.04	<3.0
S4A	0–15	0.84±0.02	1.2 ±0.04	<3.4
S4B	15–30	0.86±0.02	1.3 ±0.04	2.0±0.8
S5A	0–15	0.83±0.06	1.3 ±0.07	<2.3
S5B	15–30	0.85±0.06	1.3 ±0.09	2.0±1
S5C	30–45	0.93±0.05	1.4 ±0.09	1.3±1.6
S5D	45–60	1.0 ±0.02	1.4 ±0.04	<3.3
S5E	70–90	1.2 ±0.05	2.1 ±0.07	1.7±1
S5F	90–140	1.3 ±0.03	1.4 ±0.04	<3.7
S5G	140–165	1.2 ±0.1	2.1 ±0.2	2.0±3
		Biased samples[d]		
B1A	0–15	1.1 ±0.2	4.9 ±0.2	3.7±7.3
B1B	15–30	0.89±0.02	1.9 ±0.04	3.1±0.75
		Auger samples[e]		
A1A	60–70	1.0 ±0.03	1.6 ±0.05	<1.8
A1B	70–75	0.94±0.07	1.6 ±0.02	1.6±1.9
A4A	30–45	1.4 ±0.03	1.7 ±0.04	<4.0
A4B	45–60	2.1 ±0.11	2.2 ±0.07	3.2±2.2
A4C	60–75	2.8 ±0.14	2.8 ±0.24	3.7±1.6
A4D	75–90	2.9 ±0.09	3.1 ±0.08	3.4±0.10
A4E	90–105	2.4 ±0.01	2.6 ±0.02	3.1±0.37
A4F	105–120	2.0 ±0.04	2.3 ±0.07	3.9±1.7
A4G	120–135	1.6 ±0.07	1.6 ±0.13	<6.0
A4H	135–150	1.9 ±0.09	2.0 ±0.15	<2.9
A4I	150–165	1.67±0.04	1.79±0.06	<5.1

[a] Locations of soil samples are shown on Fig. 2.

[b] Indicated counting error is at the 95% confidence level ($\pm 2\sigma$).

[c] Systematic samples are taken at locations irrespective of gamma radiation levels.

[d] Biased samples are taken from areas shown to have elevated gamma exposure rates.

[e] Auger samples are those 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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