M-721

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for the Maywood Site, New Jersey

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HEALTH AND SAFETY RESEARCH DIVISION

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RESULTS OF THE RADIOLOGICAL SURVEY AT THE FIREMEN'S MEMORIAL PARK AND FIRE HALL NO. 2, GARIBALDI AVENUE AND KENNEDY DRIVE, LODI, NEW JERSEY (LJ066)

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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}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, the Firemen's Memorial Park and Fire Hall #2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey (LJ066), was conducted during 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 THE FIREMEN'S MEMORIAL PARK AND FIRE HALL NO. 2, GARIBALDI AVENUE AND KENNEDY DRIVE, LODI, NEW JERSEY (LJ066)*

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

*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-AC05-840R21400.

evidence on the surface. Therefore, properties in question may be drilled in search of former streambed 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 the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey, was conducted during 1987. The survey and sampling of the ground surface, as well as the subsurface investigation, were carried out on June 3-5, 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 2.9 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.[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.[4] 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 surface of the property are given in Fig. 1. Gamma exposure rates over the major portion of the property ranged from 4 to 10 μR/h. Higher gamma levels were found in isolated spots scattered over the property, measuring 11 to 21 μR/h in the largest of these spots. Other spots measured 11-17, 11-13, 10-13, and 9-10 μR/h. These areas are indicated in Fig. 1 with shading. Gamma levels from the planter on the northwestern side of the Fire Hall measured from 4 to 10 μR/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 in both the systematic and biased samples were either near or below normal background levels for the northern New Jersey area (Table 2), ranging from 0.38 to 1.2 pCi/g. In the systematic samples, thorium concentrations ranged from 0.63 to 7.2 pCi/g and were below DOE guidelines (Table 1). Thorium concentrations in the biased samples varied from 1.4 to 13 pCi/g and were above DOE criteria for samples B3A and B4A. Activity in these two samples measured 7.6 pCi/g and 8.6 pCi/g, respectively.

Auger Soil Samples

Varying thicknesses of subsurface soil were sampled from depths of 15 to 225 cm in auger holes drilled at eight separate locations. Two exceptions were A3 and A4 which were not sampled due to soil conditions. All auger holes (A) are 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 from six auger holes ranged from 0.29 to 9.5 and 0.34 to 68 pCi/g, respectively. Radionuclide concentrations for thorium were above DOE criteria (Table 1) in samples A1C&D, A6B-D, A7D&E, and A8E, with levels of 18, 15, 47, 20, 24, 28, 31, and 68 pCi/g, respectively. Elevated concentrations were found at various depths between 45 and 195 cm (Table 3).

Gamma logging was performed in each of the eight 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}Ra and/or ^{232}Th. Data from the gamma profiles of the logged auger holes are graphically represented in

Figs. 3 through 10. Readings at depths from 0.5 to 1.7 m were greater than 1000 cpm in auger hole 1, with a maximum reading of 2118 cpm at 0.6 m. Loggings in auger hole 2 were slightly elevated at 0.9, 2.0, and 2.1 m, with a maximum of 1195 cpm at 2.1 m. No readings above 1161 cpm were found in hole 3. In hole 4, elevated readings generally existed from 0.8 to 2.0 m, with a maximum of 1711 cpm at 1.7 m. Loggings for hole 5 were elevated from 0.8 to 2.0 m, with a maximum of 4564 cpm at 1.7 m. Readings in hole 6 were elevated from 0.5 to 2.3 m, with a maximum of 4624 cpm at 1.7 m. Hole 7 exceeded 1000 cpm from 0.6 to 2.3 m, with a maximum of 5494 cpm at 1.8 m. Finally, hole 8 had a maximum of 8816 cpm at 1.4 m, with elevated readings from 0.8 to 1.7 m. Generally, the areas of highest gamma loggings correspond to the greatest concentrations of radionuclides shown in Table 3.

SIGNIFICANCE OF FINDINGS

Measurements taken at Garibaldi Avenue and Kennedy Drive indicate that the property contained radioactive contamination primarily from the ^{232}Th decay chain, with some contamination from ^{226}Ra. 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}Th on this property was in excess of applicable DOE criteria (Table 1). This material was found at sample locations B3, B4, A1, A6, A7, and A8, 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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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).

4. T. E. Myrick, B. A. Berven, and F. F. Haywood, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, Oak Ridge National Laboratory, ORNL/TM-7343 (November 1981).

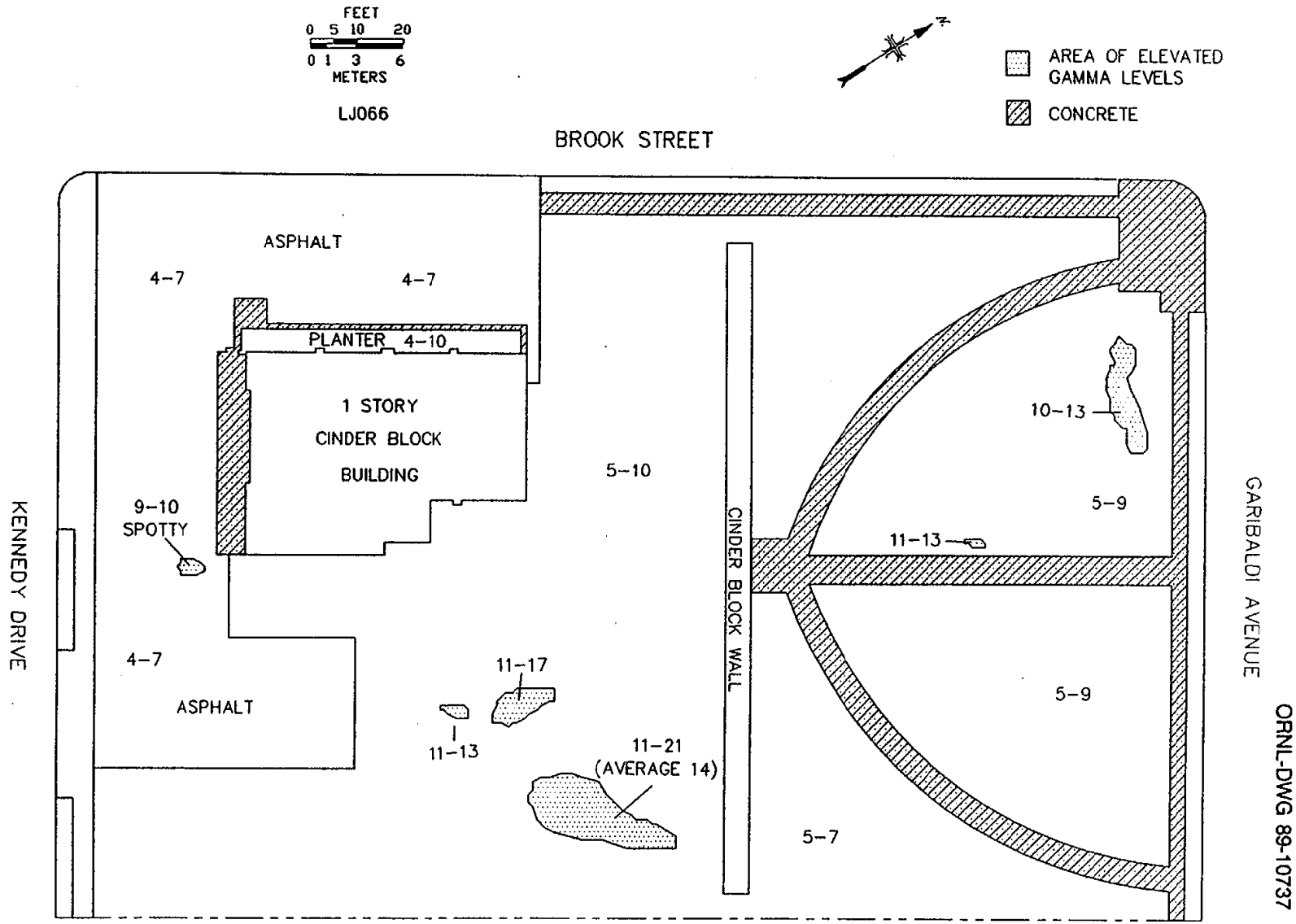

Fig. 1. Gamma radiation levels (μR/h) measured on the surface at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey (LJ066).

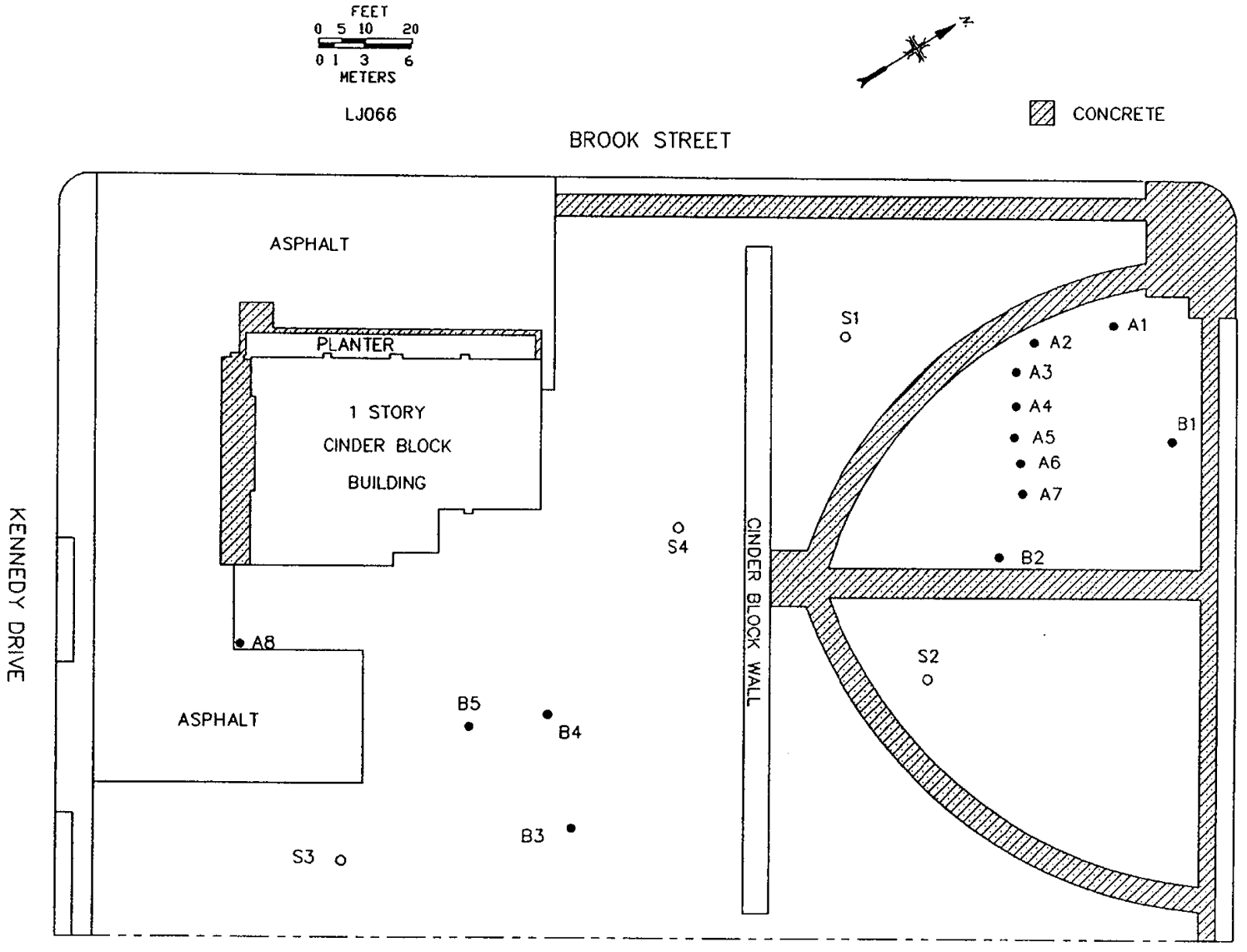

Fig. 2. Diagram showing locations of soil samples taken at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey (LJ066).

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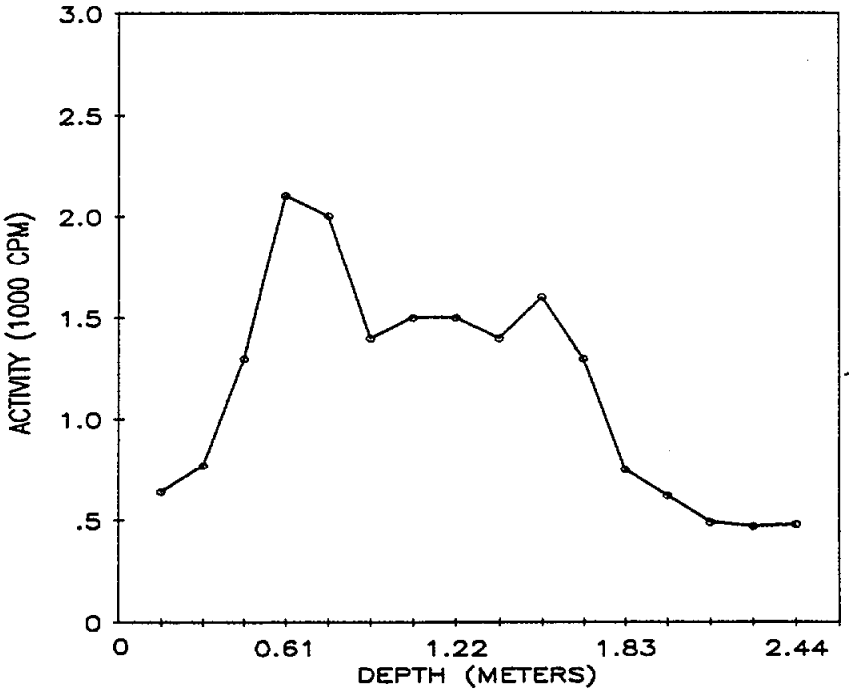

LJ066A1

Fig. 3. Gamma profile for auger hole 1 (LJ066A1) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

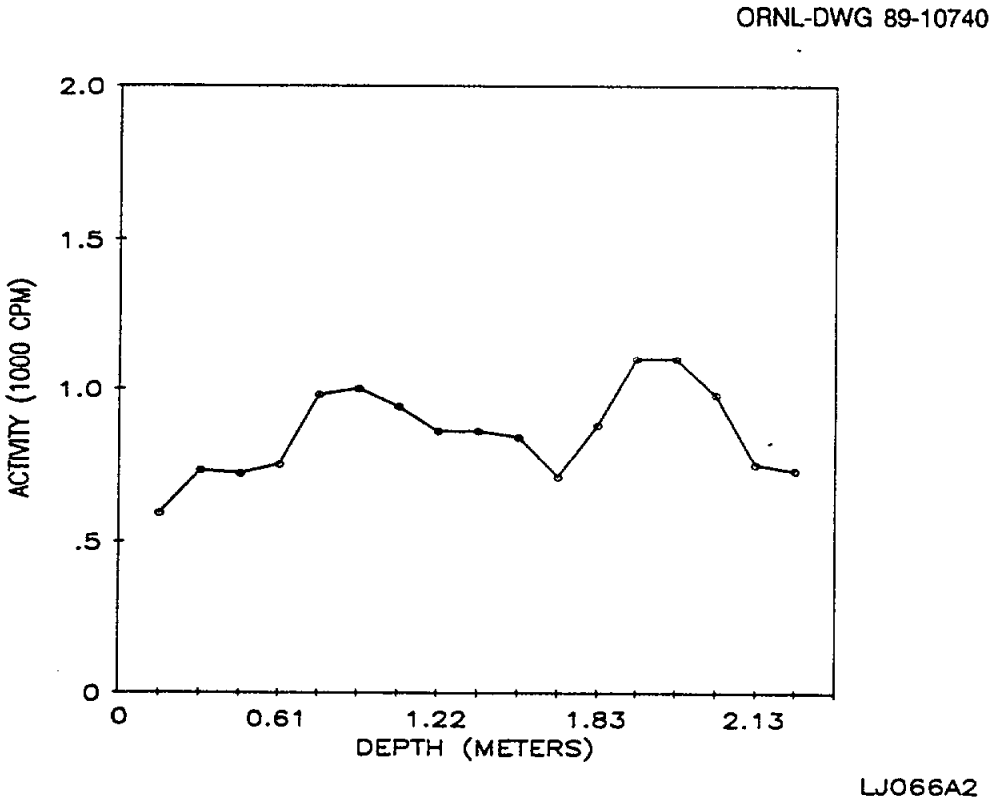

Fig. 4. Gamma profile for auger hole 2 (LJ066A2) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

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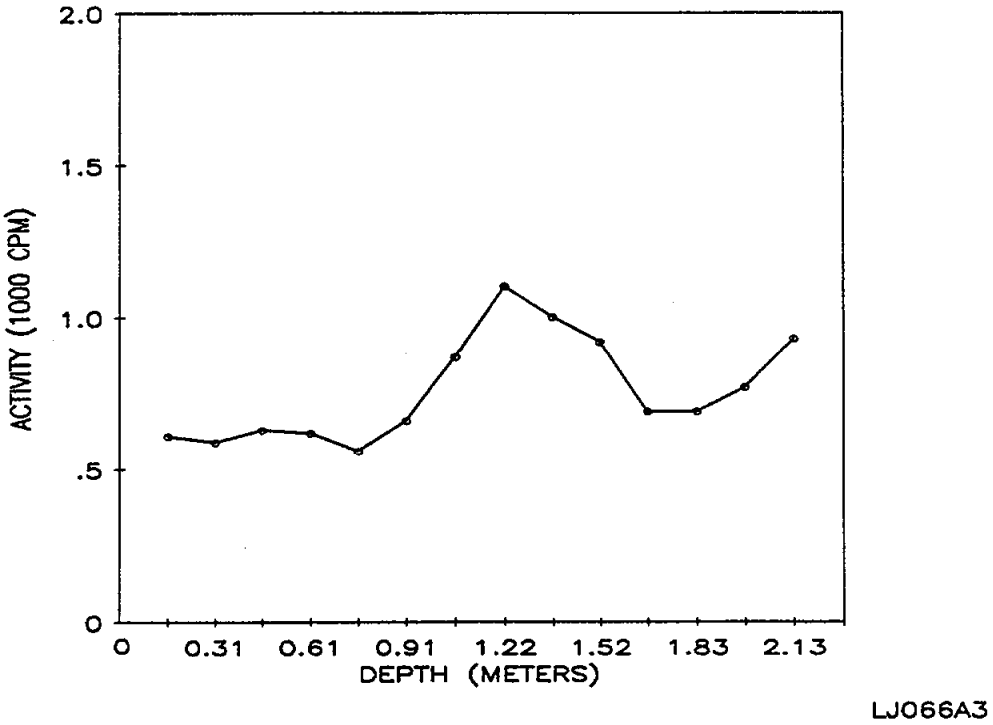

Fig. 5. Gamma profile for auger hole 3 (LJ066A3) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

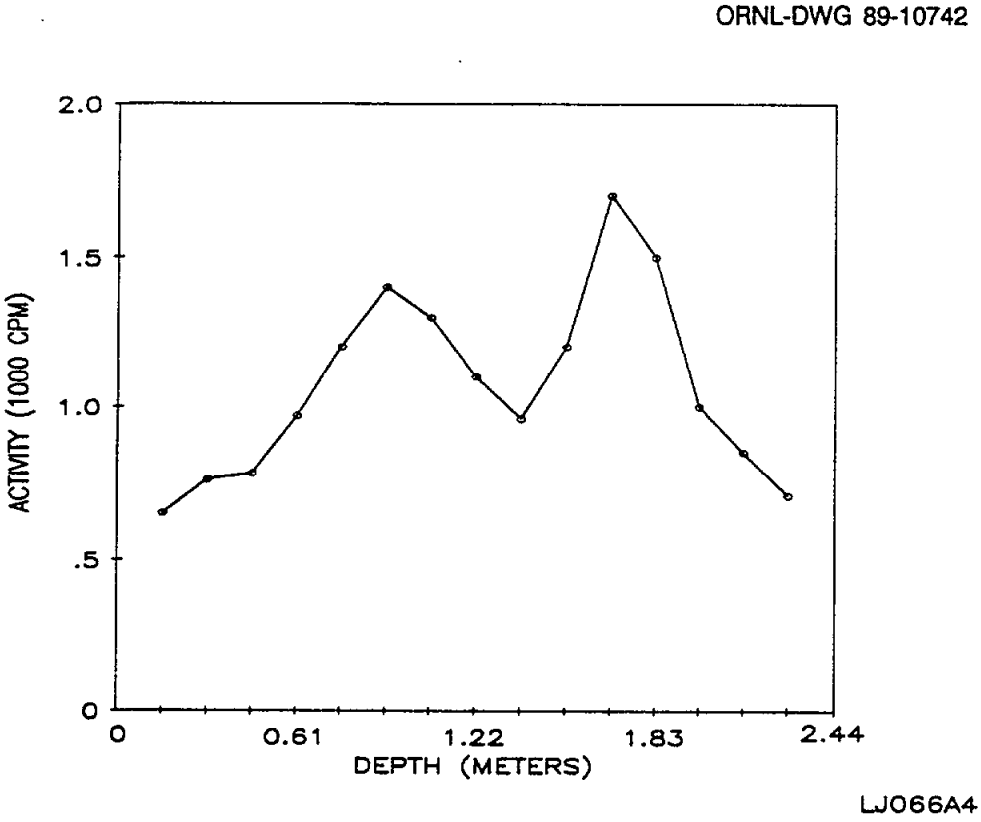

Fig. 6. Gamma profile for auger hole 4 (LJ066A4) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

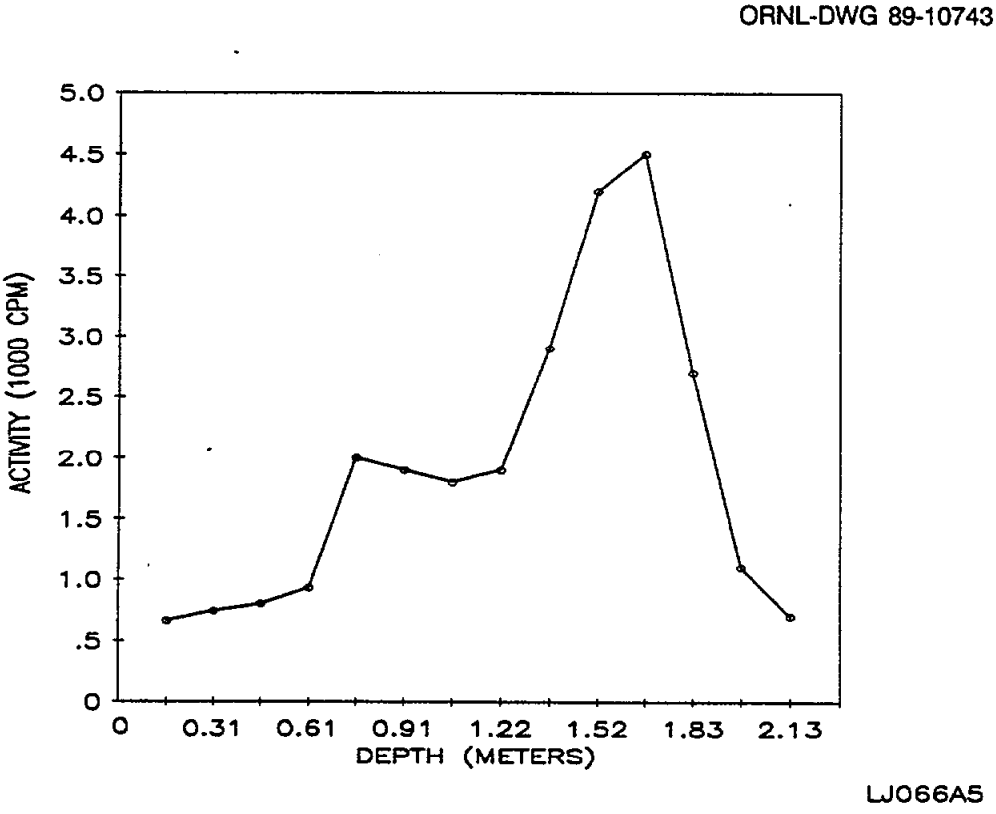

Fig. 7. Gamma profile for auger hole 5 (LJ066A5) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

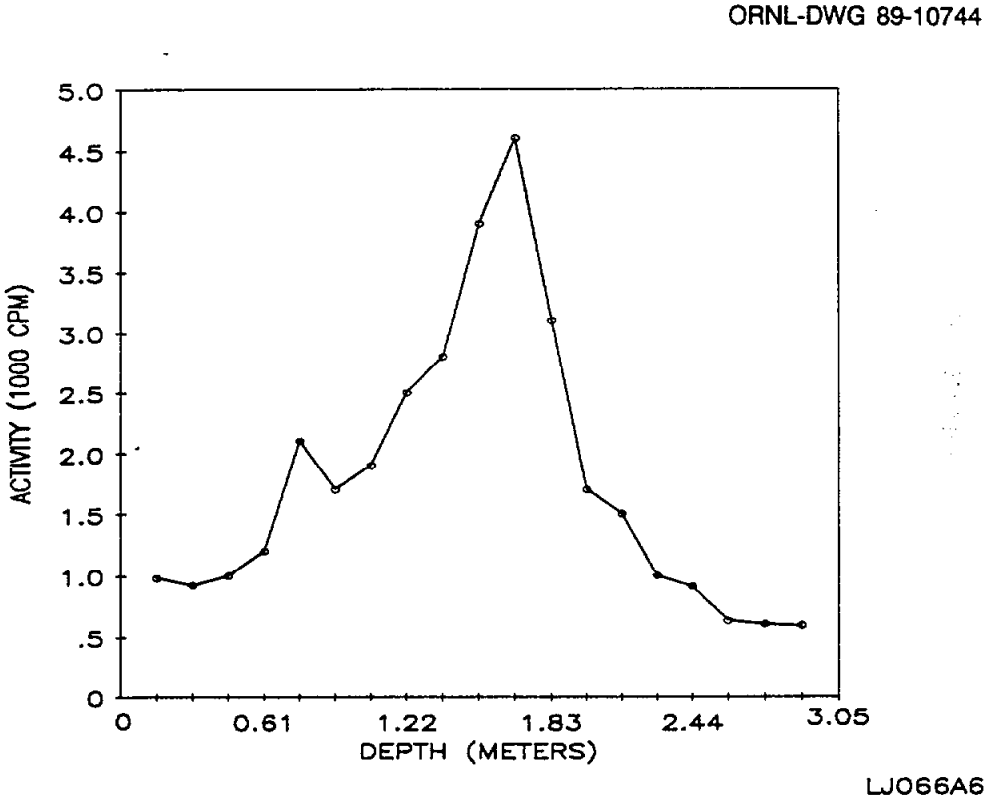

Fig. 8. Gamma profile for auger hole 6 (LJ066A6) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

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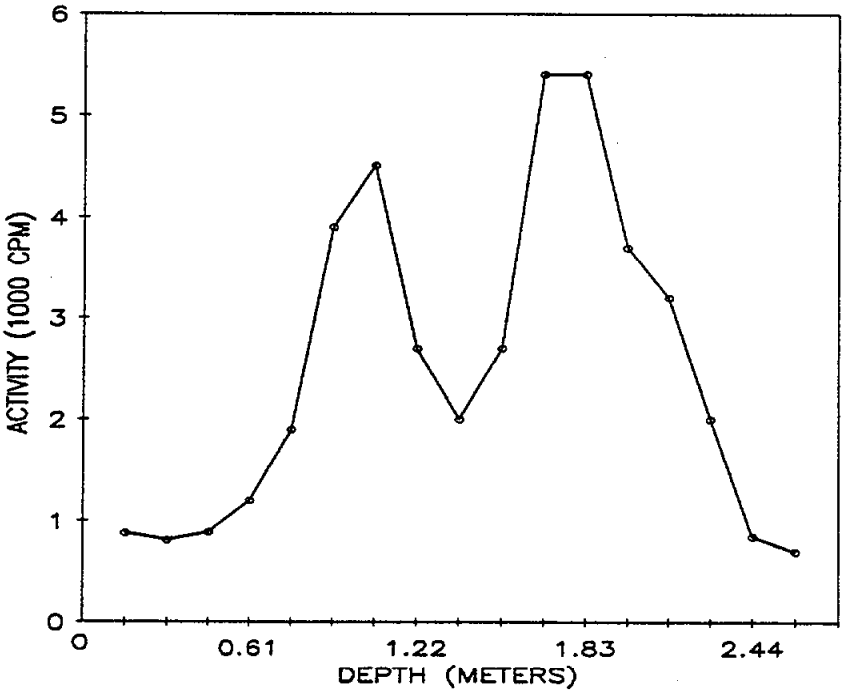

LJ066A7

Fig. 9. Gamma profile for auger hole 7 (LJ066A7) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

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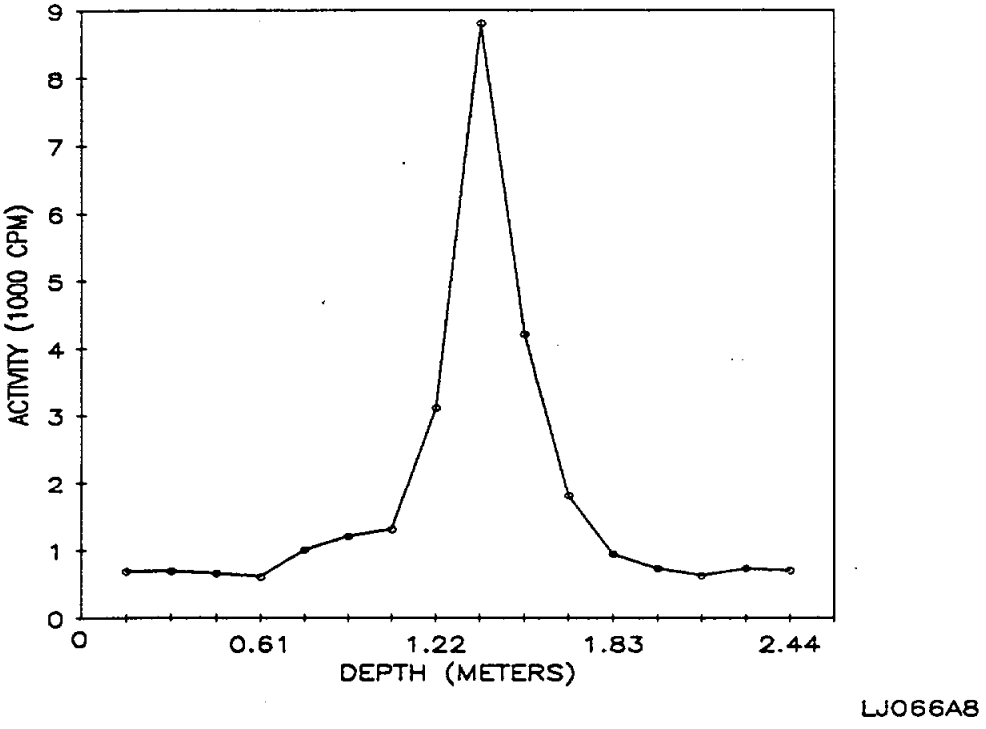

Fig. 10. Gamma profile for auger hole 8 (LJ066A8) at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey.

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
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9[a]
^{238}U	0.9[a]
^{226}Ra	0.9[a]

[a]Reference 4.

Table 3. Concentrations of radionuclides in soil at the Firemen's Memorial Park and Fire Hall No. 2, Garibaldi Avenue and Kennedy Drive, Lodi, New Jersey (LJ066)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)	
		^{226}Ra[b]	^{232}Th[b]
		Systematic samples[c]	
S1A	0-15	0.58 ± 0.06	0.63 ± 0.1
S1B	15-30	0.60 ± 0.06	0.76 ± 0.2
S1C	30-45	0.59 ± 0.07	0.70 ± 0.1
S1D	45-60	0.59 ± 0.04	0.84 ± 0.2
S1E	60-75	0.80 ± 0.2	7.2 ± 0.4
S1F	75-90	0.64 ± 0.1	4.5 ± 0.4
S2A	0-15	0.62 ± 0.02	0.76 ± 0.06
S2B	15-30	0.60 ± 0.05	0.77 ± 0.1
S3A	0-15	0.55 ± 0.09	0.63 ± 0.1
S3B	15-30	0.54 ± 0.03	0.68 ± 0.08
S4A	0-15	0.54 ± 0.04	0.65 ± 0.1
S4B	15-30	0.55 ± 0.05	0.64 ± 0.1
		Biased samples[d]	
B1A	0-15	0.62 ± 0.2	3.3 ± 0.3
B1B	15-30	0.71 ± 0.05	2.9 ± 0.09
B1C	30-45	0.65 ± 0.04	1.4 ± 0.1
B2A	0-15	0.90 ± 0.1	2.3 ± 0.1
B2B	15-30	1.1 ± 0.05	3.2 ± 0.1
B2C	30-45	1.2 ± 0.08	4.5 ± 0.4
B2D	45-60	0.85 ± 0.3	2.0 ± 0.09
B3A	0-15	0.90 ± 0.2	7.6 ± 0.3
B3B	15-30	0.38 ± 0.06	1.8 ± 0.1
B4A	0-15	0.85 ± 0.2	8.6 ± 0.4
B4B	15-30	0.91 ± 0.2	12 ± 0.1
B4C	30-45	0.39 ± 0.02	2.5 ± 0.09
B5A	0-15	0.57 ± 0.1	1.5 ± 0.3
B5B	15-30	1.1 ± 0.3	13 ± 0.7
B5C	30-45	0.49 ± 0.1	5.2 ± 0.1
		Auger samples[e]	
A1A	15-30	0.60 ± 0.3	2.5 ± 0.04
A1B	30-45	0.54 ± 0.06	2.2 ± 0.04
A1C	45-60	1.6 ± 0.2	18 ± 0.8
A1D	60-75	1.5 ± 0.1	15 ± 0.8
A1E	75-90	1.3 ± 0.3	9.6 ± 1
A1F	90-105	0.81 ± 0.09	4.8 ± 0.2
A1G	105-120	0.91 ± 0.8	5.7 ± 0.4
A1H	120-135	0.97 ± 0.3	5.6 ± 0.3

Table 3 (continued)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)	
		^{226}Ra[b]	^{232}Th[b]
		Auger samples[c]	
A1I	135-150	0.96±0.3	6.0 ±0.8
A1J	150-165	1.8 ±0.3	13 ±0.6
A1K	165-185	0.79±0.2	1.8 ±0.1
A2A	90-105	0.81±0.04	1.4 ±0.1
A2B	105-120	1.0 ±0.02	1.9 ±0.02
A2C	135-150	0.38±0.05	0.34±0.1
A2D	150-165	0.60±0.07	0.60±0.1
A2E	165-185	0.65±0.07	1.7 ±0.3
A2F	195-215	0.70±0.1	3.1 ±0.1
A5A	60-75	0.61±0.06	0.88±0.04
A5B	75-90	1.1 ±0.1	9.9 ±0.7
A5C	90-105	0.90±0.2	4.1 ±0.3
A5D	105-120	0.79±0.09	3.4 ±0.5
A5E	120-135	0.44±0.05	1.1 ±0.3
A5F	135-150	1.2 ±0.1	5.4 ±0.4
A5G	150-165	3.7 ±0.3	14 ±0.7
A5H	165-185	3.8 ±0.4	12 ±0.5
A5I	185-195	3.6 ±0.3	8.2 ±0.7
A6A	105-120	0.62±0.07	1.4 ±1
A6B	120-135	3.7 ±0.3	47 ±1
A6C	135-150	3.5 ±0.4	20 ±0.8
A6D	150-165	6.0 ±0.4	24 ±1
A6E	165-185	5.3 ±0.2	9.5 ±0.4
A6F	185-195	1.1 ±0.2	1.2 ±0.3
A6G	195-215	4.8 ±0.2	9.7 ±0.6
A6H	215-225	0.59±0.1	0.63±0.1
A7A	105-120	1.2 ±0.2	7.2 ±0.3
A7B	120-135	0.84±0.07	2.1 ±0.1
A7C	150-165	1.1 ±0.08	4.3 ±0.2
A7D	165-185	2.5 ±0.2	28 ±2
A7E	185-195	9.5 ±1	31 ±3
A7F	195-215	1.5 ±0.06	3.5 ±0.8
A8A	60-75	0.58±0.02	2.9 ±0.07
A8B	75-90	0.62±0.2	3.7 ±0.2
A8C	90-105	0.29±0.05	0.47±0.4
A8D	105-120	0.39±0.06	3.0 ±0.2
A8E	120-135	5.7 ±1	68 ±3
A8F	135-150	0.87±0.2	3.6 ±0.4
A8G	150-165	1.1 ±0.2	2.3 ±0.2

Table 3 (continued)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)	
		^{226}Ra[b]	^{232}Th[b]
A8H	185-195	0.6 ±0.06	0.86±0.3
A8I	195-215	0.8 ±0.1	1.1 ±0.1
A8J	215-225	0.8 ±0.06	1.1 ±0.09

[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 exposure.
[d]Biased samples are taken from areas shown to have elevated gamma exposure rates.
[e]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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36–37. Office of Scientific and Technical Information, DOE, P.O. Box 62, Oak Ridge, TN 37831