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RESULTS OF THE RADIOLOGICAL SURVEY AT 14 LONG VALLEY ROAD, LODI, NEW JERSEY (LJ070)

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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, 14 Long Valley Road, Lodi, New Jersey (LJ070), was conducted during 1987.

Survey measurements indicate that the property contained radioactive contamination primarily from the ^{232}Th decay chain. The radionuclide distributions are typical of the type of material originating from processing operations at the MCW. DOE guidelines were exceeded in both surface and subsurface soil.

RESULTS OF THE RADIOLOGICAL SURVEY AT 14 LONG VALLEY ROAD, LODI, NEW JERSEY (LJ070)*

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 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.

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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 with Martin Marietta Energy Systems, Inc.

As a result of the Energy and Water Appropriations Act of Fiscal Year 1984, the properties discussed in this report and others in their 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 survey discussed in this report is part of that effort and was 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 14 Long Valley Road, 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 10, 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. Systematic soil samples were then obtained at randomly selected locations irrespective of gamma exposure rates. In addition, biased soil samples were collected in areas of elevated gamma levels. To define the extent of possible subsurface soil contamination, auger holes were drilled to depths of approximately 1 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 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. 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.[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.

Surface Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan of the surface of the property are given in Fig. 1. The shaded areas indicate regions of elevated gamma measurements. Gamma exposure rates over the major portion of the property ranged from 5 to 16 μR/h. Gamma levels were higher at the redwood deck to the rear of the house (13 to 21 μR/h), and surrounding the shed and fish pond in the back yard (13 to 68 μR/h).

Systematic and Biased Soil Samples

Four systematic soil samples (S1A–S2B) and four biased soil samples (B1A–B2B) were collected from depths of 0 to 15 cm (A samples) and 15 to 30 cm (B samples) for radionuclide analyses. Locations of the samples are shown in Fig. 2, with results of laboratory analyses provided in Table 3. Concentrations of ^{226}Ra and ^{232}Th in the systematic samples ranged from 0.85 to 1.2 pCi/g and 1.0 to 2.0 pCi/g, respectively. Biased samples were found to have 1.4 to 3.6 pCi/g ^{226}Ra and 6.8 to 67 pCi/g ^{232}Th. The DOE guidelines for ^{232}Th concentrations in soil are exceeded in surface samples B1A and B2A, and in subsurface sample B1B. All radium–226 concentrations in biased samples were slightly elevated above background for the northern New Jersey area but below guidelines (Table 2).

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 0 to 105 cm in auger holes drilled at three separate locations as indicated in Fig. 2. The results of analyses of these samples are given in Table 3 (A1A–A3C). Concentrations of ^{226}Ra and ^{232}Th in the surface and subsurface samples ranged from 0.61 to 2.7 pCi/g and 0.79 to 37 pCi/g, respectively. Radionuclide concentrations in samples A1A and A1B were above DOE criteria (Table 1) for thorium–232, with levels of 37 and 26 pCi/g, respectively. The elevated concentrations were found at both surface (0–15 cm) and subsurface (15–30 cm) depths. Radium–226 concentrations approximated background except for sample A1A which contained 2.7 pCi/g, a value well below the applicable guideline.

Gamma logging was performed in each of the three 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 1,000 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 5. Readings at depths between 15 and 46 cm were greater than 1,000 cpm in auger hole 1, with a maximum reading of 4,000 cpm at 15 cm. No readings above 700 cpm were found in hole 2. Finally, elevated readings were between 15 and 30 cm in hole 3 with a maximum of 2,300 cpm at 15 cm. The areas of highest gamma readings correspond to the greatest concentrations of radionuclides shown in Table 3.

SIGNIFICANCE OF FINDINGS

Measurements taken at 14 Long Valley Road 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. The concentration and extent of ^{232}Th on this property were in excess of the applicable DOE criteria (Table 1). Guidelines are exceeded at sample locations B1, B2, and A1 (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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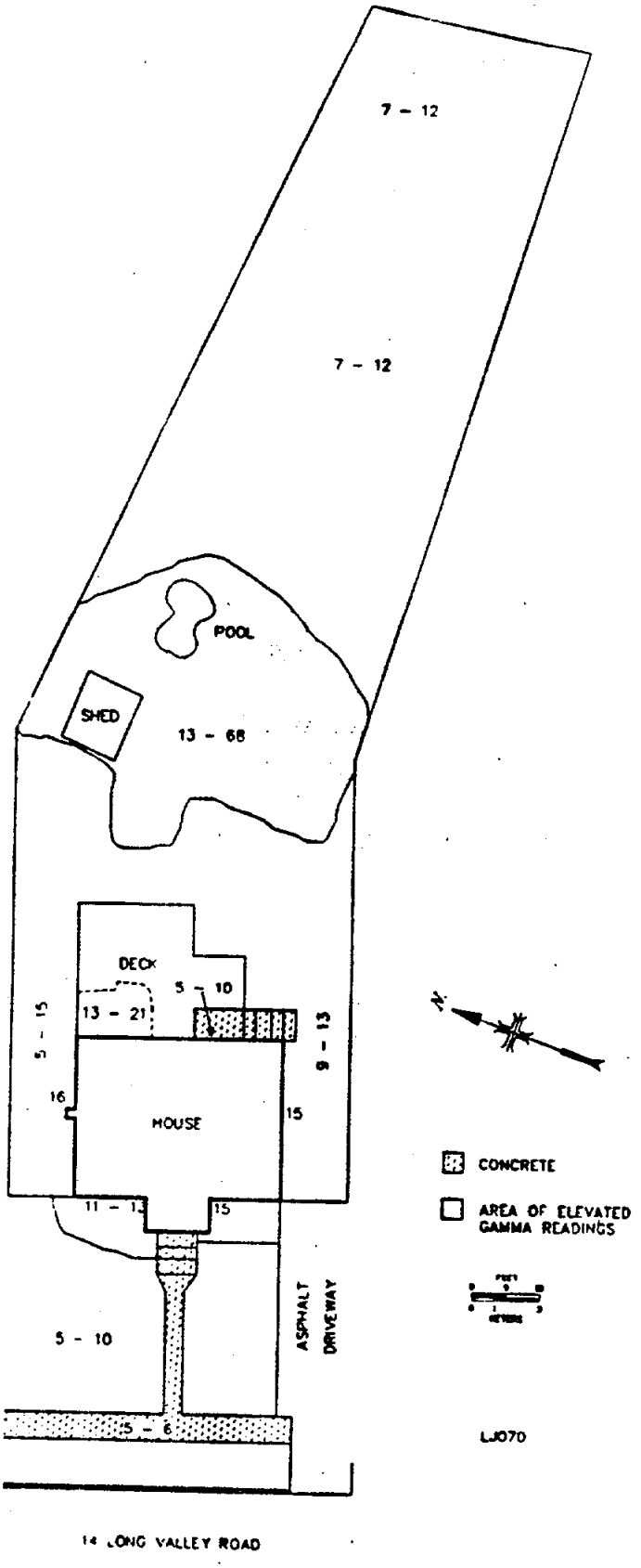

Fig. 1. Gamma radiation levels (μR/h) measured on the surface at 14 Long Valley Road, Lodi, New Jersey (LJ070).

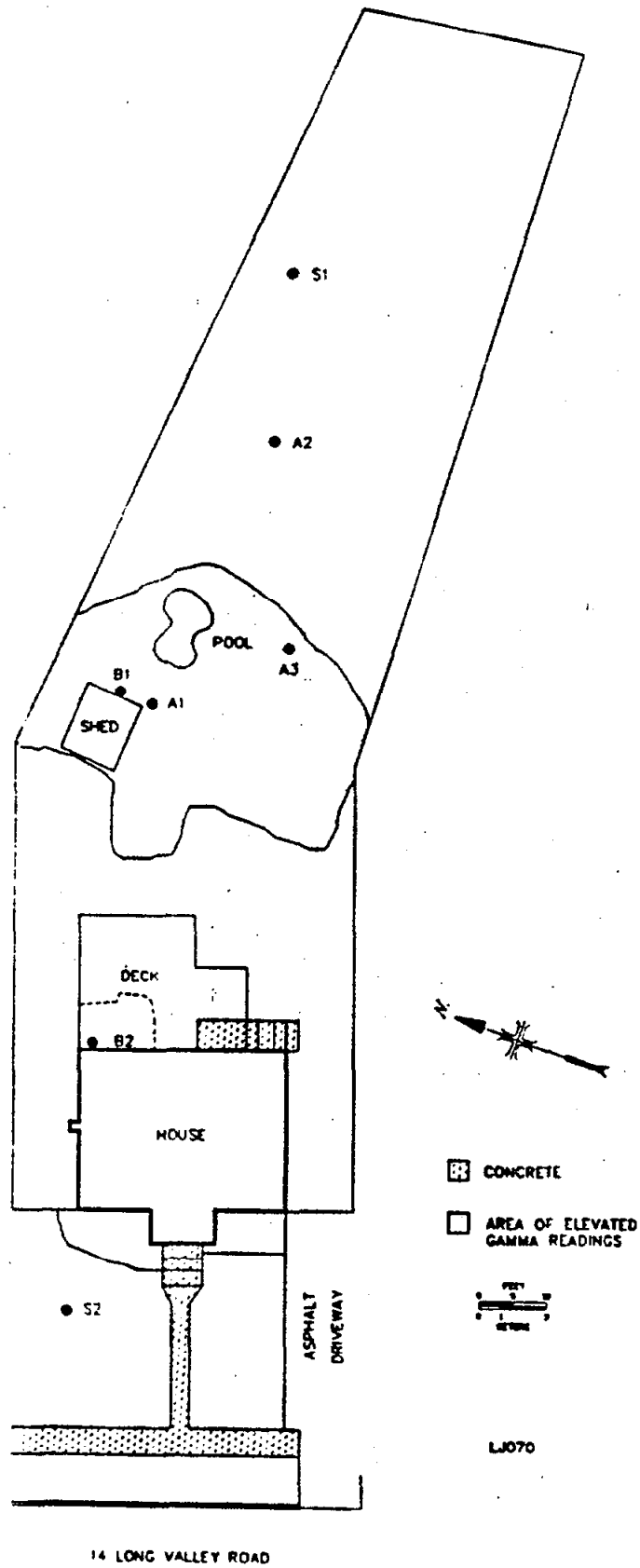

Fig. 2. Diagram showing locations of soil samples taken at 14 Long Valley Road, Lodi, New Jersey (LJ070).

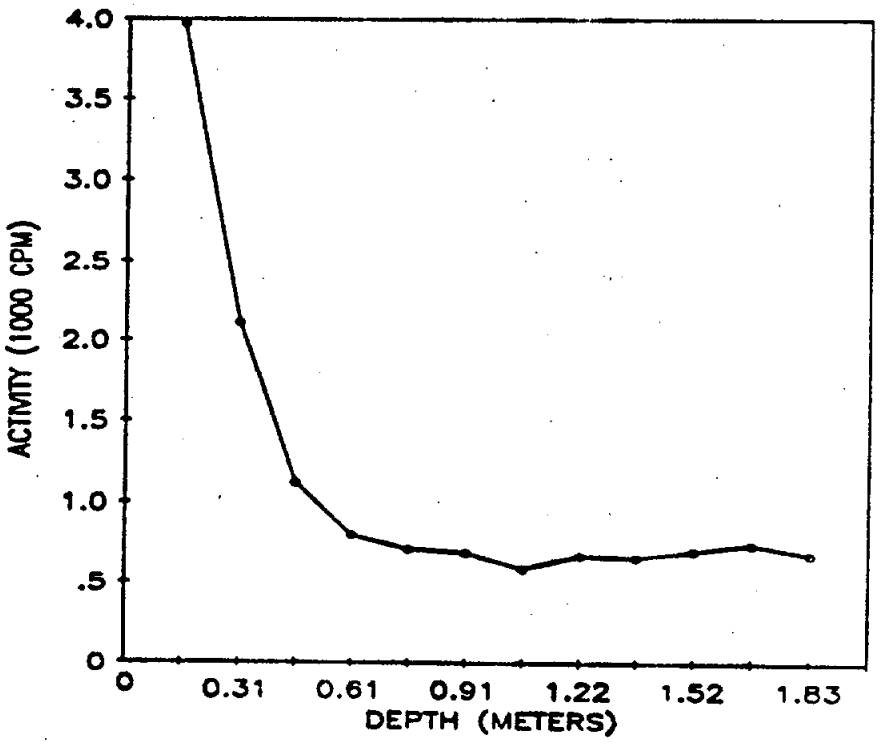

Fig. 3. Gamma profile for auger hole 1 at 14 Long Valley Road, Lodi, New Jersey.

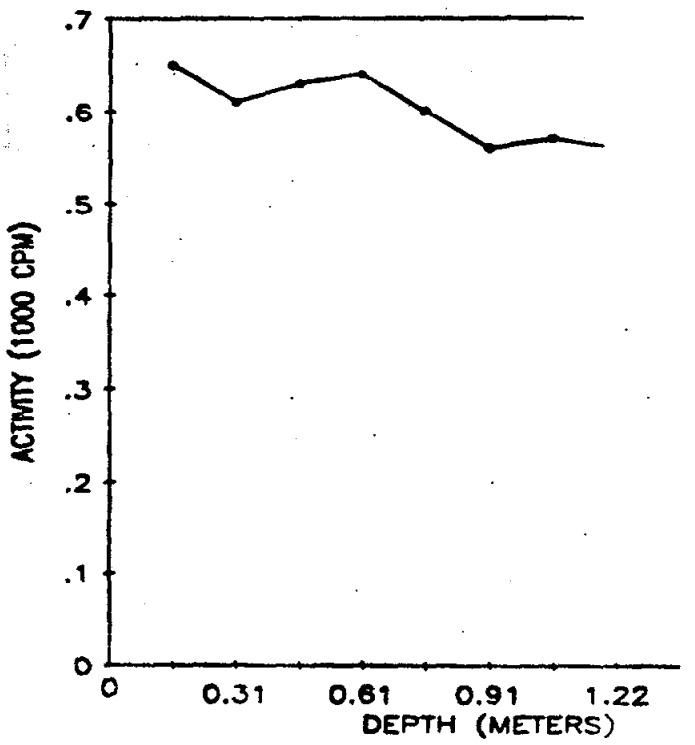

Fig. 4. Gamma profile for auger hole 2 at 14 Long Valley Road, Lodi, New Jersey.

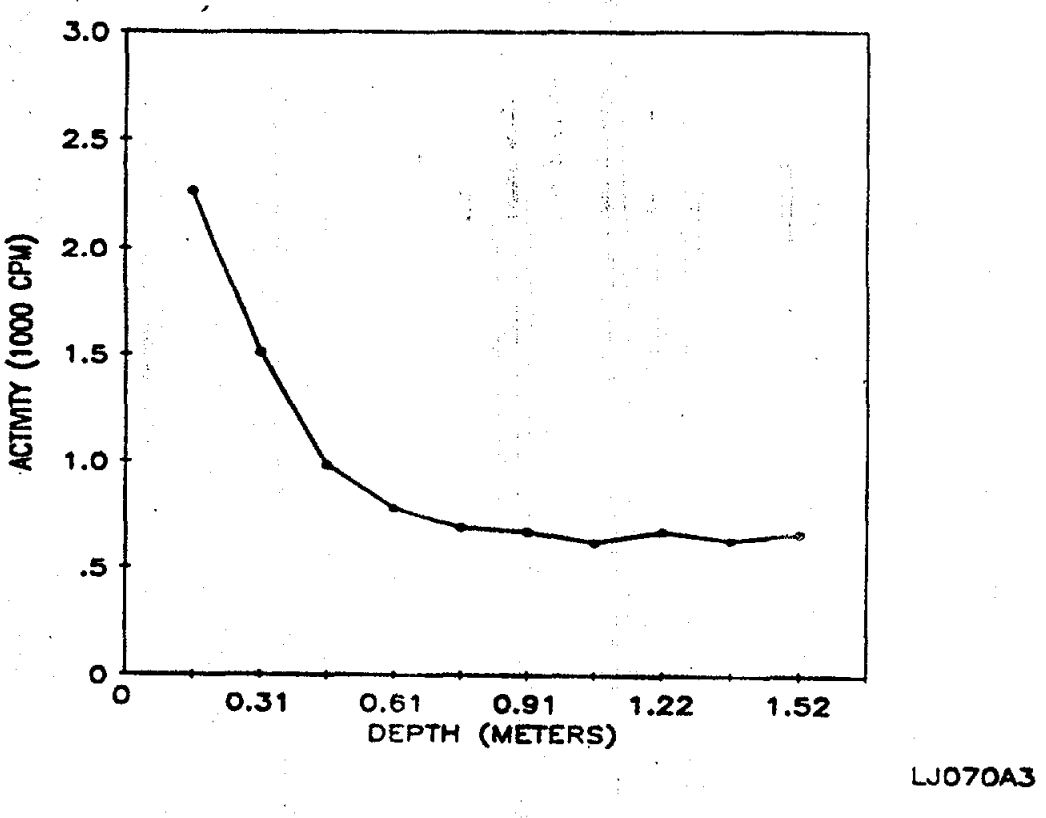

Fig. 5. Gamma profile for auger hole 3 at 14 Long Valley Road, Lodi, New Jersey.

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
Gamma exposure rate at 1 m above ground surface (μR/h)[a]	8
Concentration of radionuclides in soil (pCi/g)[b]	
^{226}Ra	0.9
^{232}Th	0.9
^{238}U	0.9

[a]Reference 4.
[b]Reference 5.

Table 3. Concentrations of radionuclides in soil at 14 Long Valley Road, Lodi, New Jersey (LJ070)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)	
		^{226}Ra[b]	^{232}Th[b]
		Systematic samples[c]	
S1A	0–15	1.2 ±0.2	2.0±0.1
S1B	15–30	0.93±0.1	1.2±0.1
S2A	0–15	0.98±0.09	1.0±0.3
S2B	15–30	0.85±0.03	1.0±0.06
		Biased samples[d]	
B1A	0–15	3.6 ±0.5	67 ±4
B1B	15–30	2.4 ±0.5	33 ±1
B2A	0–15	2.0 ±0.4	14 ±0.8
B2B	15–30	1.4 ±0.1	6.8 ±0.8
		Auger samples[e]	
A1A	0–15	2.7 ±0.9	37 ±0.7
A1B	15–30	1.9 ±0.03	26 ±1
A1C	30–45	0.97±0.2	2.1 ±0.2
A1D	45–60	0.89±0.06	3.2 ±0.1
A1E	60–75	0.91±0.05	2.4 ±0.05
A2A	15–30	0.83±0.09	1.1 ±0.02
A2B	90–105	0.61±0.02	0.79±0.2
A3A	0–15	0.94±0.3	5.1 ±0.3
A3B	15–30	0.78±0.08	1.2 ±0.1
A3C	30–45	0.91±0.04	1.5 ±0.08

[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 rate.

[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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