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RESULTS OF THE RADIOLOGICAL SURVEY AT ALLIED BENDIX AEROSPACE CORPORATION, INDUSTRIAL AND WILLIAMS AVENUES, TETERBORO, NEW JERSEY (TJ002)

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R. D. Foley and L. M. Floyd

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ABSTRACT

An investigative survey was conducted at Allied Bendix Aerospace Corporation, Industrial and Williams Avenues, Teterboro, New Jersey (TJ002), by the Measurement Applications and Development Group of the Health and Safety Research Division of Oak Ridge National Laboratory during November, 1986. The survey included a gamma radiation scan and radionuclide soil sampling. The survey objective was to determine whether this site was contaminated with radioactive residues derived from the Maywood Chemical Works (MCW) of Maywood, New Jersey, principally, ^{232}Th. MCW supplied rare earth metals and thorium compounds to various government agencies from the late 1940s to the mid 1950s.

Results of the survey demonstrated radionuclide concentrations in excess of DOE criteria for both ^{232}Th and ^{226}Ra. However, when rare earth concentrations from both sites are compared, MCW does not appear to be the source of the radium contamination, nor is there a history of residues from MCW ever being moved to this site. Prior to 1976, Bendix was licensed by the Nuclear Regulatory Commission to use thorium in an on-site Navy/Bendix process. The source of the thorium contamination is probably associated with this process and not the MCW project.

RESULTS OF THE RADIOLOGICAL SURVEY AT ALLIED BENDIX AEROSPACE CORPORATION, INDUSTRIAL AND WILLIAMS AVENUES, TETERBORO, NEW JERSEY (TJ002)*

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.

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 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.

the MCW. The principal radionuclide of concern from the MCW site is ^{232}Th. 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 (ORNL).

A radiological survey of the commercial property at Industrial and Williams Avenues, Teterboro, New Jersey, was conducted on November 17-18, 1986. Samples of the soil surface were taken for further analyses during this time. Prior to 1976, Bendix was licensed by the Nuclear Regulatory Commission to use thorium in an on-site Navy/Bendix process.

SURVEY METHODS

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

To provide better definition of the area to be surveyed, the site was subdivided into grid blocks of approximately 100 x 100 ft, as shown in Fig. 1. Each grid block is identified by the coordinates in one corner of that grid block. Shading shown in the Grid Block Key of Fig. 1 indicates the designating corner. These coordinates represent the intersection of grid lines, relative to the baseline. These intersections are referred to as the grid points. A gamma scan of each accessible grid block was performed using either portable gamma scintillation (NaI) survey meters, with the detectors held approximately three inches above the ground surface, or the mobile gamma scanning van developed by ORNL. The specially equipped, scanning van contains a Na(Tl) detection system, which is operator controlled through an on-board mini-computer with data display via the video screen or the printer. This van was used in the large parking lot to the west of the main building. Gamma radiation levels for a grid block were then recorded as a range of lowest to highest values, and the locations of any anomalous levels were noted. The ranges for all the blocks together constitute a scan of the total surveyed ground surface. On the bases of these grid blocks, soil samples were taken from the surface at systematically selected locations, irrespective of the gamma scintillation readings. Biased samples were taken at selected locations where elevated gamma levels were found; not all elevated areas were sampled. The samples were analyzed for ^{226}Ra, ^{232}Th, and ^{238}U content. 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. 2. Gamma exposure rates over the major portion of the property ranged from 7 to 17 μR/h. However, there were a number of isolated spots with elevated gamma readings. Two of these locations were in the ball field, with measurements ranging from 37 to 62 μR/h and from 471 to in excess of 200,000 μR/h. Seven additional spots were located to the west of the main building, all in close proximity to the 250,000 gallon storage tank; one of these seven was in the northern corner of the parking lot with levels ranging from 80 to 20,000 μR/h (Fig. 2). Five more were adjacent to the tank with readings from 17 to 26 μR/h. The last area was just south of the tank, measuring 157 to 15,000 μR/h. Soil samples were taken from both areas. The elevated spots were each less than one meter square.

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. 3, with results of laboratory analyses provided in Table 3. Concentrations of radium, thorium, and uranium in the biased samples ranged from 0.46 to 50,000 pCi/g, 0.34 to 5.7 pCi/g, and 0.39 to 2.0 pCi/g, respectively. Biased soil samples with the greatest concentrations of radium and thorium were B1A&B, B2, B3B&C, B4A–C, and B6A&B, each with values for radium in excess of DOE criteria (Table 1). Samples B1A&B, B3C, and B4B were not processed, because they exceeded the counting capacity of standard analytical equipment and clearly exceeded the environmental guidelines. Gamma emitting radionuclide concentrations in these samples were estimated by comparison with an established soil sample; the point of commonality was the known gamma level of each. The estimated radium concentrations for samples B1A, B1B, B3C, and B4B are 500, 50,000, 6,000, and 2,300 pCi/g, respectively. Analyses of elemental rare earths for Allied Bendix Aerospace Corporation and MCW are given in Table 4.

SIGNIFICANCE OF FINDINGS

Measurements taken at Industrial and Williams Avenues indicate that the property contained radioactive contamination in excess of DOE guidelines, both from the ^{232}Th decay chain and from ^{226}Ra. However, these guidelines are not applicable to this property as the contamination does not appear to have originated from a DOE site or from activity over which DOE has authority. The source of the specific radium contamination is not known, but it is clearly atypical of material generated by MCW. Table 4 indicates that the contaminated soil from the Bendix site did not originate at the former MCW site, as demonstrated by the dissimilar concentrations of rare earths from each site. Furthermore, no historical data has been identified which would suggest residues from MCW were ever moved to this site. However, there is some history of thorium use at the site when it was being operated for the Navy by Bendix, prior to 1976. As a result, the source of the thorium contamination on site is probably associated with the Navy/Bendix thorium processing operations and not the MCW project.

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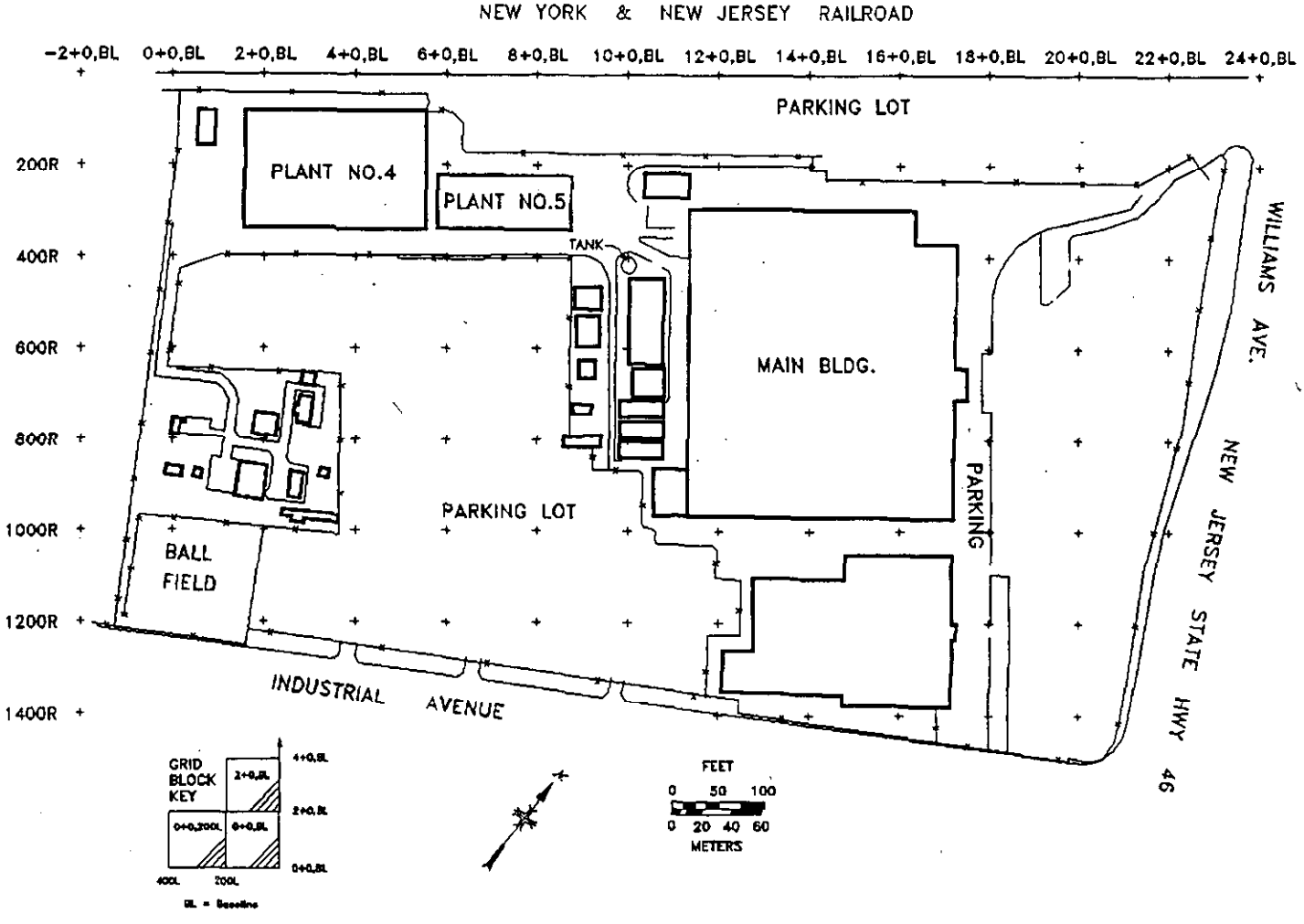

Fig. 1. Diagram showing grid lines for the property at Allied Bendix Aerospace Corporation, Industrial and Williams Avenues, Teterboro, New Jersey (TJ002).

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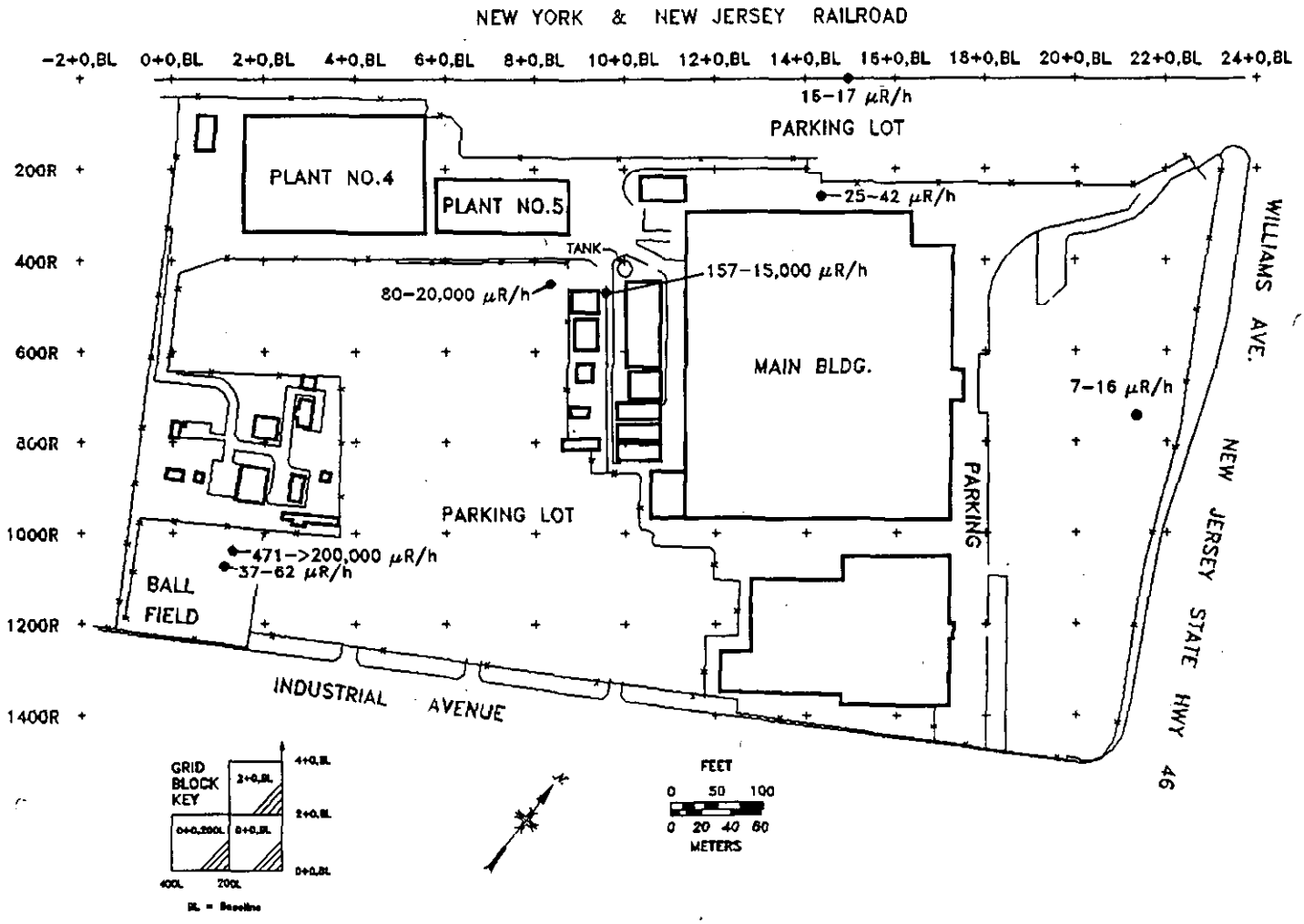

Fig. 2. Gamma radiation levels measured on the surface at Allied Bendix Aerospace Corporation, Industrial and Williams Avenues, Teterboro, New Jersey (TJ002).

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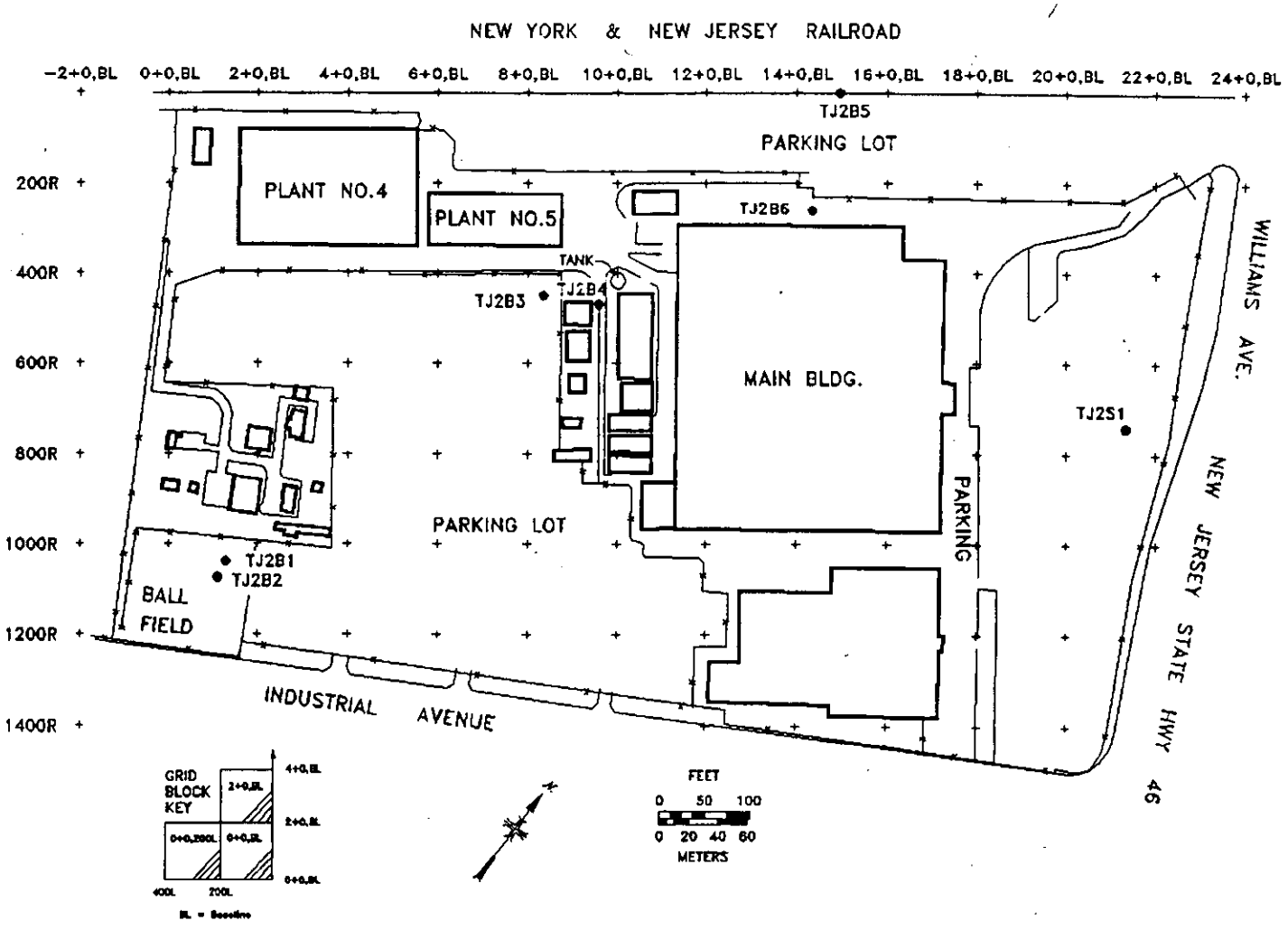

Fig. 3. Diagram showing locations of soil samples taken at Allied Bendix Aerospace Corporation, Industrial and Williams Avenues, Teterboro, New Jersey (TJ002).

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 Allied Bendix Aerospace Corporation, Industrial and Williams Avenues, Teterboro, New Jersey (TJ002)

Sample	Location[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
			^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
		Systematic samples[d]			
TJS1A	19+80, 730R	0–15	0.74±0.07	0.83±0.09	0.89
TJS1B	19+80, 730R	15–30	0.78±0.06	0.88±0.04	0.90
TJS1C	19+80, 730R	30–45	0.80±0.04	0.97±0.2	0.76
TJS1D	19+80, 730R	45–60	0.76±0.04	0.90±0.1	0.85
		Biased samples[e]			
TJB1A[f]	0+90, 1020R	0–15	500		
TJB1B[f]	0+90, 1020R	15–30	50000		
TJ2	0+80, 1050R	0–15	230 ±6	0.76±0.3	<1.7
TJB3A	7+80, 425R	10–18	0.46±0.06	0.34±0.1	0.39
TJB3B	7+80, 425R	18–30	860 ±20	0.59±	<2
TJB3C[f]	7+80, 425R	30–45	6000		
TJB4A	9+20, 445R	0–15	24 ±0.6	0.60±0.3	0.47
TJB4B[f]	9+20, 445R	15–30	2300		
TJB4C	9+20, 445R	30–45	2700 ±25	<5.7	<1.3
TJB5A	15+20, 40R	0–15	1.2 ±0.09	0.87±0.2	0.83
TJB5B	15+20, 40R	15–30	3.7 ±0.2	0.58±0.2	0.57
TJB6A	13+80, 275R	0–15	42 ±1	0.90±0.2	0.85
TJB6B	13+80, 275R	15–30	6.7 ±0.2	2.3 ±0.3	2.0
TJB6C	13+80, 275R	30–45	2.1 ±0.2	1.7 ±0.2	1.5

[a]Locations of soil samples are shown on Fig. 3.

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

[c]Total analytical error of measurement results is less than ±5% (95% confidence level).

[d]Systematic samples were taken at grid locations irrespective of gamma exposure.

[e]Biased samples were taken from areas shown to have elevated gamma exposure rates.

[f]Concentrations in biased samples TJ02B1A&B, TJ2B3C, and TJ02B4B were estimated by comparison with an established soil sample. See text for details.

Table 4. Mass Spectroscopy for Elemental Rare Earths at Various Sites in the Teterboro and Maywood, New Jersey, Areas

	Bendix Site[a] Sample Numbers		Maywood Chemical Works Site[b] Sample Numbers									
Rare Earths (ppm)	TJ2-B5A	TJ2-B4A	354	355	356	357	358	359	360	361	362	363
Ce	<5	<5	1650	1600	>10,000	>10,000	320	400	140	320	260	275
Dy	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Er	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Eu	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Gd	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ho	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
La	<5	<5	250	250	1725	1500	40	60	30	55	75	80
Lu	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nd	<5	<5	<5	350	2400	2100	30	140	<5	<5	145	145
Pr	<5	<5	70	80	550	520	20	20	10	20	20	25
Sm	<5	<5	<5	<5	600	600	<5	<5	<5	<5	<5	<5
Tb	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Y	<5	<5	10	8	55	30	5	<5	10	10	10	10
Yb	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Tm	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

[a]Allied Bendix Aerospace Corporation, Industrial and Williams Avenues, Teterboro, New Jersey.

[b]Maywood Chemical Works, Maywood, New Jersey.

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