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REPORT ON THE LIMITED RADIOLOGICAL SURVEY FOR THE CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY IN ST. LOUIS, MISSOURI

St. Louis, Missouri

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Bechtel National, Inc.

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REPORT ON THE LIMITED RADIOLOGICAL SURVEY OF THE CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY IN ST. LOUIS, MISSOURI

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UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

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EXECUTIVE SUMMARY

Radiological characterization activities were conducted on the Chicago, Burlington, and Quincy Railroad property (adjacent to the St. Louis Downtown Site) in St. Louis, Missouri, to determine if radioactivity exists in concentrations above guidelines as set forth by the U.S. Department of Energy for its Formerly Utilized Sites Remedial Action Program. Survey activities included walkover gamma surveys, soil sampling, and gamma logging. Residual radioactivity was found to be present in soil at concentrations above guidelines. However, the concentrations of radioactivity are low and, given the current use of the property, do not pose a health hazard to workers on the Chicago, Burlington, and Quincy Railroad property.

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeters
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
in.	inch
km	kilometer
m	meter
m^2	square meters
MeV	million electron volt
mi	mile
µR/h	microroentgens per hour
mrad/h	millirad per hour
pCi/g	picocurie per gram
WL	working level
yr	year

ACRONYMS

AEC	Atomic Energy Commission
BNI	Bechtel National, Inc.
DOE	Department of Energy
FUSRAP	Formerly Utilized Sites Remedial Action Program
MED	Manhattan Engineer District
SLAPS	St. Louis Airport Site
SLDS	St. Louis Downtown Site
TMA/E	Thermo Analytical/Eberline

1.0 INTRODUCTION

Characterization of the St. Louis Downtown Site (SLDS) was implemented in 1987 to determine the horizontal and vertical boundaries of radioactive contamination exceeding remedial action guidelines. As characterization activities progressed, it was determined that the potential existed for radioactive contamination to be present on properties adjacent to SLDS. As a result, limited radiological surveys were conducted on area properties suspected of having radioactive contamination above remedial action guidelines. The objective of this report is to document the findings of those surveys on one adjacent property.

The radiological surveys were conducted under the U.S. Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP). FUSRAP was created to identify, cleanup, or otherwise control sites where residual radioactive contamination that exceeds current guidelines remains from the early years of our nation's atomic energy program. FUSRAP is currently managed by DOE Oak Ridge Operations. As Project Management Contractor for FUSRAP, Bechtel National, Inc. (BNI), is responsible for planning, managing, and implementing FUSRAP.

1.1 HISTORICAL OVERVIEW

SLDS encompasses approximately 45 acres in an industrial area of St. Louis, Missouri. The site is on the eastern border of the city, approximately 61 m (200 ft) west of the Mississippi River (Figure 1-1). The property is owned by Mallinckrodt, Inc. At present, there are numerous buildings and facilities on the site used for the production of various chemical products (Figure 1-2).

From 1942 to 1966, under contracts with the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC), several operations were performed on-site, including the processing and

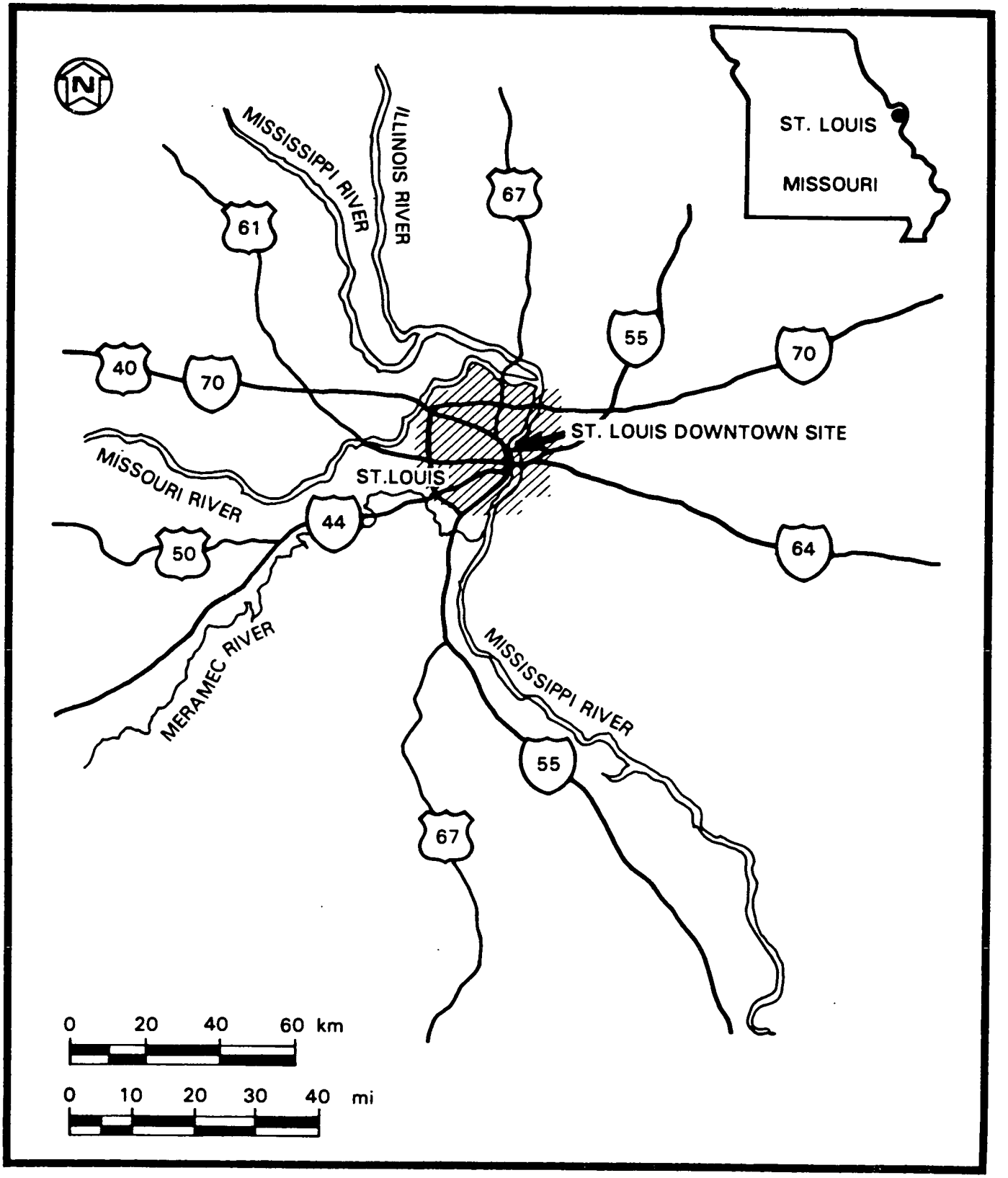

FIGURE 1-1 LOCATION OF THE ST. LOUIS DOWNTOWN SITE

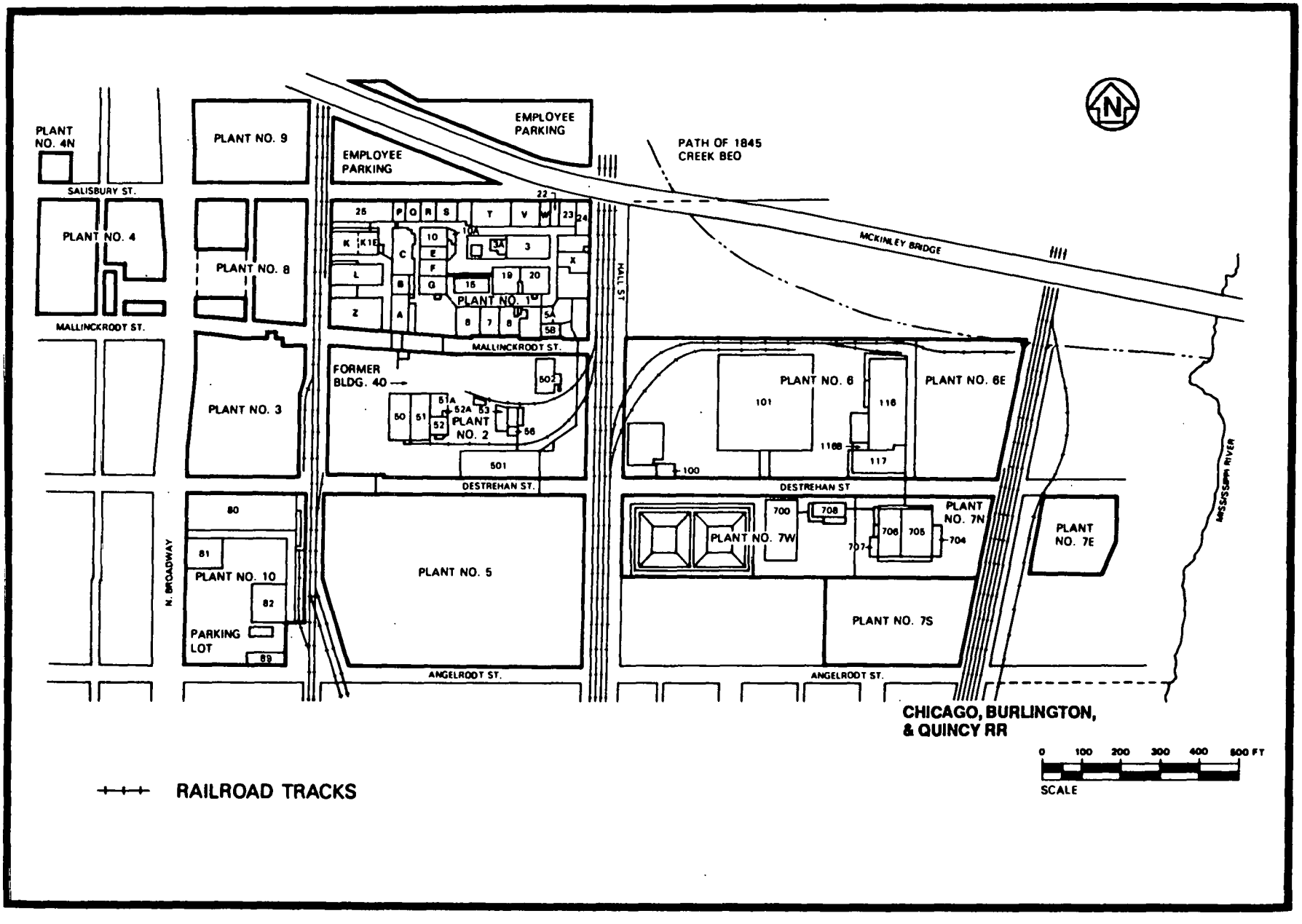

FIGURE 1-2 ST. LOUIS DOWNTOWN SITE

production of various forms of uranium compounds and the machining and recovery of uranium metal (Ref. 1).

In 1977, a radiological survey of portions of SLDS was conducted at DOE's request (Ref. 2). Results of this survey showed alpha and beta-gamma contamination levels above limits set by DOE guidelines at locations inside and outside some of the buildings. Elevated external gamma radiation levels were measured at various outdoor locations and in several buildings. Concentrations of uranium-238 and radium-226 were found in subsurface soil at levels exceeding DOE cleanup guidelines. Elevated gamma radiation levels were measured in some of the indoor drains. Radon and radon daughter concentrations in three buildings were in excess of DOE guidelines for non-occupational radiation exposure.

Current DOE guidelines governing remedial actions for radiological contamination are presented in Table 1-1 (Ref. 3). A site-specific guideline for uranium in soil is currently being developed by DOE. For the purpose of this report, a value of 50 pCi/g for uranium-238 in soil will be assumed as the guideline (Ref. 4). This value is consistent with other uranium cleanup guidelines developed by DOE for other FUSRAP sites.

1.2 SCOPE AND OBJECTIVE OF THE RADIOLOGICAL SURVEYS

Characterization activities at SLDS were conducted in two phases and included radiological, chemical, and hydrogeological surveys. The radiological surveys were designed to identify the areas of radioactive contamination (Phase 1) and to determine the vertical and horizontal extent of the contamination above remedial action guidelines (Phase 2). On completion of Phase 1 of the radiological survey, it was determined that the potential existed for radioactive contamination to be present beyond SLDS property boundaries.

The SLDS Phase 2 characterization was expanded to include limited radiological surveys of properties adjacent to SLDS where radioactive contamination was suspected. These limited radiological

TABLE 1-1
SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES

BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr.

SOIL GUIDELINES

Radionuclide	Soil Concentration (pCi/g) Above Background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Other Radionuclides	Soil guidelines will be calculated on a site-specific

STRUCTURE GUIDELINES

Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that has no radiological restrictions on its use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL[d]. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restrictions on its use shall not exceed the background level by more than 20 mR/h.

Indoor/Outdoor Structure Surface Contamination

Radionuclide[f]	Allowable Surface Residual Contamination[e] (dpm/100 cm²) Average[g,h]	Maximum[h,i]	Removable[h,j]
Transuranics, Ra-226, Ra-228, Th-230, Th-228 Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224 U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β - γ	15,000 β - γ	1,000 β - γ

TABLE 1-1
(CONTINUED)

[a]These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If either thorium-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that 1) the dose for the mixtures will not exceed the basic dose limit, or 2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[b]These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100-m^2 surface area.

[c]Localized concentrations in excess of these limits are allowable, provided that the average concentration over a 100-m^2 area does not exceed these limits. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate soil limit, regardless of the average concentration in the soil.

[d]A working level (WL) is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3 x 105 MeV of potential alpha energy.

[e]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[f]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[g]Measurements of average contamination should not be averaged over more than 1 m^2. For objects of less surface area, the average shall be derived for each such object.

[h]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[i]The maximum contamination level applies to an area of not more than 100 cm^2.

[j]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

surveys were not intended to determine the absolute extent of radiological contamination. Rather, the objective of these surveys was to determine if radioactive materials had migrated onto these properties from SLDS and if radioactivity existed in levels above DOE guidelines. The scope of this work included walkover gamma surveys to identify areas of elevated gamma radiation, soil sample collection and analysis for selected radionuclides, and gamma logging of boreholes as a gross indicator of radioactivity in soil. Surveys were conducted on the adjacent properties in only those areas that were readily accessible to the field survey crew.

Available information does not indicate whether the Chicago, Burlington, and Quincy Railroad property was used for MED/AEC activities conducted at SLDS, although such use is possible. This property was investigated to determine if radioactive contamination above guidelines was present, whether it originated from MED/AEC activities on the property or through migration from SLDS onto the Chicago, Burlington, and Quincy Railroad property.

1.3 LOCATION AND USE OF PROPERTY

The portion of the Chicago, Burlington, and Quincy Railroad property surveyed is located on the eastern portion of SLDS (Figure 1-2). The property is a narrow strip of land running northeast and southwest, and is adjacent to SLDS Plants 6E and 7S (Figure 1-3). The property consists solely of railroad tracks, which are used for commercial transport of a variety of products.

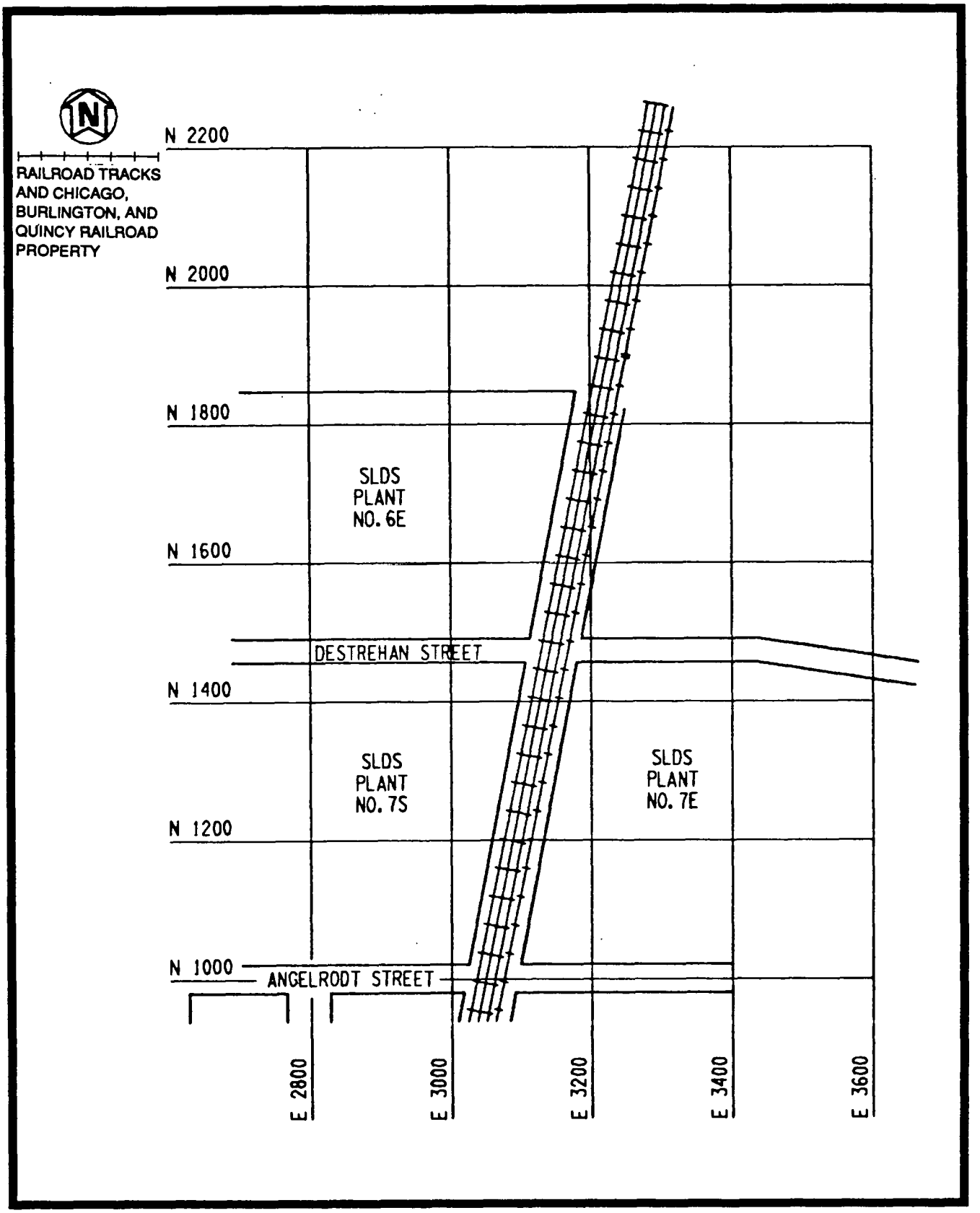

FIGURE 1-3 CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY AT SLDS

2.0 SURVEY METHODOLOGY

The limited radiological survey conducted at the Chicago, Burlington, and Quincy Railroad property included a walkover gamma survey, collection and analysis of shallow soil samples, and downhole gamma logging. The 15-m (50-ft) grid system that was developed for the SLDS characterization was used for this survey. This grid is tied to the State of Missouri grid system. All characterization data were collected in reference to this grid. Each of these survey activities is explained below.

2.1 WALKOVER GAMMA SURVEY

A walkover gamma survey was conducted on the portion of the property within the SLDS boundary. The purpose of this survey was to identify areas of elevated gamma radiation. In areas exhibiting elevated gamma radiation (twice background), biased surface soil samples were collected and analyzed to determine radionuclide concentrations.

The walkover gamma radiation survey was performed by a walkover scan of 15- by 15-m (50- by 50-ft) grid sections and recording the ranges of radioactivity as determined by instrument response. A PRS-1 scaler coupled to an unshielded Eberline SPA-3 probe was used for the walkover gamma survey. The SPA-3 probe is a sodium iodide, thallium-activited [NaI(Tl)] gamma scintillation detector. Figure 2-1 shows the areas surveyed for elevated gamma radiation.

2.2 SOIL SAMPLING

Systematic and biased soil samples were collected on each side of the Chicago, Burlington, and Quincy Railroad property. A total of 25 locations were sampled, as shown in Figure 2-2.

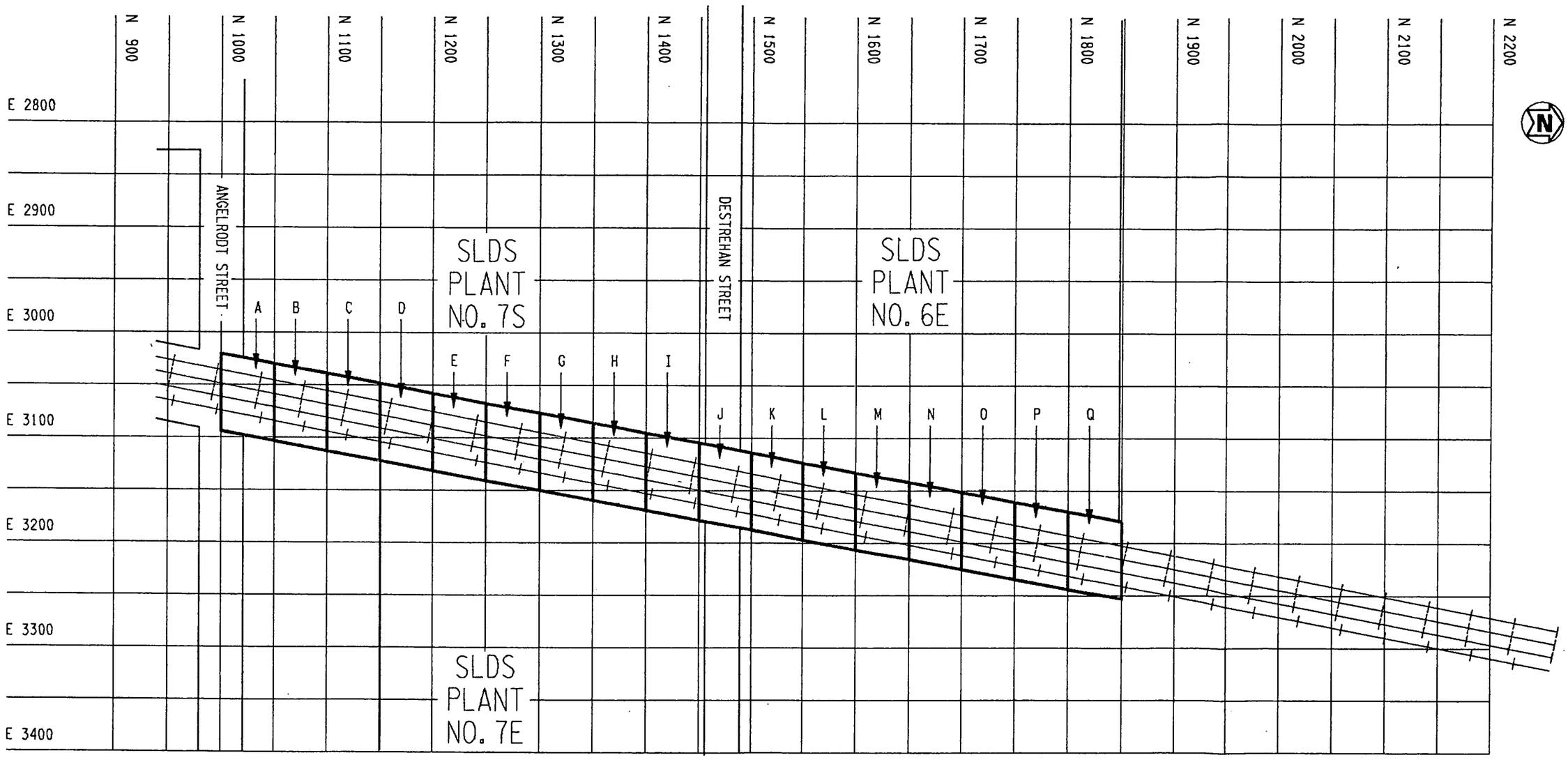

FIGURE 2-1 AREAS OF WALKOVER GAMMA SURVEY AT THE CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY

[42,4]116F019.DGN;1

Samples were collected using either a hand-held or a gas-powered auger. The auger was advanced through the soil at increments of 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 0.3 m (0.5 to 1.0 ft), 0.3 to 0.6 m (1.0 to 2.0 ft), and 0.6 to 1.0 m (2.0 to 3.0 ft). A sample was collected at each increment and placed in a plastic jar. Biased soil samples were collected at the surface increment [0.0 to 0.15 m (0.0 to 0.5 ft)].

The samples were then sent to the Thermo Analytical/Eberline (TMA/E) laboratory where the surface sample [0.0 to 0.15 m (0.0 to 0.5 ft)] from each location was analyzed for uranium-238, radium-226, thorium-232, and thorium-230. The remaining samples were archived for future use, if needed.

2.3 GAMMA LOGGING

A number of the 1-m (3-ft) holes were gamma logged with a SPA-3 detector coupled to a PRS-1 scaler. The detector was lowered into the hole, and the level of gamma radiation at specific depths was measured by instrument response. The SPA-3 is not a typical downhole gamma logging probe, but it was used because the diameter of the hole was not of sufficient size to use the typical Bicron BHP-2 shielded downhole logging probe. These gamma logs have no correlation to a concentration of radionuclides, but they were used as gross indicators of radioactivity in subsurface soil. All sampling locations, including the gamma logged holes, are shown in Figure 2-2.

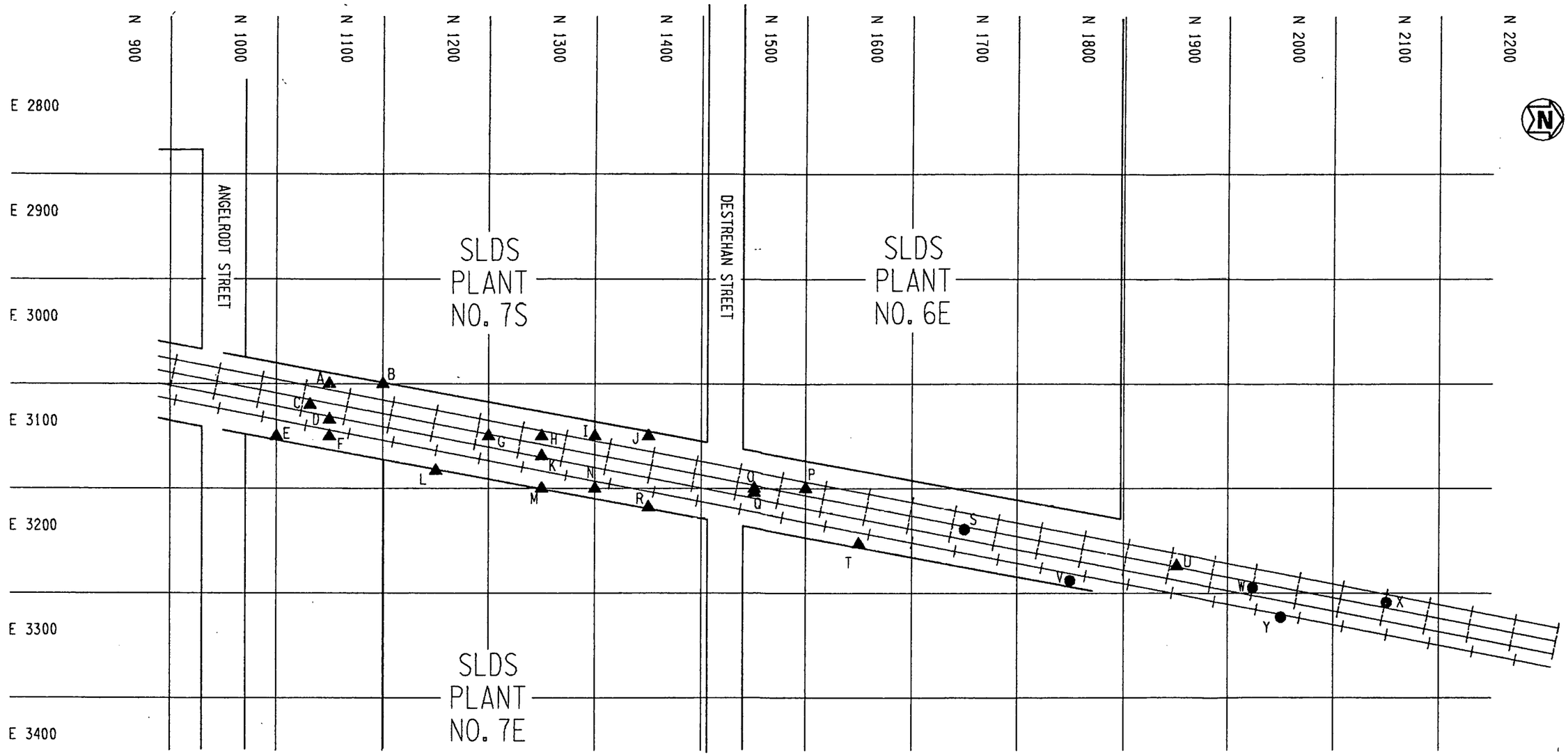

FIGURE 2-2 SOIL SAMPLING LOCATIONS AT THE CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY

[42,4]116F019.DGN;1

3.0 SURVEY RESULTS

This section provides the results of the limited radiological survey conducted on the Chicago, Burlington, and Quincy Railroad property.

3.1 WALKOVER GAMMA SURVEY

Background for near-surface gamma radiation in the St. Louis area is approximately 10,000 cpm (Table 3-1). This background measurement is based on previous radiological work conducted in 1988 in the St. Louis area. These background measurements were taken at distances of approximately 2.8 km (1.8 mi) (locations 1 and 2) and 1.6 km (1 mi) (location 3) from the St. Louis Airport Site (SLAPS). SLAPS is another FUSRAP site in St. Louis where ongoing radiological investigations are taking place. SLDS is approximately 17.2 km (10.7 mi) southwest of SLAPS. All direct field measurements represent gross readings; background measurements have not been subtracted.

Table 3-2 shows the results of the walkover gamma survey with the labeled grid blocks shown in Figure 2-1. These grid blocks represent areas of approximately 15 m by 22.7 m (50 ft by 75 ft). The results are represented in this manner for clarity, although the actual survey was conducted on 15 by 15 m (50 x 50 ft) squares. In some cases, the results in Table 3-2 represent data from more than one surveyed square. Near-surface gamma radiation measurements from the walkover survey on the Chicago, Burlington, and Quincy Railroad property ranged from 6,000 to 50,000 cpm.

The walkover gamma survey provided results measured in gross cpm. To better define exposures, these data were converted to exposure rate units of μR/hr. This conversion was based on calibrating the walkover survey instruments with a radium-226 source. The conversion factor is 1,250 cpm = 1 μR/hr. The results of this conversion are provided in Table 3-2. Exposure rates ranged from 4.8 to 40 μR/hr.

TABLE 3-1

BACKGROUND RADIONUCLIDE CONCENTRATIONS IN SOIL AND RADIATION LEVELS IN THE ST. LOUIS AREA

Measurement Location	Gamma Exposure Rate at 1 m (μR/h)	Gamma Radiation 1 m (cpm)	Near-Surface Gamma Radiation (cpm)	Radionuclide Concentration (pCi/g) +/- 2 sigma					
				Uranium-234	Uranium-235	Uranium-238	Radium-226	Thorium-232	Thorium-230
1	10	10,000	10,000	1.2 ± 0.3	<0.1	1.2 ± 0.3	0.9 ± 0.4	1.0 ± 0.6	1.2 ± 0.3
2	10	9,000	9,000	1.0 ± 0.2	<0.1	1.0 ± 0.2	0.9 ± 0.4	1.0 ± 0.5	1.3 ± 0.3
3	10	10,000	10,000	1.2 ± 0.2	0.1 ± 0.1	1.0 ± 0.2	0.9 ± 0.4	1.1 ± 0.3	1.5 ± 0.5
Average	10	10,000	10,000	1.1 ± 0.2	0.1 ± 0.1	1.1 ± 0.2	0.9 ± 0.4	1.0 ± 0.5	1.3 ± 0.4

TABLE 3-2

RESULTS OF WALKOVER GAMMA SURVEY

AT THE CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY

Grid Block	Counts per Minute (Range)	Exposure Rate (μR/h)
A	6,000 - 15,000	4.8 - 12.0
B	6,000 - 18,000	4.8 - 14.4
C	7,000 - 22,000	5.6 - 17.6
D	6,000 - 18,000	4.8 - 14.4
E	6,000 - 18,000	4.8 - 14.4
F	6,000 - 24,000	4.8 - 19.2
G	7,000 - 20,000	5.6 - 16.0
H	7,000 - 17,000	5.6 - 13.6
I	6,000 - 17,000	4.8 - 13.6
J	8,000 - 18,000	6.4 - 14.4
K	9,000 - 27,000	7.2 - 21.6
L	9,000 - 24,000	7.2 - 19.2
M	8,000 - 27,000	6.4 - 21.6
N	8,000 - 26,000	6.4 - 20.8
O	8,000 - 12,000	6.4 - 9.6
P	8,000 - 50,000	6.4 - 40.0
Q	6,000 - 20,000	4.8 - 16.0

The levels of near-surface gamma radiation remained relatively constant across the property. The higher levels were observed on the portion of the property adjacent to SLDS Plant 6E. These results indicate that gamma-emitting radionuclides are present in elevated concentrations on the Chicago, Burlington, and Quincy Railroad property. The walkover gamma survey was conducted on the portion of the property between Angelrodt Street and the northern border of SLDS Plant 6E.

3.2 SOIL SAMPLES

A total of 25 locations were sampled. The surface sample from each location was analyzed for uranium-238, radium-226, thorium-232, and thorium-230. The results of these analyses are shown in Table 3-3 with the sample locations shown in Figure 2-2. Background concentrations have not been subtracted from the values given in Table 3-3. Uranium-238 concentrations ranged from 4.0 to 120.0 pCi/g, with an average of approximately 23.8 pCi/g. Radium-226 concentrations ranged from 0.9 to 9.0 pCi/g, with an average of approximately 4.0 pCi/g. Thorium-232 ranged from 0.9 to 3.0 pCi/g, with an average of approximately 1.6 pCi/g. Thorium-230 concentrations ranged from 1.9 to 450.0 pCi/g, with an average of approximately 43.3 pCi/g.

The DOE guideline for residual radium-226, thorium-232, and thorium-230 radioactivity in soil is 5 pCi/g above background when distributed within the first 15 cm (6 in.) of surface soil and 15 pCi/g for any 15-cm (6-in.) layer below the surface layer (Table 1-1). The guideline for uranium-238 in soil is currently being developed but was assumed to be 50 pCi/g for the purposes of this report. In addition to the individual radionuclide guideline, the sum of the ratios of the soil concentration (minus background of each radionuclide) to the allowable limit for that radionuclide cannot exceed 1 ("unity"). If a "less than" value is reported, the concentration of the radionuclide is assumed to be that value during data evaluation (e.g., <3.0 pCi/g is assumed to be 3.0 pCi/g).

TABLE 3-3

RADIONUCLIDE CONCENTRATIONS IN SOIL

AT THE CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY[a]

Hole I.D.	Coordinates East	Coordinates North	Depth (ft)	Concentration[b] Uranium-238	Radium-226	Thorium-232	Thorium-230
A	3050.0	1100.0	0.0 - 0.5	35.0 ± 8.0	8.0 ± 2.0	<2.0	450.0 ± 10.0
B	3050.0	1150.0	0.0 - 0.5	23.0 ± 8.0	5.0 ± 1.0	2.0 ± 1.0	110.0 ± 10.0
C	3070.0	1082.0	0.0 - 0.5	<21.0	6.0 ± 1.0	<1.0	55.0 ± 3.0
D	3084.0	1100.0	0.0 - 0.5	18.0 ± 8.0	9.0 ± 1.0	1.6 ± 0.8	150.0 ± 10.0
E	3100.0	1050.0	0.0 - 0.5	<11.0	4.0 ± 1.0	1.6 ± 0.9	11.0 ± 1.0
F	3100.0	1100.0	0.0 - 0.5	22.0 ± 11.0	4.0 ± 1.0	3.0 ± 1.0	33.0 ± 2.0
G	3100.0	1250.0	0.0 - 0.5	34.0 ± 6.0	6.0 ± 1.0	<1.0	36.0 ± 2.0
H	3100.0	1300.0	0.0 - 3.5	55.0 ± 12.0	4.0 ± 1.0	2.0 ± 1.0	110.0 ± 10.0
I	3100.0	1350.0	0.0 - 0.5	40.0 ± 14.0	6.0 ± 1.0	2.0 ± 1.0	17.0 ± 2.0
J	3100.0	1400.0	0.0 - 0.5	120.0 ± 20.0	6.0 ± 1.0	2.0 ± 1.0	7.0 ± 0.8
K	3119.0	1300.0	0.0 - 0.5	9.0 ± 4.0	3.6 ± 0.8	2.0 ± 1.0	18.0 ± 1.0
L	3133.0	1200.0	0.0 - 0.5	< 9.0	2.0 ± 0.6	<1.0	9.5 ± 1.0
M	3150.0	1300.0	0.0 - 0.5	35.0 ± 10.0	6.0 ± 1.0	3.0 ± 1.0	6.6 ± 1.0
N	3150.0	1350.0	0.0 - 0.5	<15.0	2.6 ± 0.8	1.0 ± 1.0	10.0 ± 2.0
O	3150.0	1500.0	0.0 - 0.5	12.0 ± 10.0	4.0 ± 1.0	2.0 ± 1.0	3.6 ± 1.1
P	3150.0	1550.0	0.0 - 0.5	33.0 ± 11.0	3.0 ± 1.0	2.3 ± 0.9	12.0 ± 1.0
Q	3154.0	1500.0	0.0 - 0.5	4.0 ± 3.0	2.6 ± 0.6	1.4 ± 0.9	6.5 ± 0.8
R	3168.0	1400.0	0.0 - 0.5	18.0 ± 8.0	2.1 ± 0.8	<1.0	15.0 ± 2.0
S	3189.0	1700.0	0.0 - 0.5	<19.0	1.5 ± 1.3	<1.0	2.0 ± 0.4
T	3203.0	1600.0	0.0 - 0.5	<10.0	1.5 ± 0.6	<1.0	5.4 ± 1.1
U	3224.0	1900.0	0.0 - 0.5	14.0 ± 7.0	4.8 ± 1.0	0.9 ± 0.7	4.6 ± 1.3
V	3238.0	1800.0	0.0 - 0.5	< 8.0	1.7 ± 0.7	<1.0	3.2 ± 0.5
W	3245.0	1974.0	0.0 - 0.5	<14.0	3.0 ± 1.0	<1.0	2.6 ± 0.5
X	3259.0	2100.0	0.0 - 0.5	< 8.0	2.5 ± 0.7	2.0 ± 1.0	1.9 ± 0.4
Y	3273.0	2000.0	0.0 - 0.5	< 9.0	0.9 ± 0.5	<1.0	2.7 ± 0.5

[a]Soil sampling locations shown in Figure 2-2.

[b]Concentrations shown in pCi/g ± 2 sigma.

On the Chicago, Burlington, and Quincy Railroad property, 20 of the 25 samples exhibited radionuclide concentrations above federal guidelines. Sample results that exceeded cleanup guidelines were generally found at locations on the southern two-thirds of the area surveyed.

3.3 GAMMA LOGS

The results of the gamma logs are shown in Table 3-4 and have been rounded to the nearest thousand. These logs were used as gross indicators of radioactivity. Because the holes were not of sufficient size to use the typical downhole gamma radiation detection probe, an unshielded probe was used. There is no direct correlation between cpm and pCi/g available for this particular probe.

Although no correlation between radionuclide concentrations and gamma logging data is available, the gamma logging data obtained from other properties where the SPA-3 probe was used indicate that readings above 40,000 cpm may be associated with areas of subsurface radioactivity above cleanup guidelines. This opinion is based on a comparison of the SPA-3 gamma logging data to soil sample results from the other properties.

Eleven of the 25 sampled holes on the Chicago, Burlington, and Quincy Railroad property were gamma logged. The gamma-emitting daughters of the radionuclides of interest provided instrument responses up to 43,000 cpm. This value is greater than 40,000 cpm, which, as described above, may indicate subsurface radioactivity above cleanup guidelines. Section 3.2 substantiates this observation, in that the 11 holes that were gamma logged had samples containing radionuclide concentrations above guidelines for residual radioactivity in soil. Based on these results, additional subsurface investigations may be necessary to determine if subsurface contamination is present on the Chicago, Burlington, and Quincy Railroad property.

TABLE 3-4

RESULTS OF DOWNHOLE GAMMA LOGGING AT THE

CHICAGO, BURLINGTON, AND QUINCY RAILROAD PROPERTY

Hole I.D.	Coordinates[a] East	North	Depth (ft)	Counts per Minute
D	3084.0	1100.0	0.0	27,000
			0.5	43,000
			1.0	32,000
			2.0	23,000
			3.0	11,000
K	3119.0	1300.0	0.0	17,000
			0.5	21,000
			1.0	21,000
			2.0	16,000
			3.0	6,000
L	3133.0	1200.0	0.0	8,000
			0.5	10,000
			1.0	16,000
			2.0	20,000
			3.0	18,000
Q	3154.0	1500.0	0.0	9,000
			0.5	16,000
			1.0	24,000
			2.0	25,000
			3.0	16,000
R	3168.0	1400.0	0.0	9,000
			0.5	14,000
			1.0	13,000
			2.0	19,000
			3.0	20,000
S	3189.0	1700.0	0.0	16,000
			0.5	17,000
			1.0	15,000
			2.0	11,000
			3.0	13,000

TABLE 3-4

(continued)

Hole I.D.	Coordinates[a] East	North	Depth (ft)	Counts per Minute
T	3203.0	1600.0	0.0	8,000
			0.5	10,000
			1.0	14,000
			2.0	18,000
			3.0	16,000
U	3224.0	1900.0	0.0	11,000
			0.5	17,000
			1.0	13,000
			2.0	9,000
			3.0	-b-
V	3238.0	1800.0	0.0	8,000
			0.5	10,000
			1.0	12,000
			2.0	11,000
			3.0	12,000
X	3259.0	2100.0	0.0	10,000
			0.5	15,000
			1.0	14,000
			2.0	14,000
			3.0	18,000
Y	3273.0	2000.0	0.0	8,000
			0.5	12,000
			1.0	15,000
			2.0	17,000
			3.0	17,000

[a]Locations shown in Figure 2-2.

[b]Auger refusal at 2-ft depth.

4.0 SIGNIFICANCE OF FINDINGS

As a result of the limited radiological survey conducted at the Chicago, Burlington, and Quincy Railroad property in St. Louis, Missouri, it has been determined that residual radioactivity is present in excess of DOE guidelines. Contamination was found to be primarily on the southern two-thirds of the area surveyed.

Although radioactivity is present in concentrations above guidelines, the concentrations are low. Given the use of the property, the radioactivity does not represent a health hazard to workers on the Chicago, Burlington, and Quincy Railroad property.

This limited radiological survey may result in the need for additional work on the Chicago, Burlington, and Quincy Railroad property. Additional actions that are determined to be necessary will be addressed during the overall evaluation of SLDS.

REFERENCES

1. Ford, Bacon, and Davis Utah, Inc. Preliminary Engineering and Environmental Evaluation of the Remedial Action Alternatives for the Mallinckrodt, Inc. Site, Salt Lake City, UT, December 1981.

2. Oak Ridge National Laboratory. Radiological Survey of the Mallinckrodt Chemical Works, St. Louis, Missouri, DOE/EV-0005/27, ORNL-5715, Oak Ridge, TN, December 1981.

3. U.S. Department of Energy. Radiation Protection of the Public and the Environment. DOE Order 5400.3, Washington, D.C., October 10, 1988.

4. Meeting notes, Liedle, S. (BNI) to Distribution. Notes from SLDS Meeting on 1/18/89, CCN 059899, Oak Ridge, TN, March 15, 1989.

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