OCT 07 1985

Docket No. 40-7455 License No. SMA-1018

Whittaker Corporation
ATTN: Sol Spiller
Manager, Capital Assets
10880 Wilshire Boulevard
Los Angeles, California 90024-9990

Gentlemen:

Subject: Greenville, Pennsylvania Site

Enclosed are final reports of the recent surveys by our contractor at your facility in Greenville, Pennsylvania.

In accordance with 10 CFR 2.790(a), a copy of this letter and the enclosures will be placed in the Public Document Room.

Your cooperation with us in this matter is appreciated.

Sincerely,

John D. Kinneman, Chief
Nuclear Materials Safety Section A,
Division of Radiation Safety
and Safeguards

Enclosures:
1. Confirmatory Radiological Survey of the Former Whittaker Metals Corporation Property, Greenville, Pennsylvania, November 1984.

2. Followup Survey Findings Former Whittaker Metals Corporation Property, Greenville, Pennsylvania, December 18, 1984.

cc w/encl:
Public Document Room (PDR)
Nuclear Safety Information Center (NSIC)
Commonwealth of Pennsylvania

Greenville Metals, Inc.
ATTN: M. Bock
President
P.O. Box 671
Greenville, PA 16125

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Kinneman
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Prepared by
Oak Ridge Associated
Universities

Prepared for
Division of Fuel
Cycle and
Material Safety

U.S. Nuclear
Regulatory
Commission

CONFIRMATORY RADIOLOGICAL SURVEY OF THE FORMER WHITTAKER METALS CORPORATION PROPERTY GREENVILLE, PENNSYLVANIA

M. R. LANDIS

Radiological Site Assessment Program
Manpower Education, Research, and Training Division

FINAL REPORT

November 1984

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CONFIRMATORY RADIOLOGICAL SURVEY
OF THE
FORMER WHITTAKER METALS CORPORATION PROPERTY
GREENVILLE, PENNSYLVANIA

Prepared for

Division of Fuel Cycle and Material Safety
U. S. Nuclear Regulatory Commission

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FINAL REPORT

November 1984

This report is based on work performed under Interagency Agreement DOE No. 40-770-80 NRC Fin. No. 9093-0 between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy. Oak Ridge Associated Universities performs complementary work under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

*DOE Health Physics Fellowship student, University of Kansas, Lawrence, Kansas.

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CONFIRMATORY RADIOLOGICAL SURVEY
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GREENVILLE, PENNSYLVANIA

INTRODUCTION

Beginning in the 1960's, the Greenville, PA, firm of Mercer Alloys, a predecessor of Whittaker Metals Corporation, produced ferro-columbian and ferro-nickel alloys by an aluminathermic melting process. Columbian ores and nickel scrap used in this operation contained licensable concentrations of source material of up to approximately 2% thorium. Process slag containing thorium was retained onsite. Estimates prepared by Westinghouse Electric Corporation indicate from 1.55 to 1.72×10^4 m^3 of this slag remain on the property; some of the slag material has thorium concentrations of up to 1 to 2% by weight.[1] Natural and depleted uranium were unwanted contaminants of some of the metal scrap, and slags containing low levels of uranium contamination are present on the site. Elevated concentrations of Ra-226 have also been noted in these waste materials.

By early 1974, Whittaker had terminated operations involving licensable material. The property was sold to Exomet Inc. in late 1974, with Whittaker retaining responsibility for source materials on the premises. Beginning in July 1974, Applied Health Physics conducted a radiological survey of the property which identified areas exceeding the radionuclide contamination levels for unrestricted release. Decontamination was performed and portions of the site were certified by Applied Health Physics in June 1975 as acceptable for release for unrestricted use.[2] In 1983, Radiation Management Corporation conducted a radiological survey of an additional section of the property, and this area was decontaminated also.[3] Westinghouse Environmental Systems and Energy Impact Associates have also served as consultants to Whittaker on a variety of issues concerning the site's radiological status. Contaminated equipment, rubble, and slag removed during decontamination have been relocated to the vicinity of the slag piles along the eastern portion of the site.

As a result of the previous operations, decontamination efforts and surveys, the property has been divided into two radiologically different areas: the area of slag and contaminated rubble storage and an area actively in use by Air Products and Chemical Corporation. This latter area is the subject of this report.

SITE DESCRIPTION

The former Whittaker Corporation site is located on Crestview Drive in the Reynolds Development, approximately 6 km south of Greenville, PA. The plant occupies about 16 hectares. It is bounded on the north by rail lines and spur tracks, on the west by Crestview Drive, and on the east by the Shenango River (see Figure 1). The area proposed for release is bounded on the east by the slag pile (see Figure 2). There are eight major buildings on the property, including a large warehouse orginally constructed as part of a World War II army supply base and several recently constructed smaller support facilities.

SURVEY PROCEDURES

At the request of the U.S. Nuclear Regulatory Commission's Division of Fuel Cycle and Material Safety, a confirmatory survey of the Air Products portion of the former Whittaker Corporation site was performed by the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU). The survey was conducted during the period of June 11-29, 1984. This section describes the survey objective and the procedures followed.

Objective

The objective of the ORAU survey was to confirm the radiological data developed by Applied Health Physics, Inc., Radiation Management Corporation, Westinghouse Environmental Systems, and Energy Impact Associates (EIA) for comparison with the NRC guidelines for release of the site for unrestricted use. Radiological information collected included:

1. direct radiation exposure rates;
2. locations of elevated surface residues;
3. concentrations of radionuclides in surface and subsurface soil;
4. concentrations of radionuclides in surface water and drainage systems on the property;
5. concentrations of radionuclides in residues from trenches and drains; and
6. levels of fixed and removable surface contamination on building surfaces.

Procedures

Outside Land Areas

1. A 40 m grid system was established by E.A. Winslow and Associates of Sharpsville, PA., under contract to EIA. The grid is shown on Figure 2.

2. Walkover surface scans were conducted at 1-2 m intervals over all accessible areas of the property. Portable gamma scintillation survey meters were used for these scans. Locations of elevated contact radiation levels were noted (see Figure 3).

3. Gamma exposure rate measurements were made at the surface and at 1 m above the surface at 40 m grid intervals and grid block centers, where accessible. Measurements were performed using portable gamma NaI (Tl) scintillation survey meters. Conversion of these measurements to exposure rates in microroentgens per hour ($\mu R/h$) was in accordance with cross calibration with a pressurized ionization chamber.

4. Surface (0-15 cm) soil samples of approximately 1 kg each were collected at 40 m grid intervals and grid block centers where accessible.

5. Surface soil samples were obtained at selected locations representative of the areas of elevated surface readings.

6. Removal of the sources of radiation was attempted at all locations by EIA contracted personnel. Surface exposure rates were measured before and after removal to evaluate the effectiveness of these attempts.

7. Boreholes were drilled to provide a mechanism for logging subsurface direct radiation profiles and collecting subsurface soil samples (see Figure 4). Seventeen boreholes were drilled approximately 3 m deep by the Continental Drilling Company of New Alexandria, PA, using a truck-mounted 20 cm diameter hollow-stem auger. These holes were drilled at locations selected to be representative of the average property conditions and several areas of potential contaminated slag deposits. A gamma scan of the boreholes was performed to identify elevated radiation levels, which would indicate subsurface residues. Radiation profiles in the boreholes were determined by measuring gamma radiation at 30 cm intervals between the surface and the hole bottom. A collimated gamma scintillation detector and portable scaler were used for these measurements. Soil samples of approximately 1 kg each were collected from various depths in the holes by scraping the sides of each borehole with an ORAU designed sampling tool.

   Six shallow (∿1m) holes were dug with a posthole digger in the swamp area. Gamma logging was performed with a NaI scintillation survey meter. Soil samples were collected as described above.

Building Interiors

1. Interior building surfaces were not gridded since there was no indication that residual contamination approached guideline levels. Maps were drawn of each building showing prominent building features and locations of interior surface measurements were referenced to these features.

2. Walkover scans using gamma scintillation detectors were performed at 1-2 m intervals throughout accessible areas of buildings. Locations where residue might settle were given special attention. Locations of elevated areas were noted.

3. Exposure rates were measured at 1 m above the floor surface at locations throughout the buildings. At least one measurement per 100 m^2 was performed.

4. Direct measurements of alpha and beta-gamma contamination were performed on the floors, walls and ceiling. At least one measurement per 100 m^2 was performed on floors and lower walls and at least one measurement per 300 m^2 was performed on upper walls and ceilings.

5. Smears for transferable alpha and beta contamination were obtained at locations of direct measurements described above.

6. Soil samples were collected from buildings where either the floors had been excavated or concrete flooring had never existed. Samples from trenches were collected where possible.

7. Water was collected from the trench as in the High Temp, and Benefco buildings and from a pit in the Old Melt Shop.

Additional Measurements and Sampling

1. Exposure rates were measured at the surface and 1 m above the surface at 100-200 m intervals around the site perimeter.

2. Surface soil samples were collected at locations of exposure rate measurements described above.

3. Walkover scans were conducted in accessible areas within 10 meters of the site perimeter and along access roads and railroad lines to at least 50 m beyond the site perimeter.

4. Three soil samples and three water samples were collected from the Greenville area to provide baseline concentrations of radionuclides for comparison purposes. Direct background radiation levels were measured at locations where baseline soil samples were collected. The locations of the baseline samples and background measurements are shown on Figure 5.

Sample Analysis and Interpretation of Results

Soil samples were analyzed by gamma spectrometry. Radionuclides of primary interest were Th-232, Th-228, U-235, U-238, and Ra-226; however, spectra were reviewed for other gamma emitters. Water was analyzed for gross alpha and gross beta concentrations.

Additional information concerning analytical equipment and procedures is contained in Appendix A.

RESULTS

Background Levels and Baseline Concentrations

Background exposure rates and baseline radionuclide concentrations in soil, determined for three locations (Figure 5) in the vicinity of the former Whittaker Corporation site are presented in Table 1-A. Exposure rates ranged from 9.2 to 10.1 μR/h (typical for this area of Pennsylvania). Concentrations of radionuclides in soil were: Th-232, 0.58 to 1.15 pCi/g (picocuries per gram); Th-228, 0.51 to 0.98 pCi/g; U-235, <0.14 to 0.25 pCi/g; U-238, <0.65 to 1.46 pCi/g; Ra-226, 0.64 to 0.84 pCi/g. These concentrations are typical of the radionuclide levels normally encountered in surface soils.

Radioactivity levels in baseline water samples are presented in Table 1-B. The gross alpha and beta concentrations ranged from 0.25 to 0.82 pCi/l (picocuries per liter) and 2.55 to 4.59 pCi/l, respectively. These are typical of concentrations normally occurring in surface water.

Direct Radiation Levels

Direct radiation levels measured at 40 m grid intervals and grid block the surface ranged from 7 to 32 μR/h (average 10 μR/h). The maximum exposure rate, 32 μR/h, was located at 340, D+18, which is near a pile of recently generated slag. Another elevated exposure rate of 28 μR/h was at 240,G in the drainage area. At surface contact the rates ranged from 6 to 53 μR/h (average 11 μR/h). The 53 μR/h contact measurement was also obtained at grid location 240,G.

Direct radiation levels measured at the site perimeter are presented in Table 3. The gamma exposure rates at 1 m above the surface ranged from 8 to 12 μR/h (average 10 μR/h). Contact gamma exposure rates ranged from 8 to 14 μR/h (average 11 μR/h).

The walkover survey identified five general areas and many small isolated spots having elevated surface radiation levels. These locations are indicated on Figure 3 and associated direct radiation levels are presented in Table 4. Contact gamma exposure rates ranged from 24 to 800 μR/h. The source of the radiation levels was pieces of slag, estimated to range in weight from 0.5 to 50 kg. An EIA subcontractor tried to remove the sources of elevated radiation at each identified location. Material was removed and placed in the waste area on the east side of the property. These areas were resurveyed as necessary to confirm that they had been adequately cleaned. In most cases, efforts to remove the source were successful; however, elevated radiation levels remain in the slag pile at the north end of the New Melt Shop and in some isolated spots in the

drainage area. These locations, indicated on Figure 6, have associated contact exposure rates up to 800 μR/h. Elevated direct radiation levels south of the Aluminathermic Building and along the road in that area were reduced to 16 to 24 μR/h by removal of a section of the roadway and an area between the road and the building.

Radionuclide Concentrations in Surface Soil

Table 5 presents the concentrations of radionuclides, measured in surface soil from 40 m grid intervals and grid block centers. Concentration ranges were: Th-232, 0.23 to 3.77 pCi/g; Th-228, 0.24 to 3.51 pCi/g; U-235, <0.11 to 0.56 pCi/g; U-238, <0.38 to 6.86 pCi/g; and Ra-226, 0.37 to 2.13 pCi/g. In the majority of the samples, the concentrations of these radionuclides do not differ significantly from those in the baseline samples.

Table 6 presents the concentrations of radionuclides in the surface soil samples from the site perimeter. Ranges are similar to those listed above.

Radionuclide concentrations in three samples of slag, collected from the recently generated slag pile, are presented in Table 7. The maximum concentrations were: Th-232, 307 pCi/g; Th-228, 258 pCi/g; U-238, <65.1 pCi/g; Ra-226, 9.19 pCi/g. The baseline level concentrations in the sample from grid location 363-365, D+38-40, indicates that this sample was from the source of elevated direct radiation level at this location. The actual source was probably below the sampled material. The sample at 436-445, C+20-25 was taken, after a concrete pad had been removed, to confirm that no contamination remained.

Borehole Gamma Logging Measurements

Borehole logging identified subsurface elevated radiation levels only in borehole 15. At that location the elevated radiation extended to 3 m below the surface. This borehole was in a section of the roadway which was

later removed during decontamination operations. The gamma logging data were not used to quantify radionuclide concentrations in the subsurface soil because of the varying ratios of Th-232, Th-228, U-235, U-238, and Ra-226 occurring in soils from this site.

Radionuclide Concentrations in Subsurface Soil

Table 8 presents the radionuclide concentrations measured in soil samples from boreholes. With the exception of borehole 15, none of the boreholes contained subsurface radionuclide concentrations significantly different from baseline soil concentrations. Maximum thorium concentrations were Th-232, 15.1 pCi/g, and Th-228, 15.3 pCi/g in the sample from 0.3 m deep in borehole 15. All material was eventually removed from this location during decontamination efforts and the area refilled with clean soil.

Building Interior Surveys

The walkover survey in the buildings identified several types of material with elevated surface contact levels. This material consisted of slag, fire brick and tile, scrap metal, test samples, and flue dust. Contact exposure rates associated with these materials was less than 100 μR/h. In many cases the materials remained from previous Whittaker operations; however, some scrap metal, intended for reprocessing, had been recently received by Air Products. With the exception of fire brick and crucibles, containing only naturally occurring levels of thorium, sources of the elevated direct radiation were removed from the Aluminathermic, Benefco, Cobalt, and Old Melt Shop buildings and relocated to the slag pile area.

Gamma exposure rates at 1 m above the floor were measured in all buildings after cleanup was completed. Table 9 presents the ranges of these values. Only the Aluminathermic Building had exposure rates exceeding 13 μr/h. The gamma scan of the south exit end of that building -

the section with a dirt floor - had identified several areas of elevated gamma radiation levels (see Figure 7). There were three locations where fire brick and crucibles containing radiation levels associated with these materials ranged from 16 to 34 μR/h. Seven small (<20 cm diameter) isolated spots were identified in Bays 1, 2, 3, and 4. The contact radiation levels at these locations ranged from 20 to 24 μR/h. Direct radiation levels at 1 m above the surface in the vicinity of the fire brick and crucibles were similar to those measured during the surface scan, i.e. 16-24 μR/h. At two of the isolated locations, identified by the walkover scan, the exposure rates one meter above the surface were 21.9 μR/h. The extent of these areas was very limited, with general exposure rates throughout the building being in the range of 10-12 μR/h.

Locations of surface contamination measurements are indicated on Figures 7 through 22. The results of surface contamination measurements are also summarized in Table 9. The highest level of total alpha contamination was 191 dpm/100 cm^2 - well below the guideline of 1000 dpm/100 cm^2, average, for natural thorium. Two floor locations in the Aluminathermic Building had total beta-gamma contamination levels above 3000 dpm/100 cm^2. These two locations measured 4826 and 3534 dpm/100 cm^2. The majority of the beta-gamma measurements were below 1000 dpm/100 cm^2. No areas of significant transferrable alpha or beta contamination were noted.

The radionuclide concentrations in soil samples from building floors are presented in Table 10. The samples from the Aluminathermic Building contained radionuclide concentrations above those in background soil. The ranges were: Th-232, 0.52 to 8.93 pCi/g; Th-228, 0.45 to 10.3 pCi/g; U-238, <0.49 to 7.29 pCi/g; and Ra-226, 0.09 to 9.65 pCi/g. The samples from Bays 2 and 3 (see Figure 7) contained total thorium of 14.6 pCi/g and 19.2 pCi/g. Sampling did not identify any discrete pieces of material which might be the source of the direct radiation; the soil at these locations was primarily a sandy clay. Radionuclide concentrations in samples from the remainder of the buildings were not significantly

different than those in baseline soil samples. Samples of residues from trenches in the Benefco and High Temp buildings were also in the range of baseline soil.

Radionuclide concentrations in materials collected at selected locations of elevated radiation, identified during the surface scan, are listed in Table 7. These samples contained concentrations of Th-232 and Th-228 up to several thousand times baseline soil levels. The highest level of thorium was in a piece of thoriated-nickel scrap, intended for recycling. The Th-232 concentration in this metal was 2190 pCi/g. Concentrations of other naturally occurring radionuclides were below the detection limits; the metal was also checked for contamination by other gamma emitters but none were detected. Two test samples from the Alloy Building contained Th-232 levels of 1610 pCi/g and lower levels of U-238 and Ra-226. Flue dust contained elevated levels of radionuclides from the uranium and thorium series, but at much lower concentrations than noted in the metal scrap and test samples.

<u>Radionuclide Concentrations in Water</u>

Water obtained from four of the buildings and the drainage area contained gross alpha and beta concentrations ranging from 0.43 to 2.72 pCi/l and 5.32 to 31.70 pCi/l, respectively (see Table 11). Although these levels were slightly above baseline levels they were well within the EPA drinking water criteria of 15 pCi/l and 50 pCi/l, respectively.

SUMMARY

A confirmatory radiological survey of a portion of the former Whittaker Corporation property was conducted at the request of the Nuclear Regulatory Commission. The purpose of the survey was to verify the adequacy of previous surveys and to evaluate whether the facility satisfies NRC guidelines for release from licensing.

Numerous isolated spots and five general areas of elevated direct surface radiation levels were detected. Most of these locations were eliminated by removal and relocation of slag material to the waste storage area on the eastern portion of the site. Several isolated locations in the drainage area and eight more extensive locations in a recently generated slag pile remain. Contact radiation levels up to 800 μR/h are associated with material in the slag pile. Soils from two floor areas in the Aluminathermic Building also contained elevated concentrations of thorium.

Isolated materials, including scrap metal, containing elevated thorium levels were noted in several of the buildings. These materials were also relocated to the waste storage area.

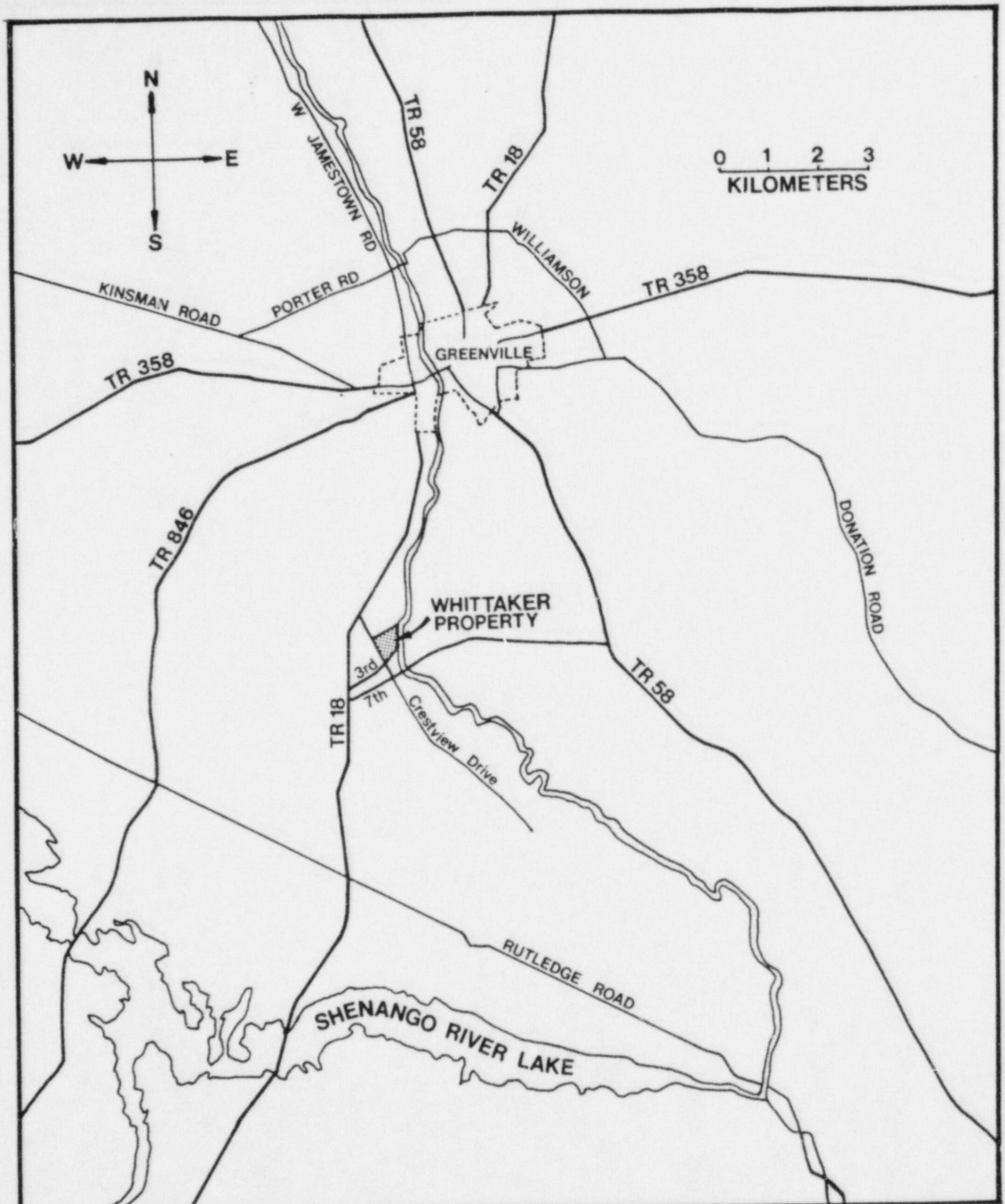

FIGURE 1: Map Indicating the Location of the Whittaker Site, Greenville, Pennsylvania

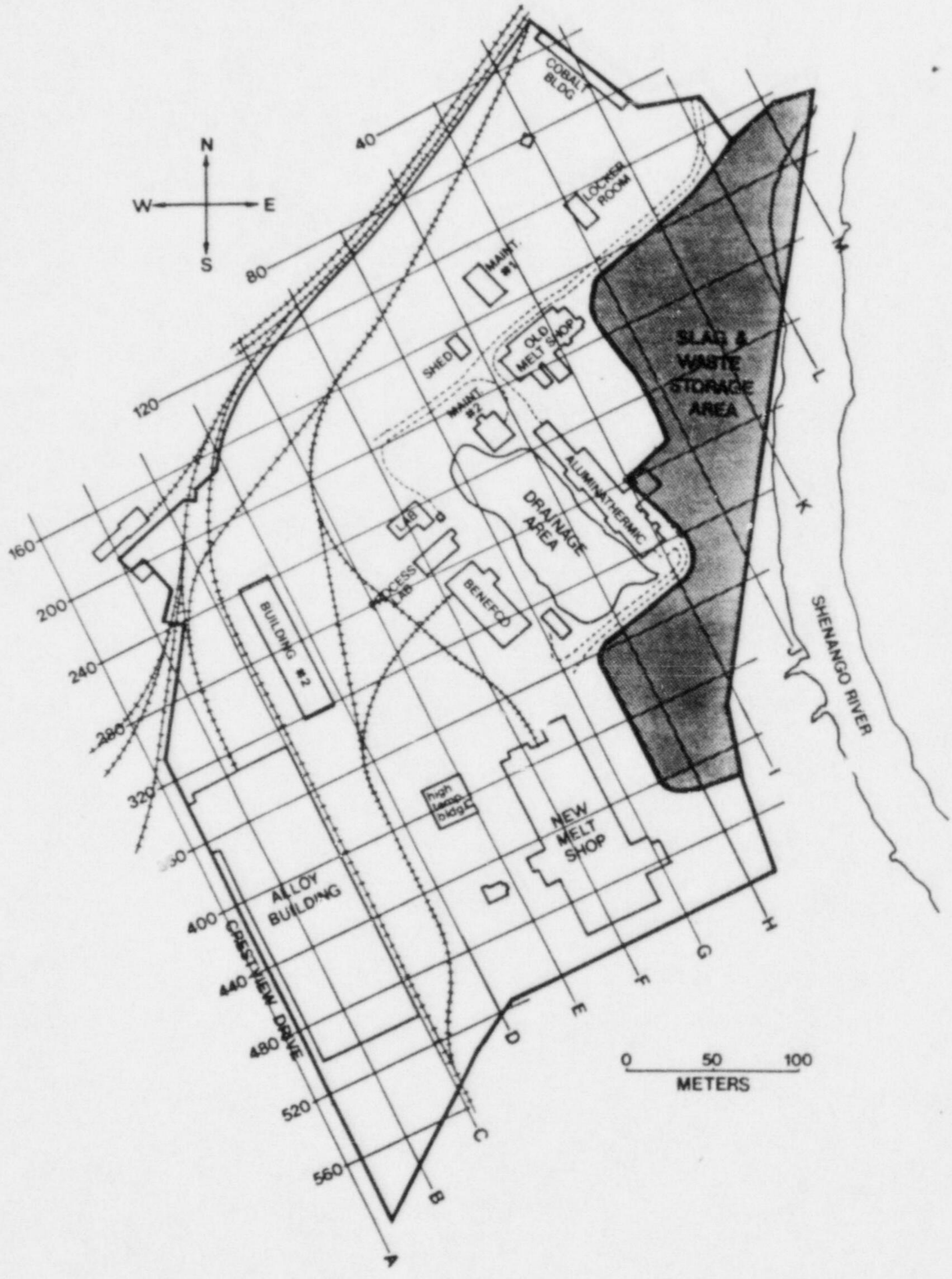

FIGURE 2: Map Indicating the Proposed Release Area Grid System for Reference of Survey Measurements

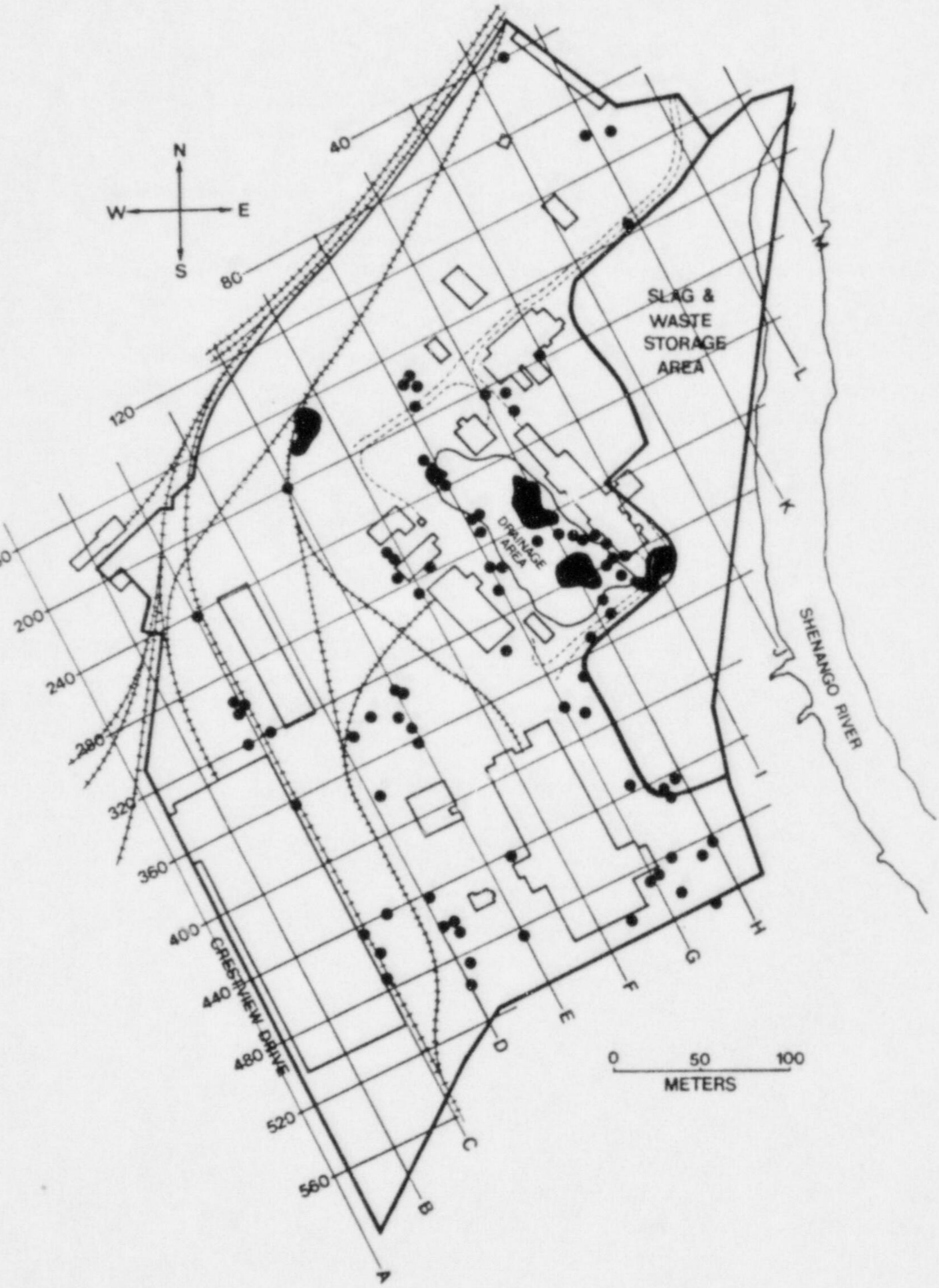

FIGURE 3: Locations of Areas of Elevated Direct Radiation Identified by Surface Gamma Monitoring

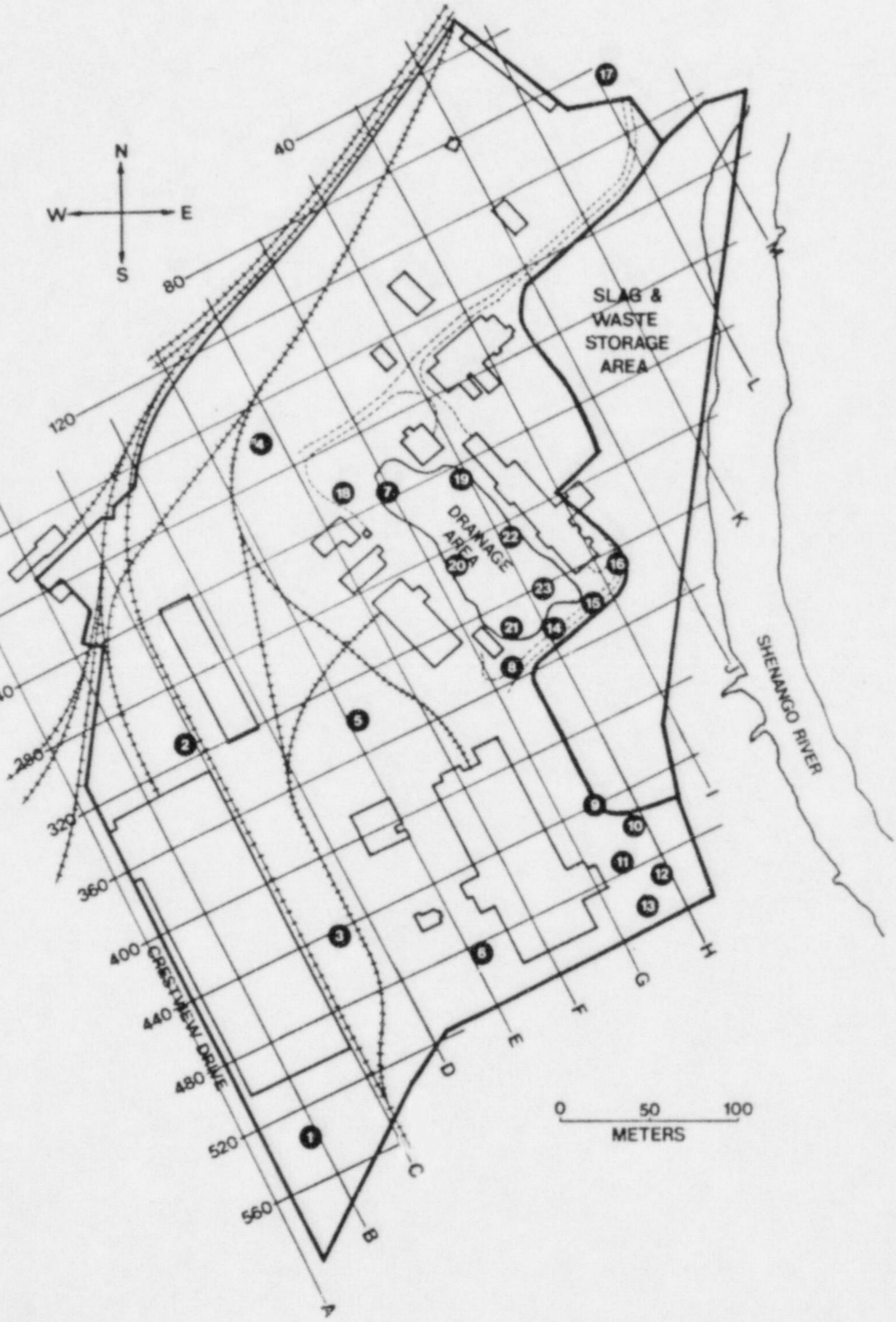

FIGURE 4: Locations of Boreholes for Subsurface Investigations

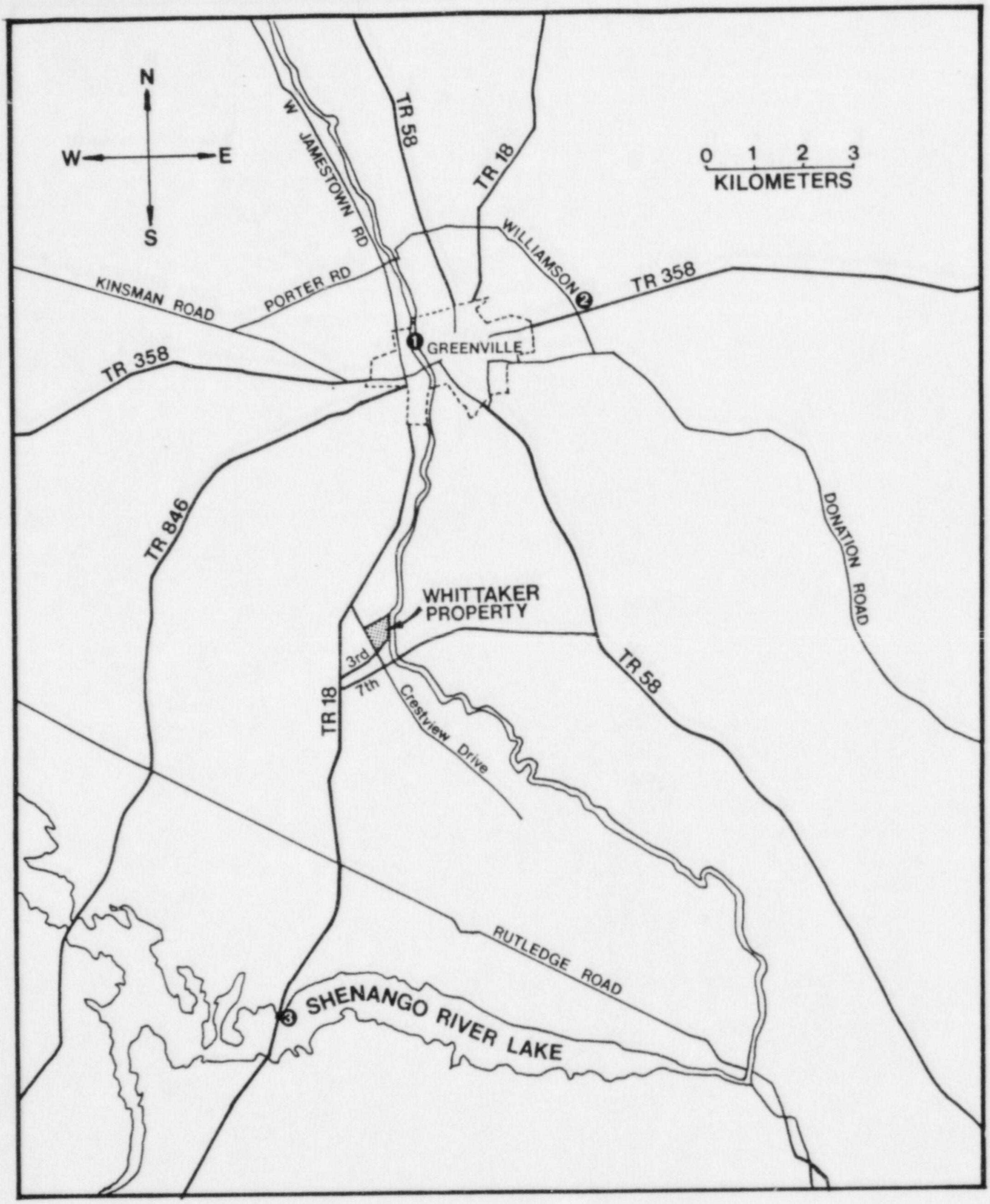

FIGURE 5: Map of Area Surrounding the Whittaker Site Showing Locations of Background Measurements and Baseline Samples.

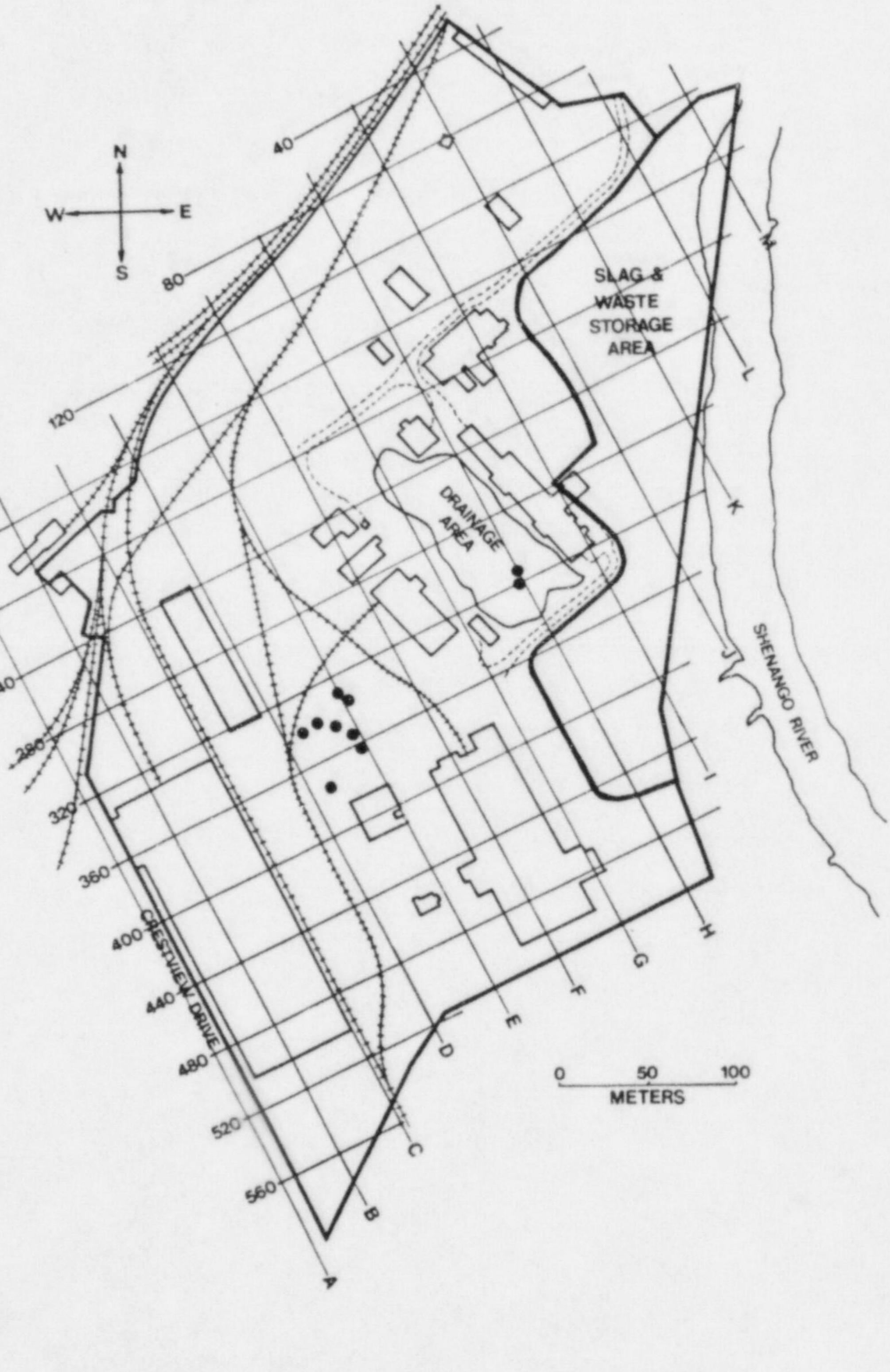

FIGURE 6: Locations of Areas of Elevated Direct Radiation After Decontamination.

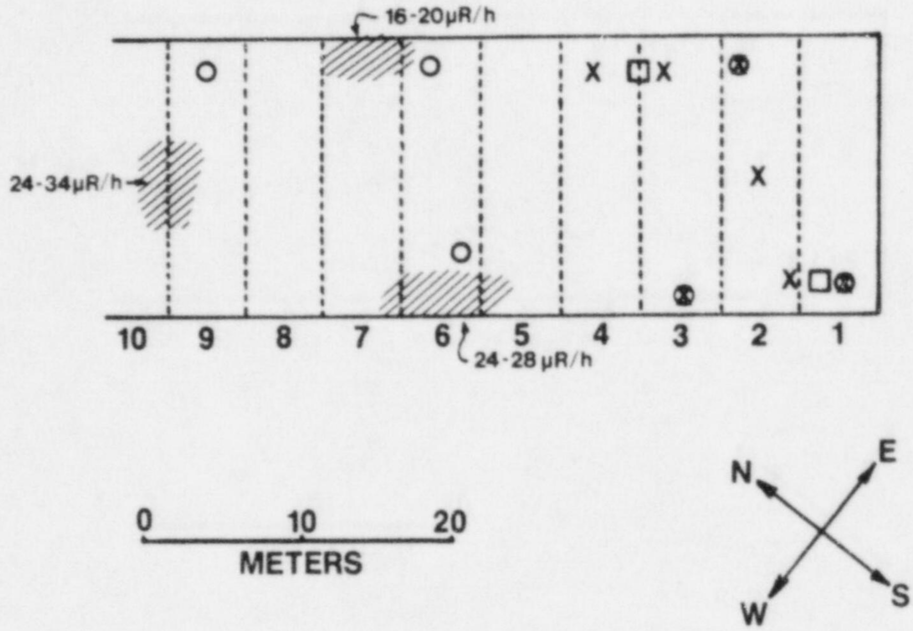

FIGURE 7: Floor Plan of a Portion of the Aluminathermic Building Indicating Locations of Elevated Gamma Radiation Levels and Soil Sampling Locations

X Isolated areas of elevated contact gamma radiation (20 - 24 μR/h).

□ Elevated gamma radiation (21.9 μR/h) at 1 m above the surface.

▨ Fire Brick and Crucibles

O Soil Sample Locations

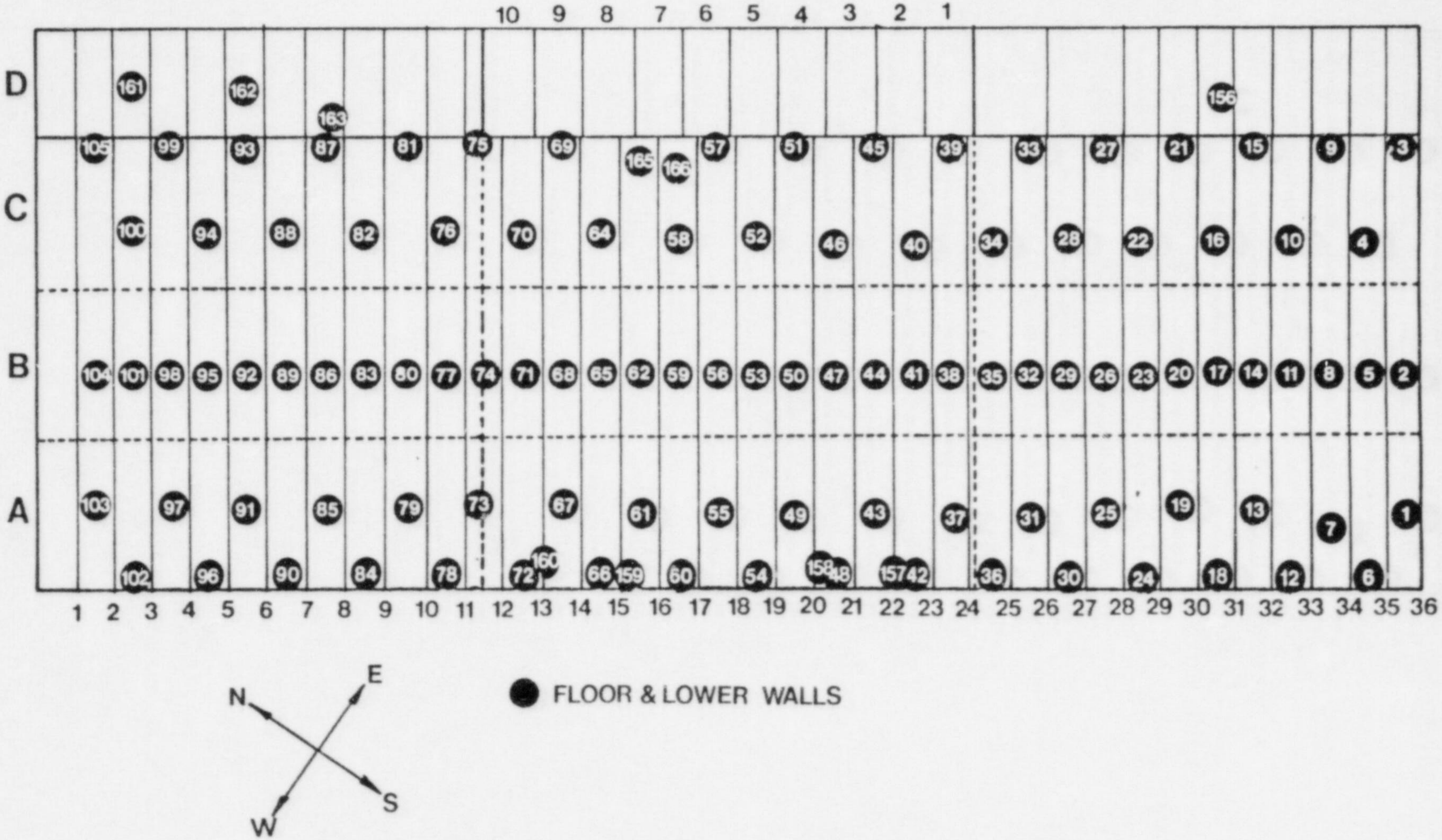

FIGURE 8A: Floor Plan of the Alloy Building Indicating Locations of Measurements and Smears (Floor and Lower Walls)

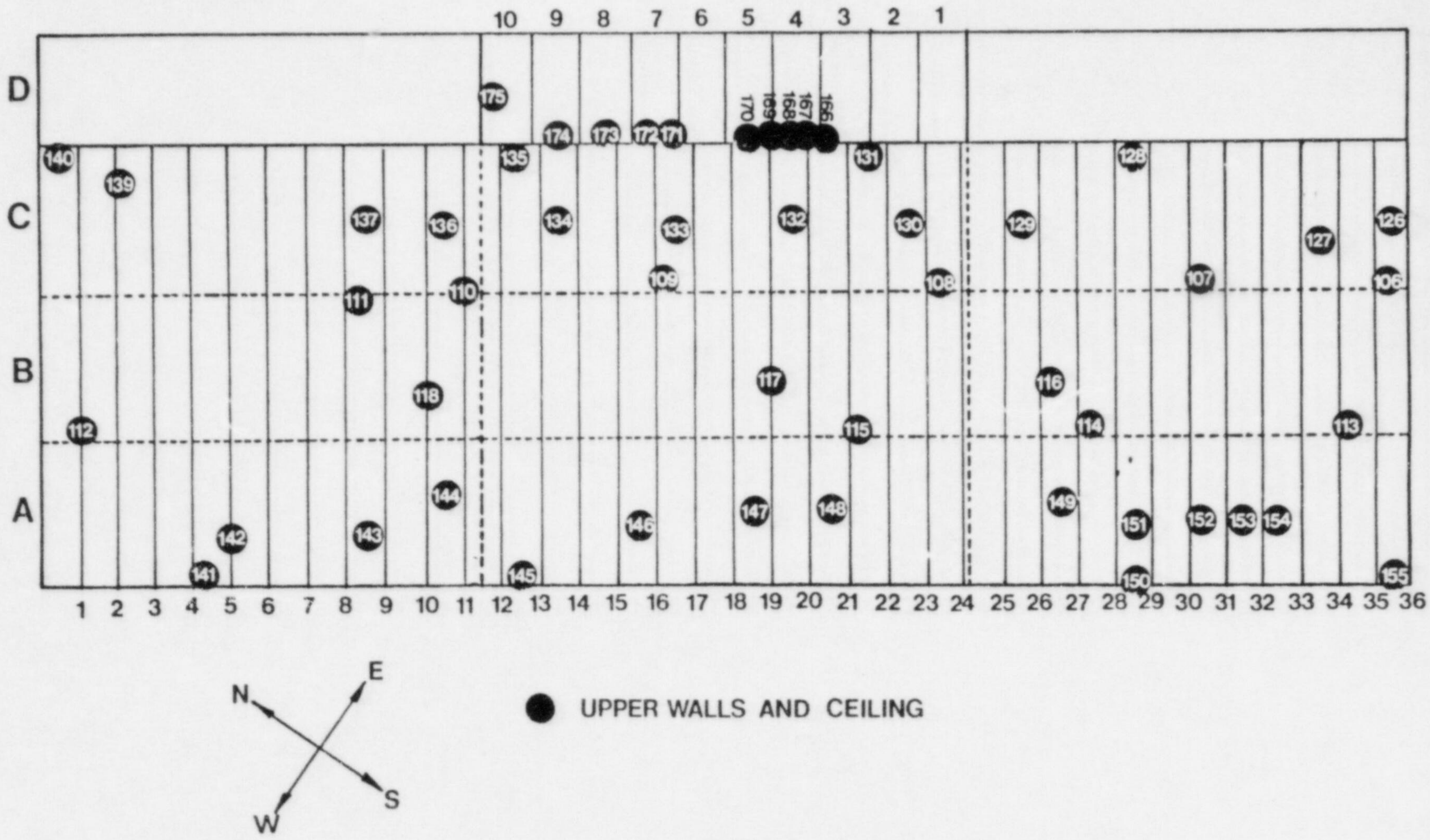

FIGURE 8B: Floor Plan of the Alloy Building Indicating Locations of Measurements and Smears (Upper Walls and Ceiling)

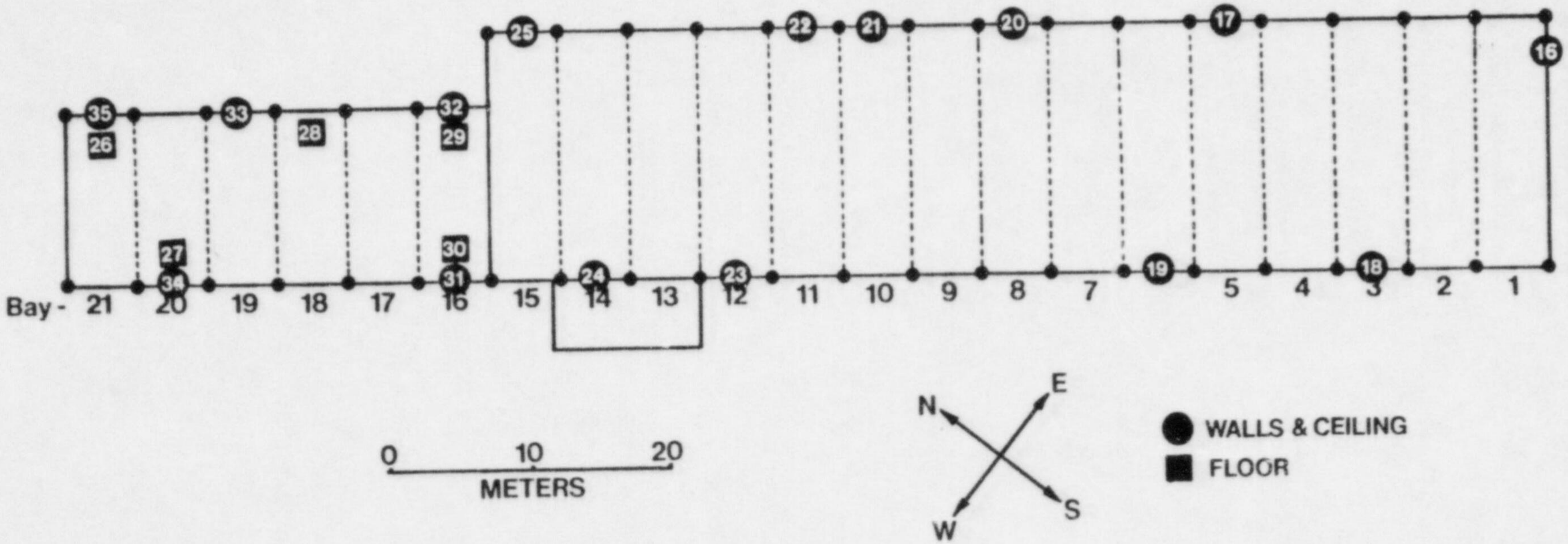

FIGURE 9: Floor Plan of the Aluminathermic Building Indicating Locations of Measurements and Smears

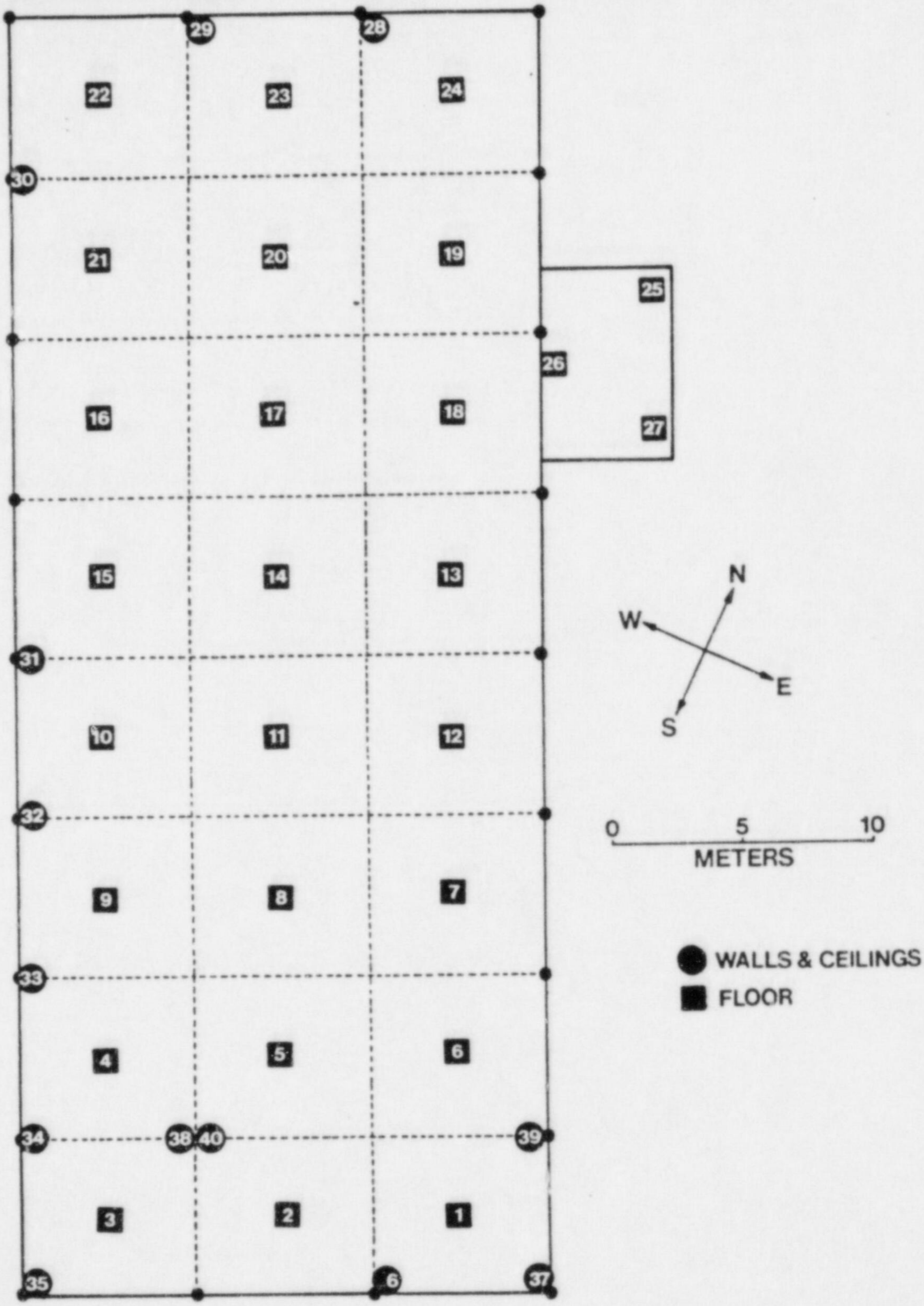

FIGURE 10: Floor Plan of the Benefco Building Indicating Locations of Measurements and Smears

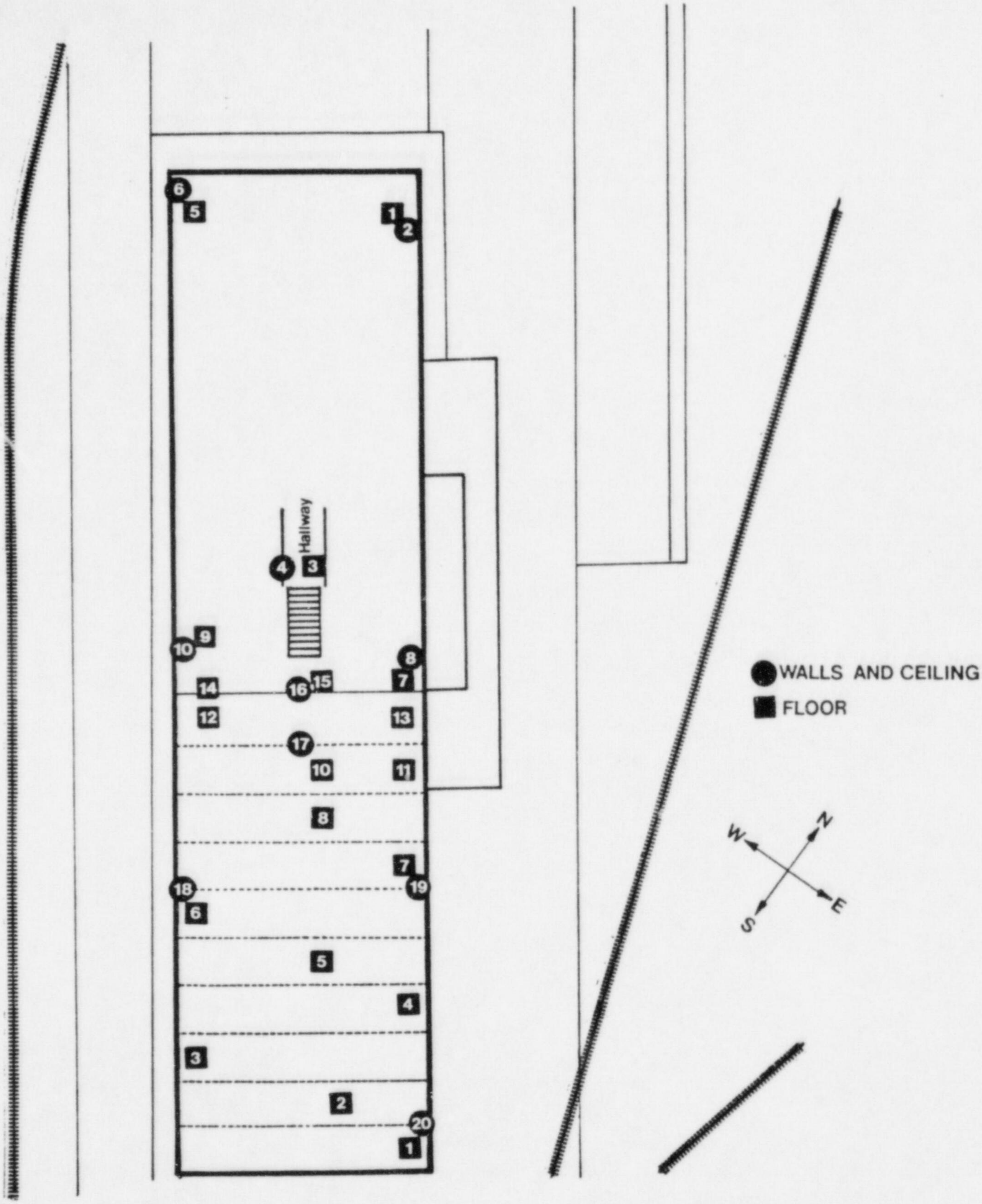

FIGURE 11: Floor Plan of Building No. 2 Indicating Locations of Measurements and Smears

(The north and south sections of this building were surveyed separately, accounting for survey locations numbers 1 through 10 being duplicated on this Figure.)

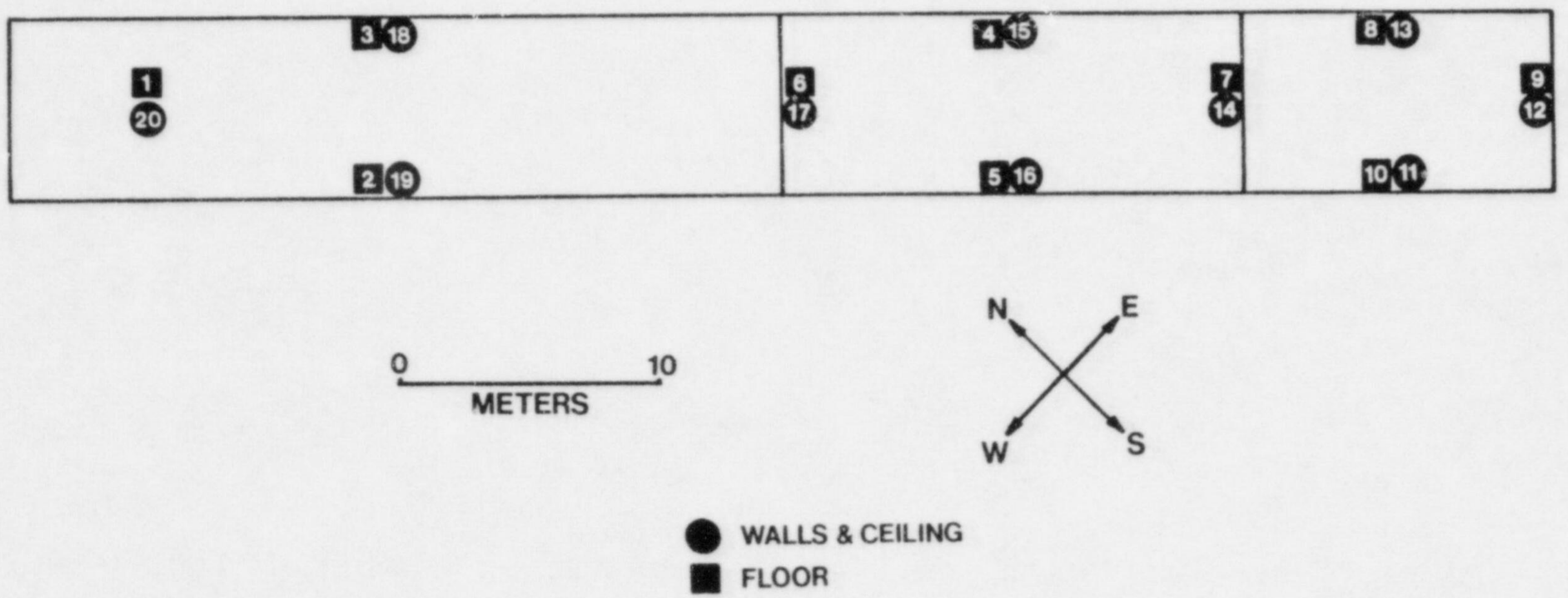

FIGURE 12: Floor Plan of the Cobalt Building Indicating Locations of Measurements and Smears

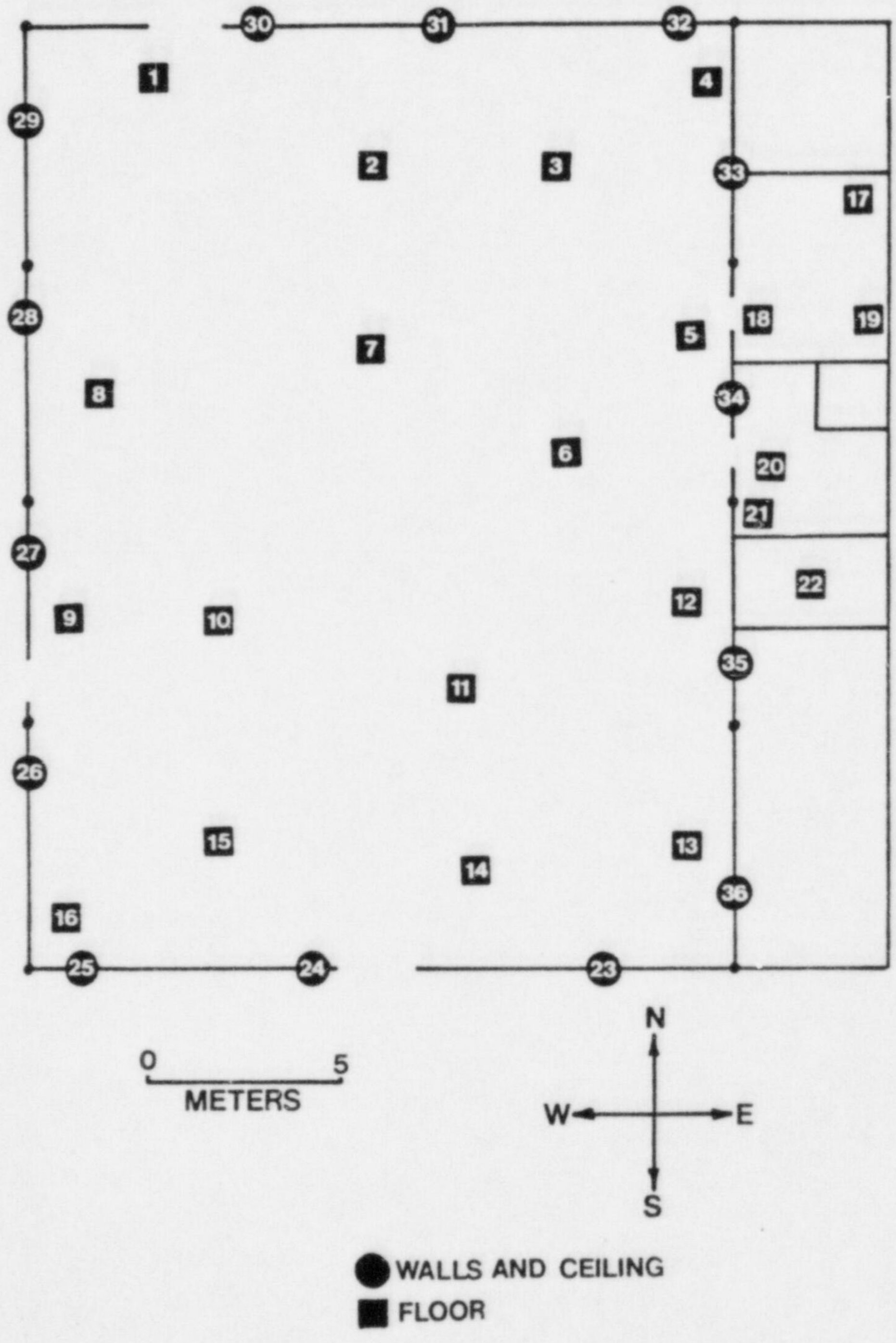

FIGURE 13: Floor Plan of the High Temp Building Indicating Locations of Measurements and Smears

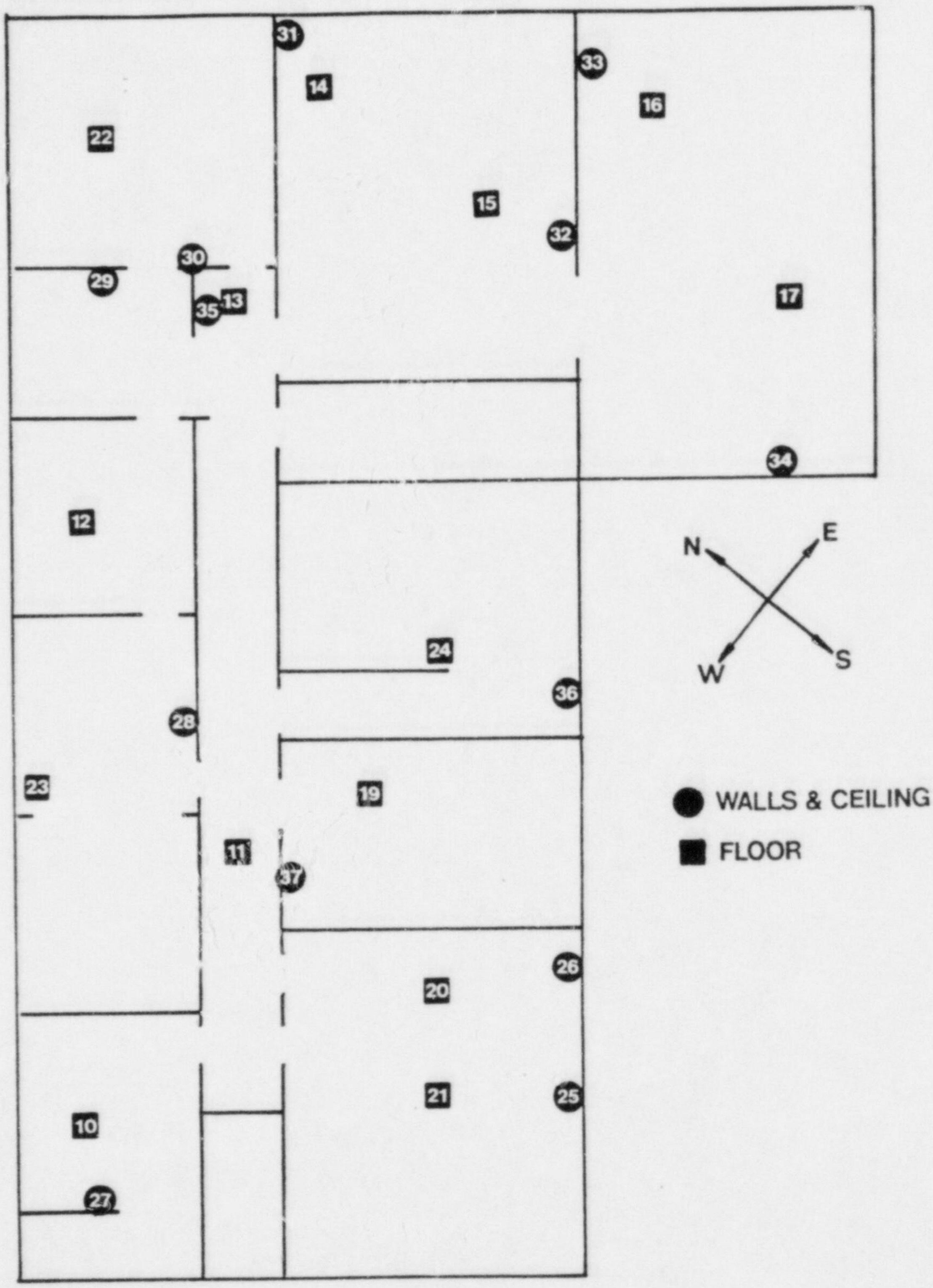

FIGURE 14: Floor Plan of the Lab Building Indicating Locations of Measurements and Smears

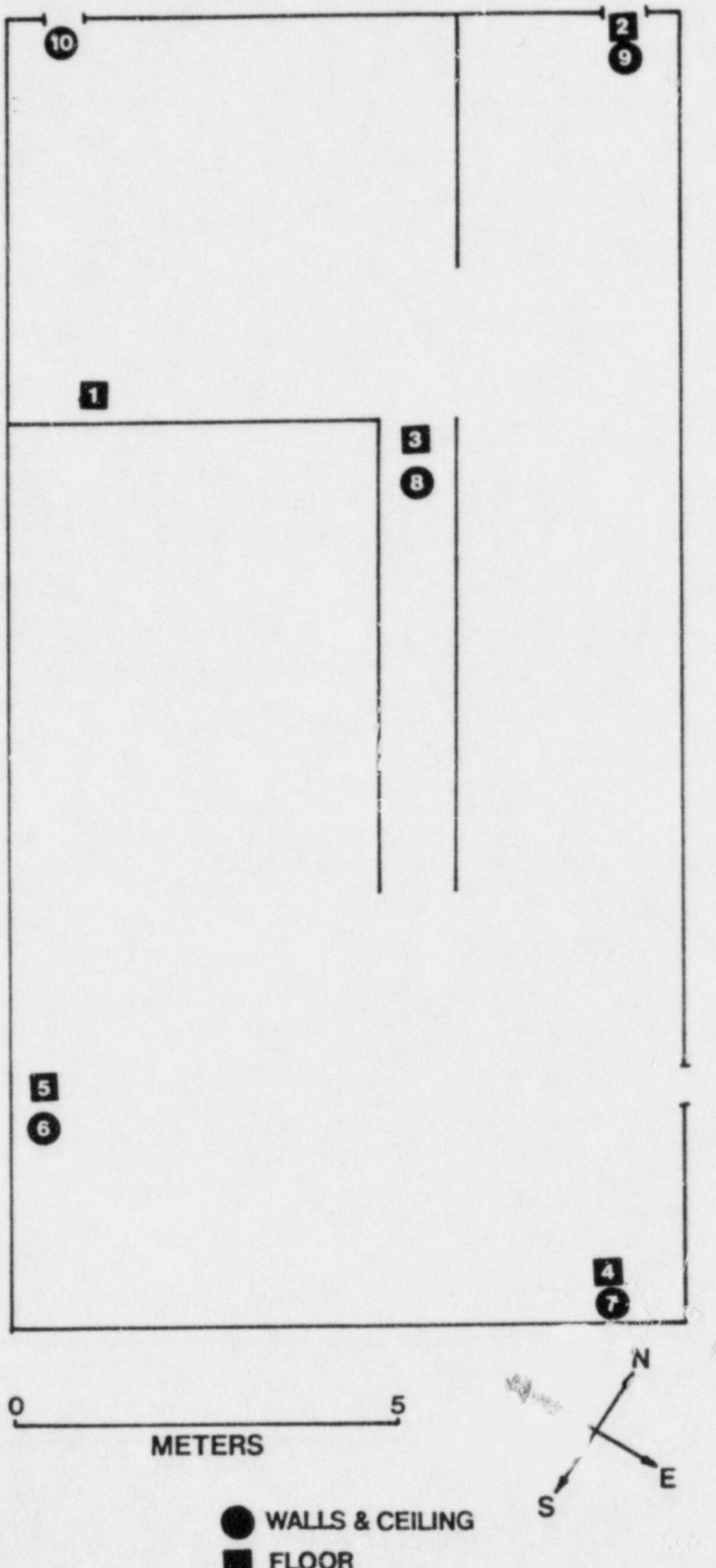

FIGURE 15: Floor Plan of the Locker Room Indicating Locations of Measurements and Smears

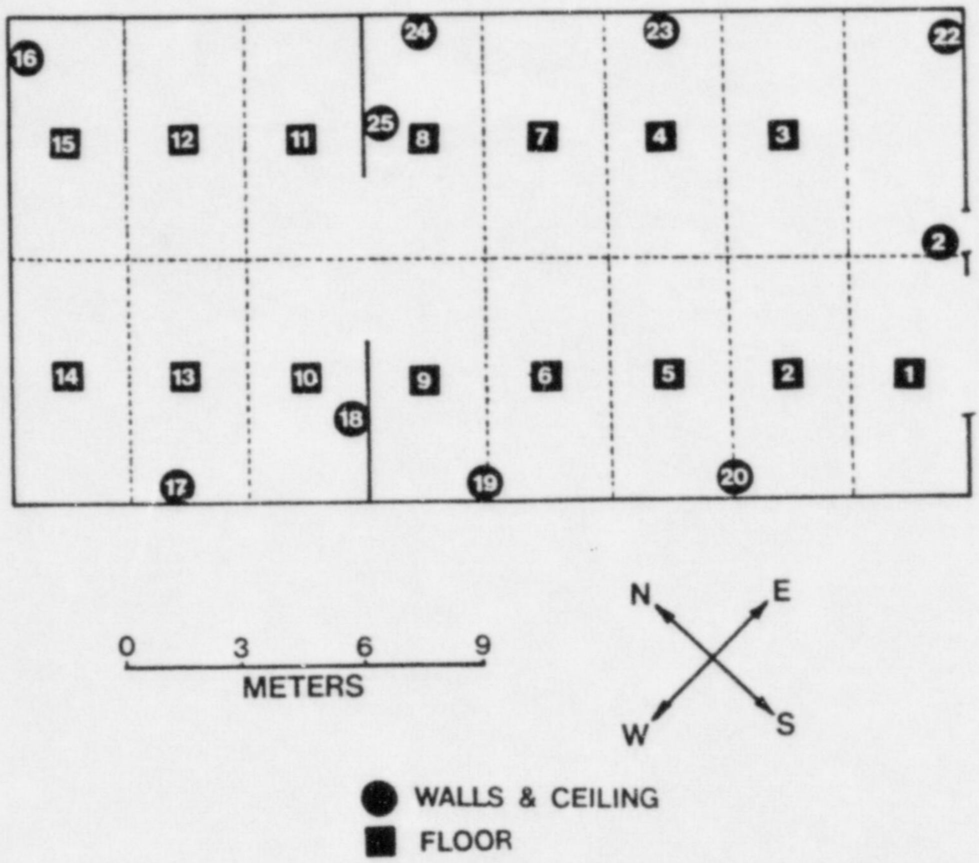

FIGURE 16: Floor Plan of the Maintenance I Building Indicating Locations of Measurements and Smears

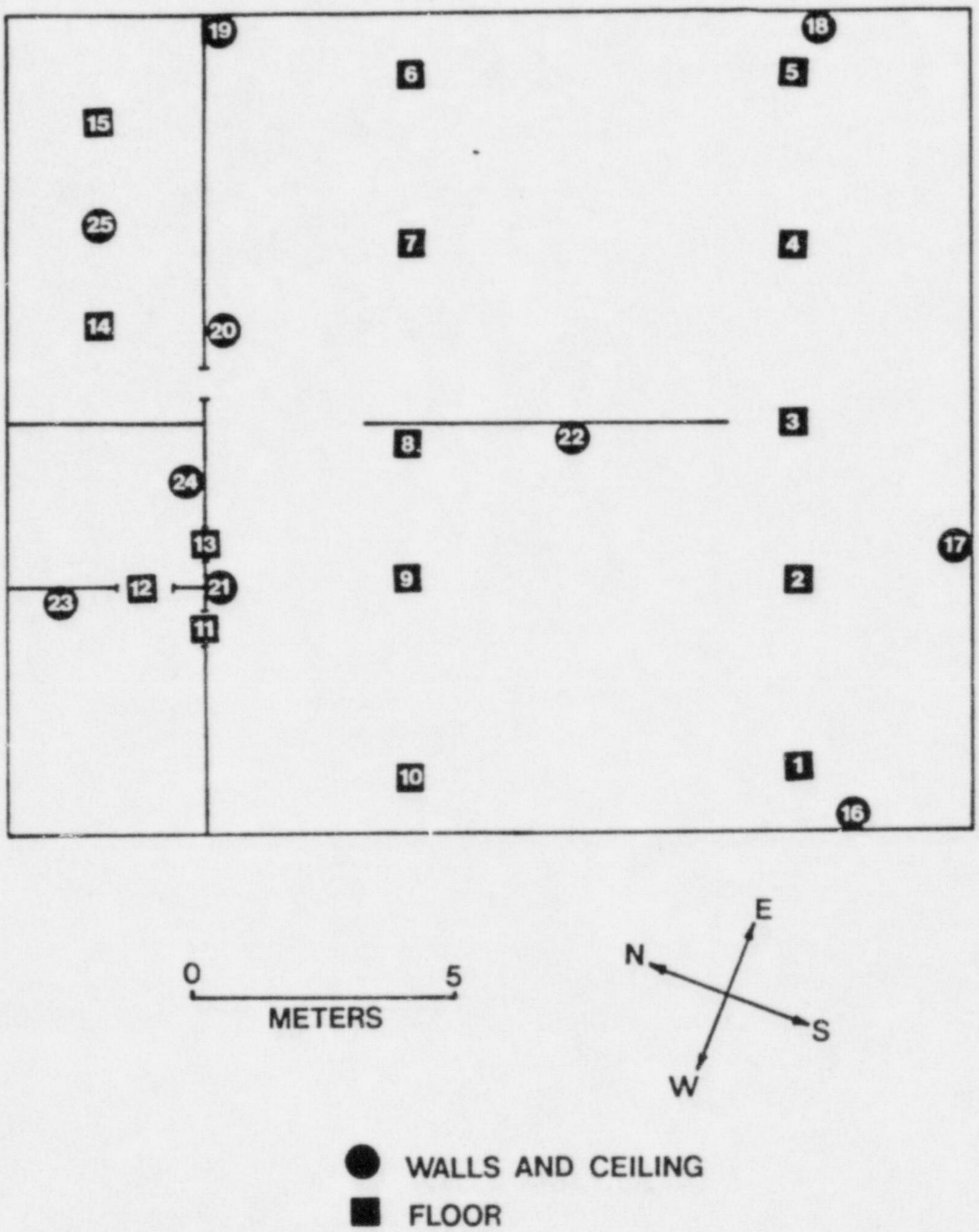

FIGURE 17: Floor Plan of the Maintenance II Building Indicating Locations of Measurements and Smears

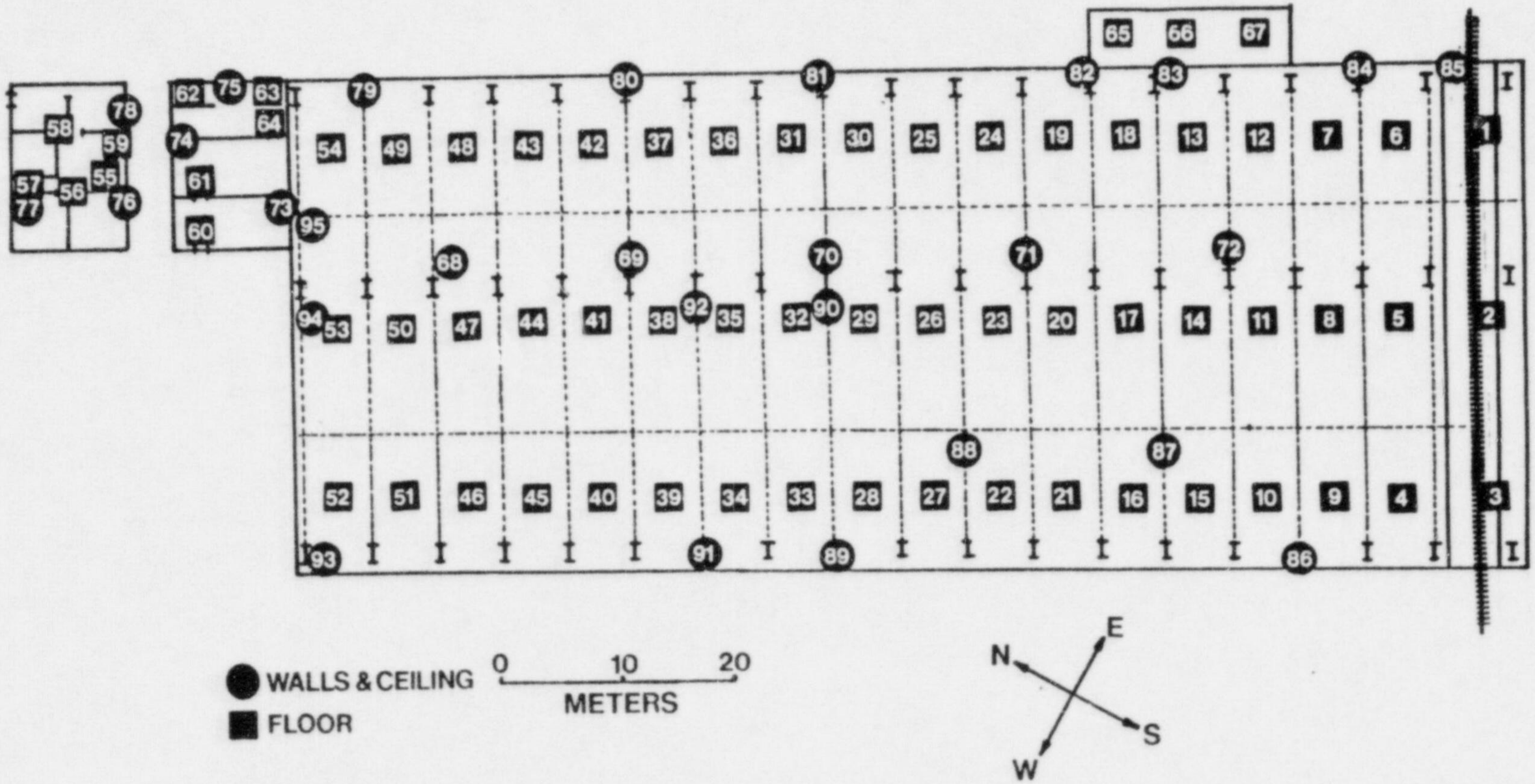

FIGURE 18: Floor Plan of the New Melt Shop Indicating Locations of Measurements and Smears

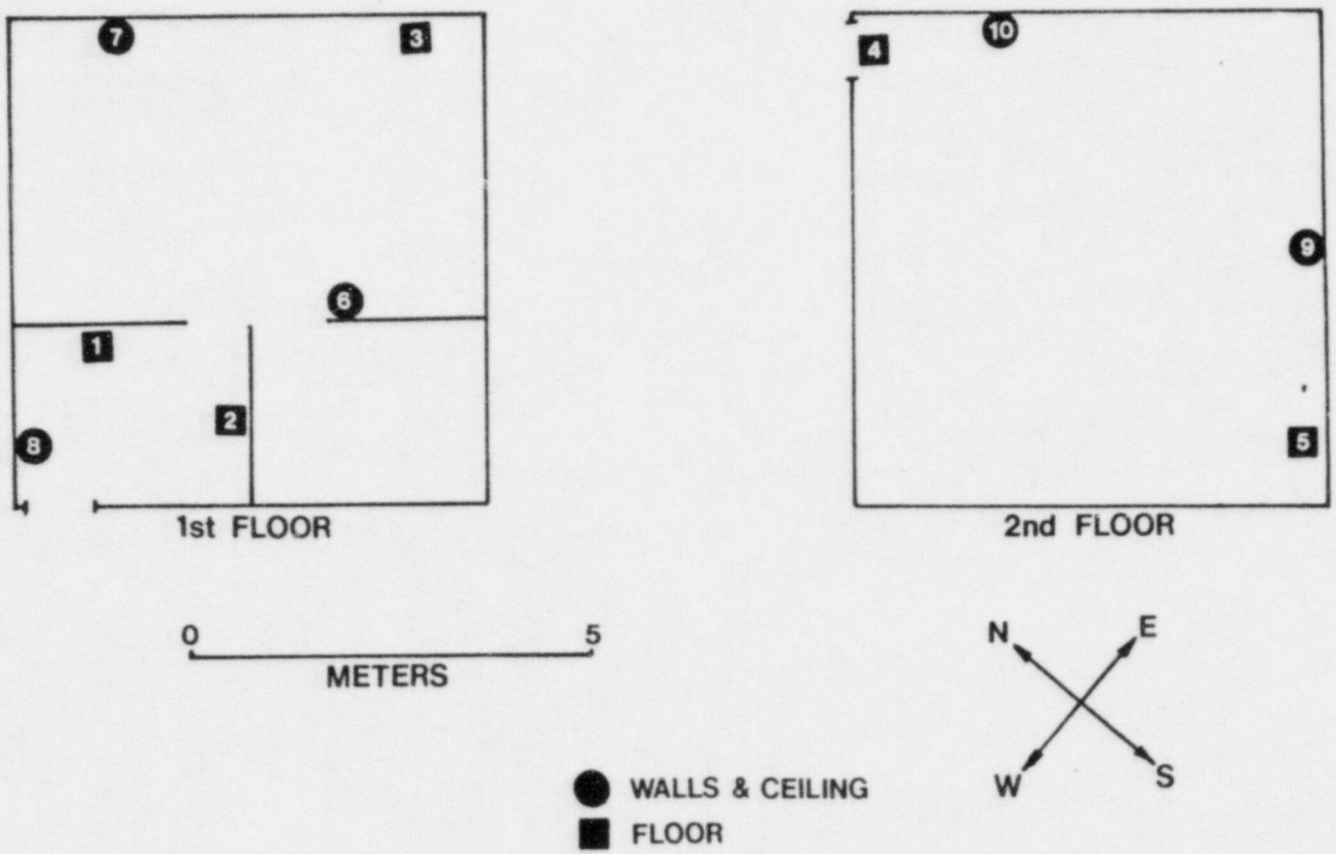

FIGURE 19: Floor Plan of the Office Building Indicating Locations of Measurements and Smears

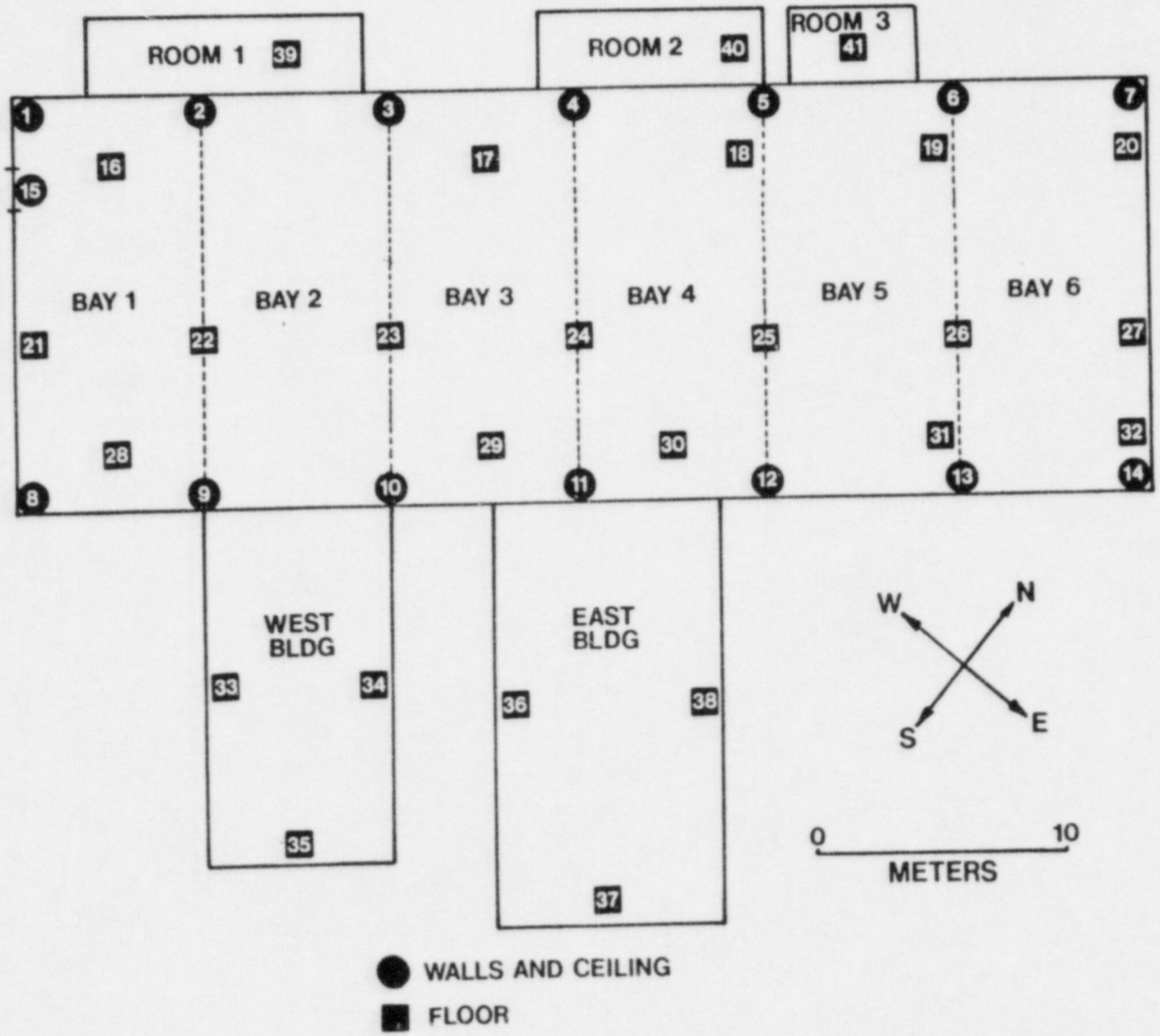

FIGURE 20: Floor Plan of the Old Melt Shop Indicating Locations of Measurements and Smears

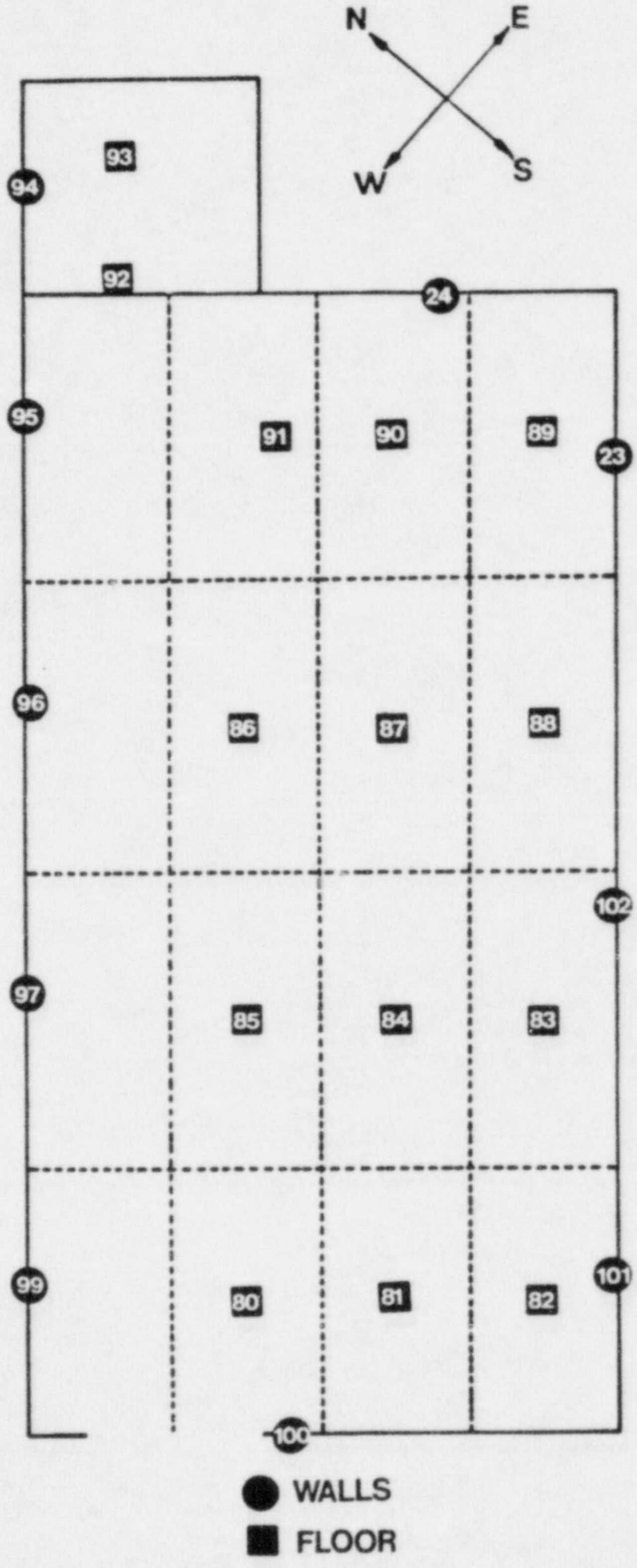

FIGURE 21: Floor Plan of the Process Lab Indicating Locations of Measurements and Smears

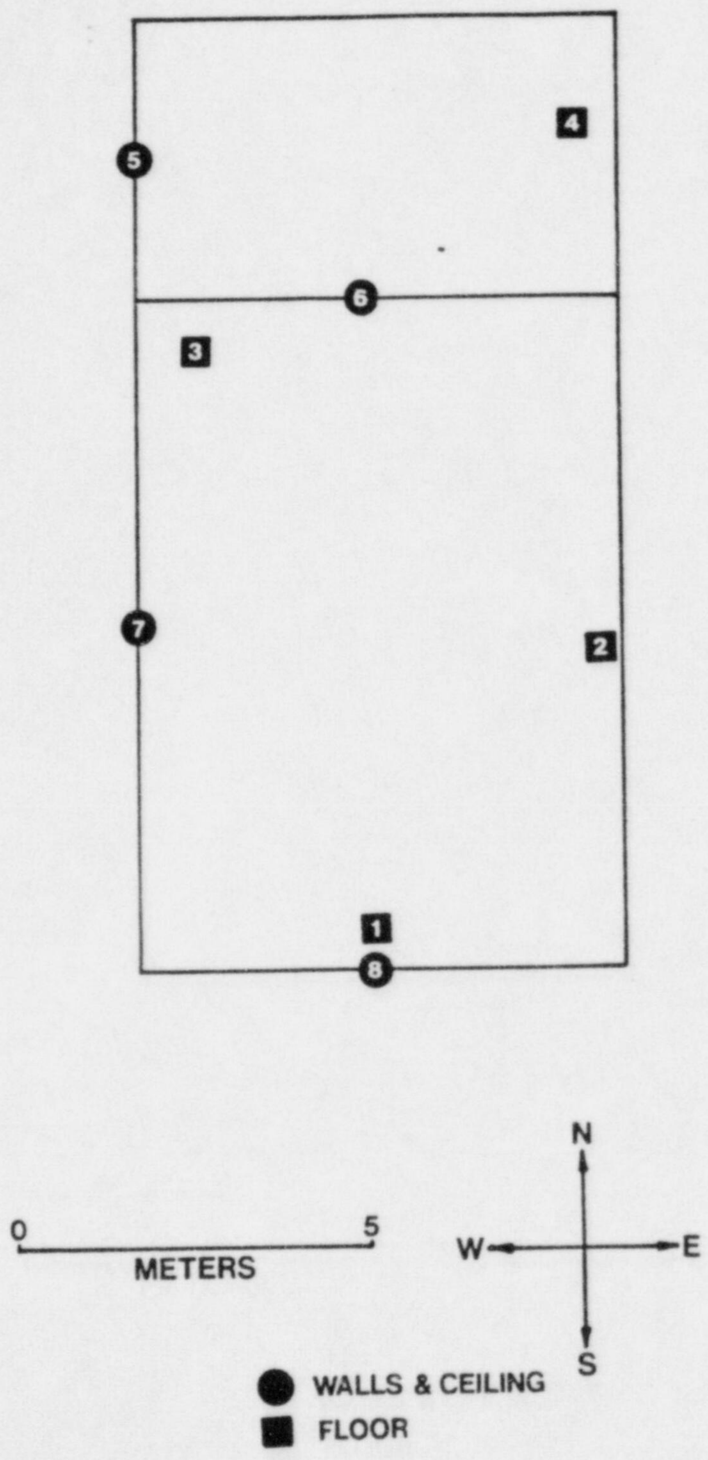

FIGURE 22: Floor Plan of the Shed Indicating Locations of Measurements and Smears

TABLE 1A

BACKGROUND EXPOSURE RATES AND BASELINE RADIONUCLIDE CONCENTRATIONS IN SOIL

Location[a]	Gamma Exposure Rate at 1 m Above the Surface (μR/hr)	Radionuclide Concentrations (pCi/g)				
		Th-232	Th-228	U-235	U-238	Ra-226
1	10.1	0.58 ± 0.27[b]	0.57 ± 0.25	<0.14	0.84 ± 1.11	0.84 ± 0.16
2	9.2	1.15 ± 0.56	0.98 ± 0.45	<0.25	1.46 ± 1.60	0.74 ± 0.25
3	10.1	0.69 ± 0.33	0.51 ± 0.27	<0.21	<0.65	0.64 ± 0.15

[a]Refer to Figure 5.
[b]Errors at 2σ based on counting statistics.

TABLE 1B

RADIONUCLIDE CONCENTRATIONS IN BASELINE WATER SAMPLES

Location[a]	Radionuclide Concentrations (pCi/l) Gross Alpha	Gross Beta
1[a]	0.42 ± 0.49[b]	2.55 ± 0.97
2	0.25 ± 0.42	3.19 ± 0.98
3	0.82 ± 0.50	4.59 ± 1.04

[a]Refer to Figure 5.

[b]Errors are 2σ based on counting statistics.

TABLE 2

DIRECT RADIATION LEVELS MEASURED AT 40 M
GRID INTERVALS AND GRID BLOCK CENTERS

Grid Location			Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)
360	A+15	a	11	12
380	A+20		12	16
400	A+15	a	10	10
420	A+15	a	12	14
440	A+15	a	10	10
460	A+20		11	12
480	A+15	a	10	10
500	A+20		10	11
520	A+15	a	10	10
540	A+20		10	10
560	A+15	a	10	10
580	A+20		11	11
240	B+20		9	10
260	B+20		11	12
280	B		9	9
300	B+20		9	10
320	B		10	10
340	B+20		8	9
520	B		9	10
540	B+20		10	10
560	B		10	10
580	B+20		10	10
180	C	a	11	10
180	C+20	a	10	10
200	C		9	8
220	C+17	b	11	12
240	C		10	11
260	C+20		11	11
280	C		10	10
300	C+20		10	11
320	C		9	9
340	C+20		9	9
360	C+5	b	8	9
400	C+5	b	8	8
420	C+20		8	8
440	C		8	10
460	C+20		8	9
480	C+6	b	8	8
500	C+20		10	9
520	C		10	10
540	C+10	a	10	10
550	C	a	9	10
160	D		7	9
180	D+20		9	10

TABLE 2 (Continued)

DIRECT RADIATION LEVELS MEASURED AT 40 M
GRID INTERVALS AND GRID BLOCK CENTERS

Grid Location			Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)
200	D		8	10
220	D+20		11	12
240	D		11	13
260	D+20		11	13
280	D+4	b	9	10
300	D+20		10	12
320	D		11	13
340	D+18	b	32	16
360	D		10	11
380	D+10	b	9	10
400	D		8	10
420	D+10	b	8	8
440	D+10	b	8	8
460	D+20		10	11
480	D		9	10
500	D+20		10	11
510	D	a	10	11
130	E	a	8	11
140	E+20		9	11
160	E		8	10
180	E+20		10	12
200	E		10	11
220	E+20		10	11
240	E		10	12
260	E+20		10	12
280	E		9	11
300	E+20		9	11
320	E		10	12
340	E+20		10	11
360	E		10	12
380	E+10	b	10	12
400	E+6	b	10	12
420	E+20		9	11
440	E		8	9
460	E+15	b	9	10
480	E		10	11
500	E+20		10	11
510	E	a	9	10
120	F		8	8
140	F+20		8	6
160	F		9	9
180	F+20		9	9
200	F		10	10
220	F+20		10	11

TABLE 2 (Continued)

DIRECT RADIATION LEVELS MEASURED AT 40 M GRID INTERVALS AND GRID BLOCK CENTERS

Grid Location			Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)
240	F		13	13
260	F+20		11	11
280	F		11	13
320	F		9	8
340	F+20		9	9
360	F		10	10
380	F+20		9	9
510	F	a	9	10
100	G+25	a	8	9
120	G+8	b	7	8
140	G+20		8	8
160	G		9	8
180	G+20		8	9
200	G		10	10
220	G+20		10	10
240	G		28	53
260	G+20		16	16
280	G		10	10
300	G+8		10	10
320	G		9	8
340	G+20		11	10
360	G		10	10
380	G+12	b	10	11
400	G+8	b	9	9
420	G+20		11	11
440	G		7	8
460	G+20		8	9
480	G+10		9	9
500	G+20		8	9
510	G	a	8	9
80	H		7	8
100	H+20		8	8
120	H		7	8
140	H+10		10	8
160	H		9	9
180	H+10		9	10
200	H		10	10
220	H+20		10	10
240	H		9	10
260	H+20		9	10
280	H		10	11
300	H+20		10	11
320	H		12	13
340	H+20		12	14

TABLE 2 (Continued)

DIRECT RADIATION LEVELS MEASURED AT 40 M
GRID INTERVALS AND GRID BLOCK CENTERS

Grid Location		Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)
60	I+20	8	8
80	I	8	9
100	I+20	8	9
120	I	7	8
140	I+20	8	10
160	I	9	10
180	I+20	10	11
200	I	9	10
220	I+20	10	11
240	I	10	11
260	I+20	9	9
280	I	11	12
320	I	12	11
40	J	8	10
60	J+20	8	8
80	J	8	9
100	J+20	10	11
120	J	9	10
140	J+20	10	11
160	J	12	11
40	K	10	11
80	K	9	10
100	K+20	10	11
120	K	8	10
140	K+20	8	10

a. Fence line.
b. Systematic grid location inaccessible; measurement obtained at nearest accessible point.

TABLE 3

DIRECT RADIATION LEVELS MEASURED AT THE SITE PERIMETER

Grid Location		Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)
315	A+15	10	10
420	A+15	10	9
530	A+15	11	10
610	A+30	11	11
210	B	11	12
170	C+25	10	11
540	C+15	9	10
115	E+35	8	9
515	E+25	8	8
380	G+12	10	11
420	G+20	11	11
340	H+20	12	14
430	H+30	12	12
515	H+20	9	9
55	I+10	10	11
180	I+20	10	11
220	I+20	10	11
260	I+20	9	9
280	I	11	12
20	J+30	10	10
160	J	12	11
140	K+20	8	10
110	L+15	10	11

TABLE 4

SURFACE RADIATION LEVELS AT LOCATIONS IDENTIFIED BY THE WALKOVER SCAN

Grid Location		Gamma Exposure Rates Prior to Decontamination (μR/h)	Gamma Exposure Rates After Decontamination (μR/h)	
292	B+36	24	10	
306	B+36	34	16	
320	B+32	16	16	
246	C+6	62	16	
300	C	180	10	
323	C+14	32	20	
368	C+8	110	12	
441	C+23	66	14	
447	C	70	14	
456	C+6	32	9	
477	C+4	140	9	
332	D+24	45	45	a
336	D+16	800	800	a
346	D+30	55	55	a
356	D+37	410	410	a
364	D+39	230	230	a
376	D+13	45	45	a
447	D+6	45	14	
472	D+6	88	14	
472	D+9	110	14	
474	D+11	280	14	
490	D+12	83	12	
500	D	26	16	
172	E+30	66	16	
175	E+34	34	16	
178	E+33	34	16	
180	E+19	55	20	
184	E+13	130	20	
201	E	250	12	
264	E+33	34	16	
269	E+34	99	16	
276	E+34	55	14	
285	E+39	45	16	
333	E+2	230	230	a
334	E	160	160	a
444	E+20	34	18	
486	E+3	38	12	
230	F+36	490	24	
279	F+12	88	14	
308	F+37	66	24	
340	F+30	28	20	
486	F+39	24	20	
502	F+26	28	12	

TABLE 4 (Continued)

SURFACE RADIATION LEVELS AT LOCATIONS IDENTIFIED BY THE WALKOVER SCAN

Grid Location		Gamma Exposure Rates Prior to Decontamination (μR/h)	Gamma Exposure Rates After Decontamination (μR/h)
178	G+12	130	14
178	G+14	66	14
180	G+14	66	14
194	G+10	34	24
250	G+36	180	20
255	G+30	180	20
255	G+39	180	20
257	G+38	180	20
258	G+8	180	20
258	G+14	180	20
258	G+30	180	20
260	G+31	180	20
261	G+8	180	20
264	G+36	180	20
267	G+39	180	20
268	G+29	180	20
269	G+29	180	20
275	G+35	180	20
280	G+36	180	20
280	G+37	180	20
290	G+30	28	14
308	G	34	13
310	G+1	34	13
315	G+39	130	16
320	G+38	130	130 b
320	G+39	130	14
357	G+31	32	14
380	G	36	14
390	G+12	24	12
429	G+17	110	14
436	G+16	28	24
442	G+39	45	14
443	G+31	24	18
449	G+32	49	12
482	G+18	53	12
488	G+4	36	12
488	G+33	88	14
498	G+19	34	14
518	G+30	88	24
200	H+36	66	12
202	H+1	130	12
205	H+16	77	14
220	H+18	110	14

TABLE 4 (Continued)

SURFACE RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SCAN

Grid Location		Gamma Exposure Rates Prior to Decontamination (μR/h)	Gamma Exposure Rates After Decontamination (μR/h)	
262	H+2	55	16	
263	H+2	130	16	
282	H+5	55	18	
290	H+3	55	16	
308	H+16	45	18	
310	H+18	45	18	
310	H+23	66	18	
312	H+24	88	16	
314	H	55	66	b
314	H+5	38	18	
319	H+26	170	16	
320	H+13	77	16	
320	H+23	45	16	
320	H+26	66	18	
321	H+11	55	18	
330	H+26	34	16	
332	H+38	490	490	c
332	H+39	110	110	c
334	H+11	45	18	
334	H+31	490	490	c
336	H+37	88	88	c
338	H+31	230	230	c
338	H+36	66	66	c
345	H+13	77	18	
484	H	41	14	
324	I+16	130	18	
325	I+8	45	16	
326	I+5	130	18	
326	I+6	45	18	
327	I+4	130	20	
329	I+4	45	20	
338	I+2	36	24	
338	I+10	49	18	
40	J+20	66	12	
104	J+36	45	12	
155	J+36	88	20	
108	K+18	66	12	

a. Contained in area of recently generated slag.

b. Unable to remove.

c. Reduced to 16-24 μR/h after road removal.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS AND
GRID BLOCK CENTERS

Grid Location		Radionuclide Concentrations				
		Th-232	Th-228	U-235	U-238	Ra-226
360	A+15[a]	2.00 ± 0.54[c]	1.29 ± 0.36	<0.22	2.30 ± 1.07	0.91 ± 0.27
380	A+20	0.66 ± 0.31	0.72 ± 0.27	<0.17	0.80 ± 0.53	0.95 ± 0.21
400	A+15[a]	0.89 ± 0.52	1.23 ± 0.42	<0.29	1.07 ± 2.49[c]	1.05 ± 0.29
420	A+20	0.88 ± 0.29	0.99 ± 0.30	0.34 ± 0.44	1.32 ± 0.66	0.56 ± 0.63
440	A+15[a]	1.41 ± 0.55	1.56 ± 0.45	<0.26	2.26 ± 1.49	0.95 ± 0.26
460	A+20	0.87 ± 0.26	0.48 ± 0.30	0.33 ± 0.36	0.69 ± 0.93	0.97 ± 0.20
480	A+15[a]	0.77 ± 0.26	0.84 ± 0.30	<0.20	1.76 ± 0.73	0.99 ± 0.22
500	A+20	0.88 ± 0.28	1.05 ± 0.24	<0.16	0.88 ± 0.58	0.75 ± 0.24
520	A+15[a]	1.07 ± 0.39	0.57 ± 0.33	<0.20	1.85 ± 0.95	1.09 ± 0.23
540	A+20	0.60 ± 0.24	0.72 ± 0.24	0.33 ± 0.45	0.88 ± 0.70	0.87 ± 0.19
560	A+15[a]	0.83 ± 0.31	0.96 ± 0.39	<0.25	0.32 ± 0.13	1.06 ± 0.22
580	A+20	0.80 ± 0.31	0.84 ± 0.24	<0.15	0.43 ± 0.46	0.90 ± 0.20
240	B+20	0.32 ± 0.33	0.48 ± 0.18	0.28 ± 0.30	0.99 ± 0.98	1.18 ± 0.23
260	B+20	1.20 ± 0.33	1.53 ± 0.36	<0.25	2.84 ± 0.93	1.74 ± 0.31
280	B	0.51 ± 0.20	0.51 ± 0.27	<1.12	<3.17	0.47 ± 0.19
300	B+20	0.50 ± 0.24	0.51 ± 0.27	<0.20	0.57 ± 2.54	0.75 ± 0.19
320	B	0.51 ± 0.35	0.24 ± 0.24	0.21 ± 0.27	1.57 ± 0.45	0.78 ± 0.16
340	B+20	0.72 ± 0.33	0.63 ± 0.24	<0.17	0.75 ± 1.73	0.84 ± 0.20
520	B	0.92 ± 0.39	0.93 ± 0.39	0.37 ± 0.33	1.40 ± 0.82	1.28 ± 0.19
540	B+20	0.53 ± 0.40	0.57 ± 0.33	<0.22	1.81 ± 0.89	1.09 ± 0.20
560	B	0.83 ± 0.30	0.78 ± 0.24	<0.14	1.45 ± 0.51	1.12 ± 0.21
580	B+20	0.63 ± 0.35	0.84 ± 0.33	<0.24	2.57 ± 1.03	1.60 ± 0.31
180	C+20[a]	0.17 ± 0.39	0.75 ± 0.69	<0.18	1.81 ± 0.62	1.24 ± 0.23
180	C [a]	0.87 ± 0.51	1.11 ± 0.36	<0.27	1.32 ± 1.85	0.92 ± 0.21
200	C	0.94 ± 0.25	0.63 ± 0.18	<0.14	0.64 ± 0.47	1.18 ± 0.19
220	C+17[b]	1.43 ± 0.42	1.50 ± 0.30	<0.29	5.02 ± 1.34	1.95 ± 0.30

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 m GRID INTERVALS AND
GRID BLOCK CENTERS

Grid Location		Radionuclide Concentrations				
		Th-232	Th-228	U-235	U-238	Ra-226
240	C	1.25 ± 0.34	0.75 ± 0.30	<0.15	0.44 ± 0.39	1.16 ± 0.21
260	C+20	0.88 ± 0.48	0.72 ± 0.24	<0.17	1.20 ± 1.38	0.94 ± 0.20
280	C	1.07 ± 0.33	0.90 ± 0.33	<0.15	2.05 ± 0.53	1.12 ± 0.20
300	C+20	0.99 ± 0.31	0.75 ± 0.45	<0.24	1.00 ± 1.65	1.29 ± 0.27
320	C	0.81 ± 0.30	0.78 ± 0.21	<0.15	0.25 ± 0.35	0.82 ± 0.17
340	C+20	0.86 ± 0.46	0.75 ± 0.24	<0.25	1.91 ± 1.43	0.97 ± 0.28
360	C+5 [b]	0.59 ± 0.22	0.36 ± 0.12	<0.14	0.89 ± 0.90	0.63 ± 0.15
400	C+5 [b]	0.46 ± 0.17	0.45 ± 0.15	0.19 ± 0.22	0.14 ± 0.22	0.65 ± 0.13
420	C+20	0.84 ± 0.30	1.08 ± 0.27	<0.16	1.91 ± 1.32	1.70 ± 0.26
440	C	1.24 ± 0.33	1.02 ± 0.21	<0.15	1.12 ± 0.50	0.99 ± 0.15
460	C+20	0.56 ± 0.24	0.54 ± 0.18	<0.20	3.55 ± 1.00	1.20 ± 0.25
480	C+6 [b]	0.50 ± 0.19	0.57 ± 0.17	<0.16	1.20 ± 0.79	0.47 ± 0.17
500	C+20	0.91 ± 0.32	0.63 ± 0.27	<0.15	1.10 ± 1.00	0.92 ± 0.17
520	C	1.02 ± 0.31	0.56 ± 0.14	<0.20	1.68 ± 0.84	1.40 ± 0.22
540	C+10[a]	0.75 ± 0.26	0.60 ± 0.15	<0.14	0.97 ± 0.47	1.00 ± 0.15
550	C [a]	1.04 ± 0.44	0.99 ± 0.39	<0.27	<0.85	1.40 ± 0.30
160	D	0.85 ± 0.23	0.87 ± 2.40	<0.19	1.17 ± 1.13	0.85 ± 0.18
180	D+20	1.28 ± 0.37	1.05 ± 0.33	<0.18	0.75 ± 0.56	0.80 ± 0.20
200	D	0.97 ± 0.29	0.75 ± 0.24	<0.19	0.96 ± 1.38[c]	1.01 ± 0.23
220	D+20	1.30 ± 0.32	1.05 ± 0.21	<0.18	1.33 ± 0.57	1.68 ± 0.20
240	D	0.96 ± 0.28	1.17 ± 0.27	<0.22	2.22 ± 0.94	1.78 ± 0.23
260	D+20	1.37 ± 0.35	1.41 ± 0.42	<0.28	3.82 ± 1.21	2.07 ± 0.27
280	D+4 [b]	1.14 ± 0.34	1.05 ± 0.30	0.30 ± 0.39	1.39 ± 0.60	1.80 ± 0.25
300	D+20	1.46 ± 0.33	1.14 ± 0.33	<0.25	1.82 ± 1.65	1.73 ± 0.30
320	D	1.15 ± 0.30	0.84 ± 0.27	<0.15	1.79 ± 0.53	1.57 ± 0.20
340	D+18	1.40 ± 0.35	1.32 ± 0.39	<0.26	1.65 ± 1.92	1.67 ± 0.31

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS AND
GRID BLOCK CENTERS

Grid Location		Radionuclide Concentrations				
		Th-232	Th-228	U-235	U-238	Ra-226
360	D	1.08 ± 0.39	1.26 ± 0.30	<0.20	3.37 ± 0.74	1.47 ± 0.25
380	D+10[b]	0.56 ± 0.25	0.57 ± 0.21	<0.16	1.58 ± 0.56	0.89 ± 0.16
400	D	0.58 ± 0.19	0.66 ± 0.21	0.22 ± 0.23	0.90 ± 0.51	0.57 ± 0.14
420	D+10[b]	0.60 ± 0.19	0.51 ± 0.21	<0.14	<0.45	0.52 ± 0.15
440	D+10[b]	0.38 ± 0.18	0.39 ± 0.12	<0.09	0.30 ± 0.52	0.23 ± 0.09
460	D+20	1.00 ± 0.38	1.05 ± 0.36	<0.25	3.12 ± 2.06	1.27 ± 0.31
480	D	0.87 ± 0.27	0.96 ± 0.27	<0.23	<0.69	0.59 ± 0.16
500	D+20	0.84 ± 0.50	0.66 ± 0.45	<0.28	1.25 ± 2.27	1.00 ± 0.33
510	D [a]	1.37 ± 0.32	1.38 ± 0.30	<0.26	<0.92	0.63 ± 0.16
130	E [a]	1.04 ± 0.32	0.87 ± 0.30	<0.22	1.50 ± 0.89	1.16 ± 0.25
140	E+20	1.14 ± 0.42	1.14 ± 0.39	<0.34	6.66 ± 2.21	0.73 ± 0.21
160	E	0.90 ± 0.31	0.96 ± 0.21	<0.14	1.05 ± 0.82	0.90 ± 0.20
180	E+20	0.79 ± 0.42	0.90 ± 0.33	<0.24	<0.82	0.66 ± 0.26
200	E	1.12 ± 0.33	1.29 ± 0.36	<0.29	2.67 ± 1 [illegible]	0.91 ± 0.21
220	E+20	0.98 ± 0.39	1.02 ± 0.36	<0.14	1.28 ± 0.5[illegible]	0.84 ± 0.19
240	E	0.95 ± 0.26	0.78 ± 0.33	<0.18	1.02 ± 1.14	0.99 ± 0.19
260	E+20	<0.28	1.55 ± 1.75	1.10 ± 0.32	1.26 ± 0.27	1.22 ± 0.23
280	E	<0.19	3.43 ± 0.69	0.98 ± 0.38	1.05 ± 0.24	1.52 ± 0.28
300	E+20	<0.19	1.35 ± 0.75	1.00 ± 0.28	1.14 ± 0.33	1.02 ± 0.17
320	E	1.61 ± 0.36	1.11 ± 0.30	0.45 ± 0.55	2.88 ± 1.82	1.40 ± 0.26
340	E+20	0.98 ± 0.35	0.93 ± 0.24	<0.15	2.23 ± 0.56	0.98 ± 0.19
360	E	1.65 ± 1.31	0.90 ± 0.27	0.27 ± 0.51	1.35 ± 1.50	1.23 ± 0.26
380	E+10[b]	1.02 ± 0.24	0.69 ± 0.18	0.56 ± 0.48	<8.22	0.97 ± 0.16
400	E+6 [b]	1.22 ± 0.31	1.05 ± 0.36	<0.19	1.68 ÷ 0.62	1.65 ± 0.26
420	E+20	1.01 ± 0.33	0.87 ± 0.39	<0.19	1.00 ± 0.69	1.02 ± 0.21
440	E	1.17 ± 0.33	0.84 ± 0.30	<0.23	<0.75	0.67 ± 0.16

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS AND
GRID BLOCK CENTERS

Grid Location		Radionuclide Concentrations				
		Th-232	Th-228	U-235	U-238	Ra-226
460	E+15[b]	1.10 ± 0.30	0.72 ± 0.24	<0.11	1.00 ± 0.37	0.60 ± 0.13
480	E	1.58 ± 0.54	0.99 ± 0.39	<0.27	2.03 ± 1.17	1.19 ± 0.33
500	E+20	1.03 ± 0.26	0.99 ± 0.21	<0.24	2.29 ± 1.64	0.74 ± 0.16
510	E [a]	0.46 ± 0.32	0.33 ± 0.24	<0.16	0.63 ± 0.46	0.53 ± 0.20
120	F	0.61 ± 0.25	0.72 ± 0.21	<0.16	<0.47	0.54 ± 0.16
140	F+20	1.29 ± 0.49	1.29 ± 0.39	<0.37	<1.19	1.05 ± 0.23
160	F	0.07 ± 0.07	0.51 ± 0.22	<0.13	0.91 ± 0.71	0.78 ± 0.16
180	F+20	0.96 ± 0.32	1.05 ± 0.27	<0.18	1.00 ± 0.11	0.96 ± 0.20
200	F	1.45 ± 0.39	1.35 ± 0.39	<0.33	0.51 ± 0.15	0.91 ± 0.21
220	F+20	1.31 ± 0.41	1.08 ± 0.36	<0.18	1.23 ± 0.96	0.76 ± 0.24
240	F	1.22 ± 0.49	1.26 ± 0.42	<0.21	1.50 ± 1.91[c]	0.81 ± 0.25
260	F+20	2.76 ± 0.51	3.00 ± 0.51	<0.48	4.73 ± 1.53	2.13 ± 0.36
280	F	0.60 ± 0.46	0.66 ± 2.73	<0.12	0.70 ± 0.42	0.78 ± 0.16
320	F	0.27 ± 0.35	1.50 ± 1.21	0.89 ± 0.33	0.72 ± 2.88	0.77 ± 0.25
340	F+20	0.77 ± 0.26	0.93 ± 0.33	<0.26	3.11 ± 1.44	0.74 ± 0.25
360	F	0.39 ± 0.17	0.44 ± 0.15	<0.08	0.18 ± 0.42	0.94 ± 0.09
380	F+20	0.83 ± 0.44	0.72 ± 0.33	<0.21	1.24 ± 1.25	0.37 ± 0.26
510	F [a]	3.77 ± 0.72	1.17 ± 0.33	<0.33	<1.06	0.82 ± 0.28
100	G+75[a]	0.25 ± 0.14	0.21 ± 0.12	<0.09	0.92 ± 0.31	0.77 ± 0.28
120	G+8 [b]	0.23 ± 0.14	0.30 ± 0.12	<0.12	0.92 ± 0.87	0.37 ± 0.13
140	G+20	1.07 ± 0.26	1.02 ± 0.21	<0.21	2.93 ± 1.23	0.71 ± 0.11
160	G	0.56 ± 0.23	0.63 ± 0.24	<0.14	2.17 ± 0.84	0.47 ± 0.16
180	G+20	0.64 ± 0.28	0.72 ± 0.30	<0.15	1.19 ± 0.85	0.74 ± 0.17
200	G	0.87 ± 0.32	1.17 ± 0.36	<0.32	2.45 ± 1.88	0.96 ± 0.24
220	G+20	0.87 ± 0.50	1.02 ± 0.30	<0.17	<0.48	0.61 ± 0.19
240	G	<0.67	1.71 ± 0.96	<0.84	0.13 ± 3.84	0.78 ± 0.56

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS AND
GRID BLOCK CENTERS

Grid Location		Radionuclide Concentrations				
		Th-232	Th-228	U-235	U-238	Ra-226
260	G+20	1.52 ± 0.42	1.50 ± 0.33	<0.19	1.42 ± 0.66	0.98 ± 0.26
280	G	0.91 ± 0.61	0.81 ± 0.42	<0.26	1.98 ± 1.08	0.96 ± 0.27
300	G+8 [b]	0.82 ± 0.59	1.17 ± 0.39	<0.34	2.08 ± 3.32	1.39 ± 0.26
320	G	0.55 ± 0.21	0.66 ± 0.15	<0.10	0.68 ± 0.51	0.46 ± 0.12
340	G+20	1.14 ± 0.52	1.17 ± 0.39	<0.24	<0.85	0.97 ± 0.22
360	G	0.88 ± 0.32	1.26 ± 0.27	<0.36	1.09 ± 0.71	0.90 ± 0.19
380	G+12[b]	1.00 ± 0.33	0.99 ± 0.33	<0.14	1.32 ± 1.01	0.57 ± 0.16
400	G+8 [b]	1.07 ± 0.45	1.60 ± 0.34	<0.22	0.98 ± 1.62	0.68 ± 0.23
420	G+20	1.94 ± 0.36	1.65 ± 0.33	<0.16	1.45 ± 0.83	0.55 ± 0.15
440	G	0.65 ± 0.23	1.14 ± 0.36	<0.18	1.22 ± 0.64	0.66 ± 0.15
460	G+20	0.06 ± 0.34	0.87 ± 2.73	<0.28	1.02 ± 1.26	0.76 ± 0.16
480	G+10[b]	0.18 ± 0.27	0.81 ± 0.24	0.23 ± 0.28	0.81 ± 0.57	0.61 ± 0.16
500	G+20	0.67 ± 0.37	0.72 ± 0.27	<0.19	<0.57	0.68 ± 0.16
510	G [a]	1.35 ± 0.63	0.90 ± 0.24	<0.30	<0.98	0.41 ± 0.13
80	H	0.50 ± 0.31	0.57 ± 0.21	<0.17	0.89 ± 0.52	0.54 ± 0.20
100	H+20	0.92 ± 0.37	0.66 ± 0.24	<0.18	0.74 ± 0.50	0.57 ± 0.15
120	H	0.80 ± 0.24	0.81 ± 2.70	<0.23	0.65 ± 1.44	0.70 ± 0.16
140	H+10	0.23 ± 0.32	0.45 ± 0.21	<0.15	1.11 ± 1.08	1.23 ± 0.25
160	H	1.14 ± 0.79	1.32 ± 0.24	<0.64	4.41 ± 1.29	1.04 ± 0.18
180	H+10	1.18 ± 0.41	1.02 ± 0.33	<0.15	0.16 ± 0.38	0.81 ± 0.21
200	H	1.60 ± 0.38	1.47 ± 0.33	<0.21	1.43 ± 0.84	0.81 ± 0.21
220	H+20	3.75 ± 0.58	3.51 ± 0.48	<0.40	2.54 ± 1.85	0.92 ± 0.25
240	H	0.70 ± 0.36	1.17 ± 0.42	<0.24	1.70 ± 2.02	0.82 ± 0.26
260	H+20	1.83 ± 0.38	1.44 ± 0.33	<0.30	1.33 ± 1.39	0.87 ± 0.21
280	H	2.59 ± 0.53	2.07 ± 0.36	<0.16	0.98 ± 0.65	0.75 ± 0.20
300	H+20	0.87 ± 0.40	1.05 ± 0.45	<0.23	<0.77	0.52 ± 0.30

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS AND
GRID BLOCK CENTERS

Grid Location		Radionuclide Concentrations				
		Th-232	Th-228	U-235	U-238	Ra-226
320	H	1.97 ± 0.52	1.68 ± 0.42	<0.42	6.86 ± 2.34	1.14 ± 0.30
340	H+20	1.79 ± 0.37	1.83 ± 0.27	<0.18	1.84 ± 0.94	1.20 ± 0.18
60	I+20	0.62 ± 0.25	0.53 ± 0.27	<0.81	<0.69	0.48 ± 0.19
80	I	0.78 ± 0.27	1.02 ± 2.40	<0.14	0.93 ± 0.66	0.68 ± 0.16
100	I+20	0.59 ± 0.24	0.66 ± 0.27	<0.25	1.19 ± 2.30	0.69 ± 0.23
120	I	0.72 ± 0.36	0.96 ± 0.27	<0.22	1.27 ± 1.17	0.71 ± 0.21
140	I+20	0.81 ± 0.25	1.05 ± 0.21	<0.12	1.18 ± 0.55	0.72 ± 0.18
160	I	1.35 ± 0.59	1.05 ± 0.45	<0.23	1.04 ± 1.53	0.86 ± 0.26
180	I+20	1.17 ± 0.56	1.38 ± 0.30	<0.32	1.78 ± 1.73	0.94 ± 0.21
200	I	2.50 ± 0.39	1.92 ± 0.30	<0.17	1.30 ± 0.55	0.77 ± 0.17
220	I+20	1.35 ± 0.29	1.05 ± 0.33	<0.17	1.10 ± 1.09	0.80 ± 0.16
240	I	1.22 ± 0.27	0.93 ± 0.24	<0.23	1.73 ± 0.84	0.60 ± 0.17
260	I+20	0.91 ± 0.21	0.93 ± 0.24	<0.11	0.56 ± 0.37	0.44 ± 0.13
280	I	1.32 ± 0.29	1.41 ± 0.24	<0.18	<0.50	0.73 ± 0.19
320	I	2.43 ± 0.37	2.85 ± 0.42	<0.32	5.22 ± 1.42	0.74 ± 0.19
40	J	0.49 ± 0.26	0.45 ± 0.24	<0.21	6.25 ± 1.10	0.64 ± 0.19
60	J+20	0.69 ± 0.27	0.96 ± 0.27	<0.24	2.35 ± 0.85	0.83 ± 0.15
80	J	1.10 ± 0.21	0.75 ± 0.21	<0.09	0.27 ± 0.48	0.69 ± 0.12
100	J+20	1.04 ± 0.34	1.08 ± 0.24	<0.21	1.60 ± 1.86	1.06 ± 0.20
120	J	1.16 ± 0.34	1.38 ± 0.30	<0.31	<0.92	0.79 ± 0.26
140	J+20	0.98 ± 0.32	1.02 ± 0.24	<0.20	1.51 ± 1.76	1.00 ± 0.19
160	J	1.32 ± 0.34	1.29 ± 0.30	<0.28	1.83 ± 1.31	0.96 ± 0.21
40	K	0.92 ± 0.55	0.93 ± 0.39	<0.29	<1.02	1.01 ± 0.44
80	K	2.16 ± 2.74	1.23 ± 0.54	<0.34	<1.05	1.40 ± 0.26
100	K+20	1.47 ± 0.35	1.08 ± 0.42	<0.33	<1.00	0.67 ± 0.25
120	K	0.23 ± 0.19	0.22 ± 0.15	<0.11	<0.38	0.38 ± 0.10

TABLE 6

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM THE SITE PERIMETER

Grid Location		Radionuclide Concentrations (pCi/g)				
		Th-232	Th-228	U-235	U-238	Ra-226
315	A+15	0.53 ± 0.54[a]	0.81 ± 0.33	<0.25	1.64 ± 1.83	1.26 ± 0.30
420	A+15	2.05 ± 0.78	2.49 ± 0.69	<0.44	3.19 ± 2.90	3.76 ± 0.52
530	A+15	1.04 ± 0.44	3.96 ± 0.36	<0.33	4.16 ± 2.27	1.49 ± 0.26
610	A+30	1.86 ± 0.46	1.38 ± 0.66	<0.47	2.33 ± 3.79	1.04 ± 0.31
210	B	0.98 ± 0.33	0.81 ± 0.39	<0.25	2.42 ± 1.15	1.00 ± 0.24
170	C+25	1.34 ± 0.44	1.11 ± 0.54	<0.34	3.29 ± 1.57	1.37 ± 0.33
540	C+15	0.61 ± 0.31	1.59 ± 0.45	<0.43	6.89 ± 3.54	0.93 ± 0.28
115	E+35	1.10 ± 0.33	1.26 ± 0.39	<0.35	2.65 ± 1.17	1.08 ± 0.27
515	E+25	1.50 ± 0.56	1.73 ± 0.42	<0.23	1.89 ± 1.08	0.83 ± 0.28
380	G+12	1.00 ± 0.33	0.99 ± 0.33	<0.14	1.32 ± 1.01	0.57 ± 0.16
420	G+20	1.94 ± 0.36	1.65 ± 0.33	<0.16	1.45 ± 0.83	0.55 ± 0.15
340	H+20	1.79 ± 0.37	1.83 ± 0.27	<0.18	1.84 ± 0.94	1.20 ± 0.18
430	H+30	1.94 ± 0.64	1.50 ± 0.57	<0.30	1.50 ± 2.75	1.37 ± 0.34
515	H+20	0.87 ± 0.34	0.90 ± 0.27	<0.27	0.94 ± 1.43	0.89 ± 0.17
55	I+10	1.48 ± 0.57	1.50 ± 0.45	<0.46	1.59 ± 2.43	1.51 ± 0.30
180	I+20	1.17 ± 0.56	1.38 ± 0.30	<0.32	1.78 ± 1.73	0.94 ± 0.21
220	I+20	1.35 ± 0.29	1.05 ± 0.33	<0.17	1.10 ± 1.09	0.80 ± 0.16
260	I+20	0.91 ± 0.21	0.93 ± 0.24	<0.11	0.56 ± 0.37	0.44 ± 0.13
280	I	1.32 ± 0.29	1.41 ± 0.24	<0.18	<0.50	0.73 ± 0.19
20	J+30	1.29 ± 0.47	1.20 ± 0.69	<0.30	<1.03	0.94 ± 0.38
160	[illegible]	1.32 ± 0.34	1.29 ± 0.30	<0.28	1.83 ± 1.31	0.96 ± 0.21
140	K+20	1.51 ± 0.36	0.99 ± 0.36	0.55 ± 0.51	1.34 ± 1.72	0.70 ± 0.21
110	L+15	1.19 ± 0.41	1.20 ± 0.51	<0.28	1.38 ± 2.04	1.08 ± 0.34

[a]Errors are 2σ based on counting statistics.

TABLE 7

RADIONUCLIDE CONCENTRATIONS IN MATERIALS FROM SELECTED LOCATIONS IDENTIFIED BY SURFACE GAMMA SCANS

Location	Remarks	Radionuclide Concentrations (pCi/g)				
		Th-232	Th-228	U-235	U-238	Ra-226
336, D+16	Slag	307 ± 13	258 ± 12	<5.99	<65.1	9.19 ± 3.38
356, D+37	Slag	144 ± 5	141 ± 5	<1.86	<24.8	1.86 ± 1.7
363-65, D+38-40	Slag	0.97 ± 0.30	0.84 ± 0.27	<0.13	0.83 ± 0.45	0.59 ± 0.15
436-445, C+20-25	Soil Sample After Pad Removal	1.47 ± 0.35	1.23 ± 0.24	<0.17	1.61 ± 0.59	1.74 ± 0.30
Alloy Bldg.,[a] Bay 3C	Test Sample	1610 ± 42[b]	1660 ± 40	<15.3	293 ± 66	94.1 ± 13.0
Alloy Bldg., Bay 3C	Test Sample	1610 ± 78	1540 ± 75	<29.6	266 ± 120	122 ± 30
Alloy Bldg., Bay 10A	Metal Piece	1140 ± 30	1004 ± 36	<17.4	<210	<5.60
Alloy Bldg., Bay 13C	Flue Dust	27.4 ± 10.3	34.2 ± 6.3	7.90 ± 8.27	38.1 ± 18.4	79.6 ± 5.9
Alloy Bldg, Bay 20D	Flue Dust	19.2 ± 1.8	2.43 ± 0.72	<0.51	13.1 ± 2.4	2.20 ± 0.60
Alloy Bldg., Bay 10A	Metal Piece	2190 ± 111	1860 ± 99	<46.1	<652	<15.4

[a]For Alloy Building locations, refer to Figures 8A and 8B.
[b]Errors are 2σ based on counting statistics.

TABLE 8

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole[a] No.	Grid Location		Depth m	Radionuclide Concentrations (pCi/g)				
				Th-232	Th-228	U-235	U-238	Ra-226
1	540	A+35	Surface	0.87 ± 0.34[b]	0.94 ± 0.29	<0.18	1.55 ± 1.35[b]	1.28 ± 0.22
			1.5	2.06 ± 0.48	1.73 ± 0.49	<0.36	2.10 ± 1.95	1.13 ± 0.24
2	310	B+37	Surface	11.8 ± 1.0	9.56 ± 0.79	<0.67	<2.12	0.92 ± 0.31
			1.5	0.99 ± 0.38	0.90 ± 0.35	<0.20	1.39 ± 0.88	0.69 ± 0.23
3	443	C+26	Surface	1.87 ± 0.37	1.82 ± 0.37	<0.37	5.32 ± 1.35	1.94 ± 0.24
			1.5	1.27 ± 0.42	1.42 ± 0.32	<0.21	<0.73	0.99 ± 0.23
4	174	E+30	Surface	1.03 ± 0.36	1.01 ± 0.22	0.35 ± 0.55	1.24 ± 1.55	0.94 ± 0.17
			1.5	1.03 ± 0.37	1.13 ± 0.28	<0.19	1.61 ± 1.18	0.89 ± 0.23
5	345	E+4	Surface	0.91 ± 0.25	1.09 ± 0.28	<0.25	2.44 ± 0.93	0.75 ± 0.16
			1.5	1.04 ± 0.30	0.79 ± 0.34	<0.18	3.02 ± 1.31	0.80 ± 0.29
6	488	E+4	Surface	1.32 ± 0.36	1.00 ± 0.24	<0.26	1.59 ± 1.22	0.77 ± 0.20
			1.5	1.33 ± 0.40	1.22 ± 0.39	<0.21	1.70 ± 0.94	0.96 ± 0.23
7	232	F+30	Surface	1.27 ± 0.45	1.23 ± 0.33	<0.31	2.73 ± 1.79	0.93 ± 0.86
			0.5	1.05 ± 0.32	<0.81	<0.22	1.13 ± 1.69	1.06 ± 0.25
			1.5	0.69 ± 0.27	0.99 ± 0.39	<0.32	3.68 ± 0.64	0.80 ± 0.25
8	355	G+20	Surface	1.89 ± 0.46	1.56 ± 0.30	<0.24	2.17 ± 1.20	1.02 ± 0.21
			0.5	1.05 ± 0.38	1.29 ± 0.33	<0.23	1.04 ± 1.80	0.74 ± 0.30
			1.5	1.06 ± 0.49	1.53 ± 0.30	<0.35	2.11 ± 1.28	1.00 ± 0.23
9	440	G+19	Surface	1.21 ± 0.30	0.97 ± 0.23	<0.30	5.88 ± 1.61	0.68 ± 0.17
			1.5	1.08 ± 0.41	1.16 ± 0.36	<0.21	1.61 ± 1.27	0.99 ± 0.22

TABLE 8 (Continued)

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.	Grid Location		Depth m	Radionuclide Concentrations (pCi/g)				
				Th-232	Th-228	U-235	U-238	Ra-226
10	458	G+34	Surface	0.89 ± 0.34	0.99 ± 0.27	<0.23	1.07 ± 1.49	0.52 ± 0.15
			0.5	0.78 ± 0.28	1.08 ± 0.38	0.34 ± 0.53	1.34 ± 1.61	0.95 ± 0.23
			2.5	1.15 ± 0.32	1.10 ± 0.31	<0.28	7.12 ± 1.28	0.92 ± 0.25
			Composite	0.51 ± 0.31	0.61 ± 0.31	<0.20	1.22 ± 1.21	0.65 ± 0.19
11	474	G+28	Surface	1.03 ± 0.30	0.94 ± 0.28	<0.26	2.69 ± 1.41	0.81 ± 0.21
			1.5	0.85 ± 0.34	0.88 ± 0.30	0.32 ± 0.54	0.58 ± 1.74	1.09 ± 0.32
			Composite	1.10 ± 0.38	1.13 ± 0.30	<0.29	1.55 ± 1.92	1.08 ± 0.20
12	490	G+38	Surface	0.66 ± 0.31	0.97 ± 0.23	<0.17	0.39 ± 1.13	0.61 ± 0.18
			0.3	1.51 ± 0.35	1.65 ± 0.33	<0.67	1.33 ± 1.31	0.90 ± 0.68
			1.5	0.83 ± 0.35	0.87 ± 0.36	<0.20	1.00 ± 1.57	0.92 ± 0.23
			Composite	0.88 ± 0.38	0.93 ± 0.21	<0.26	<0.83	
13	515	G+25	Surface	0.49 ± 0.33	1.32 ± 0.36	<0.18	1.58 ± 1.19	1.04 ± 0.27
			0.5	1.56 ± 0.33	1.23 ± 0.36	<0.29	1.57 ± 1.47	0.81 ± 0.25
			1.5	0.82 ± 0.26	0.57 ± 0.27	<0.19	<0.57	0.87 ± 0.22
14	345	H+11	Surface	1.04 ± 0.35	3.81 ± 0.51	<0.21	2.81 ± 1.17	1.04 ± 0.32
			0.5	1.30 ± 0.35	1.20 ± 0.33	<0.33	2.81 ± 1.65	1.02 ± 0.26
			1.5	1.20 ± 0.43	0.84 ± 0.36	<0.22	1.57 ± 0.96	1.19 ± 0.22
15	340	H+33	Surface	1.32 ± 0.33	1.47 ± 0.24	<0.29	0.87 ± 1.35	1.29 ± 0.23
			0.3	15.1 ± 1.0	15.3 ± 1.0	<0.62	5.87 ± 3.34	3.76 ± 0.48
			1.5	4.44 ± 0.83	5.25 ± 0.51	<0.46	7.04 ± 1.86	1.25 ± 0.25
			4.8	1.69 ± 0.38	1.56 ± 0.36	<0.21	1.24 ± 1.33	0.71 ± 0.21
16	328	I+8	Surface	0.63 ± 0.29	1.04 ± 0.25	<0.22	<0.71	0.57 ± 0.15
			0.5	0.58 ± 0.26	0.69 ± 0.21	<0.17	<0.52	0.46 ± 0.18

TABLE 8 (Continued)

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.	Grid Location		Depth m	Radionuclide Concentrations (pCi/g)				
				Th-232	Th-228	U-235	U-238	Ra-226
			1.5	0.84 ± 0.33	1.05 ± 0.24	<0.25	<0.83	0.68 ± 0.13
			Composite	1.12 ± 0.38	1.02 ± 0.30	<0.18	1.42 ± 1.46	0.72 ± 0.23
17	125	L+5	Surface	0.76 ± 0.36	1.35 ± 0.30	<0.25	1.19 ± 1.48	0.99 ± 0.35
			0.5	1.01 ± 0.46	1.08 ± 0.39	<0.28	1.62 ± 1.66	0.93 ± 0.20
			1.5	1.16 ± 0.45	1.23 ± 0.45	0.35 ± 0.47	1.16 ± 1.45	0.89 ± 0.31
18[c]	235	F+35	Surface	1.53 ± 0.45	1.35 ± 0.38	<0.33	<1.10	1.02 ± 0.23
			0.9	1.33 ± 0.48	1.60 ± 0.34	0.46 ± 0.67	<1.09	0.67 ± 0.30
19[c]	249	G+38	Surface	0.92 ± 0.38	0.98 ± 0.35	<0.18	<0.17	0.97 ± 0.22
			0.9	0.93 ± 0.32	0.87 ± 0.27	<0.25	<0.83	0.69 ± 0.20
20[c]	292	G+15	Surface	0.39 ± 0.35	1.20 ± 0.38	<0.20	1.29 ± 0.63	1.00 ± 0.27
			0.9	1.48 ± 0.35	1.36 ± 0.35	<0.22	1.61 ± 1.59	0.84 ± 0.24
21[c]	335	20	Surface	0.76 ± 0.57	0.94 ± 0.34	<0.22	1.85 ± 1.88	1.05 ± 0.26
			0.9	0.86 ± 0.29	0.89 ± 0.28	<0.26	<0.79	0.48 ± 0.12
22[c]	287	H+5	Surface	1.05 ± 0.26	0.54 ± 0.14	<0.14	0.56 ± 0.48	0.56 ± 0.18
			0.9	0.96 ± 0.32	1.10 ± 0.27	<0.21	1.55 ± 0.99	0.90 ± 0.23
23[c]	323	H+15	Surface	1.76 ± 0.36	1.70 ± 0.35	<0.27	2.91 ± 2.25	0.60 ± 0.20
			0.9	1.24 ± 0.39	1.23 ± 0.42	<0.18	1.28 ± 0.61	1.03 ± 0.25

[a]Refer to Figure 4.
[b]Errors are 2σ based on counting statistics.
[c]Shallow borehole in drainage area.

TABLE 9

SUMMARY OF SURFACE CONTAMINATION MEASUREMENTS IN BUILDINGS

Building	Refer to Figure	Surface	Range of Contamination Levels: Total Contamination ($dpm/100cm^2$) Alpha	Total Contamination ($dpm/100cm^2$) Beta-Gamma	Transferable Contamination ($dpm/100cm^2$) Alpha	Transferable Contamination ($dpm/100cm^2$) Beta	Gamma Exposure Rate at 1 m Above the Floor (μR/h)
Alloy	8	Floors	<30 - 64	<356 - 1216	<2 - 4	<6 - 11	6.8 - 12.5
		Walls/Ceilings	<30 - 127	<356 - 760	<2 - 3	<6 - 8	
Aluminathermic	9	Floors	<30 - 127	<356 - 4826	<2 - 3	<6	8.8 - 21.9
		Walls/Ceilings	<30 - 170	<356 - 2166	<2 - 4	<6 - 8	
Benefco	10	Floors	<30 - 42	<356 - 532	<2 - 4	<6	6.8 - 8.4
		Walls/Ceilings	<30 - 42	<356	<2 - 3	<6 - 9	
Building #2	11	Floors	<30 - 42	<356 - 988	<2 - 3	<6	8.8 - 12.9
		Walls/Ceilings	<30 - 148	<356 - 912	<2 - 4	<6	
Cobalt	12	Floors	<30 - 85	<356 - 722	<2 - 3	<6 - 16	8.0 - 9.7
		Walls/Ceilings	<30 - 42	<356	<2	<6	
High Temp	13	Floors	<30 - 42	<356 - 988	<2 - 4	<6 - 7	7.2 - 9.2
		Walls/Ceilings	<30 - 42	<356	<2 - 3	<6 - 9	
Lab	14	Floors	<30 - 42	<356 - 798	<2 - 3	<6	9.7 - 12.1
		Walls/Ceilings	<30 - 96	<356 - 418	<2 - 3	<6 - 7	
Locker Room	15	Floors	<30 - 42	<356 - 1254	<2 - 4	<6 - 7	8.8 - 9.7
		Walls/Ceilings	<30	<356	<2 - 6	<6 - 8	
Maintenance I	16	Floors	<30	<356 - 1026	<2 - 6	<6 - 7	6.8 - 8.6
		Walls/Ceilings	<30	<356	<2	<6 - 9	

TABLE 9 (Continued)

SUMMARY OF SURFACE CONTAMINATION MEASUREMENTS IN BUILDINGS

			Range of Contamination Levels				
			Total Contamination (dpm/100cm^2)		Transferable Contamination (dpm/100cm^2)		Gamma Exposure Rate at 1 m Above the Floor (μR/h)
Building	Refer to Figure	Surface	Alpha	Beta-Gamma	Alpha	Beta	
Maintenance II	17	Floors	<30 - 42	<356 - 798	<2 - 3	<6 - 20	8.0 - 10.5
		Walls/Ceilings	<30 - 64	<356	<2 - 3	<6 - 7	
Melt Shop	18	Floors	<30 - 127	<356 - 1406	<2 - 3	<6 - 16	6.6 - 11.3
		Walls/Ceilings	<30 - 191	<356 - 418	<2 - 7	<6 - 8	
Office	19	Floors	<30	<356 - 950	<2	<6 - 7	8.4 - 11.3
		Walls/Ceilings	<30 - 42	<356 - 418	<2	<6	
Old Melt Shop	20	Floors	<30 - 42	<356 - 1330	<2 - 4	<6 - 21	6.8 - 11.3
		Walls/Ceilings	<30 - 85	<356	<2 - 4	<6 - 19	
Process Lab	21	Floors	<30 - 64	<356 - 1026	<2 - 4	<6	7.6 - 9.9
		Walls/Ceilings	<30 - 96	<356 - 570	<2 - 3	<6 - 7	
Shed	22	Floors	<30 - 42	<356 - 380	<2 - 4	<6 - 20	8.4 - 11.7
		Walls/Ceilings	<30	<356	<2 - 3	<6 - 20	

TABLE 10

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES FROM BUILDING FLOORS

Building	Location	Radionuclide Concentrations (pCi/g)				
		Th-232	Th-228	U-235	U-238	Ra-226
Aluminathermic[a]	Bay 1	1.59 ± 0.48[b]	2.10 ± 0.39	1.09 ± 0.96	7.29 ± 2.77	9.65 ± 0.56
	Bay 2	7.19 ± 0.66	7.41 ± 0.69	<0.38	3.31 ± 2.52	1.64 ± 0.33
	Bay 3	8.93 ± 1.05	10.3 ± 1.0	<0.47	5.24 ± 1.80	0.72 ± 0.54
	Bay 6	0.52 ± 0.26	0.45 ± 0.15	0.16 ± 0.16	0.50 ± 0.81	0.18 ± 0.16
	Bay 6	1.06 ± 0.40	1.02 ± 0.24	<0.22	<0.69	<0.09
	Bay 9	0.78 ± 0.25	0.78 ± 0.24	<0.16	<0.49	0.63 ± 0.13
Benefco	Trench	1.13 ± 0.33	1.17 ± 2.91	<0.15	<0.54	0.29 ± 0.18
High Temp	Trench	0.96 ± 0.22	2.88 ± 0.24	<0.21	0.27 ± 0.96	0.49 ± 0.96
Old Melt Shop[c]	Bay 1	1.13 ± 0.33	1.35 ± 0.99	<0.29	1.56 ± 1.91	0.67 ± 0.16
	Bay 2	1.50 ± 0.47	2.10 ± 0.48	<0.22	1.39 ± 1.48	0.35 ± 0.21
	Bay 2 - Pit	3.76 ± 0.59	3.33 ± 0.60	<0.40	4.17 ± 1.92	0.87 ± 0.33
	Bay 3	0.94 ± 0.30	0.60 ± 0.27	<0.18	1.05 ± 1.03	0.33 ± 0.39
	Bay 4	2.42 ± 0.63	2.16 ± 0.36	<0.32	3.57 ± 1.26	0.59 ± 0.16
	Bay 5	1.48 ± 0.35	1.32 ± 0.36	<0.20	1.02 ± 1.17	0.69 ± 0.16
	Bay 6	1.09 ± 0.41	0.90 ± 0.33	<0.24	<0.82	0.59 ± 0.15

[a]Refer to Figure 7.
[b]Errors are 2σ based on counting statistics.
[c]Refer to Figure 20.

TABLE 11

RADIONUCLIDE CONCENTRATIONS IN WATER SAMPLES

Area	Sample Location	Radionuclide Concentrations (pCi/l) Gross Alpha	Gross Beta
Benefco	Trench 295, F+5	2.0 ± 1.69[a]	23.60 ± 2.96
High Temp	Trench East Side	1.08 ± 0.75	11.08 ± 1.33
Old Melt Shop	Pit North Side	0.43 ± 0.96	8.79 ± 1.83
Process Lab	Collection Tank 269, F+22	2.72 ± 17.27[b]	31.70 ± 26.82[b]
Drainage Area	250, G+20	1.93 ± 1.47	5.32 ± 2.11

[a]Errors are 2σ based on counting statistics.
[b]Large relative error is the result of small sample volume analyzed due to very high dissolved solids content.

REFERENCES

1. Assessment of the Quantity of Onsite Source Material for Alternate Planning Consideration, J. C. Terrill, Jr., Westinghouse Electric Corporation, March 1975.

2. Phase 1 - Health Physics Report for Whittaker Metals, Alloy Division, Greenville, Pennsylvania, Applied Health Physics, March 1975.

3. Report on Decontamination of the Aluminathermic Building, Whittaker Corporation, Greenville, Pennsylvania, Radiation Management Corporation, April 1983.

APPENDIX A

INSTRUMENTATION AND ANALYTICAL PROCEDURES

APPENDIX A

INSTRUMENTATION AND ANALYTICAL PROCEDURES

Gamma Scintillation Measurements

Walkover surface scans and measurements of gamma exposure rates were performed using Eberline Model PRM-6 portable ratemeters with Victoreen Model 489-55 gamma scintillation probes containing 3.2 cm x 3.8 cm NaI(Tl) crystals. Count rates were converted to exposure rates (μR/h) using factors determined by comparing the response of the scintillation detectors with that of a Reuter Stokes model RSS-111 pressurized ionization chamber at several locations on the surveyed property.

Borehole Logging

Borehole gamma radiation measurements were performed using a Victoreen Model 489-55 gamma scintillation probe, connected to a Ludlum Model 2200 portable scaler. The scintillation probe was shielded by a 1.25 cm thick lead shield with four 2.5 x 7 mm holes evenly spaced around the region of the scintillation detector. The probe was lowered into each hole using a tripod holder with a small winch. Measurements were performed at 30-50 cm intervals in all holes. The logging data were used to identify regions of possible residues and guide the selection of subsurface soil sampling locations. Due to the varying ratios of Th-232, Th-228, U-235, U-238, and Ra-226, there was no attempt to estimate soil radionuclide concentrations directly from the logging results.

Shallow borehole gamma radiation measurements were made with an Eberline PRM-6 portable ratemeter with Victoreen 3.2 cm x3.8 cm NaI(Tl) scintillation crystals. The probe was lowered into each hole to identify possible regions of contamination.

Surface Contamination Measurements in Building

Measurements of surface alpha contamination were performed using Eberline "Rascal" Model PRS-1, scaler/ratemeters with Model AC3-7 ZnS (Ag) alpha scintillation probes. Beta-gamma contamination was measured with Eberline Model HP-260 pancake G-M detectors and PRS-1 scaler/ratemeters. Count rates were converted to dpm/100cm^2. Conversion included subtraction of background rates and applying appropriate factors for detector calibration and effective probe areas.

Soil Sample Analysis

Soil samples were dried, mixed, and a portion sealed in a 0.5-liter Marinelli beaker. The quantity placed in each beaker was chosen to reproduce the calibrated counting geometry and ranged from 400 to 800 g of soil. Net soil weights were determined and the samples counted using Ge(Li) and intrinsic germanium detectors coupled to a Nuclear Data model ND-680 pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

Th-232 - 0.911 MeV from Ac-228*
Th-228 - 0.583 MeV from Tl-208*
U-235 - 0.143 MeV
U-238 - 0.094 MeV from the Th-234 or 1.001 MeV from Pa-234m*
Ra-226 - 0.609 MeV from Bi-214*

*Secular equilibrium was assumed.

Water Sample Analysis

Water samples were rough-filtered through Whatman No. 2 filter paper. Remaining suspended solids were removed by subsequent filtration through 0.45μ m membrane filters. The filtrate was acidified by addition of 10 ml of concentrated nitric acid. Aliquots were then evaporated to dryness and counted for gross alpha and gross beta using a Tennelec Model LB 5100 low-background proportional counter.

Calibration and Quality Assurance

With the exception of the exposure conversion factor for the portable survey gamma meter, all survey and laboratory instruments were calibrated with NBS-traceable standards. The calibration procedures for the gamma scintillation instrument are described above.

Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operations are within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA Quality Assurance Program.

APPENDIX B

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE OR SPECIAL NUCLEAR MATERIAL

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U.S. Nuclear Regulatory Commission
Divison of Fuel Cycle & Material Safety
Washington, D.C. 20555

July 1982

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces or premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

    a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

    b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of

the survey report shall be filed with the Division of Fuel Cycle and Material Safety, USNRC, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

a. Identify the premises.

b. Show that reasonable effort has been made to eliminate residual contamination.

c. Describe the scope of the survey and general procedures followed.

d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclides[a]	Average[b,c,f]	Maximum[b,d,f]	Removable[b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223 Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1000 dpm $\beta\gamma$/100 cm^2

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

[b] 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.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

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

[e] 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 assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

FOLLOWUP SURVEY FINDINGS
FORMER WHITTAKER METAL CORPORATION PROPERTY
GREENVILLE, PENNSYLVANIA

Prepared by:

J.D. Berger

ORAU Radiological Site Assessment Program

INTRODUCTION

During June 1984, the Radiological Site Assesment Program of Oak Ridge Associated Universities performed a confirmatory radiological survey of the former Whittaker Metals Corporation property in Greenville, PA. The property had been the site of foundry operations involving ores containing low levels of thorium and uranium. Slags containing thorium and uranium were waste products of this process. Results of that survey are presented in a November 1984 report to the Nuclear Regulatory Commission (NRC). The survey verified that most of the property now occupied by Greenville Metals satisfies the NRC guidelines for release for unrestricted use. However, three locations had direct radiation levels which indicated residual contamination exceeding the NRC guidelines. These locations, shown on Figure 1, were:

1. A pile of recently generated slag within grid lines D, F,320, and 400.
2. A small area of the drainage ditch, near grid coordinate H,320.
3. The south end of the Aluminathermic Building.

Remedial action has been performed at these three locations, under the direction of Energy Impact Associates. On December 6, 1984, ORAU conducted direct radiation measurements to confirm the effectiveness of these cleanup activities. The findings of this followup survey are described in this report.

Prepared by the Manpower Education, Research, and Training Division of Oak Ridge Associated Universities (ORAU) Oak Ridge, Tennessee under Interagency Agreement DOE No. 40-770-80 NRC Fin. No. 9093-0 between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy.

December 18, 1984

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PROCEDURES AND RESULTS

Area 1. Slag Pile

Inspection verified that the slag has been removed from this area. Surface scans were conducted at 4-5 m intervals using gamma scintillation detectors. Two small isolated areas of elevated contact radiation were identified at grid coordinates E+3,335 and D+13,380. Exposure rates were measured at the surface and 1 meter above the surface, at the two locations identified by the scan and at 14 additional locations within the previous slag pile area (see Figure 2). The maximum exposure rates at contact was 22 μR/h at E+3,335; at D+13,380 the contact level was 19 μR/h. Exposure rates at 1 m at these two locations were 13 and 12 μR/h, respectively (refer to Table 1). At all other locations within this area the exposure rates at contact and 1 m above the surface ranged from 9 to 10 μR/h.

Slag removed from this area had been separated, based on direct radiation monitoring. The portion determined to contain thorium and uranium contamination was placed into metal drums and, at the time of this followup survey, these drums were being loaded onto trucks for transport to the waste disposal site in Richland, Washington. The remaining (noncontaminated) slag has been relocated to another section of the property near grid coordinate G,160 (see Figures 1 and 3). A gamma scan of this slag pile did not identify any areas of elevated radiation. Exposure rates ranged from 8 to 13 μR/h on contact and 8 to 11 μR/h at 1 m above the surface.

Area 2. Drainage Ditch

An area of the drainage ditch, approximately 5 m x 7 m around grid coordinate H,320, (see Figure 4), was scanned. No locations of elevated surface radiation were noted. Exposure rates throughout this area were 9 to 15 μR/h at contact and 9 to 12 μR/h at 1 m above the surface.

Area 3. Aluminathermic Building

Five bays at the south end of the Aluminathermic Building were gamma scanned at 1-2 m intervals and one small area of elevated surface radiation was noted. Exposure rates at contact and 1 m above the surface were measured at this elevated location and at 16 additional locations throughout this portion of the building (see Figure 5). At the location identified by the scan, the contact and 1 m exposure rates were 22 and 16 μR/h, respectively. Exposure rates ranged from 14 to 17 μR/h at contact and from 13 to 18 μR/h at 1 m in other areas of the building (refer to Table 2).

CONCLUSIONS

Direct radiation measurements were performed at locations on the former Whittaker Metals Corporation property, where remedial action had been conducted. The results of these measurements confirm that remedial action activities were effective in removing contaminated slag from the site and reducing direct radiation levels. Although two small isolated locations, with surface radiation levels of 22 μR/h remain, exposure rates at 1 m above the surface are less than 20 μR/h.

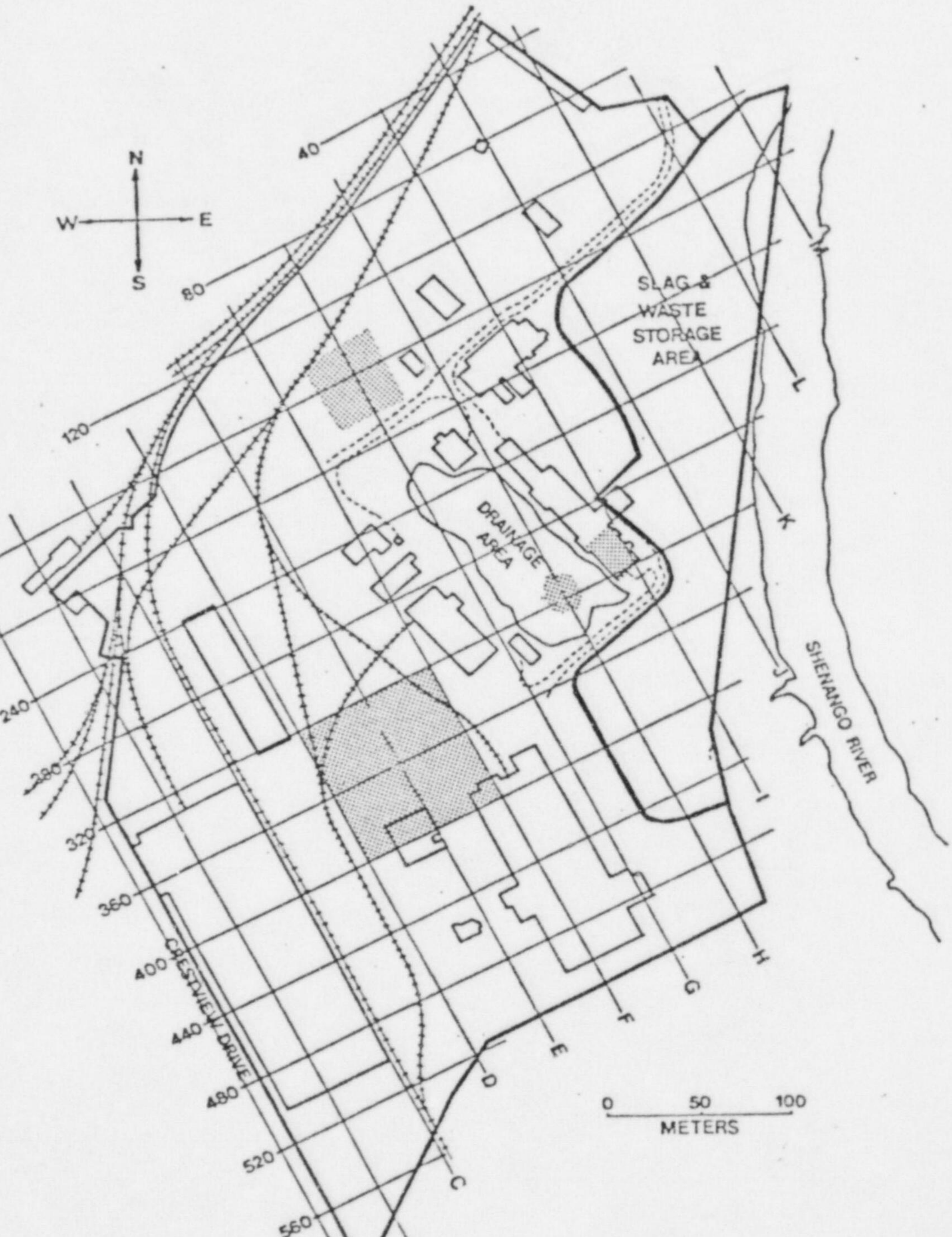

FIGURE 1: Map of the Former Whittaker Metals Corporation Property, Indicating Locations Involved in the Followup Survey.

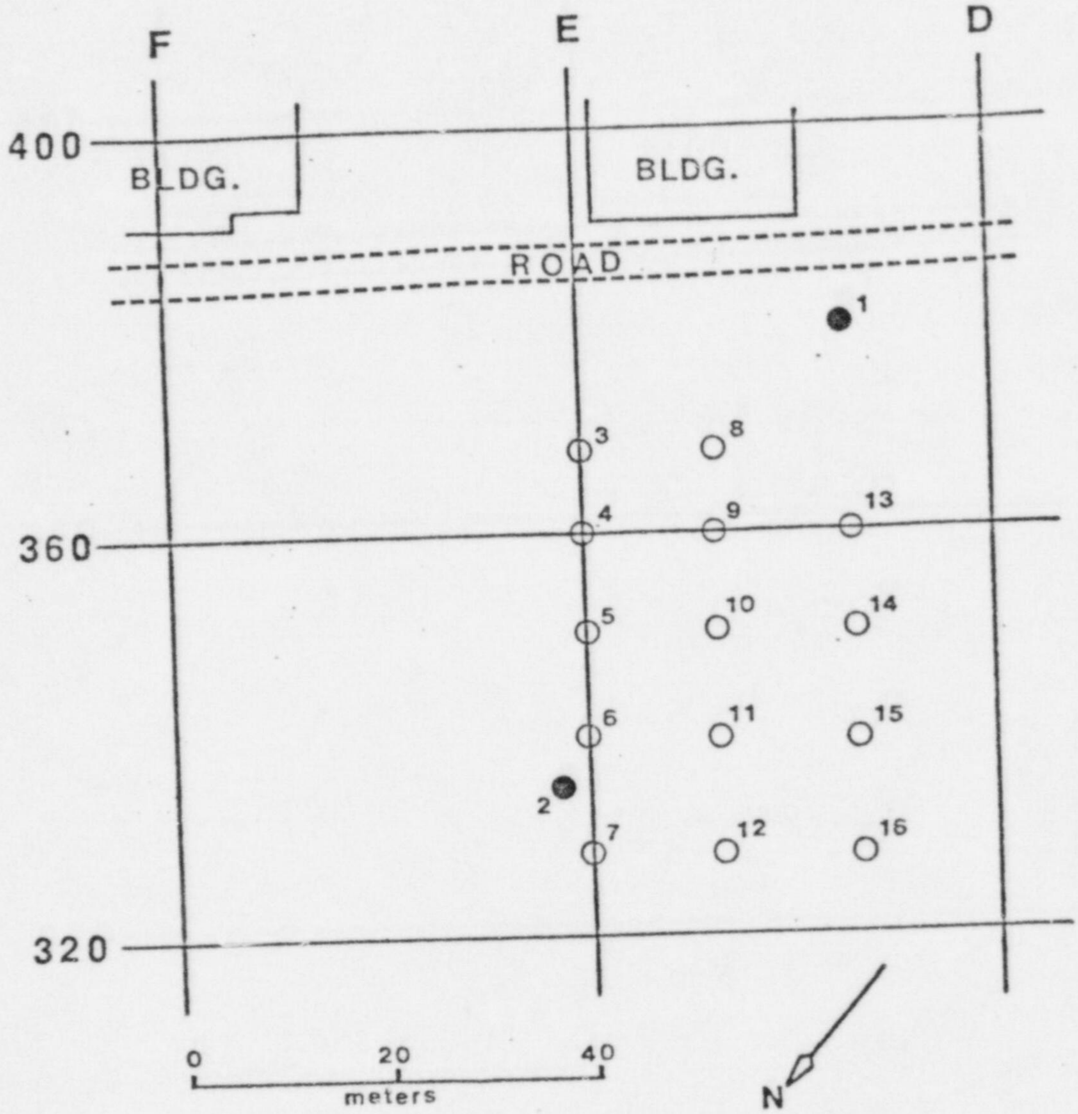

FIGURE 2: Region of Previous Slag Pile, Showing Areas of Elevated Surface Radiation and Locations of Exposure Rate Measurements.

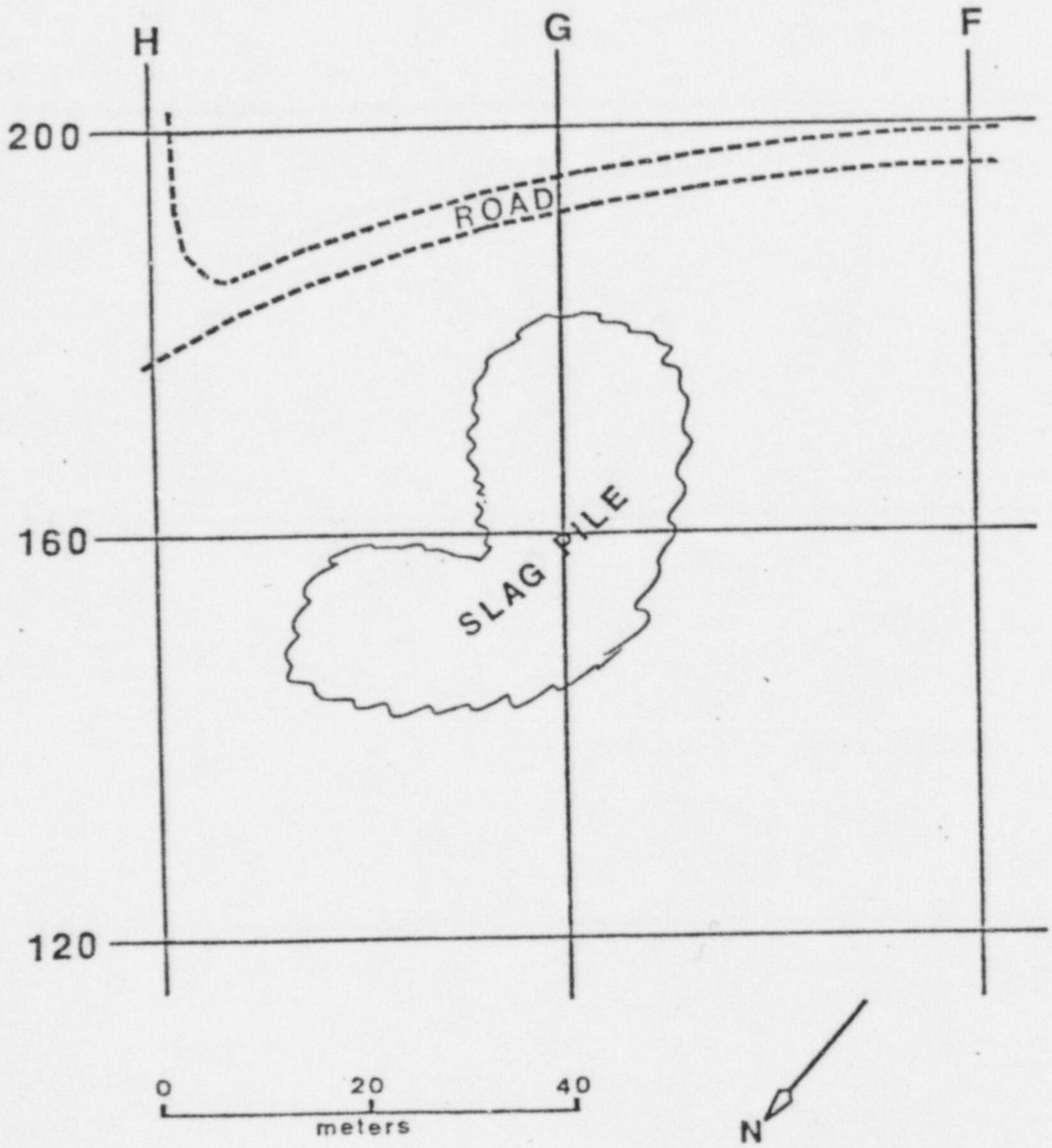

FIGURE 3: Area Containing Relocated (noncontaminated) Slag.

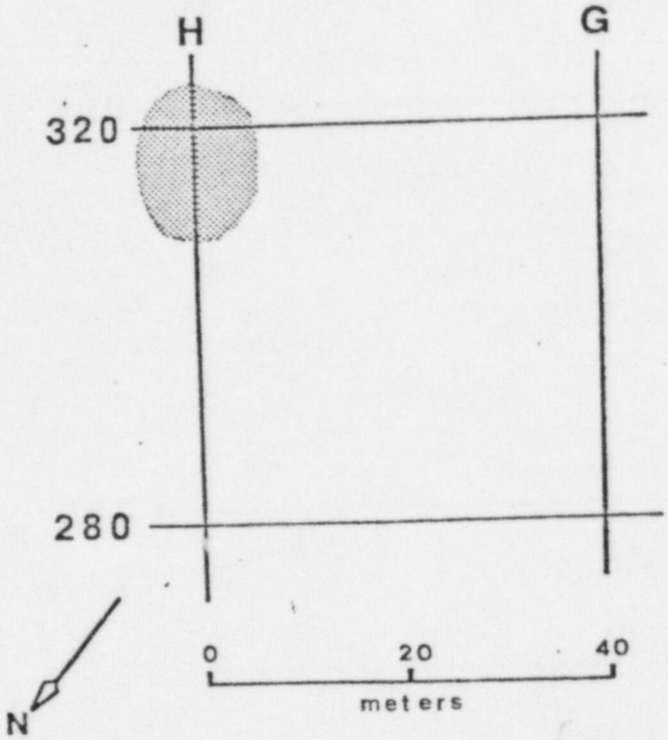

FIGURE 4: Section of Drainage Ditch, Indicating Area of Remedial Action and Resurvey.

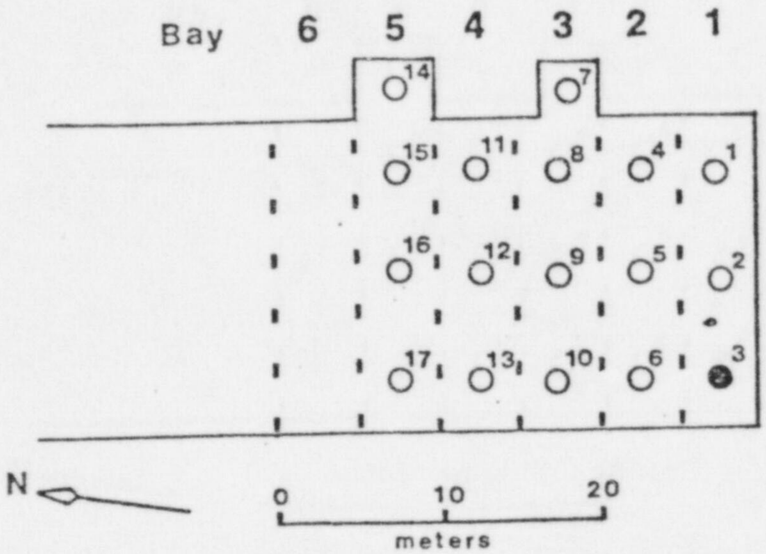

FIGURE 5: Map of South End of Aluminathermic Building, Showing Locations of Elevated Area and Exposure Rate Measurements.

TABLE 1

EXPOSURE RATES MEASURED IN THE PREVIOUS SLAG PILE AREA

Location[a]	Exposure Rate (μR/h)	
	Contact	1 m Above Surface
1	19	12
2	22	13
3	10	10
4	9	9
5	10	9
6	10	10
7	9	9
8	10	10
9	10	9
10	9	9
11	10	9
12	10	10
13	10	10
14	10	10
15	10	10
16	9	9

[a] See Figure 2.

TABLE 2

EXPOSURE RATES MEASURED IN THE ALUMINATHERMIC BUILDING

Location[a]	Exposure Rate (μR/h)	
	Contact	1 m Above Surface
1	16	16
2	15	13
3	22	16
4	16	17
5	16	14
6	15	13
7	17	18
8	14	16
9	15	15
10	14	15
11	14	16
12	16	15
13	15	15
14	16	16
15	15	15
16	16	14
17	14	15

[a] See Figure 5.