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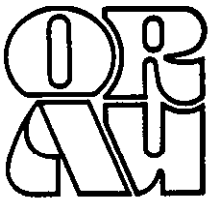

Prepared by
Oak Ridge Associated
Universities

Prepared for
U.S. Nuclear
Regulatory
Commission's
Region I Office

Supported by
Safeguards and
Materials Program
Branch;
Division of
Quality Assurance,
Safeguards, and
Inspection Programs;
Office of
Inspection and
Enforcement

CONFIRMATORY RADIOLOGICAL SURVEYS OF BUILDING 10 AND OUTSIDE AREAS ASSOCIATED WITH BUILDINGS 7 AND 8 WESTINGHOUSE NUCLEAR FUEL DIVISION CHESWICK, PENNSYLVANIA

A. J. BOERNER

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

FINAL REPORT

November 1984

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Prepared for

Safeguards and Materials Program Branch
Division of Quality Assurance, Safeguards, and Inspection Programs
U.S. Nuclear Regulatory Commission
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This report is based on work performed under Interagency Agreement DOE No. 40-816-83 NRC Fin. No. A-9076 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.

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INTRODUCTION

From 1959 through 1979, the Nuclear Fuel Division of the Westinghouse Electric Corporation performed process development and pilot fabrication of reactor fuels at the Cheswick, Pennsylvania, site. Operations in the Uranium Oxide Laboratory, Building 7, and Plutonium Fuels Development Laboratory, Building 8, were terminated in 1979 and decontamination and decommissioning efforts began. Upon completion of the final radiological surveys of these facilities, the licensee presented the results in two reports (August and October, 1983, respectively) submitted to the Nuclear Regulatory Commission (NRC). The licensee's survey findings indicated the radiological conditions in both buildings satisfied the criteria for release for unrestricted use. The Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU) subsequently confirmed these findings in separate May, 1984 reports forwarded to the NRC Region 1 headquarters. At the additional request of the Nuclear Regulatory Commission, ORAU has also conducted confirmatory radiological surveys of Building 10, a small section of Building 7, and outside areas associated with Buildings 7 and 8. This report presents the procedures and results of those surveys.

SITE DESCRIPTION

The Cheswick Operations Facility of Westinghouse Electric Corporation is located on Low Grade Road, approximately 0.5 km northwest of Cheswick, Pennsylvania (see Figure 1). Buildings on this site, in which radioactive materials were handled, included: Building 6, the Astronuclear Laboratory; Building 7, housing the Uranium Oxide Laboratory and the Plutonium Development Laboratory; Building 8, the Plutonium Fuels Development Laboratory; and Building 9, the Naval Pump Repair Facility. Building 6 was previously decommissioned and has been demolished; Building 7 has also been decommissioned and the restricted portion removed; and Building 8, having

been decontaminated, has been decommissioned and dismantled. The Naval Pump Repair Facility adjacent to Building 7 is still in operation. Building 10 served as a security and receiving area for Building 8 and was more recently used for storage and to house a laboratory in support of decommissioning activities.

SURVEY PROCEDURES

During the period of May 7-12, 1984, ORAU personnel conducted confirmatory radiological surveys of Building 10 and outside areas in the vicinity of Buildings 7 and 8. The purpose of these surveys was to verify the adequacy and accuracy of the licensee's final survey and confirm the radiological condition of the facility and outside soil locations relative to decommissioning criteria.

Objectives

The objectives of these surveys were to:

1. measure direct radiation levels in Building 10 and outside areas associated with buildings 7 and 8.
2. measure total and removable surface contamination on floors, ceiling areas, walls, miscellaneous fixtures, sumps and drains in Building 10.
3. measure direct radiation and contamination in a small lean-to adjacent to Building 7.
4. determine radionuclide concentrations in soil and water and,
5. determine radionuclide concentrations in sediment from indoor and outdoor drains and sanitary sewers.

A. Building 10

Gridding

The grid system established by the licensee, i.e. 1 m x 1 m, on floors, walls and ceilings was used to reference measurements whenever possible.

In areas where decontamination activities had removed the original grid system, ORAU reestablished the grid. The grid system is presented in Figure 2.

Surface Measurements

Floor areas were scanned with an alpha floor monitor and low-energy gamma scintillation probe. Locations inaccessible to the floor monitor were scanned with a hand-held alpha scintillation probe. Alpha scanning was performed also on lower walls and horizontal overhead surfaces such as ledges, beams, pipes, and duct work.

Approximately 10% of the floor, 5% of the lower walls (to 2 m), and 2.5% of the upper walls and ceiling grid blocks were selected for confirmatory measurements.

In each grid block surveyed, direct measurements of alpha and beta-gamma contamination levels were systematically performed at the center and four equidistant points, midway between the center and block corners. Smears for transferable alpha and beta contamination were performed at the location in each grid block where the highest total measurement was obtained. Total and transferable contamination measurements were performed also on ledges, piping, and ungridded horizontal and vertical surfaces.

Exposure Rate Measurements

Gamma exposure rates at 1 m above the floor were measured at 20 locations throughout the building using a pressurized ionization chamber.

Water Sampling

Water samples were collected from four indoor drain locations and the south pit in Building 10 (see Figure 3).

B. Building 7

Exploratory measurements were performed in a 9 m x 12 m lean-to situated on the southwest corner of Building 7.

Portable ratemeters attached to NaI (Tl) gamma scintillation detectors were used for the walkover surface scan. Measurements of total contamination were performed on the floor, walls, ceiling, piping and miscellaneous equipment. Alpha scintillation detectors and beta-gamma probes connected to ratemeter/scalers were used to perform these measurements. Smears for transferable alpha and beta contamination levels were taken at locations of direct readings.

C. Outside Areas in the Vicinity of Buildings 7 and 8

The area surrounding Building 7 was gridded in 30-foot intervals with the exception of the area adjacent to the Naval Pump Repair Facility where a 10-foot grid pattern was established (Figure 4). A 30-foot grid pattern was established in the area previously occupied by Building 8 (see Figure 5); this grid duplicated the licensee's grid system.

Surface Measurements

a. A walkover surface scan of the gridded areas was performed using NaI (Tl) gamma scintillation detectors with audible ratemeters to identify locations of elevated radiation levels. The surface scan identified isolated areas of elevated readings on the south side of Building 7 which necessitated further subdivision of the grid into a 10-foot pattern.

b. Gamma exposure levels at the surface and 1 m above the surface and beta-gamma dose rates at the surface were measured at alternating grid line intersections (60-foot intervals) in the vicinity of Building 8. Exposure levels and dose rates in the vicinity of

Building 7 were recorded at each grid point and at locations of elevated surface readings. NaI (Tl) gamma scintillation detectors with audible ratemeters were used for exposure measurements. Beta-gamma dose rates were determined using G-M pancakes with scaler/ratemeters.

Surface Sampling

Surface (0-15 cm) soil samples were collected at each grid line intersection and at locations noted by the surface scan. The surface scan identified loose powdered material on the asphalt surface situated on the south side of Building 7; samples of this material were collected for analysis.

Subsurface Sampling

Shallow boreholes (0.30-0.60 m) were drilled on the east and south sides of Building 7 in suspected areas (as determined by the walkover surface scan) of Co-60, U-235, and U-238 contamination. Samples were collected from these shallow holes.

Sample Analysis and Interpretation of Data

Smears were counted to determine gross alpha activity. Soil samples were analyzed by gamma spectrometry for Am-241, Th-232, U-238, U-235, Co-60, Cs-137, and any other identifiable photopeaks. Major analytical equipment used for this survey is listed in Appendix A. Appendix B contains a description of the analytical procedures applicable to this survey.

Results were compared with guidelines for release of facilities for unrestricted use. Surface contamination guidelines, established by the Nuclear Regulatory Commission, are presented in Appendix C. The contamination guidelines for total plutonium alpha contamination are 100 dpm/100 cm^2 averaged over an area of 1 m^2 and 300 dpm/100 cm^2 maximum. Total uranium alpha surface contamination limits are 15,000 dpm/100 cm^2

maximum and 5000 dpm/100 cm^2 when averaged over an area of 1 m^2. The guideline for transferable alpha for uranium is 1000 dpm/100 cm^2. The recommended NRC guideline for plutonium, americium, and enriched uranium in soil is 30 pCi/g. A 10 pCi/g guideline was established for Co-60 in soil.

RESULTS

Building 10

Exposure Rates

Exposure rate measurements at 1 m above the floor throughout Building 10 ranged from 9 to 12 μR/h. These exposure rates are consistent with normal background levels.

Surface Contamination Levels

The results of surface contamination measurements are summarized in Table 1. Direct measurements of total plutonium alpha contamination levels were performed on floors, lower walls, upper walls, and ceilings. One area was identified as exceeding the maximum (300 dpm/100 cm^2) guideline value; this was 780 dpm/100 cm^2 at an isolated spot on a pipe located along the lower wall in grid block H-13. The piping was cleaned by the licensee and decontaminated to a level below the release guidelines. All grid blocks surveyed satisfied the guideline of 100 dpm/100 cm^2, average. Transferable plutonium alpha contamination levels at each smear location were below the 20 dpm/100 cm^2 criterion.

Radionuclide Concentrations in Water Samples

Five water samples were collected from four indoor drains and a pit located on the south end of Building 10 (refer to Table 2 and Figure 3). Gross alpha concentrations ranged from 1.05 to 10.8 pCi/l; gross beta concentrations ranged from 9.06 to 191 pCi/l. The highest level in both instances was found in the sample collected from the pit. Although the

beta activity is elevated, this water is not a source of drinking water or an effluent stream and does not exceed any guidelines.

Building 7 Lean-to

Exposure Rates

Gamma exposure rates (9 μR/h) at 1 m above the floor were in the range of normal background levels.

Surface Contamination Levels

Total alpha and beta contamination levels on the floor ranged from 28-730 dpm/100 cm^2 and <370-2210 dpm/100 cm^2, respectively. Direct measurements of alpha contamination levels on the walls and ceiling ranged from <18-55 dpm/100 cm^2. Beta contamination levels were less than the minimum detectable activity. Transferable contamination levels at smear locations throughout the area ranged from <2-11 dpm/100 cm^2 (alpha) and <5-20 dpm/100 cm^2 (beta). These results are well within the guidelines for uranium surface contamination.

Equipment, ductwork, and other accessible surfaces were scanned with an alpha detector. Three pieces of contaminated wood were identified and removed.

Outside Area - Building 7

Direct Radiation Levels

Direct radiation levels measured at grid line intersections in the vicinity of Building 7 are presented in Table 3. Contact gamma exposure levels ranged from 6 to 120 μR/h. The highest levels were recorded on the east side of the building and are due to ongoing activities at the adjacent Naval Pump Repair Facility. The maximum surface reading of 120 μR/h was recorded at grid point 90S,0W; the highest level at 1 m (80 μR/h) was observed at grid locations 130S,29W and 140S,29W, adjacent to the building.

The origin of the elevated levels at these two locations was later identified as a source being used by Westinghouse for instrument calibration at the time of the survey.

Beta-gamma dose rates ranged from 6 to 910 µrad/h. The highest level was recorded at grid point 175S,150W. It should be noted that direct radiation levels along the east fence (0W grid line) varied significantly during the period of the survey as a result of operations on the Naval Pump Repair Facility property. At one time gamma exposure rates at 1 m above the surface between grid points 110S,0W and 125S,0W exceeded 500 µR/h (the maximum level measureable using the sensitive instrumentation used by ORAU for confirmatory surveys).

The walkover surface scan identified eight locations of elevated contact gamma radiation levels. Those locations are indicated on Figure 6 and associated radiation levels presented in Table 4. Surface exposure rates ranged from 17 to 200 µR/h. The highest level was at grid location 171S,196W.

Beta-gamma dose rates ranged from 68 to 250 µrad/h; the highest dose rate was also measured at location 171S,196W. Sampling at these locations reduced the contact exposure rate, with the exception of location 172S,196W.

Radionuclide Concentrations in Soil

Radionuclide concentrations in surface soil collected from grid line intersections in the vicinity of Building 7 are presented in Table 5. The levels of U-238 ranged from <0.58 pCi/g to 3580 pCi/g. The highest concentration was recorded at grid location 175S,150W. The U-235 level at this grid point was also elevated (77.2 pCi/g). The survey identified Co-60 concentrations ranging from <0.03 to 116 pCi/g; the highest level was found at grid points 80S,0W and 90S,0W, along the east fenceline delineating the Building 7 area from the Naval Pump Repair Facility (Building 9). Concentrations of Th-232 were slightly elevated at several locations - 12.6 pCi/g at 175S,150W and 3.93 pCi/g at 70S,20W.

Americium-241 and Cs-137 concentrations were in the ranges of typical background levels or below the detection limits of the analytical procedure.

Radionuclide concentrations in samples from locations identified by the walkover scan are presented in Table 6. Samples from locations 70S,4W and 76S,10W identified Co-60 contamination in excess of the 10 pCi/g guideline (100 and 104 pCi/g, respectively). Surface sampling at grid points along the east fenceline also indicated the general presence of this contaminant. Samples from the south side of Building 7 identified U-238 concentrations ranging from 31.6 to 621 pCi/g; levels of U-235 ranged from 3.21 to 852 pCi/g. Maximum U-238 and U-235 concentrations of 5150 and 5420 pCi/g were observed in samples of loose, powder-like material removed from the macadam near the southwest corner of the building. A small graphite cylinder, containing high levels of U-238 (861 pCi/g) and U-235 (1660 pCi/g), was also removed from this general area.

Shallow boreholes (to 0.60 m) were drilled near Building 7, at five locations (Figure 7) suspected of having residual contamination levels exceeding guideline limits. Radionuclide concentrations in samples from these boreholes are presented in Table 7.

The licensee, at the time of ORAU's arrival in May, had removed an area of approximately 4.5 m^3 of soil (2.4 x 6.1 m x 0.3 m) on the east side originating at the fenceline (62-70S) separating Building 7 from the Naval Pump Repair Facility and extending west to the walkway (0-20W). Westinghouse determined that contamination extended to a depth of 0.60 m. ORAU collected two samples from location 70S,4W in the excavated area. A surface Co-60 concentration of 100 pCi/g was found; however, this level decreased to 6.58 pCi/g at a depth of 0.60 m.

Based on borehole logging measurements and subsurface soil samples, uranium contamination on the south side of the building was primarily in the surface soil layer. At each of the locations (171S,196W; 172S,196W; and 175S,150W) the concentrations decreased at 30 cm and 45 cm depths; however, the levels still exceed the guidelines at 45 cm deep at 171S,196W

and at 30 cm deep at 175S,150W. Co-60 contamination of 117 pCi/g on the surface at location 169S,173W decreased to 0.11 pCi/g at 45 cm deep.

The NRC asked the licensee to perform remedial action in areas identified by the ORAU survey as exceeding the soil concentration guidelines. Subsequent cleanup on the east side of Building 7 resulted in the removal of an estimated 7.5 m^3 of soil. Approximately 3.4 m^3 of soil, asphalt and, wood was removed from isolated locations on the south side of the building.

Table 8 presents results of surface sampling following the cleanup activities. Results indicate that surface concentrations of Co-60 exceeding 10 pCi/g remain along the fence (0W grid line). The maximum level measured was 48.9 pCi/g at 125S,0W. One additional area at 90S,20W, contained Co-60 at 18.5 pCi/g.

Twelve additional boreholes in the vicinity of the excavated trench area were drilled and results are presented in Table 9. Elevated levels of Co-60 were identified at only three locations: 70S,0W; 71S,20W; and 130S,0W. The highest level was 31.1 pCi/g at grid point 130S,0W. The contamination at this location and at 70S,0W is limited to the top 15-30 cm. At 71S,20W the contamination extends to approximately 60 cm.

Outside Areas - Previous Building 8 Location

Direct Radiation Levels

Table 10 presents the direct radiation levels measured in the area previously occupied by Building 8. Exposure rates at the surface ranged from 6 to 11 µR/h and at 1 m from 6 to 10 µR/h.

Beta-gamma dose rates ranged from 6 to 41 µrad/h. These levels are in the range of typical background radiation. No areas of elevated direct radiation were identified by the walkover scan.

Radionuclide Concentrations in Soil

Table 11 presents radionuclide concentrations in surface soil collected from grid line intersections in the area previously occupied by Building 8. Concentrations of Am-241 ranged from <0.03 to 0.86 pCi/g. Levels of other radionuclides were below gamma spectrometry detection limits or in the range of typical background concentrations. Composite samples were prepared for plutonium analysis by alpha spectroscopy (refer to Table 12). Each composite represented from 4 to 12 individual samples. Concentrations of Pu-238 ranged from 0.03 to 0.25 pCi/g; combined Pu-239 and Pu-240 concentrations ranged from <0.02 to 0.22 pCi/g. The results are well below the 30 pCi/g guideline established for plutonium in soil.

Radionuclide Concentrations in Sediment Samples from Drains

A sediment sample, collected from a sanitary sewer line near the metering station southeast of the previous Building 8 location, contained 485 pCi/g of U-238 and 130 pCi/g of U-235. The Co-60 concentration in this sample was 7.17 pCi/g. The licensee cleaned the sanitary sewer lines. Following this remedial action, an ORAU survey identified no residual sediment in the lines. Direct monitoring using gamma scintillation detectors indicated levels in the range of typical background.

Four samples were collected at the base of the storm drain outfall situated approximately 90 m west of previous Building 8. Am-241 concentrations ranged from <0.05 to 0.51 pCi/g. Concentrations of Th-232, U-238, U-235, Co-60 and, Cs-137 were also in the range of background levels or less than the minimum detectable activity.

SUMMARY

At the request of the Nuclear Regulatory Commission, ORAU conducted radiological surveys of Building 10, a small section of Building 7, and outside areas associated with Buildings 7 and 8 at the Westinghouse Nuclear Fuel Division in Cheswick, Pennsylvania, during May 7-12 and August 22-24, 1984. The purpose of the surveys was to verify the adequacy and accuracy

of the licensee's survey and to evaluate whether the facility and outdoor locations satisfy NRC guidelines for release from licensing.

The survey of Building 10 identified one small area of alpha contamination exceeding the established limits on an electrical conduit. The area was subsequently decontaminated to below the guideline values.

Three pieces of contaminated wood were removed from a small indoor area on the southwest corner of Building 7. No other locations of elevated activity were noted following direct measurements on the floors, walls, ceiling, piping, and equipment.

No locations of elevated radiation levels or soil contamination were found in the restricted outside areas surrounding Building 10 and the recently demolished Plutonium Fuels Development Laboratory (Building 8). Concentrations of Pu-238 and Pu-239/240 in composites of soil samples collected from grid point locations were well below the 30 pCi/g guideline of plutonium in soil.

Elevated uranium concentrations were identified in sediment collected from a sanitary sewer southeast of the previous Building 8 area. Westinghouse performed adequate decontamination of that area.

In the vicinity of Building 7, elevated direct radiation levels were identified along the east fenceline. These levels fluctuate, depending on activities in the adjacent Naval Pump Repair Facility; exposure rates exceeding 500 μR/h were measured on several occasions. There were several isolated and general areas of soil contamination to the east and south of Building 7. Contaminants were Co-60, U-235, and U-238. The licensee performed remedial action in those areas. Followup surveys indicate residual Co-60 contamination remains at grid location 90S,20W and in a general area along the east fenceline. All other areas were decontaminated to within the guideline concentrations.

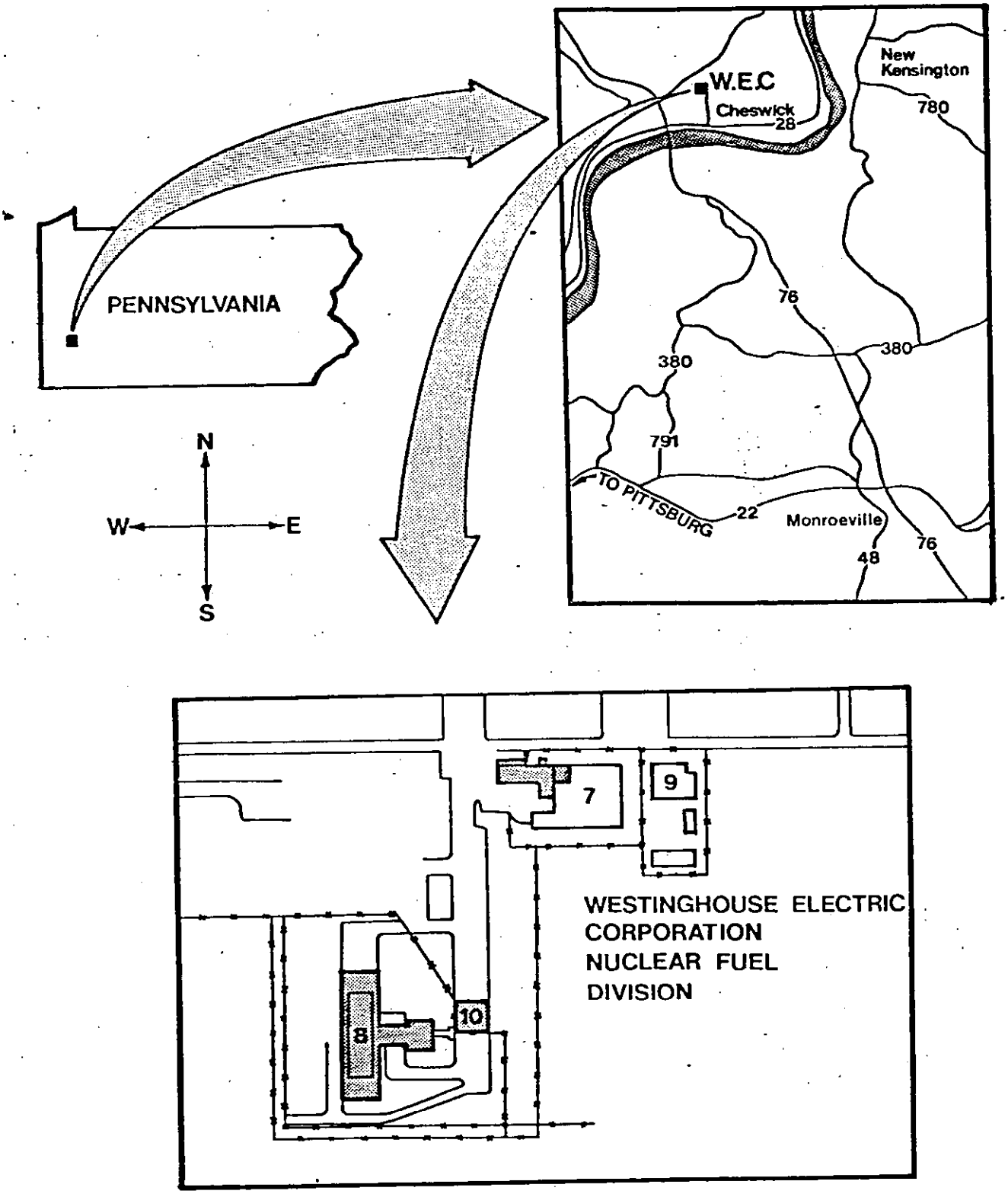

FIGURE 1: Maps Indicating the Location and General Layout of the Westinghouse Nuclear Fuel Division

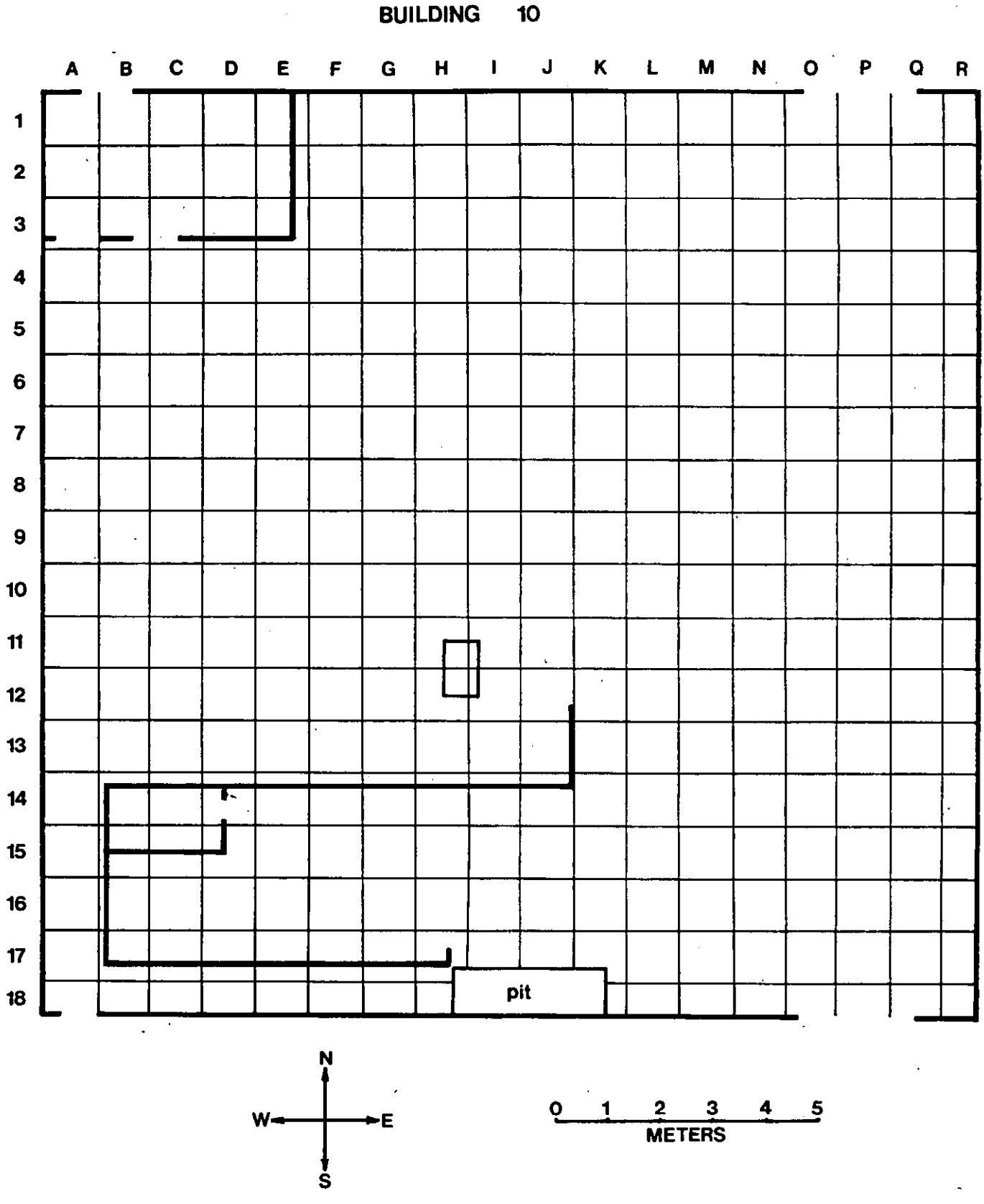

FIGURE 2: Floor Plan of Building 10 Indicating Reference Grid System

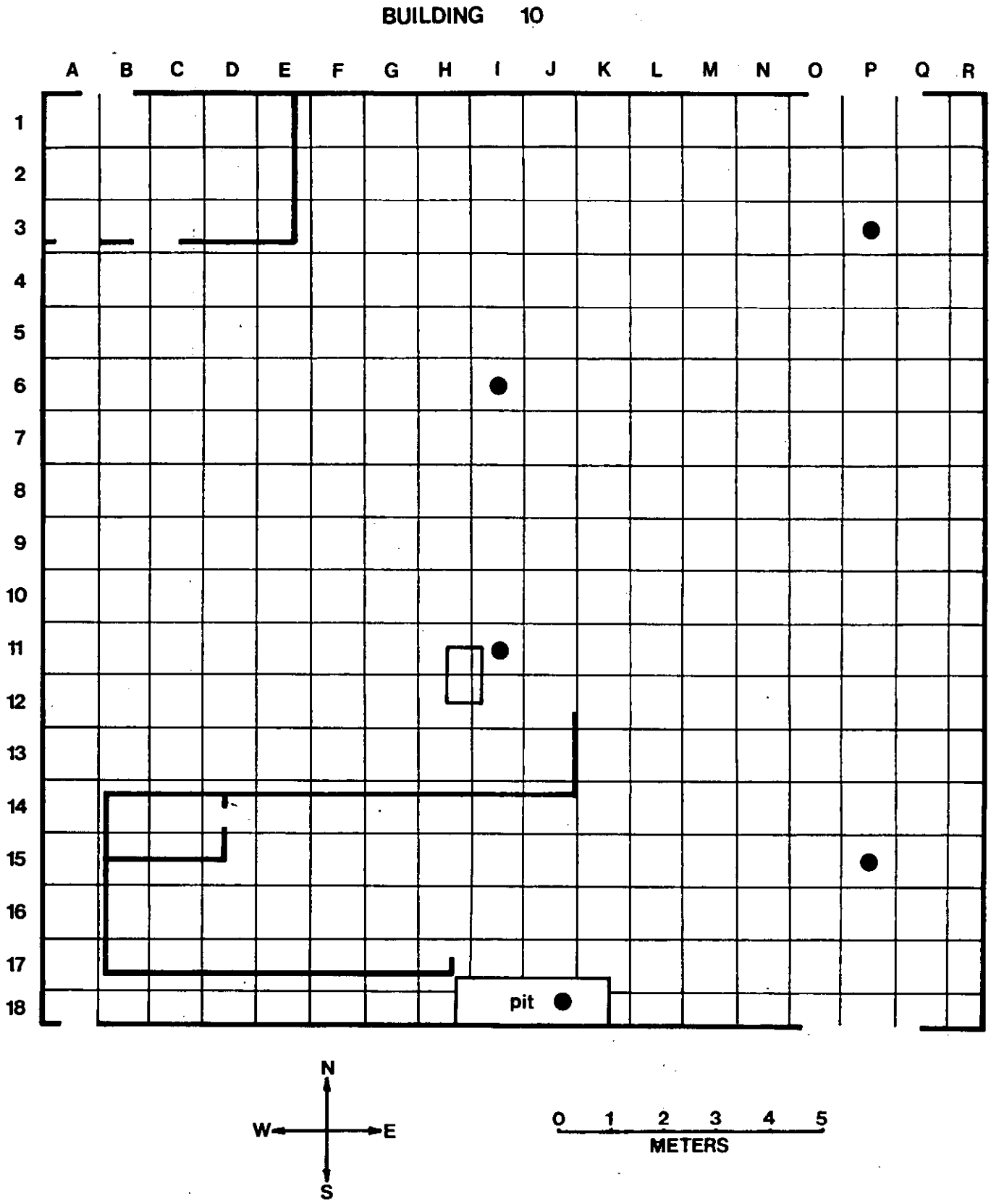

FIGURE 3: Location of Water and Sediment Samples from Building 10

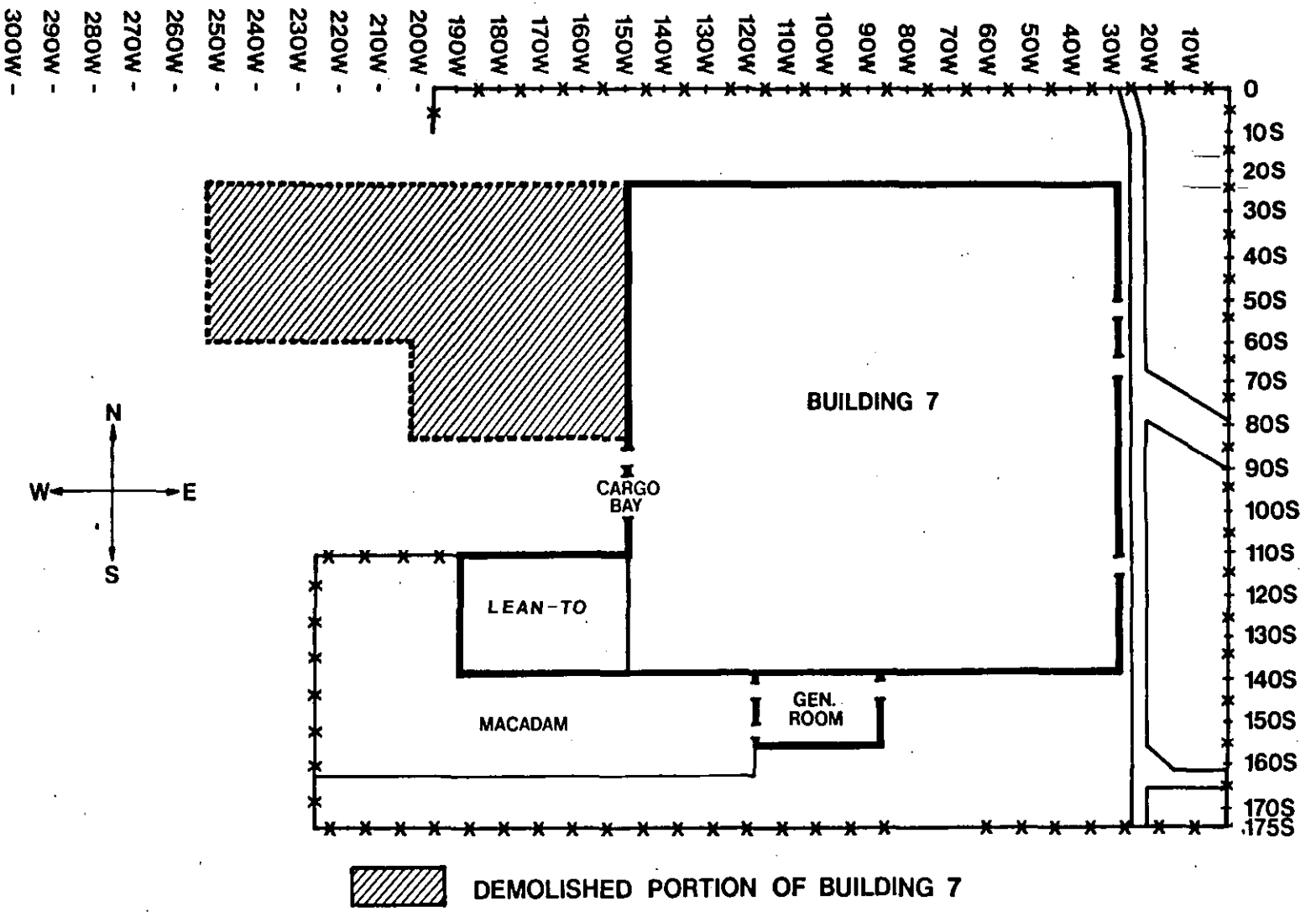

FIGURE 4: Grid System Established in the Vicinity of Building 7

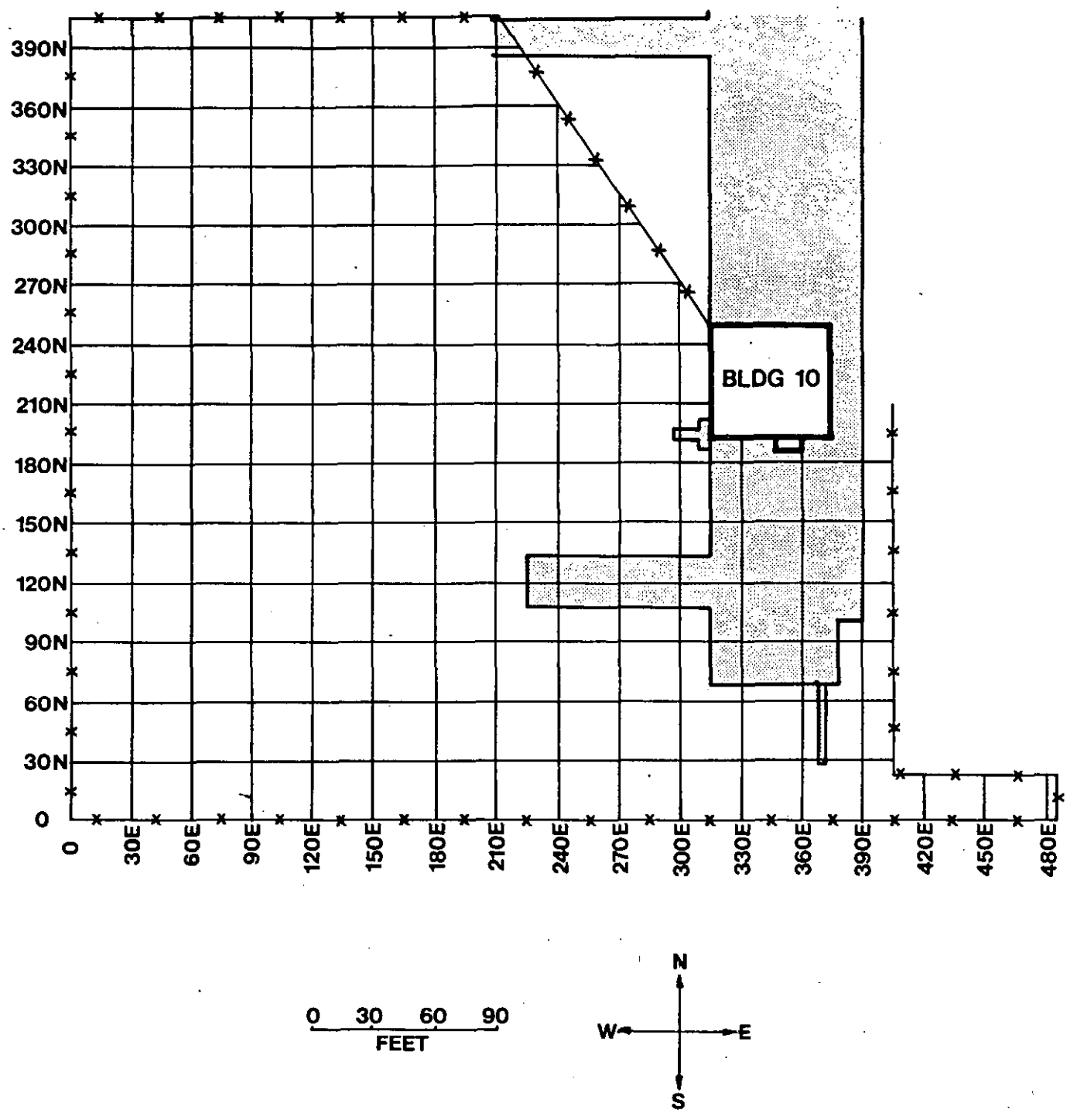

FIGURE 5: Grid System Established in the Area Previously Occupied by Building 8

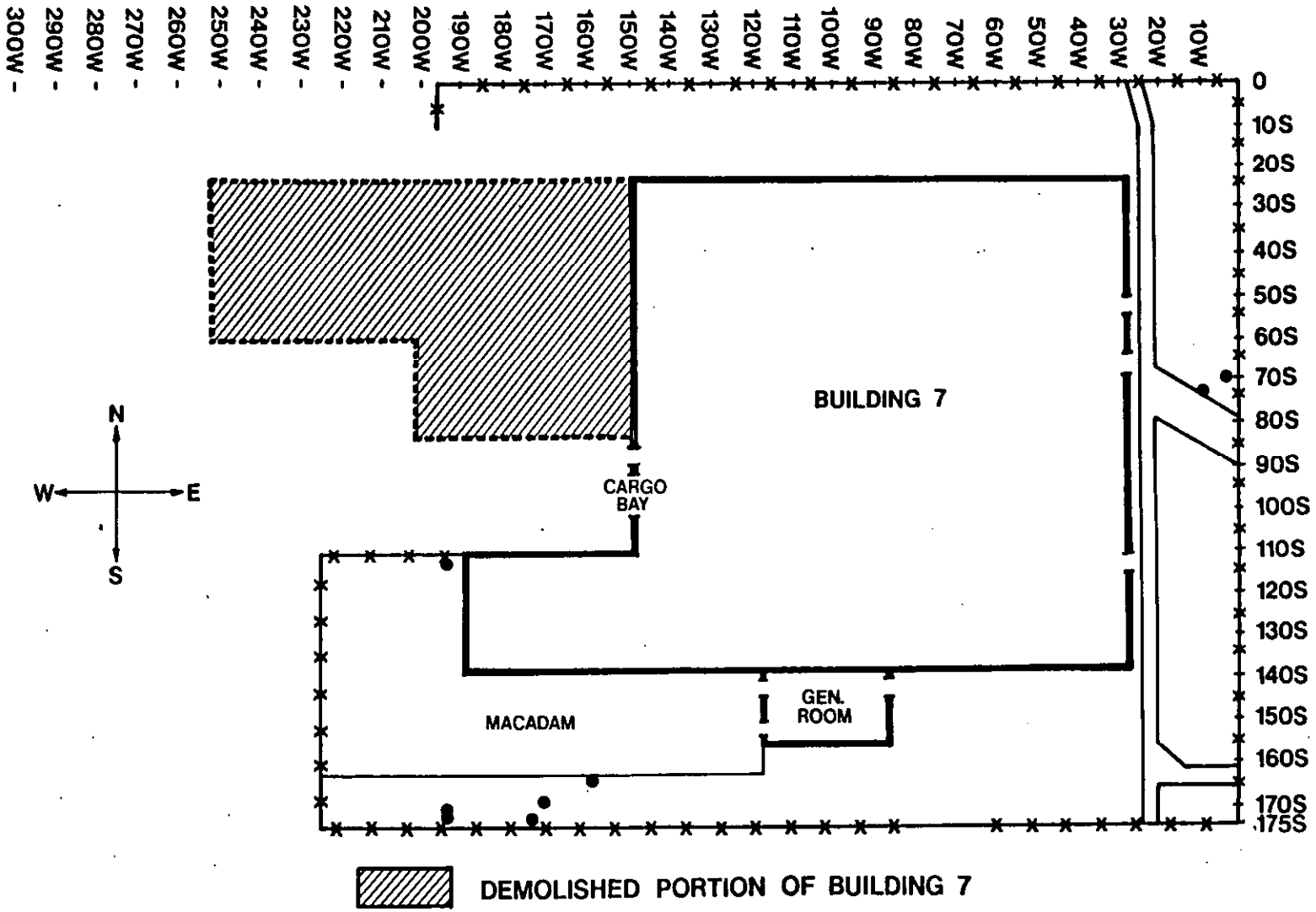

FIGURE 6: Locations of Elevated Direct Radiation Levels Identified in the Vicinity of Building 7

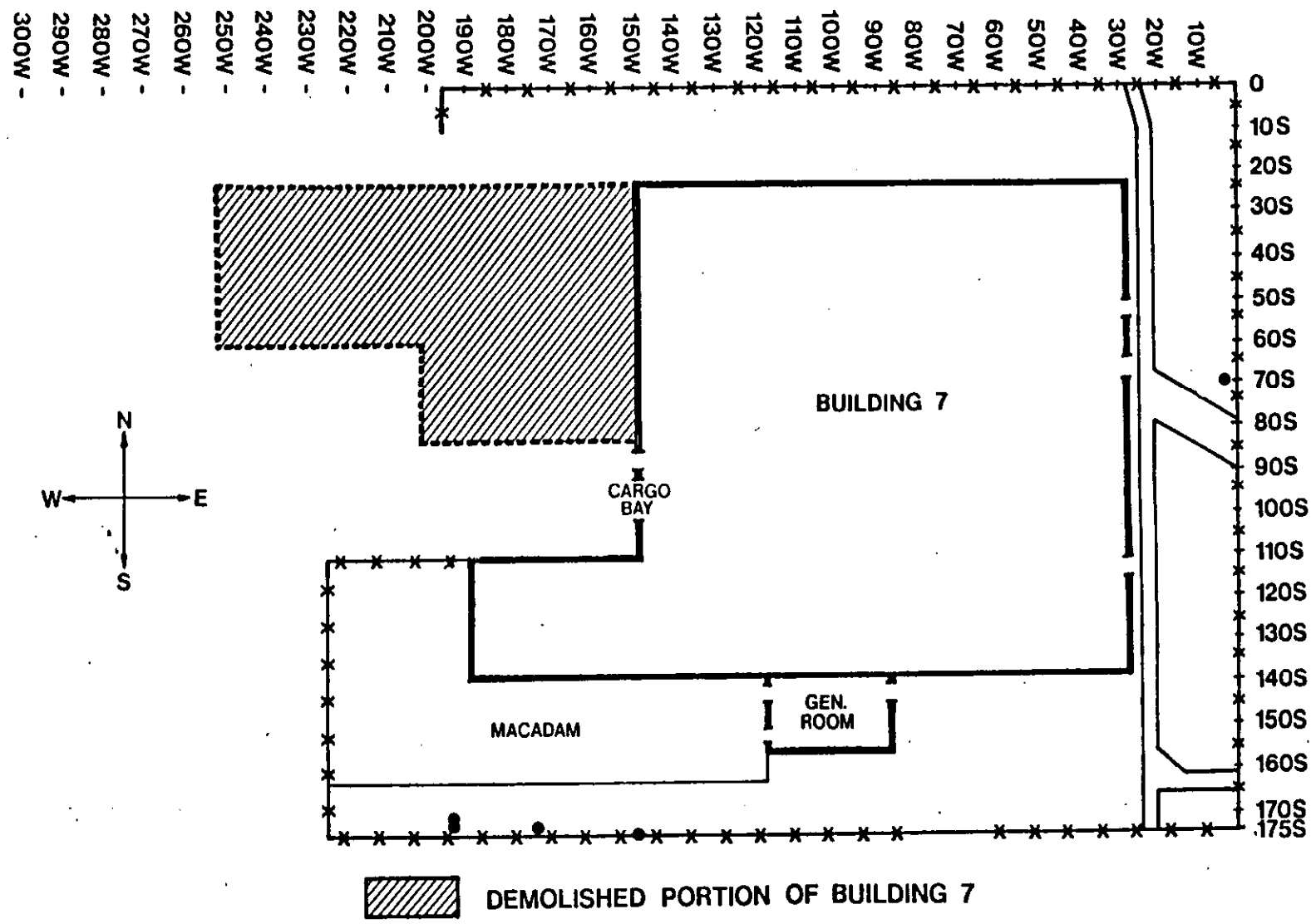

FIGURE 7: Location of Initial Boreholes near Building 7 for Subsurface Sampling

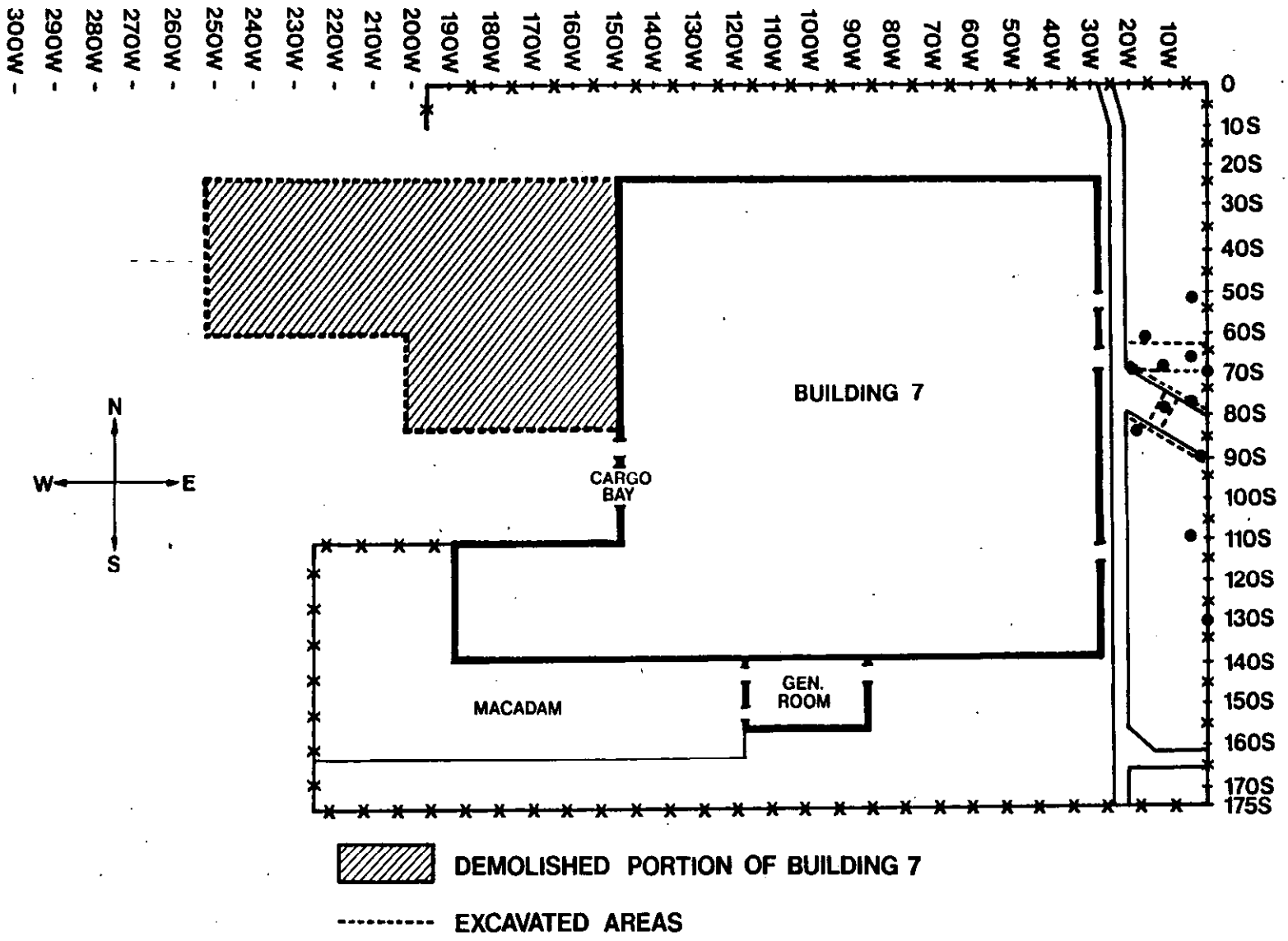

FIGURE 8: Location of Boreholes for Sampling near Building 7 after Remedial Action

TABLE 1

SUMMARY OF SURFACE CONTAMINATION MEASUREMENTS IN BUILDING 10

Surface	No. of Measurements	Total Alpha Contamination (dpm/100 cm^2)	Transferable Alpha Contamination (dpm/100 cm^2)
Floor	32	<27 - 160	<2 - 4
Lower Walls	19	<27 - 141	<2
Upper Walls	9	<27 - 179	<2
Ceiling	9	<27 - 141	<2
Conduit (Grid Block H-13, Lower Wall)	1	780 (Before Decontamination)	<2
Conduit (Grid Block H-13, Lower Wall)	1	66 (After Decontamination)	--

TABLE 2

RADIONUCLIDE CONCENTRATIONS IN WATER SAMPLES FROM BUILDING 10

Sample Type	Grid[a] Location	Radionuclide Concentrations (pCi/l) Gross Alpha	Gross Beta
Floor Drain	I-6	8.12 ± 5.63[b]	39.8 ± 8.7
Floor Drain	I-11	1.05 ± 0.78	9.06 ± 1.22
Floor Drain	P-3	3.84 ± 1.30	24.8 ± 2.0
Floor Drain	P-15	1.85 ± 0.63	16.7 ± 1.1
Pit	J-18	10.8 ± 2.2	191 ± 5

[a]Refer to Figure 3.
[b]Errors are 2σ based on counting statistics.

TABLE 3

DIRECT RADIATION LEVELS MEASURED AT GRID LINE INTERSECTIONS - BUILDING 7

Grid[a] Location S	Grid[a] Location W	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
0	0	21	21	33
0	10	21	17	29
0	20	17	17	20
0	30	17	17	34
0	60	13	13	18
0	90	13	13	25
0	120	10	10	19
0	150	10	10	10
0	180	8	11	27
0	210	9	10	16
0	240	10	9	9
0	270	10	10	32
0	300	11	13	33
10	0	25	25	31
10	10	21	21	27
10	20	21	19	21
10	30	21	19	29
10	60	17	13	13
10	90	13	13	13
10	120	13	13	30
10	150	10	8	8
20	0	21	21	41
20	10	21	17	32
20	20	21	21	23
20	30	21	19	19
20	60	11	11	11
20	90	10	9	17
20	120	12	13	18
20	150	10	10	10
23	30	13	13	19
23	60	10	11	18
23	90	8	8	8
23	120	8	10	10
23	150	9	9	21
30	0	25	25	45
30	10	21	21	21
30	20	25	25	48
30	29	25	21	21
30	60	b	b	b
30	90	b	b	b
30	120	b	b	b
30	150	7	7	24

TABLE 3, cont.

DIRECT RADIATION LEVELS MEASURED AT GRID LINE INTERSECTIONS - BUILDING 7

Grid Location S	Grid Location W	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
30	180	8	6	6
30	210	7	7	7
30	240	7	7	15
30	270	9	9	12
30	300	11	11	21
40	0	25	25	25
40	10	25	23	23
40	20	25	27	40
40	29	25	25	25
40	60	b	b	b
40	90	b	b	b
40	120	b	b	b
40	150	8	8	10
50	0	29	29	35
50	10	25	21	21
50	20	27	29	29
50	29	25	25	25
50	60	b	b	b
50	90	b	b	b
50	120	b	b	b
50	150	9	8	11
60	0	29	33	66
60	10	29	29	37
60	20	29	29	48
60	29	33	29	32
60	60	b	b	b
60	90	b	b	b
60	120	b	b	b
60	150	8	7	7
60	180	8	8	8
60	210	8	8	18
60	240	9	8	10
60	270	10	10	20
60	300	11	13	13
70	0	33	50	87
70	10	33	33	73
70	20	33	63	77
70	29	27	25	25
70	60	b	b	b
70	90	b	b	b
70	120	b	b	b
70	150	8	7	7

TABLE 3, cont.

DIRECT RADIATION LEVELS MEASURED AT GRID LINE INTERSECTIONS - BUILDING 7

Grid Location S	Grid Location W	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
80	0	37	63	77
80	10	33	29	44
80	20	37	63	83
80	29	33	42	55
80	60	b	b	b
80	90	b	b	b
80	120	b	b	b
80	150	8	7	16
90	0	46	120	170
90	10	37	40	50
90	20	33	42	42
90	29	25	21	21
90	60	b	b	b
90	90	b	b	b
90	120	b	b	b
90	150	8	8	35
90	180	10	11	21
90	210	11	11	12
90	240	10	11	15
90	270	10	10	14
90	300	9	9	9
100	0	46	71	93
100	10	37	33	49
100	20	29	29	42
100	29	40	31	44
100	60	b	b	b
100	90	b	b	b
100	120	b	b	b
100	150	8	8	15
100	270	11	12	12
110	0	46	54	89
110	10	37	33	33
110	20	29	29	29
110	29	46	33	49
110	60	b	b	b
110	90	b	b	b
110	120	b	b	b
110	150	8	8	12
110	180	9	9	9
110	189	9	10	12
110	200	10	9	15
110	210	10	10	14

TABLE 3, cont.

DIRECT RADIATION LEVELS MEASURED AT GRID LINE INTERSECTIONS - BUILDING 7

Grid Location S	Grid Location W	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
110	220	10	10	20
110	224	11	11	11
110	240	12	12	20
110	270	10	11	25
120	0	46	59	110
120	10	37	33	33
120	20	29	29	45
120	29	57	33	33
120	60	b	b	b
120	90	b	b	b
120	120	b	b	b
120	150	b	b	b
120	180	b	b	b
120	190	8	8	15
120	200	10	10	23
120	210	8	9	9
120	220	11	10	10
120	224	9	10	24
120	240	9	10	10
120	270	10	10	10
120	300	8	9	29
130	0	42	44	97
130	10	33	31	50
130	20	29	29	39
130	29	80	46	62
130	60	b	b	b
130	90	b	b	b
130	120	b	b	b
130	150	b	b	b
130	180	b	b	b
130	190	10	9	22
130	200	10	10	19
130	210	11	10	23
130	220	12	13	30
130	224	12	15	33
130	240	11	11	11
130	270	10	9	24
130	300	10	10	10
140	0	42	37	63
140	10	37	29	41
140	20	25	25	25
140	29	80	78	82

TABLE 3, cont.

DIRECT RADIATION LEVELS MEASURED AT GRID LINE INTERSECTIONS - BUILDING 7

Grid Location S	Grid Location W	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
140	60	25	25	25
140	88	17	13	15
140	120	10	10	22
140	130	9	9	33
140	140	9	9	22
140	150	10	10	43
140	160	10	10	40
140	170	11	10	140
140	180	12	13	51
140	190	11	11	30
140	200	11	11	12
140	210	12	11	28
140	220	12	11	23
140	224	10	12	19
140	240	11	11	13
140	270	8	8	22
140	300	11	10	15
150	0	42	37	37
150	10	29	29	32
150	20	25	21	26
150	30	63	46	46
150	60	25	25	28
150	88	21	17	17
150	120	10	10	33
150	150	9	9	49
150	160	11	11	38
150	170	11	11	73
150	180	13	17	94
150	190	10	10	40
150	200	10	11	41
150	210	10	10	12
150	220	10	10	30
150	224	10	10	35
150	240	9	9	22
150	270	8	9	29
150	300	8	8	22
160	0	37	25	40
160	10	29	25	37
160	20	25	21	21
160	30	71	50	50
160	60	37	33	34
160	90	25	21	21

TABLE 3, cont.

DIRECT RADIATION LEVELS MEASURED AT GRID LINE INTERSECTIONS - BUILDING 7

Grid Location S	Grid Location W	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
160	120	19	17	50
160	130	17	13	33
160	140	13	17	50
160	150	13	13	66
160	160	13	13	53
160	170	12	13	46
160	180	13	11	47
160	190	14	10	37
160	200	10	10	39
160	210	11	11	69
160	220	10	11	19
160	224	11	11	23
160	240	12	10	10
160	270	11	10	28
160	300	10	10	26
170	0	37	29	44
170	10	29	25	25
170	20	21	19	31
170	30	73	50	50
170	60	40	27	36
170	90	23	21	48
170	120	19	17	30
170	130	17	17	24
170	140	17	17	26
170	150	17	14	14
170	160	15	15	15
170	170	15	15	20
170	180	15	15	17
170	190	13	13	26
170	200	13	13	23
170	210	13	13	25
170	220	11	11	18
170	224	11	11	11
170	240	12	13	27
170	270	11	10	14
170	300	10	11	13
175	0	33	29	47
175	10	25	21	38
175	20	19	21	28
175	30	17	17	19
175	60	17	15	47
175	90	13	13	13

TABLE 3, cont.

DIRECT RADIATION LEVELS MEASURED AT GRID LINE INTERSECTIONS - BUILDING 7

Grid Location S	Grid Location W	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
175	120	11	13	30
175	130	17	17	17
175	140	15	16	43
175	150	13	29	910
175	160	13	13	16
175	170	13	13	13
175	180	10	10	27
175	190	13	13	23
175	200	11	11	11
175	210	10	9	9
175	220	10	10	10
175	224	11	11	11
175	240	10	10	33
175	270	8	8	17
175	300	8	8	11

[a]Refer to Figure 4.
[b]Measurement not performed due to presence of building.

TABLE 4

DIRECT RADIATION LEVELS AT LOCATIONS IDENTIFIED
BY THE WALKOVER SURFACE SCAN NEAR BUILDING 7

Grid Location[a,b]		Exposure Rate (μR/h)		Surface Dose Rate (μrad/h)	Contact Exposure Rate After Sample Removal (μR/h)
S	W	Contact	1 m Above Surface		
70	4	59	52	c	c
76	10	110	52	c	c
113	196	17	10	76	15
164	159	23	15	68	19
168	170	25	15	130	17
169	173	67	15	170	67
171	196	200	21	250	120
172	196	180	19	200	220

[a]Refer to Figure 6.
[b]Radionuclide concentrations are presented in Table 6.
[c]Measurement not performed.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
COLLECTED FROM GRID LINE INTERSECTIONS
IN THE VICINITY OF BUILDING 7

Grid Location[a]		Radionuclide Concentrations (pCi/g)					
S	W	Am-241	Th-232	U-238	U-235	Co-60	Cs-137
0	0	<0.27	0.76 ± 0.27[b]	<0.99	<0.32	0.54 ± 0.16	0.34 ± 0.08
0	10	<0.05	0.98 ± 0.34	1.34 ± 0.46	<0.14	0.58 ± 0.14	0.18 ± 0.08
0	20	<0.35	0.88 ± 0.45	1.97 ± 1.96	1.03 ± 0.51	0.93 ± 0.22	0.55 ± 0.15
0	30	<0.43	0.86 ± 0.37	<0.81	<0.24	0.31 ± 0.10	0.31 ± 0.12
0	60	<0.28	1.09 ± 0.33	2.60 ± 1.44	<0.30	<0.05	0.09 ± 0.06
0	90	<0.07	0.87 ± 0.34	<0.59	0.40 ± 0.41	0.23 ± 0.16	0.37 ± 0.11
0	120	<0.37	1.01 ± 0.33	2.21 ± 1.50	<0.24	<0.06	0.22 ± 0.12
0	150	<0.36	1.29 ± 0.47	1.97 ± 1.83	<0.24	<0.06	0.22 ± 0.12
0	180	<0.36	1.48 ± 0.50	7.54 ± 2.09	<0.37	0.14 ± 0.12	0.19 ± 0.07
0	210	<0.07	0.85 ± 0.77	1.81 ± 0.67	<0.20	<0.04	0.25 ± 0.12
0	240	<0.40	1.13 ± 0.38	2.17 ± 1.85	0.33 ± 0.62	0.13 ± 0.11	0.28 ± 0.09
10	0	<0.55	1.29 ± 0.63	<1.03	<0.32	3.39 ± 0.39	0.70 ± 0.20
10	10	<0.34	1.58 ± 0.67	5.96 ± 2.28	<0.38	0.83 ± 0.18	0.51 ± 0.13
10	20	<0.07	1.29 ± 0.44	2.11 ± 0.71	<0.18	1.02 ± 0.20	0.41 ± 0.12
10	30	<0.47	1.22 ± 0.78	<0.93	<0.27	0.27 ± 0.26	0.6 ± 0.15
10	60	<0.39	0.56 ± 0.29	3.41 ± 1.77	<0.21	0.30 ± 0.11	0.43 ± 0.13
10	90	<0.35	1.47 ± 0.49	6.18 ± 2.41	<0.38	0.32 ± 0.16	0.75 ± 0.15
10	120	<0.06	1.27 ± 0.33	2.04 ± 0.66	<0.18	0.13 ± 0.08	0.20 ± 0.09
10	150	<0.38	1.40 ± 0.58	1.03 ± 1.64	0.31 ± 0.63	0.05 ± 0.06	<0.06
10	180-300	[c]	[c]	[c]	[c]	[c]	[c]
20	0	<0.46	1.22 ± 0.49	<0.93	<0.29	1.32 ± 0.25	0.28 ± 0.11
20	10	<0.34	1.55 ± 0.65	2.90 ± 1.96	<0.38	0.81 ± 0.17	0.46 ± 0.11
20	20	<0.07	1.35 ± 0.39	1.51 ± 0.97	0.25 ± 0.48	1.18 ± 0.24	0.49 ± 0.14
20	30	<0.39	0.57 ± 0.40	2.31 ± 1.54	<0.25	0.50 ± 0.16	1.00 ± 0.21
20	60	<0.30	<0.30	2.00 ± 2.43	<0.31	0.28 ± 0.10	0.44 ± 0.11
20	90	[c]	[c]	[c]	[c]	[c]	[c]
20	120	0.66 ± 0.26	1.33 ± 0.51	1.10 ± 1.84	<0.25	0.39 ± 0.17	0.48 ± 0.13

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
COLLECTED FROM GRID LINE INTERSECTIONS
IN THE VICINITY OF BUILDING 7

Grid Location S	W	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
20	150-300	c	c	c	c	c	c
30	0	<0.47	0.69 ± 0.52	1.96 ± 2.20	<0.29	1.81 ± 0.29	0.39 ± 0.17
30	10	<0.43	1.34 ± 0.47	<0.85	0.29 ± 0.61	0.49 ± 0.22	0.20 ± 0.12
30	20	<0.34	1.41 ± 0.52	10.0 ± 2.6	<0.35	1.49 ± 0.22	0.71 ± 0.15
30	30-300	c	c	c	c	c	c
40	0	<0.07	0.89 ± 0.61	1.74 ± 0.66	<0.24	5.73 ± 0.47	0.74 ± 0.26
40	10	<0.38	1.27 ± 0.57	<0.85	<0.24	1.16 ± 0.24	0.55 ± 0.14
40	20	<0.53	1.19 ± 0.71	1.62 ± 2.43	<0.38	2.33 ± 0.31	0.79 ± 0.20
40	30-300	c	c	c	c	c	c
50	0	<0.57	2.10 ± 1.85	3.35 ± 3.55	<0.63	1.30 ± 0.67	1.76 ± 0.28
50	10	<0.06	1.06 ± 0.61	1.07 ± 1.20	<0.17	1.30 ± 0.22	0.31 ± 0.08
50	20	<0.39	1.08 ± 0.55	2.35 ± 1.80	<0.24	1.33 ± 0.29	0.26 ± 0.13
50	30-300	c	c	c	c	c	c
60	0	<0.62	1.88 ± 1.10	2.38 ± 2.37	<0.36	6.36 ± 0.52	1.08 ± 0.26
60	10	<0.38	1.39 ± 0.70	2.00 ± 4.08	<0.44	2.59 ± 0.32	0.62 ± 0.18
60	20	<0.07	1.11 ± 0.88	0.72 ± 1.23	<0.20	4.02 ± 0.37	0.42 ± 0.14
60	30-300	c	c	c	c	c	c
70	0	<0.47	1.58 ± 0.91	<1.43	<0.52	1.30 ± 0.6	0.59 ± 0.20
70	10	0.36 ± 0.52	1.21 ± 1.11	1.71 ± 1.78	<0.34	7.25 ± 0.50	0.45 ± 0.15
70	20	<0.56	3.93 ± 1.45	3.07 ± 2.73	<0.69	2.91 ± 0.9	0.52 ± 0.24
70	30-300	c	c	c	c	c	c
80	0	<0.15	<1.25	<1.12	<0.58	116 ± 2	0.65 ± 0.38
80	10						
80	20	<1.00	<1.10	<1.96	<0.70	51.0 ± 1.5	0.95 ± 0.40
80	30-300	c	c	c	c	c	c
90	0	<0.73	<1.04	<2.19	<0.86	116 ± 2	1.13 ± 0.46
90	10	0.37 ± 0.62	2.45 ± 0.77	3.14 ± 2.16	<0.43	6.73 ± 0.48	0.52 ± 0.18

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
COLLECTED FROM GRID LINE INTERSECTIONS
IN THE VICINITY OF BUILDING 7

Grid Location S	W	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
90	20	<0.07	0.92 ± 0.85	0.97 ± 0.56	<0.24	11.0 ± 0.6	0.32 ± 0.21
90	30-200	c	c	c	c	c	c
90	270	<0.29	1.01 ± 0.42	1.29 ± 1.45	<0.22	<0.05	0.13 ± 0.06
100	0	<1.19	<1.35	5.39 ± 4.38	<0.89	1.14 ± 2.02	1.07 ± 0.52
100	10	<0.26	0.76 ± 0.73	<8.49	<0.31	6.06 ± 0.44	0.36 ± 0.14
100	20	<0.42	1.85 ± 1.06	3.37 ± 2.55	<0.46	6.26 ± 0.46	0.65 ± 0.22
100	30-240	c	c	c	c	c	c
100	270	<0.40	0.73 ± 0.43	1.55 ± 1.55	<0.19	<0.03	0.17 ± 0.11
110	0	<0.10	2.27 ± 1.19	2.15 ± 1.51	<0.36	4.00 ± 0.40	1.00 ± 0.25
110	10	<0.44	1.35 ± 0.66	1.10 ± 2.68	<0.28	4.00 ± 0.40	0.42 ± 0.18
110	20	<0.26	<0.26	5.28 ± 1.41	<0.33	7.13 ± 0.45	0.46 ± 0.17
110	30-180	c	c	c	c	c	c
110	189	<0.07	1.15 ± 0.36	1.14 ± 1.28	<0.18	0.09 ± 0.06	0.36 ± 0.14
110	224	0.50 ± 1.05	0.90 ± 0.47	1.81 ± 1.97	0.70 ± 0.71	0.07 ± 0.07	0.22 ± 0.18
110	240	<0.27	1.95 ± 0.74	<0.92	0.33 ± 0.31	<0.04	0.12 ± 0.10
110	270	<0.06	1.00 ± 0.43	1.66 ± 1.22	<0.18	<0.03	0.20 ± 0.10
120	0	<0.80	<1.23	3.15 ± 4.21	<0.89	62.7 ± 1.3	1.47 ± 0.40
120	10	<0.01	1.06 ± 0.70	2.73 ± 0.76	<0.22	5.70 ± 0.42	0.51 ± 0.11
120	20	<0.45	0.71 ± 0.53	1.28 ± 2.54	<0.31	3.84 ± 0.38	0.35 ± 0.17
120	30-210	c	c	c	c	c	c
120	224	<0.52	0.57 ± 0.51	13.9 ± 2.8	<0.30	<0.09	0.76 ± 0.18
120	240	<0.27	1.65 ± 0.38	1.81 ± 1.52	<0.31	<0.05	<0.04
120	270	<0.05	1.42 ± 0.40	0.17 ± 0.37	0.37 ± 0.42	<0.03	0.19 ± 0.08
130	0	<0.41	<0.55	<1.25	<0.46	31.1 ± 0.9	1.06 ± 0.25
130	10	<0.34	2.66 ± 0.55	<1.11	<0.37	2.82 ± 0.28	0.37 ± 0.14
130	20	<0.07	1.23 ± 0.50	0.99 ± 0.63	<0.21	3.21 ± 0.33	0.40 ± 0.12
130	30-210	c	c	c	c	c	c
130	224	<0.35	1.00 ± 0.51	<1.61	2.18 ± 0.72	0.17 ± 0.10	0.59 ± 0.14

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
COLLECTED FROM GRID LINE INTERSECTIONS
IN THE VICINITY OF BUILDING 7

Grid Location S	Grid Location W	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
130	240	<0.06	0.90 ± 0.30	0.73 ± 1.43	<0.13	<0.04	0.10 ± 0.08
130	270	c	c	c	c	c	c
140	0	<0.28	0.75 ± 0.91	<0.95	<0.31	12.1 ± 0.64	0.40 ± 0.19
140	10	<0.34	1.40 ± 0.65	2.60 ± 1.12	<0.40	2.98 ± 0.37	0.48 ± 0.17
140	20	<0.06	1.37 ± 0.43	0.92 ± 0.56	<0.16	0.47 ± 0.16	0.32 ± 0.08
140	30	<0.46	0.77 ± 0.35	1.85 ± 1.08	<0.25	0.55 ± 0.25	0.44 ± 0.16
140	60	<0.19	0.73 ± 0.67	<0.66	<0.20	0.14 ± 0.12	0.28 ± 0.09
140	90-210	c	c	c	c	c	c
140	224	<0.43	0.80 ± 0.31	3.59 ± 1.43	1.60 ± 1.23	0.11 ± 0.16	0.33 ± 0.17
140	240	<0.27	0.79 ± 0.41	1.45 ± 1.57	<0.27	<0.04	<0.05
140	270	c	c	c	c	c	c
150	0	<0.42	1.77 ± 0.76	0.91 ± 2.54	<0.46	6.12 ± 0.45	0.56 ± 0.17
150	10	<0.06	1.11 ± 0.50	1.36 ± 0.96	<0.16	0.50 ± 0.15	0.29 ± 0.15
150	20	<0.48	1.72 ± 0.43	<0.97	<0.27	0.06 ± 0.07	<0.05
150	30	<0.19	0.92 ± 0.46	<0.71	<0.23	2.86 ± 0.14	0.32 ± 0.10
150	60	<0.39	1.29 ± 0.55	3.05 ± 1.21	<0.39	2.02 ± 0.27	0.59 ± 0.19
150	88	<0.06	1.07 ± 0.71	1.67 ± 0.91	<0.18	0.32 ± 0.16	0.43 ± 0.11
150	120-210	c	c	c	c	c	c
150	224	1.28 ± 1.01	0.87 ± 0.63	7.22 ± 2.03	0.57 ± 0.67	0.18 ± 0.09	0.73 ± 0.16
150	240	<0.38	1.35 ± 0.34	<0.76	<0.21	0.05 ± 0.06	<0.04
150	270	<0.41	0.71 ± 0.37	1.02 ± 1.57	<0.25	<0.03	<0.05
156	90	<0.41	1.41 ± 0.57	1.58 ± 1.91	<0.23	0.25 ± 0.12	0.48 ± 0.11
160	0	<0.32	1.21 ± 0.43	2.39 ± 1.58	0.90 ± 0.68	0.67 ± 0.17	0.56 ± 0.12
160	10	<0.07	1.05 ± 0.39	1.42 ± 0.66	<0.19	0.43 ± 0.16	0.39 ± 0.12
160	20	0.84 ± 1.12	1.15 ± 0.54	2.35 ± 1.08	<0.23	0.48 ± 0.17	0.65 ± 0.14
160	30	<0.46	0.82 ± 0.32	1.68 ± 1.80	<0.25	0.33 ± 0.14	0.39 ± 0.14
160	60	<0.33	0.93 ± 0.33	4.15 ± 2.42	<0.35	0.31 ± 0.14	0.39 ± 0.14

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
COLLECTED FROM GRID LINE INTERSECTIONS
IN THE VICINITY OF BUILDING 7

Grid Location S	W	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
160	90	<0.07	1.00 ± 0.34	<0.65	<0.20	0.47 ± 0.14	0.52 ± 0.11
160	120-210	c	c	c	c	c	c
160	224	<0.40	0.73 ± 0.34	3.81 ± 1.08	<0.23	0.09 ± 0.06	0.47 ± 0.13
160	240	<0.28	1.21 ± 0.32	1.90 ± 1.45	<0.30	<0.05	<0.05
160	270	c	c	c	c	c	c
170	0	<0.45	1.33 ± 0.57	0.99 ± 3.04	<0.30	0.23 ± 0.15	0.18 ± 0.18
170	10	<0.37	1.49 ± 0.60	4.76 ± 2.92	<0.44	1.04 ± 0.25	1.31 ± 0.19
170	20	<0.06	1.31 ± 0.35	0.93 ± 0.59	<0.18	0.70 ± 0.19	0.86 ± 0.16
170	30	0.67 ± 0.85	0.98 ± 0.35	1.18 ± 1.63	<0.27	0.53 ± 0.21	0.13 ± 0.20
170	60	<0.43	1.26 ± 0.54	0.94 ± 2.89	<0.29	0.22 ± 0.14	0.17 ± 0.18
170	90	<0.31	1.12 ± 0.40	2.82 ± 1.15	<0.32	0.23 ± 0.14	0.90 ± 0.14
170	120	0.11 ± 0.09	1.08 ± 0.59	2.73 ± 0.74	0.45 ± 0.42	0.35 ± 0.17	0.44 ± 0.10
170	130	<0.39	1.26 ± 0.40	2.64 ± 0.97	<0.25	0.22 ± 0.09	0.28 ± 0.12
170	140	<0.52	1.35 ± 0.36	7.92 ± 2.60	1.06 ± 0.87	0.32 ± 0.15	0.99 ± 0.17
170	150	<0.36	1.63 ± 0.48	12.6 ± 2.57	0.84 ± 0.74	0.48 ± 0.13	0.72 ± 0.15
170	160	<0.07	1.66 ± 0.49	6.47 ± 0.87	0.59 ± 0.41	0.14 ± 0.10	0.41 ± 0.11
170	170	<0.43	1.23 ± 0.72	3.87 ± 2.09	<0.28	0.26 ± 0.16	0.75 ± 0.15
170	180	<0.44	0.80 ± 0.58	3.15 ± 2.12	0.93 ± 0.71	0.11 ± 0.16	0.65 ± 0.14
170	190	<0.34	1.29 ± 0.39	7.09 ± 2.31	1.05 ± 0.71	0.10 ± 0.13	0.73 ± 0.16
170	200	<0.07	1.56 ± 0.48	1.33 ± 0.76	0.83 ± 0.48	0.13 ± 0.21	0.63 ± 0.16
170	210	<0.50	1.07 ± 0.58	2.27 ± 1.04	<0.28	<0.06	0.43 ± 0.12
170	220	<0.49	1.07 ± 0.55	1.38 ± 1.95	<0.32	1.00 ± 0.24	1.09 ± 0.19
170	224	<0.32	2.68 ± 0.76	1.38 ± 2.83	<0.37	0.17 ± 0.16	0.90 ± 0.16
170	240	0.72 ± 0.48	1.04 ± 0.40	1.37 ± 1.35	<0.23	<0.05	0.08 ± 0.10
170	270	c	c	c	c	c	c
175	0	<0.67	1.11 ± 0.31	0.99 ± 1.24	<0.18	0.40 ± 0.15	0.45 ± 0.11
175	10	0.66 ± 0.18	1.10 ± 0.54	<0.80	<0.25	0.86 ± 0.26	0.86 ± 0.19

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
COLLECTED FROM GRID LINE INTERSECTIONS
IN THE VICINITY OF BUILDING 7

Grid Location S	W	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
175	20	<0.48	1.03 ± 0.53	1.29 ± 1.89	<0.31	0.96 ± 0.23	1.05 ± 0.18
175	30	<0.25	0.77 ± 0.31	1.55 ± 1.92	<0.27	0.34 ± 0.13	0.36 ± 0.11
175	60	<0.07	1.57 ± 0.44	1.23 ± 0.65	<0.19	0.35 ± 0.15	0.13 ± 0.11
175	90	<0.33	0.67 ± 0.51	1.61 ± 0.92	<0.24	0.34 ± 0.13	0.87 ± 0.18
175	120	<1.55	2.38 ± 0.91	185 ± 11	5.13 ± 2.20	0.29 ± 0.16	0.86 ± 0.25
175	130	<0.38	1.19 ± 0.51	4.93 ± 2.69	0.98 ± 0.71	0.10 ± 0.07	0.67 ± 0.14
175	140	<0.08	1.56 ± 0.48	4.42 ± 1.87	0.52 ± 0.60	0.61 ± 0.19	1.43 ± 0.22
175	150	<5.27	12.6 ± 3.4	3580 ± 190	77.2 ± 7.2	0.36 ± 0.30	0.54 ± 0.67
175	160	<0.46	1.94 ± 0.71	7.02 ± 2.07	<0.84	0.42 ± 0.20	0.88 ± 0.23
175	170	<0.08	1.07 ± 0.52	1.05 ± 0.82	0.39 ± 0.43	0.21 ± 0.16	0.81 ± 0.17
175	180	<0.46	1.31 ± 0.46	2.52 ± 1.22	0.76 ± 0.80	0.20 ± 0.15	0.70 ± 0.19
175	190	<0.47	0.99 ± 0.53	1.41 ± 1.02	<0.30	0.13 ± 0.13	0.55 ± 0.13
175	200	<0.38	1.82 ± 0.57	5.31 ± 2.40	<0.37	<0.06	0.83 ± 0.16
175	210	<0.08	0.51 ± 0.48	2.97 ± 0.76	0.43 ± 0.51	0.10 ± 0.11	1.08 ± 0.19
175	220	<0.40	1.60 ± 0.42	1.31 ± 1.72	<0.28	<0.06	0.25 ± 0.13
175	224	<0.50	0.98 ± 0.46	1.81 ± 1.25	<0.27	<0.06	<0.05
175	240	<0.32	1.00 ± 0.53	7.41 ± 2.19	<0.34	<0.04	0.16 ± 0.13
175	270	<0.41	1.01 ± 0.37	1.01 ± 1.51	0.44 ± 0.53	<0.46	0.14 ± 0.10

[a]Refer to Figure 4.
[b]Errors are 2σ based on counting statistics.
[c]Sample not collected due to presence of building or asphalt.

TABLE 6

RADIONUCLIDE CONCENTRATIONS IN SURFACE SAMPLES FROM
LOCATIONS IDENTIFIED BY THE WALKOVER SCAN NEAR BUILDING 7

Grid Location[a] S	W	Description	Radionuclide Concentrations (pCi/g)[b] Am-241	Th-232	U-238	U-235	Co-60	Cs-137
76	10	Soil	<1.02	<1.66	4.38 ± 4.68	<1.21	104 ± 2	1.02 ± 0.44
113	196	Soil	<0.13	1.06 ± 0.51	33.2 ± 2.3	6.18 ± 0.71	<0.05	0.22 ± 0.13
164	159	Soil	<0.85	2.23 ± 0.55	58.7 ± 3.9	3.21 ± 1.01	6.77 ± 0.18	0.73 ± 0.18
168	170	Soil	<0.73	1.26 ± 0.44	31.6 ± 5.5	29.6 ± 2.3	0.30 ± 0.16	0.71 ± 0.17
169	173	Soil	<0.18	<1.44	2.40 ± 2.87	<0.68	117 ± 2	0.97 ± 0.52
171	196	Soil	<0.43	1.01 ± 0.32	621 ± 16	852 ± 8	<0.07	0.24 ± 0.14
172	196	Soil	5.06 ± 1.08	0.80 ± 0.33	375 ±	506 ± 6	0.25 ± 0.12	0.70 + 0.13
Macadam		Powder	<3.14	<0.32	528 ± 6	163 ± 7	0.42 ± 0.18	0.64 ± 0.27
Macadam		Graphite Cylinder	3.85 ± 5.21	<0.72	861 ± 45	1660 ± 40	<0.17	<0.11
Macadam		Powder	35.2 ± 24.9	<0.51	5150 ± 80	5420 ± 40	<0.15	<0.15

[a]Refer to Figure 6.
[b]Refer to Table 4 for direct radiation levels.
[c]Errors are 2σ based on counting statistics.

TABLE 7

RADIONUCLIDE CONCENTRATIONS IN INITIAL BOREHOLE SOIL SAMPLES
IN THE VICINITY OF BUILDING 7

Grid Location[a]			Radionuclide Concentrations (pCi/g)[b]					
S	W	Depth (m)	Am-241	Th-232	U-238	U-235	Co-60	Cs-137
70	4	Surface	<0.15	3.18 ± 2.21b	<1.09	<0.55	100 ± 2	0.68 ± 0.42
		0.60	0.99 ± 1.04	2.66 ± 0.77	1.41 ± 2.14	<0.32	6.58 ± 0.51	0.13 ± 0.14
169	173	Surface	<0.18	<1.44	2.40 ± 2.87	<0.68	117 ± 2	0.97 ± 0.52
		0.30	<0.97	<1.09	<1.80	<0.67	48.1 ± 1.5	<0.22
		0.45	<0.36	1.33 ± 0.42	1.41 ± 2.09	<0.23	0.11 ± 0.07	<0.04
171	196	Surface	<4.73	1.01 ± 0.32	621 ± 16	852 ± 8	<0.07	0.24 ± 0.14
		0.30	<0.99	1.60 ± 0.39	54.2 ± 4.5	70.5 ± 2.9	0.10 ± 15	<0.05
		0.45	<0.68	1.05 ± 0.36	19.4 ± 2.3	20.3 ± 1.7	<0.04	<0.03
172	196	Surface	5.06 ± 1.08	0.80 ± 0.33	375 ± 9	506 ± 6	0.25 ± 0.12	0.70 ± 0.13
		0.30	<2.68	1.23 ± 0.47	217 ± 10	327 ± 6	0.10 ± 0.19	0.83 ± 0.21
		0.45	<0.30	1.36 ± 0.44	<1.12	1.16 ± 0.53	<0.06	<0.04
175	150	Surface	<5.27	12.6 ± 3.4	3580 ± 190	77.2 ± 7.2	0.36 ± 0.30	0.54 ± 0.67
		0.30	<1.40	2.16 ± 0.82	168 ± 10	4.65 ± 2.00	0.26 ± 0.15	0.78 ± 0.23

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

TABLE 8

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
COLLECTED FOLLOWING REMEDIAL ACTION

Grid Location[a]		Radionuclide Concentrations (pCi/g)					
S	W	Am-241	Th-232	U-238	U-235	Co-60	Cs-137
76	10	<0.31	1.70 ± 0.67[b]	<1.09	<0.34	3.65 ± 0.29	0.09 ± 0.14
90	20	<0.09	1.08 ± 0.92	2.58 ± 1.64	<0.30	18.5 ± 0.9	0.51 ± 0.24
115	0	<0.57	6.11 ± 1.60	<1.84	<0.66	26.2 ± 0.9	1.15 ± 0.27
125	0	<0.88	<0.94	<1.65	<0.59	48.9 ± 1.3	0.54 ± 0.36
135	0	<0.47	1.11 ± 1.01	1.07 ± 3.08	<0.53	17.7 ± 0.7	0.67 ± 0.30
145	0	<0.06	1.84 ± 0.63	2.82 ± 1.01	<0.19	4.70 ± 0.38	0.29 ± 0.09
155	0	<0.06	1.25 ± 0.63	0.84 ± 0.80	<0.18	2.53 ± 0.30	0.36 ± 0.13
165	0	<0.05	<0.26	1.52 ± 0.73	<0.17	5.31 ± 0.34	0.96 ± 0.16
165	121	<0.46	<0.42	19.4 ± 3.7	1.05 ± 0.84	5.95 ± 0.47	0.89 ± 0.23
168	170	<0.39	0.93 ± 0.55	2.25 ± 1.07	1.04 ± 0.60	0.25 ± 0.13	0.37 ± 0.14
173	0	<0.27	<0.28	0.88 ± 2.01	<0.32	1.48 ± 0.21	0.25 ± 0.11
175	150	<0.42	1.06 ± 0.43	8.68 ± 2.37	0.25 ± 0.54	0.23 ± 0.11	0.70 ± 0.15

[a]Refer to Figure 4.
[b]Errors are 2σ based on counting statistics.

TABLE 9

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES
COLLECTED FOLLOWING REMEDIAL ACTION

Grid Location[a] S	W	Depth (m)	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
52	5	Surface	<0.32	0.93 ± 0.87b	1.99 ± 2.09	<0.41	3.15 ± 0.32	0.85 ± 0.18
		0.15	<0.37	1.34 ± 0.82	<0.79	<0.23	0.81 ± 0.21	0.22 ± 0.14
		0.30	<0.23	1.02 ± 0.34	<0.91	<0.27	0.12 ± 0.13	0.18 ± 0.07
62	15	0.25	<0.42	1.33 ± 0.51	0.98 ± 2.27	<0.22	0.50 ± 0.13	0.22 ± 0.13
		0.40	<0.05	1.13 ± 0.34	0.51 ± 1.32	<0.15	0.10 ± 0.05	0.06 ± 0.07
		0.55	<0.30	0.88 ± 0.31	2.04 ± 0.85	0.51 ± 0.41	<0.04	<0.03
65	5	0.25	<0.29	1.54 ± 0.38	2.60 ± 2.44	0.33 ± 0.61	0.42 ± 0.14	<0.05
		0.40	<0.32	0.73 ± 0.53	1.37 ± 1.46	<0.19	0.22 ± 0.09	<0.04
		0.55	<0.31	1.28 ± 0.48	2.79 ± 1.92	<0.33	<0.04	<0.04
69	11	0.25	<0.42	1.30 ± 0.60	1.69 ± 1.52	<0.27	1.67 ± 0.31	<0.07
		0.40	<0.29	0.93 ± 0.34	3.37 ± 1.84	<0.31	0.31 ± 0.10	<0.05
		0.55	<0.32	0.99 ± 0.45	2.38 ± 1.56	<0.23	0.12 ± 0.14	<0.05
70	0	0.25	<0.47	1.58 ± 0.91	<1.43	<0.52	13.0 ± 0.6	0.59 ± 0.20
		0.40	<0.39	0.98 ± 0.54	2.05 ± 1.84	<0.22	1.26 ± 0.21	0.10 ± 0.05
		0.55	<0.27	0.83 ± 0.53	2.89 ± 2.05	<0.28	0.19 ± 0.14	0.09 ± 0.09
		0.70	<0.35	1.39 ± 0.35	1.27 ± 1.90	<0.20	0.15 ± 0.10	<0.04
71	20	0.40	<0.59	<0.84	<1.77	<0.67	27.0 ± 0.9	0.39 ± 0.29
		0.50	0.07 ± 0.08	1.56 ± 0.80	1.37 ± 1.06	<0.22	12.9 ± 0.6	0.14 ± 0.14
		0.65	<0.33	0.79 ± 0.77	1.82 ± 1.61	<0.21	1.57 ± 0.21	<0.05
		0.80	<0.25	1.24 ± 0.47	1.19 ± 0.79	<0.25	0.53 ± 0.13	0.07 ± 0.07

TABLE 9 (Continued)

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES
COLLECTED FOLLOWING REMEDIAL ACTION

Grid Location S	Grid Location W	Depth (m)	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
79	5	0.30	<0.06	1.06 ± 0.38	0.79 ± 1.16	<0.15	0.10 ± 0.07	<0.04
		0.45	<0.35	0.62 ± 0.28	1.15 ± 1.26	<0.22	<0.05	0.30 ± 0.15
		0.60	<0.27	0.96 ± 0.41	2.96 ± 1.24	<0.28	<0.03	<0.04
80	12	0.25	<0.07	0.56 ± 0.91	1.29 ± 0.96	<0.21	8.53 ± 0.49	0.26 ± 0.16
		0.40	<0.40	0.83 ± 0.36	2.27 ± 1.06	<0.25	0.10 ± 0.07	<0.05
		0.55	<0.28	1.17 ± 0.63	<1.01	<0.28	0.30 ± 0.11	<0.04
		0.70	<0.05	0.74 ± 0.34	0.63 ± 1.35	<0.15	0.13 ± 0.06	<0.03
82	19	0.25	<0.06	1.02 ± 0.44	2.66 ± 0.89	<0.17	3.12 ± 0.28	0.08 ± 0.11
		0.40	<0.36	0.93 ± 0.34	1.54 ± 1.56	<0.20	0.18 ± 0.10	<0.04
		0.55	<0.24	1.16 ± 0.55	2.46 ± 1.22	<0.27	<0.04	0.35 ± 0.10
88	1	0.25	<0.05	0.86 ± 0.52	0.71 ± 1.01	<0.16	3.54 ± 0.27	0.10 ± 0.12
		0.40	<0.42	0.75 ± 0.67	1.03 ± 1.15	<0.21	0.24 ± 0.10	<0.06
		0.55	<0.28	1.04 ± 0.39	0.88 ± 1.62	<0.29	0.11 ± 0.08	0.11 ± 0.11
110	5	Surface	<0.53	0.94 ± 1.40	2.91 ± 1.87	<0.35	9.23 ± 0.60	0.68 ± 0.29
		0.15	<0.30	1.20 ± 0.50	2.35 ± 2.06	<0.33	0.94 ± 0.20	0.23 ± 0.12
		0.30	<0.06	1.05 ± 0.38	1.71 ± 0.60	<0.15	0.79 ± 0.15	<0.04

TABLE 9 (Continued)

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES
COLLECTED FOLLOWING REMEDIAL ACTION

Grid Location S	Grid Location W	Depth (m)	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
130	0	Surface	<0.41	<0.55	<1.25	<0.46	31.1 ± 0.9	1.06 ± 0.25
		0.15	<0.06	0.95 ± 0.56	1.00 ± 0.98	<0.18	7.06 ± 0.41	0.19 ± 0.13
		0.30	<0.36	1.37 ± 0.51	0.94 ± 1.84	<0.26	2.67 ± 0.30	0.13 ± 0.12
		0.45	<0.30	1.24 ± 0.45	8.80 ± 2.34	<0.34	0.48 ± 0.11	<0.05

[a]Refer to Figure 8.
[b]Errors are 2σ based on counting statistics.

TABLE 10

DIRECT RADIATION LEVELS MEASURED AT ALTERNATING GRID LINE INTERSECTIONS NEAR PREVIOUS BUILDING 8 LOCATION

Grid[a] Location N	Grid[a] Location E	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
0	0	9	9	15
0	60	9	9	27
0	120	8	8	16
0	180	8	8	32
0	240	8	8	13
0	300	8	7	21
0	360	8	8	13
0	405	8	8	8
0	450	8	9	20
21	420	8	8	13
21	480	8	8	11
30	30	8	8	22
30	90	8	8	19
30	150	8	8	12
30	210	7	7	20
30	270	7	7	7
30	330	7	8	15
30	390	8	8	20
60	0	8	9	15
60	60	8	9	16
60	120	8	8	18
60	180	7	7	7
60	240	7	8	30
60	300	8	8	9
60	360	8	8	20
60	406	8	8	20
90	30	8	9	12
90	90	8	8	21
90	150	7	7	15
90	210	7	8	23
90	270	8	8	18
90	330	8	8	24
90	390	8	8	13
120	0	8	9	9
120	60	9	8	17
120	120	8	8	8
120	180	7	8	13
120	240	7	6	16
120	300	6	6	11
120	360	8	8	26
120	406	8	8	14
150	30	9	9	10

TABLE 10, cont.

DIRECT RADIATION LEVELS MEASURED AT ALTERNATING GRID LINE INTERSECTIONS NEAR PREVIOUS BUILDING 8 LOCATION

Grid Location N	Grid Location E	Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
150	90	8	9	19
150	150	8	7	13
150	210	8	8	21
150	270	8	8	14
150	330	8	8	14
150	390	7	6	11
180	0	8	8	14
180	60	9	8	21
180	120	8	8	17
180	180	8	8	27
180	240	8	7	16
180	300	8	9	9
180	360	8	8	13
180	406	8	8	8
191	330	8	7	14
191	360	7	7	12
210	30	8	9	15
210	90	8	9	20
210	150	8	7	14
210	210	8	8	13
210	270	8	8	9
210	315	8	8	8
206	376	6	6	6
240	0	7	8	15
240	60	8	9	19
240	120	9	9	26
240	180	8	8	8
240	240	8	9	28
240	300	8	9	16
240	315	7	9	30
270	30	8	9	13
270	90	9	9	19
270	150	8	9	32
270	210	8	8	14
270	270	8	8	9
300	0	7	8	28
300	60	8	8	11
300	120	9	8	41
300	180	10	11	11
300	240	8	9	9
300	282	8	8	10
330	0	8	8	18

TABLE 10, cont.

DIRECT RADIATION LEVELS MEASURED AT ALTERNATING GRID LINE INTERSECTIONS NEAR PREVIOUS BUILDING 8 LOCATION

Grid Location		Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
N	E			
330	60	8	9	25
330	120	8	9	33
330	180	8	8	16
330	240	9	9	13
360	30	8	9	41
360	90	8	9	9
360	150	9	9	9
360	210	8	8	8
390	0	7	8	8
390	60	8	9	19
390	120	9	9	27
390	180	9	9	40
406	30	8	8	20
406	90	8	7	16
406	150	9	9	23
406	210	8	8	23

[a]Refer to Figure 5.

TABLE 11

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL COLLECTED
FROM GRID LINE INTERSECTIONS IN THE PREVIOUS LOCATION OF BUILDING 8

Grid Location[a]		Radionuclide Concentrations (pCi/g)					
N	E	Am-241	Th-232	U-238	U-235	Co-60	Cs-137
0	0	<0.36	1.51 ± 0.61[b]	1.64 ± 1.01	<0.24	<0.05	<0.04
0	30	<0.36	1.15 ± 0.42	1.28 ± 1.43	<0.21	<0.04	0.14 ± 0.07
0	60	<0.25	1.59 ± 0.34	1.31 ± 1.59	<0.26	<0.04	0.09 ± 0.06
0	90	<0.04	0.70 ± 0.21	1.24 ± 0.42	<0.114	<0.03	0.06 ± 0.05
0	120	<0.26	1.05 ± 0.44	0.69 ± 0.62	<0.20	<0.04	0.08 ± 0.06
0	150	<0.29	0.90 ± 0.30	1.06 ± 1.30	<0.18	<0.03	<0.03
0	180	<0.23	1.19 ± 0.27	1.86 ± 0.73	<0.26	<0.04	0.05 ± 0.06
0	210	<0.05	1.07 ± 0.29	0.77 ± 0.44	<0.13	<0.04	0.02 ± 0.02
0	240	0.37 ± 0.80	1.25 ± 0.40	<0.63	<0.19	<0.04	<0.04
0	270	<0.32	1.20 ± 0.50	<0.65	<0.20	<0.03	0.22 ± 0.06
0	300	<0.24	1.53 ± 0.33	3.99 ± 1.16	<0.27	0.09 ± 0.09	0.19 ± 0.08
0	330	<0.05	0.73 ± 0.36	1.05 ± 0.77	<0.15	<0.03	<0.03
0	360	<0.27	0.88 ± 0.30	1.73 ± 0.82	<0.20	<0.04	0.06 ± 0.04
0	390	<0.41	0.86 ± 0.30	2.26 ± 1.92	<0.22	<0.04	0.28 ± 0.08
0	405	<0.31	1.01 ± 0.34	<1.06	<0.34	<0.06	0.39 ± 0.10
0	420	<0.05	1.10 ± 0.44	1.17 ± 0.56	<0.17	<0.04	0.12 ± 0.07
0	450	<0.97	1.26 ± 0.56	8.19 ± 1.73	<0.22	0.06 ± 0.08	0.18 ± 0.11
0	480	<0.32	0.98 ± 0.34	1.32 ± 1.21	<0.22	<0.05	0.14 ± 0.10
30	0	<0.24	1.05 ± 0.56	1.50 ± 0.83	<0.26	0.08 ± 0.11	<0.04
30	30	<0.06	1.27 ± 0.34	1.21 ± 0.56	<0.17	<0.03	0.22 ± 0.07
30	60	<0.40	1.29 ± 0.67	1.02 ± 1.51	<0.23	<0.06	0.34 ± 0.13
30	90	<0.31	0.73 ± 0.32	0.77 ± 1.56	<0.20	<0.03	0.18 ± 0.09
30	120	<0.23	1.22 ± 0.34	5.60 ± 1.36	<0.25	<0.03	<0.03
30	150	<0.04	0.86 ± 0.24	0.93 ± 0.69	<0.12	<0.02	<0.02
30	180	0.54 ± 0.61	0.77 ± 0.42	<0.65	<0.20	<0.03	<0.02
30	210	<0.28	0.62 ± 0.30	<0.40	<0.18	<0.01	<0.03
30	240	<0.20	0.68 ± 0.24	1.12 ± 1.04	<0.24	<0.02	<0.03
30	270	<0.07	1.27 ± 0.37	0.82 ± 0.91	<0.20	<0.04	0.29 ± 0.12

TABLE 11 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL COLLECTED
FROM GRID LINE INTERSECTIONS IN THE PREVIOUS LOCATION OF BUILDING 8

Grid Location N	Grid Location E	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
30	300	<0.36	0.92 ± 0.40	<0.77	<0.24	<0.03	0.18 ± 0.10
30	330	<0.35	1.14 ± 0.45	1.26 ± 2.74	<0.26	<0.05	0.30 ± 0.08
30	360	<0.27	1.15 ± 0.41	2.76 ± 1.66	<0.30	<0.05	0.24 ± 0.09
30	390	<0.06	0.98 ± 0.27	1.33 ± 0.60	<0.17	<0.03	0.12 ± 0.09
30	405	0.86 ± 0.71	0.91 ± 0.55	3.26 ± 1.19	0.55 ± 0.48	<0.06	0.14 ± 0.13
60	0	<0.34	1.03 ± 0.31	<0.65	<0.21	<0.04	<0.04
60	30	<0.30	1.48 ± 0.40	3.28 ± 2.95	<0.36	<0.05	0.38 ± 0.12
60	60	<0.06	1.39 ± 0.40	1.14 ± 0.57	<0.17	<0.04	0.26 ± 0.09
60	90	0.33 ± 1.35	1.38 ± 0.40	<0.78	<0.23	<0.05	0.18 ± 0.14
60	120	<0.33	1.03 ± 0.39	<0.71	<0.22	<0.03	0.05 ± 0.05
60	150	<0.30	0.28 ± 0.31	<0.59	0.22 ± 0.45	<0.04	<0.03
60	180	<0.05	0.61 ± 0.26	0.22 ± 0.42	<0.13	<0.03	<0.03
60	210	<0.30	0.97 ± 0.29	0.99 ± 2.34	<0.24	<0.05	0.08 ± 0.07
60	240	<0.36	1.11 ± 0.37	1.04 ± 1.43	<0.22	<0.04	0.07 ± 0.05
60	270	<0.26	2.11 ± 0.39	3.87 ± 2.11	<0.32	<0.04	0.18 ± 0.07
60	300	0.21 ± 0.11	1.53 ± 0.37	1.53 ± 0.60	<0.15	<0.05	0.18 ± 0.07
60	330	<0.39	0.97 ± 0.38	1.54 ± 1.60	<0.24	<0.05	0.18 ± 0.08
60	360	<0.40	0.96 ± 0.35	5.94 ± 2.04	<0.23	<0.04	0.13 ± 0.10
60	390	<0.26	1.57 ± 0.49	<0.98	<0.32	<0.04	<0.05
60	405	<0.06	0.90 ± 0.34	0.65 ± 0.54	0.21 ± 0.36	<0.04	0.10 ± 0.05
90	0	<0.30	1.32 ± 0.71	1.68 ± 0.74	<0.21	<0.03	0.13 ± 0.07
90	30	<0.46	1.20 ± 0.60	1.81 ± 2.30	<0.29	<0.05	0.33 ± 0.17
90	60	<0.30	1.60 ± 0.50	<1.01	0.72 ± 0.69	<0.07	0.33 ± 0.10
90	90	0.10 ± 0.07	1.38 ± 0.33	1.18 ± 0.80	<0.18	<0.02	0.29 ± 0.09
90	120	<0.30	0.87 ± 0.26	<0.60	<0.18	<0.04	<0.03
90	150	<0.30	1.25 ± 0.38	2.56 ± 1.59	<0.20	<0.04	0.05 ± 0.04
90	180	<0.24	1.01 ± 0.39	<0.89	<0.25	<0.05	<0.04
90	210	<0.06	1.09 ± 0.40	0.99 ± 0.84	<0.16	<0.04	0.07 ± 0.06

TABLE 11 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL COLLECTED
FROM GRID LINE INTERSECTIONS IN THE PREVIOUS LOCATION OF BUILDING 8

Grid Location N	Grid Location E	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
90	240	<0.39	1.22 ± 0.38	2.98 ± 1.13	<0.25	0.16 ± 0.09	0.20 ± 0.11
90	270	<0.43	1.45 ± 0.47	1.27 ± 1.74	<0.26	<0.04	0.08 ± 0.10
90	300	<0.30	1.20 ± 0.44	4.72 ± 1.18	<0.31	<0.05	0.12 ± 0.08
90	330-360	c	c	c	c	c	c
90	390	<0.05	0.97 ± 0.30	0.60 ± 0.92	<0.14	<0.05	0.09 ± 0.05
90	405	<0.36	1.10 ± 0.34	1.19 ± 1.81	<0.20	<0.05	0.11 ± 0.06
120	0	<0.33	1.09 ± 0.37	2.88 ± 1.15	0.33 ± 0.30	<0.03	0.16 ± 0.08
120	30	<0.32	1.32 ± 0.35	<1.15	<0.36	<0.05	0.34 ± 0.12
120	60	<0.06	1.20 ± 0.46	1.01 ± 0.65	0.29 ± 0.35	<0.03	0.26 ± 0.11
120	90	<0.60	0.92 ± 0.42	<0.90	<0.27	<0.05	0.21 ± 0.10
120	120	<0.37	1.32 ± 0.48	0.97 ± 1.42	<0.24	<0.04	0.30 ± 0.10
120	150	<0.22	0.65 ± 0.44	0.66 ± 1.79	<0.26	<0.36	<0.04
120	180	<0.05	0.72 ± 0.29	0.88 ± 0.81	<0.13	<0.03	<0.02
120	210	<0.43	1.17 ± 0.40	2.11 ± 1.97	<0.24	<0.05	0.10 ± 0.14
120	240	<0.25	0.55 ± 0.37	0.40 ± 1.87	<0.15	<0.02	<0.03
120	270	<0.20	0.70 ± 0.25	1.71 ± 1.50	<0.23	<0.03	<0.03
120	300	<0.03	0.36 ± 0.14	0.56 ± 0.31	<0.09	<0.03	<0.01
120	330	c	c	c	c	c	c
120	406	<0.40	0.84 ± 0.31	1.86 ± 1.59	<0.25	<0.05	0.40 ± 0.14
150	0	<0.36	1.12 ± 0.50	<0.70	<0.22	<0.05	0.15 ± 0.06
150	30	<0.30	1.06 ± 0.30	2.79 ± 1.75	<0.31	<0.06	0.44 ± 0.12
150	60	<0.06	1.25 ± 0.31	1.87 ± 0.59	<0.16	<0.03	0.26 ± 0.07
150	90	<0.35	1.10 ± 0.40	1.10 ± 3.13	<0.24	<0.04	0.35 ± 0.13
150	120	<0.36	1.19 ± 0.37	1.65 ± 1.49	<0.25	0.03 ± 0.05	0.32 ± 0.11
150	150	<0.23	0.88 ± 0.29	1.99 ± 0.90	<0.23	<0.04	<0.03
150	180	<0.05	1.13 ± 0.38	1.20 ± 0.72	<0.13	<0.025	0.07 ± 0.10
150	210	<0.35	0.72 ± 0.41	0.92 ± 1.64	<0.22	<0.03	0.12 ± 0.09
150	240	<0.36	1.11 ± 0.38	<0.66	<0.20	<0.03	0.16 ± 0.10

TABLE 11 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL COLLECTED
FROM GRID LINE INTERSECTIONS IN THE PREVIOUS LOCATION OF BUILDING 8

Grid Location N	Grid Location E	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
150	270	<0.30	1.45 ± 0.38	2.83 ± 1.50	<0.30	<0.04	0.23 ± 0.11
150	300	<0.07	1.27 ± 0.40	1.22 ± 0.55	<0.16	0.05 ± 0.10	0.24 ± 0.09
150	330-390	c	c	c	c	c	c
150	406	0.97 ± 1.04	1.29 ± 0.52	1.13 ± 0.89	0.39 ± 0.47	<0.06	0.05 ± 0.10
180	0	<0.31	1.04 ± 0.34	0.92 ± 1.31	<0.18	<0.04	0.11 ± 0.04
180	30	<0.28	1.46 ± 0.45	1.70 ± 1.76	<0.31	<0.05	0.48 ± 0.13
180	60	<0.06	1.33 ± 0.43	1.10 ± 0.86	0.20 ± 0.31	<0.04	0.27 ± 0.09
180	90	<0.39	0.74 ± 0.28	0.96 ± 1.68	<0.22	<0.06	0.18 ± 0.14
180	120	<0.41	1.14 ± 0.42	1.25 ± 2.27	<0.26	<0.05	0.26 ± 0.10
180	150	<0.20	0.68 ± 0.29	2.39 ± 1.12	<0.21	<0.04	<0.03
180	180	<0.05	0.77 ± 0.25	0.61 ± 0.48	<0.13	<0.03	0.04 ± 0.07
180	210	<0.30	1.13 ± 0.38	0.60 ± 0.63	0.29 ± 0.46	<0.03	0.08 ± 0.05
180	240	<0.28	0.96 ± 0.29	<0.61	<0.19	<0.03	0.04 ± 0.04
180	270	<0.25	0.92 ± 0.28	4.01 ± 1.25	<0.27	<0.04	<0.04
180	300	<0.06	1.01 ± 0.26	0.84 ± 0.51	<0.15	<0.04	0.29 ± 0.07
180	330-390	c	c	c	c	c	c
180	406	0.51 ± 0.83	1.15 ± 0.42	<0.72	<0.22	0.04 ± 0.04	0.06 ± 0.06
206	406	<0.34	1.03 ± 0.35	1.27 ± 1.59	<0.25	<0.06	<0.04
210	0	<0.27	0.75 ± 0.36	<0.67	<0.21	<0.04	0.26 ± 0.09
210	30	<0.32	1.28 ± 0.34	2.02 ± 1.35	<0.33	<0.05	0.41 ± 0.11
210	60	<0.06	1.10 ± 0.34	1.20 ± 0.74	0.36 ± 0.33	<0.04	0.22 ± 0.09
210	90	<0.40	1.05 ± 0.33	2.08 ± 1.03	<0.24	<0.05	0.36 ± 0.13
210	120	<0.47	1.06 ± 0.53	3.80 ± 1.24	<0.25	<0.05	0.28 ± 0.11
210	150	<0.26	1.25 ± 0.44	<3.91	<0.27	<0.04	<0.04
210	180	<0.05	1.28 ± 0.34	1.08 ± 0.53	<0.15	<0.05	0.11 ± 0.06
210	210	<0.31	0.80 ± 0.53	<0.58	<0.18	<0.05	0.11 ± 0.06
210	240	<0.30	0.78 ± 0.25	1.35 ± 1.71	<0.19	<0.03	<0.04
210	270	<0.28	1.12 ± 0.44	2.13 ± 1.36	<0.29	<0.05	<0.04

TABLE 11 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL COLLECTED
FROM GRID LINE INTERSECTIONS IN THE PREVIOUS LOCATION OF BUILDING 8

Grid Location N	Grid Location E	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
210	300	<0.06	1.24 ± 0.36	1.45 ± 0.62	<0.17	<0.03	0.30 ± 0.11
210	315	<0.28	1.54 ± 0.41	4.50 ± 2.17	0.60 ± 0.62	<0.04	0.26 ± 0.09
210	330-406	c	c	c	c	c	c
240	0	<0.34	1.22 ± 0.61	0.94 ± 1.28	<0.22	<0.04	0.37 ± 0.12
240	30	<0.46	1.15 ± 0.41	<0.97	<0.24	<0.06	0.24 ± 0.10
240	60	<0.32	1.45 ± 0.42	3.46 ± 1.99	<0.34	0.12 ± 0.11	0.30 ± 0.11
240	90	<0.06	1.09 ± 0.39	1.09 ± 0.66	<0.17	<0.03	0.27 ± 0.08
240	120	<0.41	1.46 ± 0.43	<0.84	<0.26	<0.06	0.43 ± 0.15
240	150	<0.32	0.85 ± 0.27	1.88 ± 0.83	<0.22	<0.04	<0.037
240	180	<0.26	0.99 ± 0.40	1.63 ± 1.34	<0.26	<0.04	0.12 ± 0.08
240	210	<0.06	1.30 ± 0.35	0.66 ± 0.90	<0.17	<0.04	0.07 ± 0.05
240	240	<0.40	1.03 ± 0.39	1.93 ± 1.58	<0.22	<0.04	0.36 ± 0.12
240	270	<0.47	1.95 ± 0.55	1.32 ± 2.74	<0.25	<0.06	0.18 ± 0.11
240	300	<0.34	1.79 ± 0.42	<1.13	<0.35	<0.06	0.38 ± 0.15
240	315	<0.05	0.71 ± 0.40	1.08 ± 0.71	<0.13	<0.04	0.15 ± 0.06
240	330,406	c	c	c	c	c	c
270	0	<0.06	1.10 ± 0.37	<0.43	<0.15	<0.03	0.09 ± 0.06
270	30	<0.39	1.68 ± 0.51	1.76 ± 1.98	<0.26	<0.07	0.26 ± 0.09
270	60	<0.46	1.15 ± 0.32	1.56 ± 2.02	<0.27	<0.04	0.27 ± 0.10
270	90	<0.33	1.74 ± 0.48	1.80 ± 2.42	<0.33	<0.05	0.41 ± 0.12
270	120	<0.06	1.15 ± 0.54	0.52 ± 0.58	<0.16	<0.04	0.19 ± 0.11
270	150	<0.33	0.77 ± 0.29	1.66 ± 0.82	<0.21	<0.04	<0.05
270	180	<0.35	2.42 ± 0.44	1.87 ± 1.29	<0./21	0.10 ± 0.06	<0.05
270	210	<0.34	1.27 ± 0.39	<1.17	<0.39	<0.05	0.29 ± 0.14
270	240	<0.07	0.90 ± 0.44	<1.17	<0.17	<0.04	0.17 ± 0.08
270	270	<0.37	1.33 ± 0.38	1.46 ± 1.69	<0.24	<0.05	0.08 ± 0.08
270	300	<0.28	1.17 ± 0.48	4.01 ± 1.75	<0.32	<0.04	0.31 ± 0.10
270	303	<0.06	1.05 ± 0.39	0.87 ± 0.54	0.41 ± 0.40	<0.04	0.09 ± 0.07

TABLE 11 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL COLLECTED
FROM GRID LINE INTERSECTIONS IN THE PREVIOUS LOCATION OF BUILDING 8

Grid Location N	Grid Location E	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
300	0	<0.05	1.10 ± 0.31	1.00 ± 0.81	<0.15	<0.03	0.16 ± 0.08
300	30	<0.41	1.30 ± 0.38	1.97 ± 1.71	<0.26	<0.04	0.19 ± 0.10
300	60	<0.44	0.82 ± 0.44	1.39 ± 1.56	<0.23	<0.03	0.23 ± 0.12
300	90	<0.30	1.67 ± 0.44	2.07 ± 2.04	<0.34	<0.05	0.40 ± 0.12
300	120	<0.06	<0.06	1.55 ± 0.88	<0.17	<0.04	0.25 ± 0.09
300	150	0.34 ± 0.73	1.03 ± 0.43	0.73 ± 0.76	<0.20	<0.04	<0.03
300	180	<0.39	1.39 ± 0.63	1.45 ± 1.72	<0.26	<0.06	<0.05
300	210	<0.26	1.03 ± 0.56	3.10 ± 1.06	<0.28	<0.04	0.15 ± 0.07
300	240	<0.06	1.23 ± 0.42	1.64 ± 0.54	<0.17	<0.04	0.26 ± 0.12
300	270	<0.44	1.18 ± 0.56	<0.99	<0.28	<0.04	0.25 ± 0.13
300	282	<0.40	0.91 ± 0.43	3.59 ± 1.86	<0.24	<0.04	0.29 ± 0.10
330	0	<0.36	1.01 ± 0.34	<0.75	<0.23	<0.04	0.16 ± 0.06
330	30	<0.30	1.17 ± 0.36	2.60 ± 1.12	<0.33	<0.06	0.35 ± 0.12
330	60	<0.06	0.84 ± 0.47	1.06 ± 0.90	<0.17	<0.04	0.33 ± 0.11
330	90	<0.36	1.36 ± 0.35	1.97 ± 1.55	0.36 ± 0.51	<0.06	0.21 ± 0.12
330	120	<0.30	0.74 ± 0.32	0.91 ± 2.30	<0.18	<0.03	0.09 ± 0.06
330	150	<0.26	0.90 ± 0.31	1.86 ± 1.32	<0.28	<0.04	0.13 ± 0.90
330	180	<0.05	1.35 ± 0.34	0.70 ± 0.81	<0.16	<0.04	<0.03
330	210	<0.46	0.93 ± 0.52	1.16 ± 2.65	<0.28	<0.06	0.28 ± 0.15
330	240	<0.49	1.83 ± 0.52	1.70 ± 1.86	<0.28	<0.03	0.38 ± 0.12
330	264	<0.27	0.93 ± 0.37	1.53 ± 0.87	<0.31	<0.04	0.07 ± 0.04
360	0	<0.06	0.81 ± 0.35	0.82 ± 0.95	<0.17	<0.05	0.30 ± 0.09
360	30	<0.35	1.19 ± 0.50	1.11 ± 2.10	<0.25	<0.06	0.20 ± 0.09
360	60	<0.32	1.13 ± 0.51	2.70 ± 1.80	<0.33	<0.06	0.51 ± 0.11
360	90	<0.06	1.27 ± 0.68	0.80 ± 0.53	<0.14	0.09 ± 0.05	0.26 ± 0.09
360	120	<0.34	0.66 ± 0.57	1.27 ± 1.30	<0.21	<0.04	0.13 ± 0.11
360	150	<0.34	0.50 ± 0.36	1.35 ± 1.64	<0.20	<0.04	<0.04
360	180	0.68 ± 0.64	1.88 ± 0.51	2.20 ± 1.20	1.05 ± 0.60	0.14 ± 0.12	0.80 ± 0.20

TABLE 11 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL COLLECTED
FROM GRID LINE INTERSECTIONS IN THE PREVIOUS LOCATION OF BUILDING 8

Grid Location N	Grid Location E	Radionuclide Concentrations (pCi/g) Am-241	Th-232	U-238	U-235	Co-60	Cs-137
360	210	<0.06	1.46 ± 0.42	1.20 ± 0.97	<0.18	0.10 ± 0.12	0.27 ± 0.08
360	240	<0.37	1.27 ± 0.42	1.65 ± 2.0	<0.24	<0.06	0.36 ± 0.13
390	0	<0.32	0.84 ± 0.40	<0.68	<0.21	<0.05	0.28 ± 0.11
390	30	<0.28	1.24 ± 0.60	1.30 ± 0.90	<0.30	<0.04	0.26 ± 0.09
390	60	<0.06	1.10 ± 0.37	1.45 ± 0.58	<0.16	<0.04	0.21 ± 0.11
390	90	<0.42	1.10 ± 0.43	1.65 ± 1.08	0.33 ± 0.57	<0.05	0.40 ± 0.12
390	120-223	[c]	[c]	[c]	[c]	[c]	[c]
406	0	<0.32	0.84 ± 0.40	<0.68	<0.21	<0.05	0.28 ± 0.11
406	30	<0.34	1.14 ± 0.30	<1.10	<0.34	<0.06	0.30 ± 0.11
406	60-210	[c]	[c]	[c]	[c]	[c]	[c]

[a]Refer to Figure 5.
[b]Errors are 2σ based on counting statistics.
[c]No sample collected due to presence of asphalt or building.

TABLE 12

RADIONUCLIDE CONCENTRATIONS IN COMPOSITE SOIL SAMPLES FROM GRID LINE INTERSECTIONS IN THE AREA PREVIOUSLY OCCUPIED BY BUILDING 8

Grid Line N	Grid Line E	No. of Composite Samples	Radionuclide Concentrations (pCi/g) Pu-238	Pu-239/40
0	0-240	9	0.25 ± 0.11[b]	0.10 ± 0.07
0	270-480	9	0.15 ± 0.07	0.22 ± 0.09
30	0-210	8	0.17 ± 0.05	0.08 ± 0.03
30	240-405	7	0.05 ± 0.02	<0.02
60	0-210	8	0.04 ± 0.03	<0.02
60	240-405	7	0.05 ± 0.03	<0.02
90	0-150	6	0.03 ± 0.02	0.02 ± 0.02
90	180-405	7	0.08 ± 0.04	0.04 ± 0.03
120	0-406	12	0.04 ± 0.02	<0.02
150	0-406	12	0.12 ± 0.05	<0.02
180	0-406	12	0.06 ± 0.03	<0.02
210	0-300	12	0.07 ± 0.03	0.02 ± 0.02
240	0-300	12	0.03 ± 0.02	<0.02
270	0-300	12	0.08 ± 0.04	<0.02
300	0-270	11	0.04 ± 0.03	<0.02
330	0-264	10	0.03 ± 0.02	0.03 ± 0.02
360	0-240	9	0.03 ± 0.02	<0.02
390	0-90	4	0.08 ± 0.05	0.02 ± 0.03

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

APPENDIX A

MAJOR ANALTYICAL EQUIPMENT

APPENDIX A

Major Analtyical Equipment

The display or description of a specific product is not to be construed as an endorsement of that product or its manufacturer by the authors or their employer.

A. Direct Radiation Measurements

Eberline "RASCAL"
Portable Scaler/Ratemeter
Model PRS-1
(Eberline, Sante Fe, NM)

Eberline PRM-6
Portable Ratemeter
(Eberline, Sante Fe, NM)

Ludlum Floor Monitor
Model 239-1
(Ludlum, Sweetwater, TX)

Eberline Alpha Scintillation Probe
Model AC-3-7
(Eberline, Sante Fe, NM)

Eberline Low-Energy Gamma Scintillation Probe
Model PG-2
(Eberline, Sante Fe, NM)

Reuter-Stokes Pressurized Ionization Chamber
Model RSS-111
(Reuter-Stokes, Cleveland, OH)

B. Laboratory Analyses

Low Background Alpha-Beta Counter
Model LB5100-2080
(Tennelec Inc., Oak Ridge, TN)

Ge(Li)Detectors (2)
Model LGCC2220SD, 23% efficiency
(Princeton Gamma-Tech, Princeton, NJ)

Used in Conjunction with:
Lead Shield, SPG-16
(Applied Physical Technology, Smyrna, GA)

High-Purity Germanium Detector
Model GMX-23195-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead shield, G-16
(Gamma Products, Inc., Palos Hills, IL)

Pulse Height Analyzer, ND680
Model 88-0629
(Nuclear Data, Inc., Schaumburg, IL)

Alpha Spectrometer
Tennelec TC-256
(Tennelec Inc., Oak Ridge, TN)

Surface Barrier Detector
Model CR-25-450-100
(EG&G ORTEC, Oak Ridge, TN)

APPENDIX B

ANALYTICAL PROCEDURES

APPENDIX B

Analytical Procedures

Alpha and Beta-Gamma Measurements

Measurements of direct alpha radiation levels were performed using Eberline Model PRS-1 portable scaler/ratemeters with Model AC-3-7 alpha scintillation probes. Measurements of direct beta-gamma radiation levels were performed using Eberline Model PRS-1 portable scaler/ratemeters with Model HP-260 thin-window "pancake" G-M probes. Count rates (cpm) were converted to disintegration rates (dpm/100 cm^2) by dividing the net rate by the 4π efficiency and correcting for active area of the detector. Effective window areas are 59 cm^2 for the ZnS detectors and 15 cm^2 for the G-M detectors. Background count rates for ZnS alpha probes averaged approximately 1 cpm; the average background count rate was 30 cpm for the G-M probes.

Surface Scans

Surface scans of grid blocks in Building 10 and outside soil areas were performed by passing the probes slowly over the surface. The distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Alpha scans of large surface areas on the floor of the facility were accomplished by use of a gas proportional alpha floor monitor, with a 600 cm^2 sensitive area. The instrument is slowly moved in a systematic pattern to cover 100% of the accessible area. Combinations of detectors and instruments for the scans were:

Low-Energy Gamma	- Thin-window NaI scintillation with PRM-6 ratemeter
Gamma	- NaI scintillation detector (3.2 cm x 3.8 cm crystal) with PRM-6 ratemeter.
Alpha	- ZnS probe with "RASCAL" scaler/ratemeter

Alpha	- Gas proportional floor monitor with PRM-6 ratemeter and headphones.
Beta-Gamma	- Pancake G-M probe with PRS-1 scaler/ratemeter.

Gamma Exposure Rates

Measurements of gamma exposure rates were performed using a Reuter-Stokes pressurized ionization chamber. The chamber was placed at 1 m above the surface at various locations throughout Building 10 and the vicinity of Building 7. The average of several readings was determined at each location.

Transferable Contamination Measurements

Smear measurements were performed on numbered filter paper disks, 47 mm in diameter. Each smear was sealed in a labeled envelope with the location and other pertinent information recorded. A low-background alpha-beta counting system was used to count individual smears.

Soil Sample Analysis

Soil samples were dried, ground, mixed, and a portion placed in a 0.5 liter Marinelli beaker. The quantity placed in each beaker was chosen to reproduce the calibrated counting geometry and typically ranged from 500 to 800 g of soil. Net weights were determined and the samples counted using either Ge(Li) or high purity germanium detectors coupled to a Nuclear Data Model ND 680 pulse height analyzer. The following energy peaks were used for determination of the radionuclides of concern:

Am-241 - 0.060 MeV
Th-232 - 0.911 MeV from Ac-228 (secular equilibrium assumed)
U-235 - 0.143 MeV
U-238 - 0.094 MeV from Th-234 (secular equilibrium assumed)
Co-60 - 1.17 and 1.33 MeV
Cs-137 - 0.662 MeV

Peak identification and calculations of concentrations, statistical errors, and detection sensitivities were performed by the computer capabilities inherent in the analyzer system.

Alpha spectroscopy was performed on composites of soil samples to identify plutonium radioisotopes. The samples were dissolved by a combination of potassium fluoride and pyrosulfate fusions. The cake was dissolved and alpha emitters were precipitated using barium sulfate as a carrier. The barium sulfate was dissolved and the plutonium separated by liquid-liquid extraction. It was then precipitated by carrying with cerium fluoride and counted with an alpha spectrometer system.

Water Sample Analysis

Water samples were rough filtered through Whatman No. 2 filter paper. Remaining suspended solids were removed by filtration through 0.45 μm pore size membrane filters and the filtrate was acidified by addition of concentrated nitric acid (10 ml acid per 3.8 l of water). A known volume of each sample was evaporated to dryness and counted using a low-background proportional counter.

Errors and Detection Limits

The errors associated with the analytical data presented in the tables of this report, represent the 95% (2σ) confidence levels for that data. These errors were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the 2σ statistical deviation of the background count, the sample concentration was reported at less than the minimum detectable activity (<MDA). This means that the radionuclide was not present, to the best of our ability to measure it, utilizing the analytical techniques described in this appendix. Because of variation in background levels, caused by other constituents in the samples, the MDAs for specific radionuclides differ from sample to sample.

Calibration and Quality Assurance

Portable survey equipment and laboratory and analytical instruments were calibrated using NBS-traceable standards. Calibration of the instrumentation used for the gross alpha in soil technique was accomplished by the use of NBS-traceable standards. Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA Quality Assurance Program.

APPENDIX C

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BY-PRODUCE, 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.