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COMPREHENSIVE RADIOLOGICAL SURVEY
OFF-SITE PROPERTY S
NIAGARA FALLS STORAGE SITE
LEWISTON, NEW YORK

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

FINAL REPORT

February 1984

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Prepared for

U.S. Department of Energy
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COMPREHENSIVE RADIOLOGICAL SURVEY

OFF-SITE PROPERTY S NIAGARA FALLS STORAGE SITE LEWISTON, NEW YORK

INTRODUCTION

Beginning in 1944, the Manhattan Engineer District and its successor, the Atomic Energy Commission (AEC), used portions of the Lake Ontario Ordnance Works (presently referred to as the Niagara Falls Storage Site (NFSS) and off-site properties), approximately 3 km northeast of Lewiston, New York, for storage of radioactive wastes. These wastes were primarily residues from uranium processing operations; however, they also included: contaminated rubble and scrap from decommissioning activities, biological and miscellaneous wastes from the University of Rochester, and low-level fission-product waste from contaminated-liquid evaporators at the Knolls Atomic Power Laboratory (KAPL). Receipt of radioactive waste was discontinued in 1954, and, following cleanup activities by Hooker Chemical Co., 525 hectares of the original 612-hectare NFSS were declared surplus. This property was eventually sold by the General Services Administration to various private, commercial, and governmental agencies.¹

SCA Chemical Services, Inc., (SCA) is the current owner of a tract identified as off-site property S (see Figure 1). A radiological survey of that tract, conducted in April - June 1983, is the subject of this report.

SITE DESCRIPTION

Figure 2 is a plot plan of off-site property S. The property occupies approximately 9.2 hectares, and is bounded on the north by "M" Street and on the east by Campbell Street. The Department of Energy's Niagara Falls Storage Site is located directly south of property S, and the town of Lewiston owns the parcel of land bordering the site on the west.

This property is presently unused and is partially overgrown with brush, weeds, and trees. There are no structures on the site; however, there is a concrete pad adjacent to "M" Street. The Central Drainage Ditch passes through the property in a north/south direction.

Radiological History

There is no evidence of storage or burial of contaminated material on this property. Previous surveys have indicated elevated radiation levels along portions of the Central Drainage Ditch and along Campbell and "M" Streets. These latter areas may be attributable to naturally occurring radionuclides in the roadbed slag.¹⁻³

SURVEY PROCEDURES

A comprehensive survey of NFSS off-site property S was performed by the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU), during the period of April 13 - June 2, 1983. The survey was in accordance with a plan dated March 14, 1983, approved by the Department of Energy's Office of Nuclear Energy. The objective and procedures from that plan are presented in this section. It should be noted that the Central Drainage Ditch and an easement, 13 m either side of the upper bank of the ditch, are being surveyed and dredged by Bechtel National, Inc.; this area was therefore excluded from the ORAU survey.

Objective

The objective of the survey was to provide a comprehensive assessment of the radiological conditions on property S. Radiological information collected included:

1. direct radiation exposure rates and surface beta-gamma dose rates,
2. locations of elevated surface residues,
3. concentrations of radionuclides in surface and subsurface soil,
4. concentrations of radionuclides in surface and ground water, and

5. concentrations of radionuclides in sediment samples from drainage ditches.

Procedures

1. Site Preparation
 - a. Brush and weeds were cleared as needed to provide access for gridding and surveying, and a 40 m grid system was established. These services were provided by McIntosh and McIntosh of Lockport, NY, under subcontract. This grid system is shown on Figure 3.
 - b. An area, 30 m x 50 m, around a concrete pad adjacent to "M" Street was subdivided into 5 m intervals by the ORAU survey team. This subdivision was performed as a result of the generally elevated direct radiation levels noted in this area during the walkover scan.
2. Gamma exposure rate measurements were made at the surface and at 1 m above the surface at each accessible intersection of major grid lines. Measurements were performed using portable gamma NaI(Tl) scintillation survey meters. Conversion of these measurements to exposure rates in microroentgens per hour ($\mu\text{R}/\text{h}$) was in accordance with cross calibration with a pressurized ionization chamber.
3. Beta-gamma dose rate measurements were performed 1 cm above the surface at each accessible grid line intersection. These measurements were conducted using thin-window ($<7 \text{ mg}/\text{cm}^2$) G-M detectors and portable scaler/ratemeters. Measurements were also obtained with the detector shielded to evaluate contributions of nonpenetrating beta and low-energy gamma radiations. Meter readings were converted to dose-rate in microrads per hour ($\mu\text{rad}/\text{h}$), based on cross calibration with a thin-window ionization chamber.

4. Surface (0-15 cm) soil samples of approximately 1 kg each were collected at each accessible grid line intersection.
5. Walkover surface scans were conducted over all accessible areas of the property. Scanning intervals were 1-2 m along roads and in areas where elevated radiation levels were observed; in other areas scanning was at 2-5 m intervals. Portable gamma scintillation survey meters were used for these scans. Locations of elevated contact radiation levels were noted.
6. At locations of elevated surface radiation levels, gamma exposure rates at 1 m above the surface and beta-gamma dose rates at 1 cm above the surface were measured. Surface soil samples were obtained from these locations and, following sampling, the surface exposure levels were remeasured to evaluate the effectiveness of shallow sampling on removal of the radiation source.
7. Detection Sciences Group of Carlisle, MA, performed ground penetrating radar surveys in the vicinity of the concrete pad and at proposed borehole locations. The purpose of these radar scans was to identify subsurface objects or anomalies which might be indicative of burials on the site and to identify the presence of underground piping or utilities which would preclude borehole drilling.
8. Boreholes were drilled to provide a mechanism for logging subsurface direct radiation profiles and collecting subsurface soil and water samples. Seven boreholes to ground water depth (2-6 m) and ten shallower (1.0-1.5 m) boreholes were drilled by Site Engineers, Inc., of Cherry Hill, NJ, using a truck mounted 20 cm diameter hollow-stem auger. The shallow boreholes were primarily at locations where direct radiation measurements had indicated possible contamination. The locations of these boreholes are shown on Figure 4.

The boreholes were gamma scanned over their entire length for the presence of subsurface residues. Radiation profiles in the boreholes were determined by measurements of gamma radiation at 15-30 cm intervals between the surface and ground water (deep holes) or the hole bottom (shallow holes) and at locations of elevated readings identified by the borehole scan. A collimated gamma scintillation detector and portable scaler were used for these measurements.

Water samples of approximately 3.5 liters each were collected from six borehole locations using a hand bailer. Soil samples of approximately 1 kg each were collected from various depths in the holes by scraping the sides of the borehole with a specially constructed sampling tool.

9. One water sample was collected from an on-site ditch (see Figure 5).
10. Sediment samples were collected from four locations in on-site ditches (see Figure 5).
11. Twenty soil samples and seven water samples were collected from the Lewiston area (but not on NFSS or associated off-site properties) 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 6.

Sample Analyses and Interpretation of Results

Soil and sediment samples were analyzed by gamma spectrometry. Radium-226 was the major radionuclide of concern, although spectra were reviewed for Cs-137, U-235, U-238, and other gamma emitters. Water samples were analyzed for gross alpha and beta concentrations. Two samples were also

analyzed for Ra-226 concentrations. Additional information concerning analytical equipment and procedures is contained in Appendix A.

Results of this survey were compared to the applicable guidelines for formerly utilized radioactive materials handling sites, which are presented in Appendix B.

RESULTS

Background Levels and Baseline Concentrations

Background exposure rates and baseline radionuclide concentrations in soil, determined for 20 locations (Figure 6) in the vicinity of the Niagara Falls Storage Site, are presented in Table 1-A. Exposure rates ranged from 6.8 to 8.8 $\mu\text{R/h}$ (typical levels for this area of New York). Concentrations of radionuclides in soil were: Ra-226, <0.09 to 1.22 pCi/g (picocuries per gram); U-235, <0.14 to 0.46 pCi/g; U-238, <2.20 to 6.26 pCi/g; Th-232, 0.32 to 1.18 pCi/g; and Cs-137, <0.02 to 1.05 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 gross beta concentrations ranged from 0.55 to 1.87 pCi/l (picocuries per liter) and <0.63 to 14.3 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, are presented in Table 2. The gamma exposure rates at 1 m above the surface ranged from 9 to 16 $\mu\text{R/h}$ (average 11 $\mu\text{R/h}$). Surface contact exposure rates also ranged from 9 to 16 $\mu\text{R/h}$ (average 11 $\mu\text{R/h}$). Beta-gamma dose rates at the surface ranged from 9 to 18 $\mu\text{rad/h}$ (average 12 $\mu\text{rad/h}$). Measurements performed with the detector shielded averaged approximately 20% less than those with the unshielded detector. This indicates only a small portion of the surface dose rate is due to nonpenetrating beta or low-energy photon radiations. These measurements indicated slightly higher levels along Campbell Street.

The walkover survey identified one area of generally higher direct radiation levels. This area was between grid line 5S, 30S, 0, and 50W, in the vicinity of a concrete pad. Table 3 presents direct radiation levels measured at 5 m intervals in that area. Exposure rates at these locations ranged from 10 to 32 $\mu\text{R}/\text{h}$ at 1 m above the surface and from 10 to 50 $\mu\text{R}/\text{h}$ at surface contact. Beta-gamma dose rates ranged from 10 to 130 $\mu\text{rad}/\text{h}$. Levels were generally higher on the east, west, and south sides of this pad.

Several small, isolated regions with contact radiation levels significantly higher than those on adjacent areas were also identified by the surface scan. These locations are shown on Figure 3, and the associated radiation levels are presented in Table 4. Gamma exposure rates at contact with these regions ranged from 24 to 88 $\mu\text{R}/\text{h}$. The highest level was measured at grid point 22S,11W near the concrete pad. Surface beta-gamma dose rates at these locations ranged from 35 to 100 $\mu\text{rad}/\text{h}$.

At most locations, contact exposure rates were not reduced by soil sampling; exposure rates actually increased following sampling at several of the locations. For example, the contact exposure rate after sampling at 22S,11W (location 3) was 120 $\mu\text{R}/\text{h}$ as compared to the level of 88 $\mu\text{R}/\text{h}$ before sampling. These results indicate that the contamination extends greater than 15 cm below the surface and/or is diffused rather than in discrete deposits.

Radionuclide Concentrations in Surface Soil

Table 5 lists the concentrations of radionuclides measured in surface soil from 40 m grid intervals. These samples contained Ra-226 concentrations ranging from 0.31 to 2.90 pCi/g. The highest level was in the sample from grid location 3S,120W. All samples collected along the shoulder of "M" Street contained slightly elevated Ra-226 levels, ranging from 1.48 to 2.90 pCi/g. Ra-226 concentrations in other systematic samples and concentrations of U-235, U-238, and Cs-137 were not significantly different from those in baseline soil samples.

Concentrations of radionuclides in surface soil samples, collected at 5 m intervals from the vicinity of the concrete pad, are presented in Table 6.

Ra-226 concentrations in these samples ranged from 0.55 to 34.9 pCi/g. These samples contained U-238 concentrations ranging from <0.84 to 34.2 pCi/g. The U-238 and Ra-226 levels were generally equivalent within the statistical errors of measurement. This equilibrium suggests naturally occurring material. The elevated areas around the pad were noted to contain a layer of crushed rock. X-ray fluorescence and neutron activation analyses of samples of this rock showed the composition to be primarily calcium and silicon with smaller or trace levels of iron, strontium, titanium, lead, manganese, zinc, copper, aluminum, chromium, zirconium, rubidium, thorium, and uranium.

The results indicate that the rock is probably pseudowallastonite - a slag material produced during the separation of elemental phosphorus. Previous investigations by Oak Ridge National Laboratory have shown this material to be commonly used for fill and as a paving base in the Niagara Falls, New York area.⁴ There is no evidence that this material was associated with previous Manhattan Engineer District or Atomic Energy Commission activities on the property.

Analytical results for samples collected from locations of elevated contact radiation levels are presented in Table 7. All of these samples contained Ra-226 concentrations exceeding the baseline levels. Samples B3-B8 were from the vicinity of the concrete pad; other analyses indicate that their radionuclide content is not attributable to government operations at this site. Samples B1-A and B1-B are also of the same composition. Sample B2 (grid point 192S, 47E) contains 62.3 pCi/g of Ra-226 and 12.2 pCi/g of U-238. This sample consists mainly of soil, and the unequal levels of Ra-226 to U-238 indicate that this is probably contamination resulting from previous MED/AEC activities at this site. These samples did not contain Cs-137 or other radionuclides at levels differing from those normally present in soil.

Ground Penetrating Radar Findings

The subcontractor's report, summarizing the ground penetrating radar survey results for property S is provided in Appendix C. Subsurface interferences (probably piping) were detected at several points proposed for boreholes, necessitating slight relocation of drilling points. There was no indication of buried objects in the vicinity of the concrete pad.

Borehole Gamma-Logging Measurements

Elevated scintillation measurements were noted only in boreholes drilled in the vicinity of the concrete pad and at locations of elevated surface radiation levels. In all cases these measurements indicated that the contamination is confined within 15 to 30 cm of the surface. As evidenced by sample analyses, the gamma count rates determined by the borehole measurements were reliable indicators of elevated subsurface radionuclide levels. However, the gamma logging data was not useful in quantifying the radionuclide concentrations in the subsurface soil, because of the varying ratios of Ra-226 and U-238 occurring in soil and rock from this site.

Radionuclide Concentrations in Subsurface Soil

Table 8 presents the radionuclide concentrations measured in soil samples from boreholes. The seven boreholes (H1-H7), selected to provide a representative coverage of the property, had subsurface radionuclide concentrations either in the range of baseline samples or less than the minimum detectable activity (MDA).

Boreholes H8-H15 were in the vicinity of the concrete pad, where the walkover scan survey had identified elevated direct radiation levels. Gamma radiation logging did not identify the presence of significant subsurface residues. The maximum subsurface Ra-226 concentration was 3.43 pCi/g. Boreholes H16 and H17, near isolated areas of elevated direct radiation, did not contain Ra-226 levels differing from those in baseline soils. None of the subsurface samples contained elevated concentrations of U-235, U-238, Cs-137 or other gamma emitting radionuclides.

Radionuclide Concentrations in Water

The results of water sample analyses are presented in Table 9. It should be noted that all water samples contained high concentrations of dissolved solids, resulting in residues, which adversely affected the measurement

sensitivities and errors for the gross alpha and gross beta procedure. The surface water sampled, collected from a drainage ditch, contained 15.1 pCi/l and 41.4 pCi/l, gross alpha and gross beta, respectively.

Water obtained from six of the boreholes contained gross alpha concentrations ranging from <1.70 to 6.87 pCi/l and gross beta concentrations ranging from <2.75 to 26.3 pCi/l. The surface water sample and the sample from borehole H1 were also analyzed for Ra-226 and found to contain 0.27 pCi/l and 0.28 pCi/l, respectively.

Radionuclide Concentrations in Sediment Samples

Concentrations of radionuclides in four sediment samples collected from drainage ditches (other than the Central Drainage Ditch) on property S were in the ranges of levels in baseline soil.

COMPARISON OF SURVEY RESULTS WITH GUIDELINES

The guidelines applicable to cleanup of the Niagara Falls Storage Site off-site properties are presented in Appendix B. All exposure rates at 1 m above the ground surface on property S are well below the 60 μ R/h criteria established for open land areas.

There is an area adjacent to the concrete pad where the Ra-226 soil concentrations, averaged over 100 m², exceed the level of 5 pCi/g above background. Further analysis of samples from this area indicates that the elevated radionuclide levels are contained in a rock slag commonly used for fill and as a paving base. This material originates from chemical processing operations and the radium and uranium levels contained in it do not result from previous government activities on this site. A similar material has been noted at numerous locations on the NFSS and the off-site properties and in the Niagara Falls and Lewiston areas. There is one small isolated area at grid location 192S, 47E which appears to be Ra-226 contamination associated with previous site activities; however, the concentrations averaged over 100 m² would be below the 5 pCi/g criteria level.

Ground-penetrating radar did not indicate the presence of subsurface objects which would suggest buried materials. Borehole measurements and sampling indicate all subsurface soil concentrations are within the applicable guidelines of 15 pCi/g for Ra-226.

Radionuclide concentrations in subsurface water samples are within the EPA Interim Drinking Water Standards. The one surface water sample collected from a drainage ditch slightly exceeded gross alpha concentration limits of 15 pCi/l, but the Ra-226 level in the sample (0.27 pCi/l) was well within the limit set by the EPA.

SUMMARY

A comprehensive survey of off-site property S at the Niagara Falls Storage Site was conducted by Oak Ridge Associated Universities during April-June 1983. The survey included surface radiation scans, measurements of direct radiation levels, and analyses of radionuclide concentrations in surface and subsurface soil and water samples. Analyses of sediment samples were also performed. Ground penetrating radar was used to identify subsurface anomalies, which might suggest buried materials.

The results of the survey indicated areas of crushed rock containing Ra-226 and U-238. This material is believed to be chemical processing slag commonly used for fill and as a paving base in the Niagara Falls area. It is not attributable to previous radioactive waste handling and storage activities at this site.

No subsurface soil contamination was noted. Water samples are within the EPA Interim Drinking Water Standards, with the exception of the one surface water sample.

Radionuclide levels on this property do not pose potential health risks and there is no evidence that migration of the radioactive materials is adversely affecting adjacent properties or the ground water.

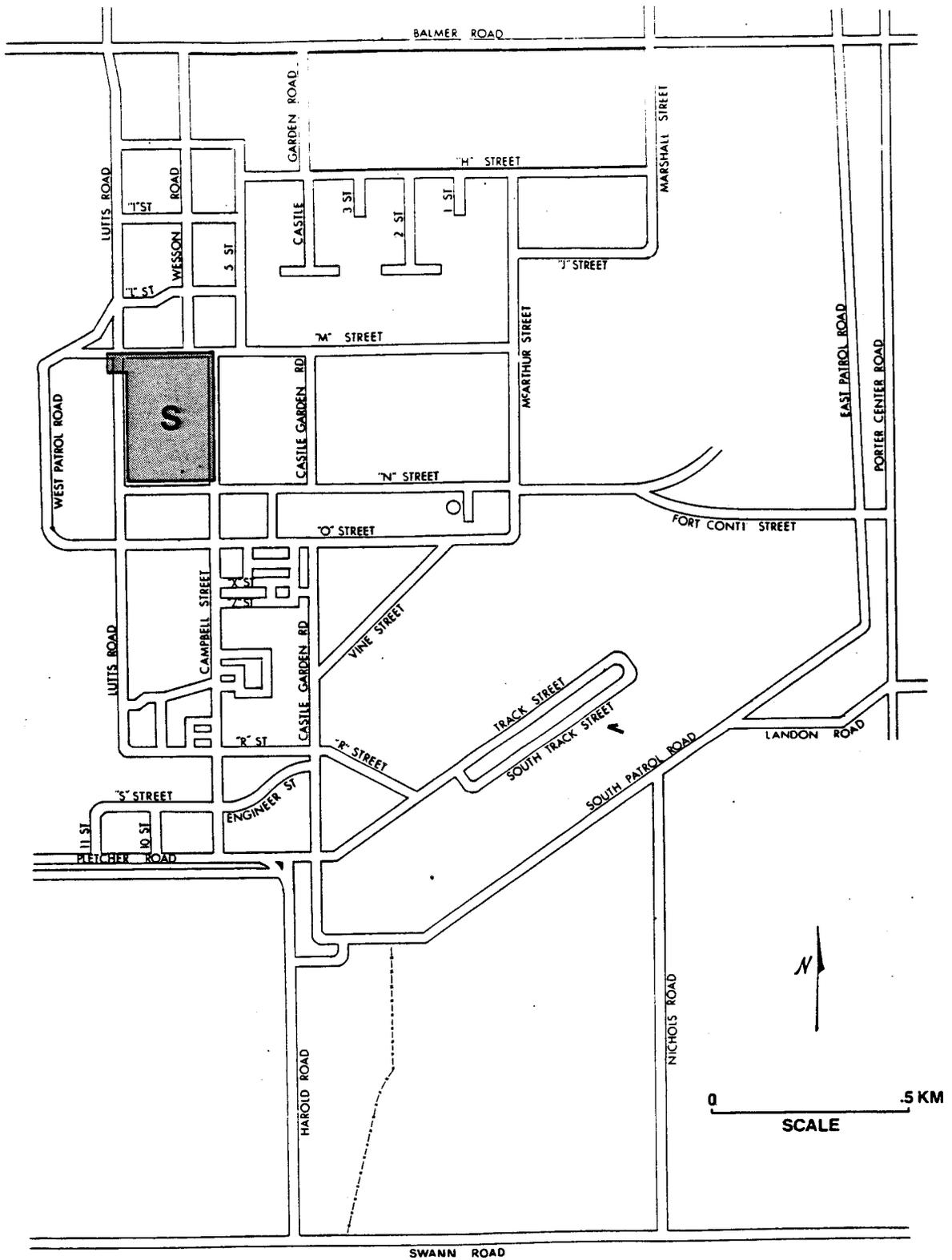


FIGURE 1. Map of Niagara Falls Storage Site and Off-Site Properties, Lewiston, New York, Indicating the Location of Off-Site Property S.

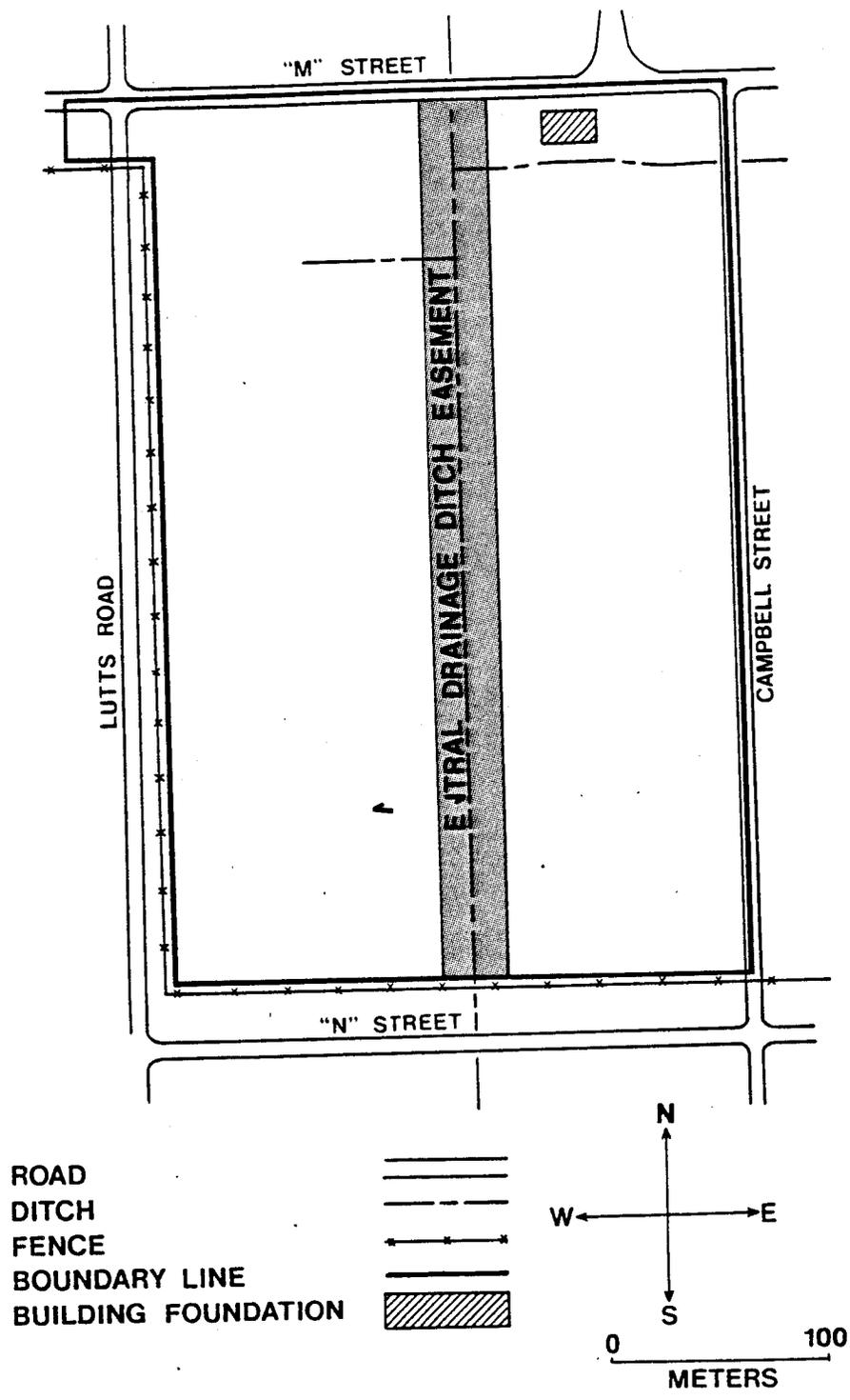


FIGURE 2. Plan View of Off-Site Property S, Indicating Prominent Surface Features. (Note: The Central Drainage Ditch and its Easement are Being Surveyed by Bechtel National, Inc., and are Therefore Excluded From the ORAU Survey.)

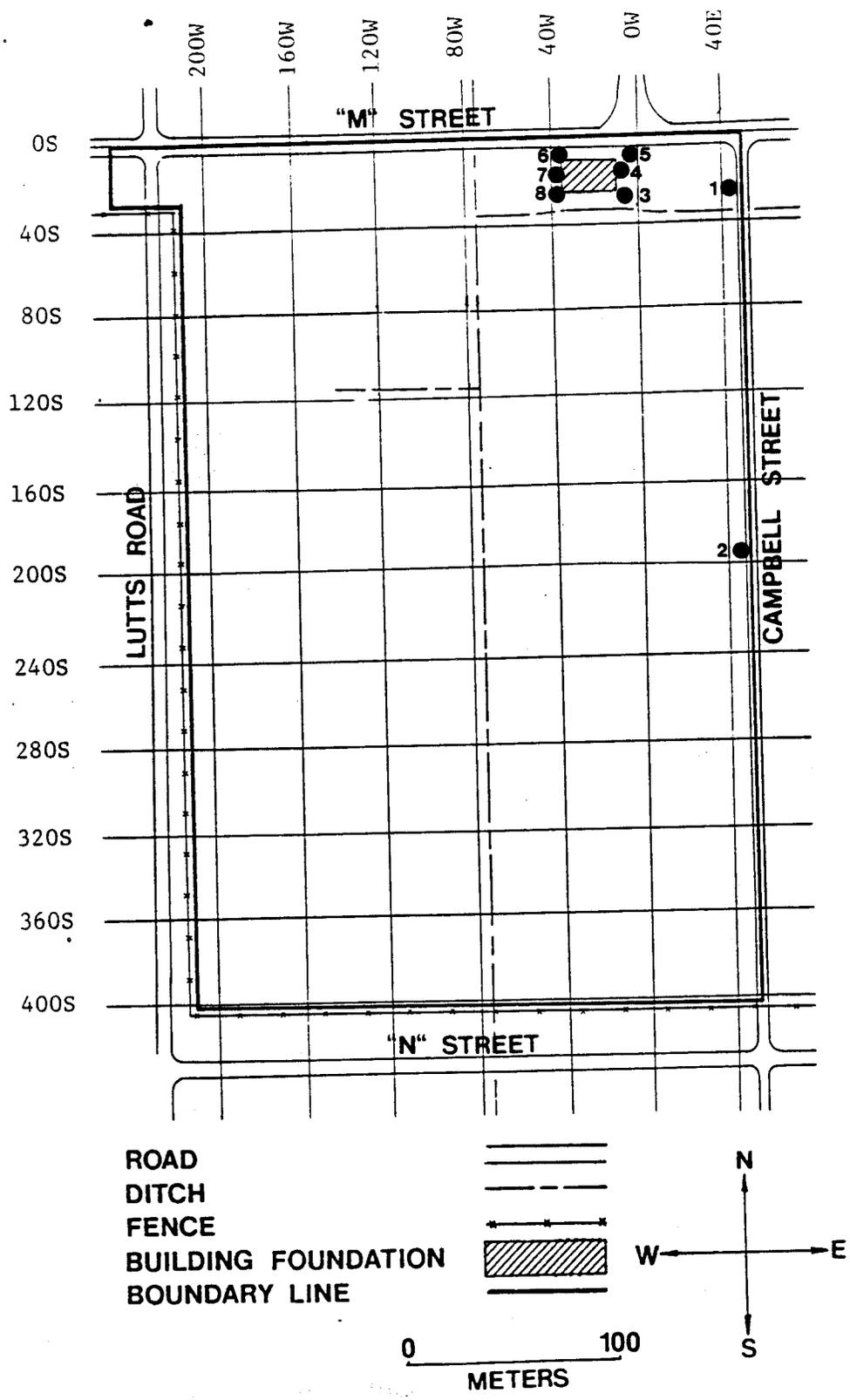


FIGURE 3. Areas of Elevated Direct Radiation Levels Identified by the Walkover Surface Scan.

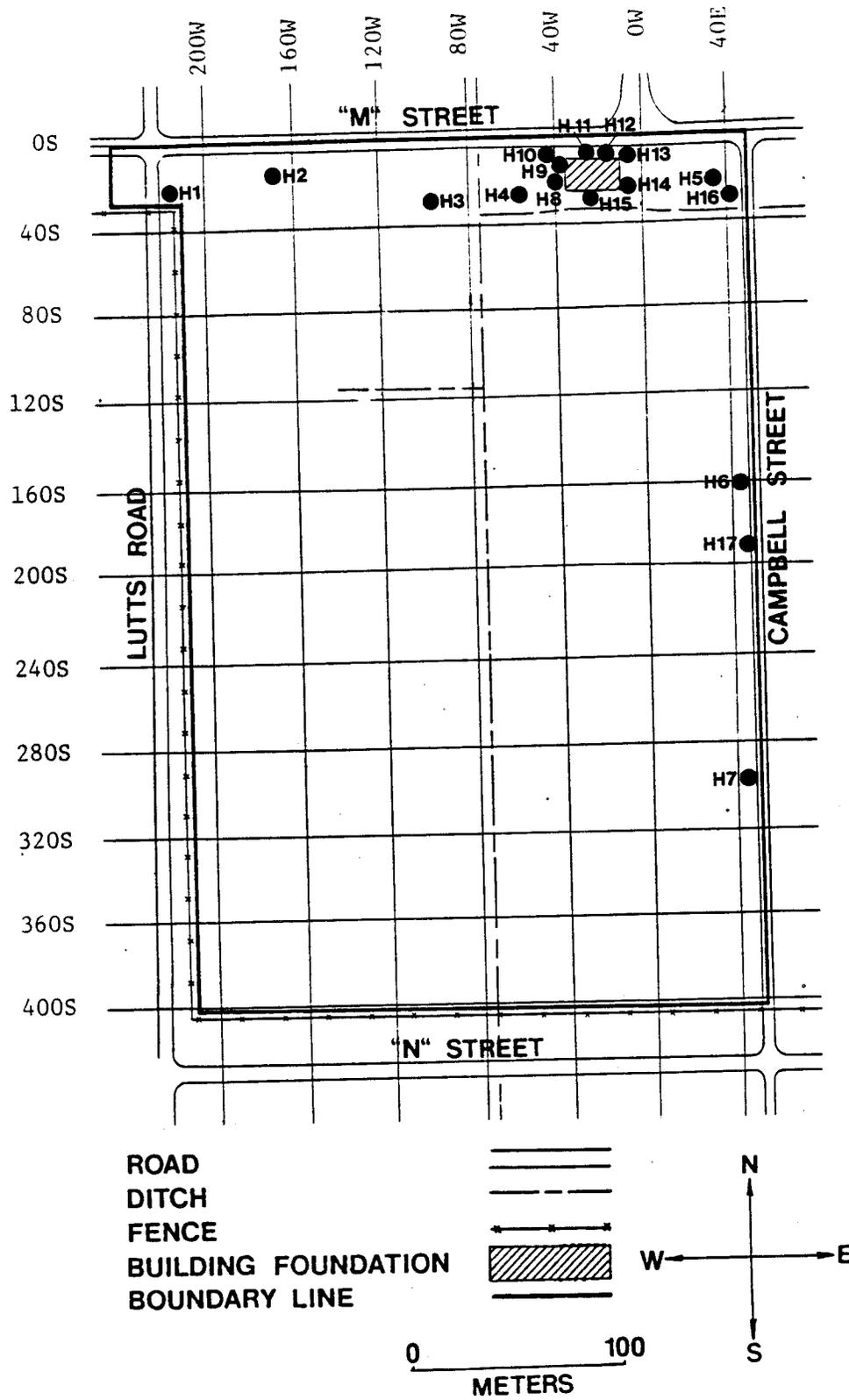


FIGURE 4. Locations of Boreholes for Subsurface Investigations

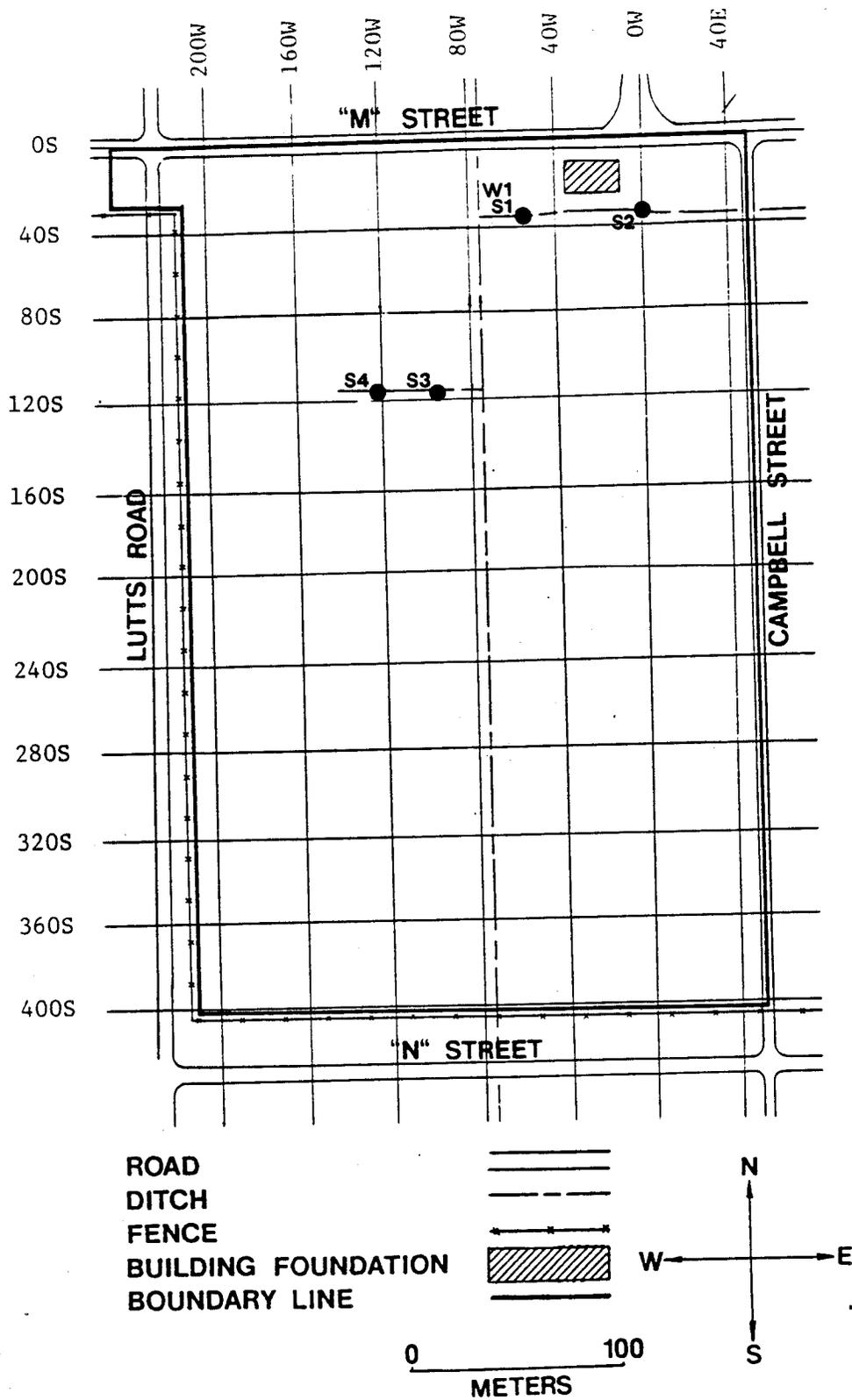


FIGURE 5. Locations of Surface Water (W1) and Sediment (S1-S4) Samples Collected from Drainage Ditches.

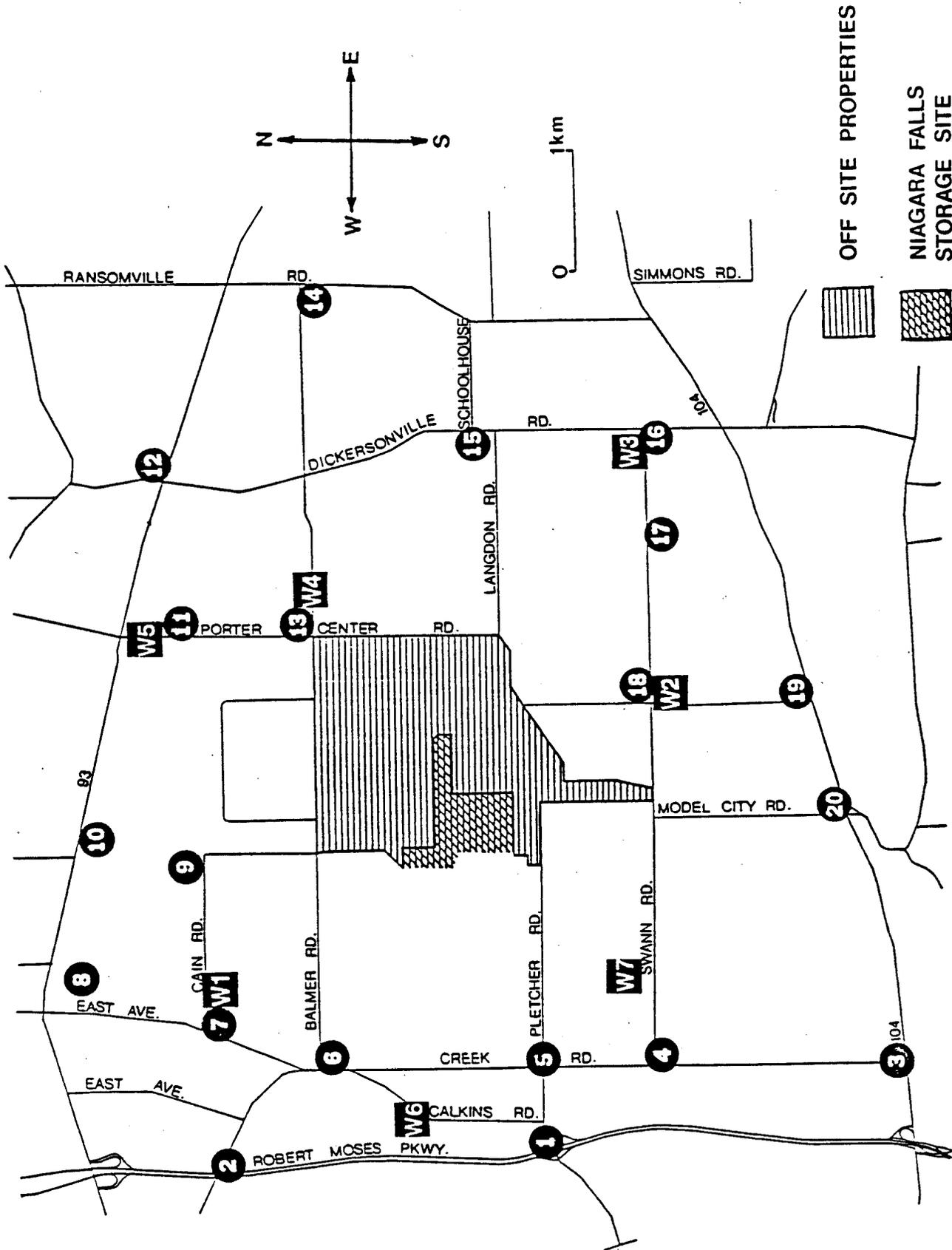


FIGURE 6. Map of Northern Niagara County, New York, Showing Locations of Background Measurements and Baseline Samples (#1-20: Soil Samples and Direct Measurements; W1-W7: Water Samples).

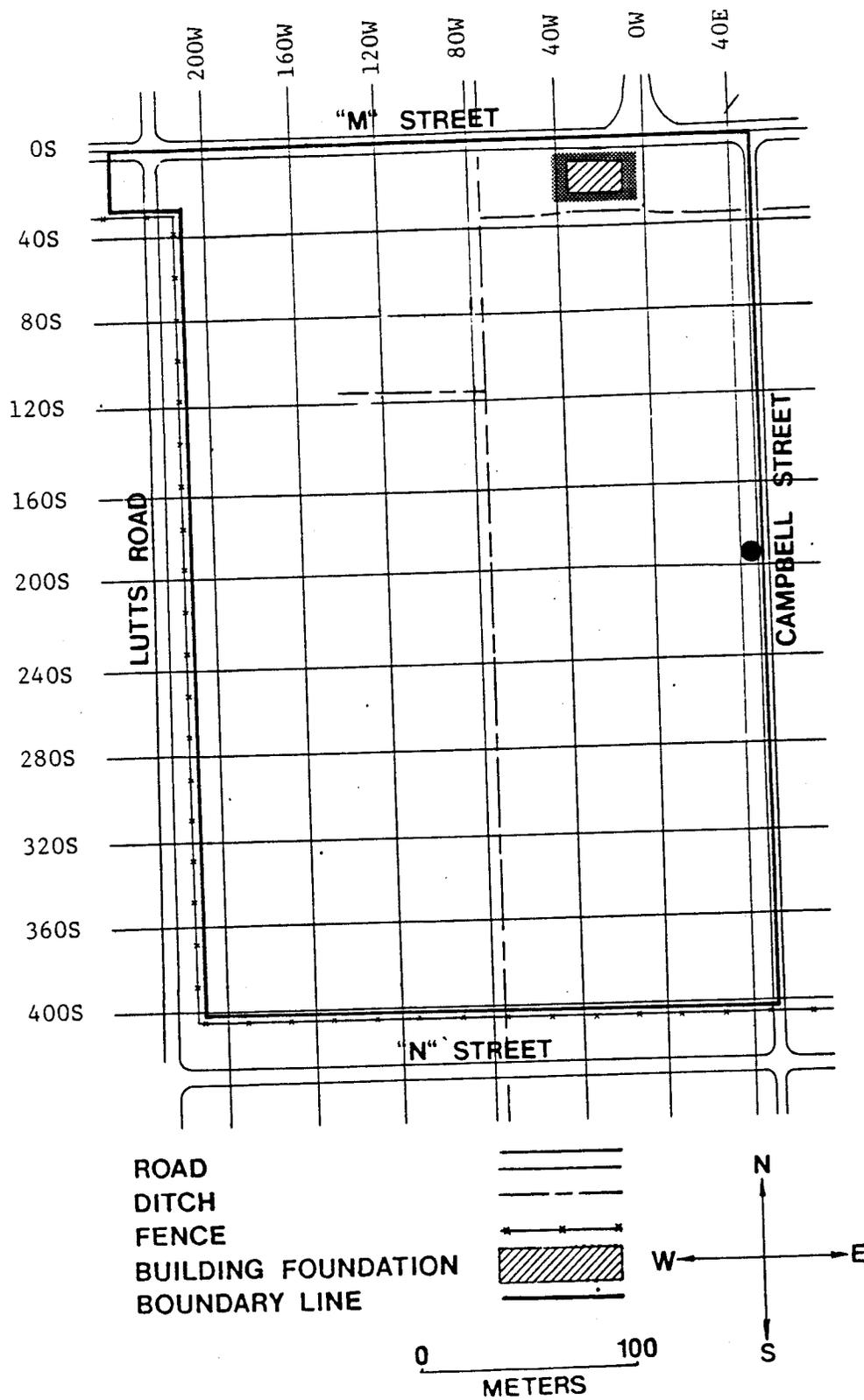


FIGURE 7. Locations (Shaded) on Property S Where Ra-226 Concentrations in Soil Exceed Guideline Levels. (Radionuclides are Either of Natural Origin or Would not Exceed Criteria When Averaged Over an Area of 100 m².)

TABLE 1-A

BACKGROUND EXPOSURE RATES
AND
RADIONUCLIDE CONCENTRATIONS IN BASELINE SOIL SAMPLES

Location ^a	Exposure Rate ^b (μ R/h)	Radionuclide Concentrations (pCi/g)				
		Ra-226	U-235	U-238	Th-232	
1	6.8	0.74 ± 0.16 ^c	<0.19	<2.89	0.70 ± 0.46	
2	6.8	0.75 ± 0.19	<0.19	<3.35	0.86 ± 0.24	
3	8.3	0.71 ± 0.18	0.46 ± 0.41	<3.72	0.88 ± 0.33	
4	7.9	0.67 ± 0.18	<0.22	<4.10	1.18 ± 0.35	
5	7.3	0.70 ± 0.16	<0.17	<3.34	0.68 ± 0.24	
6	7.7	0.50 ± 0.15	<0.16	<2.33	0.52 ± 0.38	
7	7.7	0.63 ± 0.13	<0.17	<2.73	0.83 ± 0.24	
8	7.6	0.59 ± 0.12	<0.14	<2.20	0.54 ± 0.23	
9	7.1	0.63 ± 0.20	<0.23	<4.16	0.83 ± 0.38	
10	7.1	0.70 ± 0.16	<0.19	<2.98	0.59 ± 0.25	
11	6.7	<0.09	<0.19	<2.83	0.49 ± 0.31	
12	7.1	0.48 ± 0.13	<0.16	<2.84	0.65 ± 0.26	
13	6.7	0.57 ± 0.14	<0.17	<2.36	0.49 ± 0.26	
14	6.8	0.68 ± 0.17	<0.19	<3.24	0.67 ± 0.25	
15	8.2	0.65 ± 0.14	<0.17	<3.20	0.72 ± 0.35	
16	7.4	0.91 ± 0.17	<0.71	<3.58	0.83 ± 0.28	
17	7.0	0.48 ± 0.14	<0.16	<2.73	0.32 ± 0.22	
18	7.7	0.73 ± 0.16	<0.18	6.26 ± 9.23	1.01 ± 0.44	
19	8.8	1.22 ± 0.22	<0.23	<3.79	1.08 ± 0.49	
20	8.6	0.83 ± 0.17	<0.21	<3.59	0.84 ± 0.29	
Range	6.8 to 8.8	<0.09 to 1.22	<0.14 to 0.46	<2.20 to 6.26	0.32 to 1.18	<0.02 to 1.05

^a Refer to Figure 6.

^b Measured at 1 m above the surface.

^c Errors are 2 σ based on counting statistics.

TABLE 1-B
 RADIONUCLIDE CONCENTRATIONS IN BASELINE WATER SAMPLES

Location ^a	Radionuclide Concentrations (pCi/l)	
	Gross Alpha	Gross Beta
W1	0.95 ± 0.93 ^b	4.79 ± 1.15
W2	0.95 ± 0.94	9.17 ± 1.31
W3	0.55 ± 0.78	2.73 ± 1.05
W4	0.63 ± 0.89	5.37 ± 1.17
W5	0.73 ± 0.68	<0.64
W6	1.87 ± 1.84	14.3 ± 2.4
W7	1.16 ± 0.66	<0.63
Range	0.55 to 1.87	<0.63 to 14.3

^a Refer to Figure 6.

^b Errors are 2σ based on counting statistics.

TABLE 2
 DIRECT RADIATION LEVELS MEASURED
 AT 40 M GRID INTERVALS

Grid Location	Gamma Exposure Rates at 1 m Above the Surface ($\mu\text{R/h}$)	Gamma Exposure Rates at the Surface ($\mu\text{R/h}$)	Beta-Gamma Dose Rates at 1 cm Above the Surface ($\mu\text{rad/h}$)
0 , 50E ^a	12	12	12
0 , 40E	12	13	13
0 , 0	12	13	13
0 , 40W	13	12	15
0 , 52W ^b	13	13	17
0 , 97W ^b	12	13	13
0 ,120W	12	13	13
0 ,160W	12	12	12
0 ,200W	11	13	14
0 ,235W ^a	11	12	12
40S, 50E ^a	16	16	18
40S, 40E	11	12	12
40S, 0	11	11	15
40S, 40W	12	11	11
40S, 54W ^b	12	12	12
40S, 95W ^b	10	10	10
40S,120W	10	10	18
40S,160W	10	10	10
80S, 50E ^a	16	16	16
80S, 40E	10	10	10
80S, 4E ^c	10	10	10
80S, 40W	10	11	16
80S, 54W ^b	11	12	18
80S, 95W ^b	10	11	11
80S,120W	10	10	15
80S,165W ^c	9	10	10
80S,200W	10	10	11
120S, 50E	14	14	14
120S, 40E	9	9	9
120S, 0	10	10	12
120S, 40W	10	10	12
120S, 55W ^b	11	11	12
120S, 95W ^b	10	10	10
120S,120W	10	10	13
120S,160W	10	10	11
120S,200W	10	10	10
160S, 50E ^a	14	14	14
160S, 40E	10	10	11
160S, 0	11	10	12
160S, 40W	10	11	11
160S, 53W ^b	10	10	15

TABLE 2, cont.

DIRECT RADIATION LEVELS MEASURED
AT 40 M INTERVALS

Grid Location	Gamma Exposure Rates at 1 m Above the Surface ($\mu\text{R/h}$)	Gamma Exposure Rates at the Surface ($\mu\text{R/h}$)	Beta-Gamma Dose Rates at 1 cm Above the Surface ($\mu\text{rad/h}$)
160S, 96W ^b	10	10	15
160S, 120W	10	10	10
160S, 160W	10	10	10
160S, 200W	10	9	9
200S, 50E ^a	16	16	16
200S, 40E	10	10	10
200S, 0	10	10	10
200S, 40W	10	10	16
200S, 54W ^b	10	10	10
200S, 97W ^b	10	11	11
200S, 120W	10	10	10
200S, 160W	9	9	11
200S, 200W	10	10	10
240S, 50E ^a	13	16	18
240S, 40E	10	10	11
240S, 0	10	10	16
240S, 40W	10	10	10
240S, 53W ^b	10	10	14
240S, 95W ^b	10	11	11
240S, 120W	10	10	10
240S, 160W	9	9	11
280S, 50E ^a	16	16	16
280S, 40E	11	10	10
280S, 0	10	10	10
280S, 40W	10	10	12
280S, 54W ^b	10	11	11
280S, 95W ^b	10	10	13
280S, 120W	10	11	11
280S, 160W	10	10	10
280S, 200W	9	10	12
320S, 50E ^a	15	16	16
320S, 40E	11	10	10
320S, 0	10	10	10
320S, 40W	10	11	13
320S, 51W ^b	11	11	11
320S, 95W ^b	10	10	11
320S, 120W	10	10	10
320S, 160W	9	10	12
320S, 200W	10	10	10
360S, 50E ^a	16	16	16
360S, 40E	12	11	11

TABLE 2, cont.

DIRECT RADIATION LEVELS MEASURED
AT 40 M INTERVALS

Grid Location	Gamma Exposure Rates at 1 m Above the Surface ($\mu\text{R/h}$)	Gamma Exposure Rates at the Surface ($\mu\text{R/h}$)	Beta-Gamma Dose Rates at 1 cm Above the Surface ($\mu\text{rad/h}$)
360S, 0	10	10	10
360S, 40W	11	10	15
360S, 53W ^b	11	10	11
360S, 95W ^b	10	10	10
360S, 120W	10	10	11
360S, 160W	9	10	12
360S, 200W	10	10	10
400S, 50E ^a	16	16	17
400S, 40E	10	11	11
400S, 0	11	11	12
400S, 53W ^b	10	10	11
400S, 96W ^b	10	11	11
400S, 120W	10	10	10
400S, 160W	10	10	13
400S, 200W	10	10	11

a Measurement performed at property boundary.

b Measurement performed at edge of drainage ditch easement.

c 40 m grid intersection not accessible; measurement performed at closest accessible point.

TABLE 3

DIRECT RADIATION LEVELS MEASURED AT 5 M GRID INTERVALS
IN THE VICINITY OF THE CONCRETE PAD

Grid Location	Gamma Exposure Rates at 1 m Above the Surface ($\mu\text{R}/\text{h}$)	Gamma Exposure Rates at the Surface ($\mu\text{R}/\text{h}$)	Beta-Gamma Dose Rates at 1 cm Above the Surface ($\mu\text{rad}/\text{h}$)
5S, 0	16	11	13
5S, 5W	11	11	11
5S, 10W	14	16	16
5S, 15W	11	10	11
5S, 20W	11	11	15
5S, 25W	10	12	12
5S, 30W	10	12	12
5S, 35W	11	13	15
5S, 40W	14	21	21
5S, 45W	10	12	15
5S, 50W	11	12	21
10S, 0	10	11	14
10S, 5W	11	12	12
10S, 10W	16	20	20
10S, 15W	12	16	16
10S, 20W	12	12	17
10S, 25W	13	12	12
10S, 30W	12	11	15
10S, 35W	13	11	18
10S, 40W	12	13	16
10S, 45W	12	13	12
10S, 50W	12	12	12
15S, 0	11	11	15
15S, 5W	13	12	44
15S, 10W	16	14	43
15S, 15W	14	12	12
15S, 20W	10	10	10
15S, 25W	10	11	11
15S, 30W	10	11	12
15S, 35W	12	12	12
15S, 40W	22	35	65
15S, 45W	14	13	13
15S, 50W	12	14	14
20S, 0	11	11	13
20S, 5W	13	12	15
20S, 10W	30	50	96
20S, 15W	12	10	11
20S, 20W	10	10	10
20S, 25W	11	10	10
20S, 30W	11	10	14

TABLE 3, cont.

DIRECT RADIATION LEVELS MEASURED AT 5 M GRID INTERVALS
IN THE VICINITY OF THE CONCRETE PAD

Grid Location	Gamma Exposure Rates at 1 m Above the Surface ($\mu\text{R/h}$)	Gamma Exposure Rates at the Surface ($\mu\text{R/h}$)	Beta-Gamma Dose Rates at 1 cm Above the Surface ($\mu\text{rad/h}$)
20S, 35W	11	10	10
20S, 40W	28	49	120
20S, 45W	12	11	16
20S, 50W	11	11	11
25S, 0	10	11	12
25S, 5W	19	21	64
25S, 10W	32	42	130
25S, 15W	20	19	42
25S, 20W	21	27	73
25S, 25W	22	23	52
25S, 30W	21	22	22
25S, 35W	24	22	75
25S, 40W	29	37	110
25S, 45W	17	12	15
25S, 50W	11	11	14
30S, 0	11	11	11
30S, 5W	12	11	11
30S, 10W	15	11	11
30S, 15W	16	12	12
30S, 20W	16	12	12
30S, 25W	19	12	14
30S, 30W	16	12	12
30S, 35W	16	13	13
30S, 40W	14	12	12
30S, 45W	11	11	11
30S, 50W	10	10	13

TABLE 4

DIRECT RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SURFACE SCAN

Location ^a	Grid Location	Exposure Rate ($\mu\text{R}/\text{h}$)		Surface Dose Rate ($\mu\text{rad}/\text{h}$)	Sample ^b	Contact Exposure Rate After Sample Removal ($\mu\text{R}/\text{h}$)
		Contact	1 m Above Surface			
1	22S, 42E	24	16	40	B1 A & B	24
2	192S, 47E	41	22	100	B2	73
3	22S, 11W	88	82	82	B3	120
4	13S, 15W	28	19	44	B4	30
5	8S, 8W	38	18	61	B5	35
6	5S, 39W	28	17	35	B6	25
7	14S, 39W	38	27	69	B7	41
8	20S, 40W	75	30	100	B8	70

a Refer to Figure 3.

b Soil concentrations presented in Table 7.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS

Grid Location	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-235	U-238
7S, 40E ^b	2.28 + 0.48 ^a	<0.27	<1.06
4S, 0 b	1.78 + 0.43	<0.28	1.55 + 0.99
3S, 40W ^b	2.03 + 0.38	<0.27	2.77 + 2.01
3S, 52W ^{b,c}	2.31 + 0.39	<0.31	2.32 + 1.82
3S, 97W ^{b,c}	2.23 + 0.41	<0.27	1.94 + 2.20
3S, 120W ^b	2.90 + 0.41	<0.31	<1.27
3S, 160W ^b	1.75 + 0.36	<0.26	2.17 + 1.97
3S, 200W ^b	1.48 + 0.33	<0.24	1.93 + 2.09
40S, 40E	0.94 + 0.31	0.40 + 0.05	2.47 + 1.19
40S, 0	1.01 + 0.38	<0.13	0.73 + 0.83
40S, 40W	0.66 + 0.25	<0.24	1.58 + 1.13
40S, 54W ^c	0.96 + 0.23	<0.50	1.06 + 0.69
40S, 95W ^c	0.61 + 0.28	<0.22	1.47 + 0.93
40S, 120W	1.05 + 0.42	<0.21	<0.95
40S, 160W	0.81 + 0.21	<0.49	0.96 + 0.79
40S, 200W	0.85 + 0.21	<0.52	0.88 + 0.78
80S, 40E	1.04 + 0.34	<0.22	<0.94
80S, 4E ^b	0.73 + 0.28	<0.49	0.61 + 1.04
80S, 40W	0.59 + 0.23	0.14 + 0.08	1.72 + 1.54
80S, 54W ^c	0.69 + 0.17	<0.51	0.83 + 0.86
80S, 95W ^c	0.76 + 0.33	<0.20	1.76 + 1.89
80S, 120W	0.84 + 0.30	<0.51	0.67 + 0.98
80S, 165W ^b	0.80 + 0.26	<0.20	<1.02
80S, 200W	0.78 + 0.23	<0.23	<0.97
120S, 40E	0.74 + 0.28	<0.27	<1.04
120S, 0	0.95 + 0.24	<0.27	1.47 + 1.58
120S, 40W	1.08 + 0.33	<0.27	1.27 + 1.98
			1.69 + 0.20
			0.71 + 0.16
			0.63 + 0.16
			0.53 + 0.14
			0.73 + 0.15
			0.76 + 0.16
			0.70 + 0.15
			0.76 + 0.14
			0.28 + 0.16
			0.21 + 0.11
			0.38 + 0.11
			<0.09
			0.44 + 0.15
			0.67 + 0.14
			0.67 + 0.10
			0.67 + 0.14
			0.86 + 0.18
			0.21 + 0.08
			<0.04
			<0.07
			0.49 + 0.11
			0.67 + 0.12
			0.68 + 0.16
			0.69 + 0.14
			0.72 + 0.15
			0.11 + 0.12
			0.39 + 0.11

TABLE 5, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS

Grid Location	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-235	U-238
120S, 55WC	0.78 + 0.21	<0.51	1.44 + 0.69
120S, 95WC	0.45 + 0.23	<0.44	<0.94
120S, 120W	0.85 + 0.30	<0.29	1.70 + 2.18
120S, 160W	0.74 + 0.40	<0.33	1.78 + 2.28
120S, 200W	0.66 + 0.23	<0.27	1.61 + 1.93
160S, 40E	0.91 + 0.30	<0.26	2.59 + 1.66
160S, 0	0.83 + 0.23	<0.48	1.19 + 0.81
160S, 40W	0.70 + 0.26	<0.21	<0.90
160S, 53WC	0.70 + 0.25	<0.27	<0.97
160S, 96WC	0.79 + 0.30	0.26 + 0.12	5.12 + 1.88
160S, 120W	0.94 + 0.24	<0.20	1.24 + 2.34
160S, 160W	0.99 + 0.32	<0.30	2.72 + 0.58
160S, 200W	0.54 + 0.40	<0.20	<0.88
200S, 40E	0.80 + 0.26	<0.49	0.98 + 0.91
200S, 0	0.76 + 0.21	<0.21	1.22 + 1.64
200S, 40W	0.78 + 0.28	<0.29	<0.94
200S, 54WC	0.95 + 0.26	0.23 + 0.12	<0.91
200S, 97WC	0.53 + 0.30	<0.24	<0.89
200S, 120W	0.65 + 0.25	<0.25	2.25 + 1.54
200S, 160W	0.45 + 0.20	<0.34	0.63 + 0.62
200S, 200W	0.73 + 0.21	<0.51	1.51 + 0.57
240S, 40E	0.91 + 0.38	<0.25	2.02 + 1.57
240S, 0	0.79 + 0.30	<0.21	<0.84
240S, 40W	0.78 + 0.33	<0.22	<0.88
240S, 52WC	0.80 + 0.33	<0.20	2.14 + 1.31
240S, 95WC	1.01 + 0.30	<0.23	<0.89
240S, 120W	0.68 + 0.21	0.27 + 0.22	0.50 + 0.78
240S, 160W	0.70 + 0.30	<0.21	<0.81
240S, 200W	0.66 + 0.23	<0.53	0.75 + 0.94
			0.33 + 0.10
			0.96 + 0.16
			1.00 + 0.17
			0.49 + 0.11
			0.67 + 0.13
			<0.11
			0.26 + 0.11
			0.22 + 0.13
			0.68 + 0.13
			0.75 + 0.14
			0.55 + 0.20
			0.69 + 0.14
			0.78 + 0.12
			0.70 + 0.14
			0.61 + 0.14
			0.52 + 0.19
			0.71 + 0.14
			0.65 + 0.14
			0.50 + 0.10
			0.67 + 0.11
			0.29 + 0.11
			0.45 + 0.12
			0.38 + 0.10
			0.78 + 0.17
			0.64 + 0.18
			0.78 + 0.18
			0.24 + 0.13
			0.64 + 0.15

TALBE 5, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS

Grid Location	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-238	Cs-137
280S, 40E	0.79 ± 0.23	1.12 ± 0.67	0.24 ± 0.09
280S, 0	0.81 ± 0.26	1.62 ± 2.12	0.31 ± 0.09
280S, 40W	0.51 ± 0.35	<0.87	0.52 ± 0.14
280S, 54WC	1.64 ± 0.31	0.80 ± 0.45	0.95 ± 0.16
280S, 95WC	0.84 ± 0.30	<0.93	0.60 ± 0.17
280S, 120W	0.66 ± 0.28	3.60 ± 1.65	0.44 ± 0.17
280S, 160W	0.55 ± 0.18	0.56 ± 1.29	0.50 ± 0.14
280S, 200W	0.66 ± 0.23	2.89 ± 1.28	0.69 ± 0.19
320S, 40E	0.91 ± 0.25	2.17 ± 1.78	0.88 ± 0.18
320S, 0	1.01 ± 0.24	0.61 ± 1.39	0.79 ± 0.15
320S, 40W	0.93 ± 0.25	<0.29	0.71 ± 0.15
320S, 51WC	0.73 ± 0.28	<0.95	0.78 ± 0.17
320S, 95WC	0.79 ± 0.28	2.17 ± 1.42	0.66 ± 0.17
320S, 120W	0.63 ± 0.29	2.25 ± 1.55	0.87 ± 0.16
320S, 160W	0.69 ± 0.26	<0.83	0.95 ± 0.24
320S, 200W	0.88 ± 0.26	1.74 ± 1.12	0.57 ± 0.12
360S, 40E	1.03 ± 0.34	<0.90	1.03 ± 0.19
360S, 0	0.69 ± 0.25	1.03 ± 0.81	0.68 ± 0.12
360S, 40W	0.94 ± 0.25	0.59 ± 1.07	0.67 ± 0.16
360S, 53WC	0.73 ± 0.28	1.60 ± 0.92	0.80 ± 0.15
360S, 95WC	0.64 ± 0.25	<0.96	0.58 ± 0.14
360S, 120W	0.74 ± 0.21	3.30 ± 1.62	0.68 ± 0.20
360S, 160W	0.31 ± 0.25	<0.71	0.61 ± 0.12
360S, 200W	0.46 ± 0.30	1.33 ± 0.69	0.42 ± 0.10
400S, 40E	1.03 ± 0.33	<0.94	0.67 ± 0.15
400S, 0	0.74 ± 0.29	<0.96	0.66 ± 0.13

TABLE 5, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 40 M GRID INTERVALS

Grid Location	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-235	U-238
400S, 40W	0.79 ± 0.52	<0.27	<0.96
400S, 53W ^c	1.10 ± 0.28	<0.27	<1.05
400S, 96W ^c	0.94 ± 0.23	<0.54	0.41 ± 0.13
400S, 120W	0.89 ± 0.28	0.25 ± 0.12	<0.98
400S, 160W	0.75 ± 0.28	<0.24	1.24 ± 2.06
400S, 200W	0.65 ± 0.30	<0.19	<0.93
			Cs-137
			0.80 ± 0.15
			0.63 ± 0.13
			0.76 ± 0.15
			0.52 ± 0.13
			0.79 ± 0.16
			0.81 ± 0.15

a Errors are 2σ based on counting statistics.

b 40 m grid intersection not accessible or soil not available;
sample collected from nearest available location.

c Sampling at edge of drainage ditch easement.

TALBE 6

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 5 M GRID INTERVALS
IN THE VICINITY OF THE CONCRETE PAD

Grid Location	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-235	Cs-137
5S, 0	0.74 + 0.30 ^a	<0.54	0.78 + 0.16
5S, 5W	1.11 + 0.31	<0.57	0.66 + 0.12
5S, 10W	5.13 + 0.63	0.59 + 0.82	0.55 + 0.18
5S, 15W	0.70 + 0.23	<0.54	0.32 + 0.11
5S, 20W	1.13 + 0.34	<0.29	0.61 + 0.17
5S, 25W	0.79 + 0.30	<0.21	0.53 + 0.15
5S, 30W	1.11 + 0.21	<0.51	0.54 + 0.12
5S, 35W	1.11 + 0.28	0.21 + 0.07	0.36 + 0.12
5S, 40W	3.19 + 0.45	<0.28	0.32 + 0.13
10S, 0	1.15 + 0.33	<0.28	0.58 + 0.20
10S, 5W	0.75 + 0.16	<0.49	0.05 + 0.07
10S, 10W	2.31 + 0.35	<0.31	0.13 + 0.10
10S, 15W	1.89 + 0.39	<0.33	0.18 + 0.11
10S, 20W	0.91 + 0.21	<0.26	0.10 + 0.08
10S, 25W	0.86 + 0.28	<0.27	0.13 + 0.06
10S, 30W	1.01 + 0.29	<0.23	0.15 + 0.09
10S, 35W	1.64 + 0.34	<0.31	0.13 + 0.09
10S, 40W	0.95 + 0.20	<0.54	<0.10
10S, 45W	1.00 + 0.34	<0.24	<0.05
10S, 50W	1.48 + 0.40	<0.26	<0.05
15S, 0	1.03 + 0.35	<0.29	0.34 + 0.10
15S, 5W	1.16 + 0.30	<0.20	0.24 + 0.16
15S, 10W	0.98 + 0.23	<0.45	0.06 + 0.07
15S, 15W	1.03 + 0.25	<0.25	0.34 + 0.09
15S, 20W	0.99 + 0.45	<0.30	0.11 + 0.07
15S, 25W	0.84 + 0.26	<0.22	0.08 + 0.05
			1.59 + 0.89
			0.84 + 1.17
			1.86 + 3.69
			0.86 + 0.85
			<1.13
			<0.95
			1.30 + 0.80
			<1.03
			2.45 + 1.62
			1.59 + 1.61
			1.03 + 0.63
			2.24 + 2.41
			2.30 + 1.24
			1.88 + 1.29
			1.68 + 1.13
			2.55 + 1.25
			1.50 + 0.99
			0.63 + 1.28
			<0.94
			1.67 + 1.24
			2.00 + 1.05
			1.59 + 2.01
			0.97 + 0.70
			4.28 + 2.12
			1.38 + 2.34
			3.62 + 1.15

TABLE 6, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 5 M GRID INTERVALS
IN THE VICINITY OF THE CONCRETE PAD

Grid Location	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-235	U-238
15S, 30W	0.91 + 0.28	0.18 + 0.11	2.22 + 1.71
15S, 35W	0.96 + 0.29	<0.28	1.28 + 1.49
15S, 40W	5.25 + 0.80	<0.52	5.28 + 2.72
15S, 45W	0.96 + 0.25	<0.28	1.25 + 1.62
15S, 50W	1.90 + 0.36	<0.26	2.94 + 2.43
20S, 0	0.68 + 0.15	0.30 + 0.03	1.17 + 1.67
20S, 5W	0.88 + 0.20	<0.48	<1.09
20S, 10W	26.9 + 1.1	<0.99	25.8 + 3.7
20S, 15W	b	b	b
20S, 20W	b	b	b
20S, 25W	b	b	b
20S, 30W	b	b	b
20S, 35W	b	b	b
20S, 40W	34.9 + 1.2	<1.16	34.2 + 4.4
20S, 45W	0.84 + 0.30	<0.23	1.36 + 1.70
20S, 50W	0.98 + 0.23	<0.52	1.26 + 0.72
25S, 0	0.55 + 0.19	<0.21	<0.84
25S, 5W	1.04 + 0.28	<0.31	2.37 + 1.84
25S, 10W	31.5 + 1.0	1.94 + 1.30	15.2 + 1.9
25S, 15W	5.51 + 0.59	<0.93	3.19 + 2.39
25S, 20W	16.7 + 0.9	1.86 + 1.27	11.6 + 1.4
25S, 25W	2.98 + 0.48	<0.41	2.88 + 3.32
25S, 30W	6.89 + 0.68	<0.55	3.47 + 1.94
25S, 35W	2.55 + 0.38	<0.25	2.99 + 2.60
25S, 40W	15.3 + 0.8	0.96 + 1.00	11.2 + 2.3
25S, 45W	0.78 + 0.29	<0.55	1.12 + 0.79
25S, 50W	1.45 + 0.31	<0.24	1.63 + 1.88
			<0.06
			0.30 + 0.14
			0.43 + 0.19
			0.29 + 0.09
			0.44 + 0.16
			0.36 + 0.12
			0.43 + 0.08
			1.15 + 0.20
			b
			b
			b
			b
			b
			0.40 + 0.17
			0.54 + 0.13
			0.68 + 0.15
			0.40 + 0.15
			0.64 + 0.16
			0.65 + 0.14
			0.46 + 0.15
			0.41 + 0.13
			0.78 + 0.16
			0.55 + 0.19
			0.48 + 0.18
			0.98 + 0.17
			0.78 + 0.15
			0.07 + 0.11

TABLE 6, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 5 M GRID INTERVALS
IN THE VICINITY OF THE CONCRETE PAD

Grid Location	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-235	U-238
30S, 0	0.91 + 0.35	<0.55	1.45 + 1.08
30S, 5W	0.95 + 0.29	<0.24	<0.97
30S, 10W	0.71 + 0.28	<0.20	1.80 + 2.59
30S, 15W	0.59 + 0.43	<0.28	<1.03
30S, 20W	0.70 + 0.20	<0.27	2.47 + 1.67
30S, 25W	0.83 + 0.34	<0.28	2.25 + 1.19
30S, 30W	0.95 + 0.31	<0.27	<0.93
30S, 35W	0.70 + 0.26	0.32 + 0.51	<0.85
30S, 40W	0.98 + 0.25	<0.47	1.10 + 0.79
30S, 45W	1.06 + 0.29	<0.27	1.52 + 1.27
30S, 50W	0.65 + 0.20	<0.52	0.97 + 0.75
			0.65 + 0.14
			0.64 + 0.13
			0.57 + 0.16
			0.59 + 0.24
			0.45 + 0.12
			0.75 + 0.16
			0.51 + 0.14
			0.54 + 0.15
			<0.25
			0.70 + 0.18
			0.12 + 0.08

a Errors are 2σ based on counting statistics.
b Sample not available due to presence of concrete pad.

TABLE 7

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

Sample ^a No.	Grid Location	Radionuclide Concentrations (pCi/g) ^b		
		Ra-226	U-235	U-238
B1-A (Gravel)	22S, 42E	8.47 ± 0.71 ^c	<0.48	9.68 ± 4.04
B1-B (Rock)	22S, 42E	168	10.3 ± 11.1	126 ± 23
B2	192S, 47E	62.3 ± 1.8	<1.46	12.2 ± 7.2
B3	22S, 1W	32.1 ± 1.2	<0.91	32.2 ± 4.9
B4	13S, 15W	11.6 ± 0.7	<0.58	6.21 ± 4.04
B5	8S, 8E	23.7 ± 1.1	<0.98	22.0 ± 3.7
B6	5S, 39W	15.9 ± 0.8	<0.82	15.5 ± 4.5
B7	14S, 39W	4.33 ± 0.42	<0.81	2.56 ± 1.56
B8	20S, 40W	33.2 ± 1.2	<1.10	26.6 ± 4.0
				0.65 ± 0.16
				<0.64
				1.59 ± 0.24
				0.92 ± 0.18
				0.53 ± 0.13
				0.55 ± 0.16
				0.34 ± 0.12
				0.23 ± 0.15
				0.26 ± 0.15

^a Refer to Figure 3.

^b Refer to Table 4 for direct radiation levels.

^c 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)			
			Ra-226	U-235	U-238	Cs-137
H1	27S, 220W	Surface	1.18 ± 0.73 ^b	<0.29	1.59 ± 1.39	0.40 ± 0.10
		0.5	0.78 ± 0.26	<0.21	2.01 ± 1.49	<0.03
		1.0	0.78 ± 0.20	<0.21	0.91 ± 1.72	<0.03
		2.0	0.83 ± 0.29	<0.23	<0.82	<0.04
3.0	1.03 ± 0.24	<0.27	<0.85	<0.03		
H2	16S, 173W	Surface	0.88 ± 0.20	<0.26	1.70 ± 0.79	<0.03
		0.5	0.65 ± 0.24	<0.18	0.63 ± 0.37	<0.03
		1.0	0.90 ± 0.19	<0.16	0.52 ± 1.60	<0.04
		2.0	0.74 ± 0.18	<0.17	0.51 ± 0.29	<0.03
3.0	0.76 ± 0.24	<0.20	0.87 ± 0.89	<0.03		
H3	32S, 97W	Surface	0.73 ± 0.23	<0.20	1.41 ± 1.48	0.10 ± 0.05
		0.5	0.96 ± 0.26	<0.24	0.64 ± 0.51	<0.03
		1.0	0.84 ± 0.21	<0.21	1.45 ± 0.51	<0.03
		2.0	1.14 ± 0.39	<0.33	2.58 ± 3.65	<0.06
3.0	0.85 ± 0.28	<0.20	1.08 ± 1.85	<0.03		
H4	25S, 52W	Surface	0.96 ± 0.29	<0.29	<0.92	<0.03
		0.5	0.85 ± 0.25	<0.17	1.49 ± 1.45	<0.04
		1.0	0.80 ± 0.23	<0.28	<0.88	<0.04
		2.0	0.94 ± 0.33	<0.22	1.00 ± 0.74	<0.03
3.0	0.64 ± 0.19	<0.20	1.35 ± 1.66	<0.04		
H5	22S, 30E	Surface	0.70 ± 0.23	<0.22	1.62 ± 1.75	0.19 ± 0.07
		0.5	0.91 ± 0.24	<0.20	0.83 ± 1.41	<0.03
		1.0	0.69 ± 0.24	<0.20	1.02 ± 0.67	<0.03
		2.0	1.39 ± 0.41	<0.32	2.05 ± 1.99	<0.05

TABLE 8, cont.

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.	Grid Location	Depth (m)	Radionuclide Concentrations (pCi/g)			
			Ra-226	U-235	U-238	Cs-137
H6	160S, 45E	Surface	0.67 ± 0.25	<0.20	2.44 ± 1.69	<0.03
		0.5	0.84 ± 0.20	<0.20	1.07 ± 0.75	<0.04
		1.0	0.78 ± 0.24	<0.20	<0.82	<0.04
H7	296S, 45E	2.0	0.77 ± 0.21	<0.22	1.17 ± 0.80	<0.03
		Surface	1.26 ± 0.33	<0.25	4.63 ± 2.11	0.68 ± 0.13
		0.5	0.90 ± 0.19	<0.24	2.04 ± 0.62	<0.04
H8	19S, 40W	1.0	0.91 ± 0.31	<0.22	1.90 ± 0.61	<0.04
		Surface	21.7 ± 0.8	1.78 ± 0.99	17.8 ± 1.5	0.32 ± 0.10
		0.5	3.43 ± 0.55	<0.23	2.37 ± 2.13	<0.02
H9	14S, 37W	1.0	1.70 ± 0.33	<0.35	<1.19	<0.05
		Surface	6.73 ± 0.58	<0.37	4.56 ± 2.53	0.33 ± 0.09
		0.5	2.30 ± 0.34	<0.26	2.30 ± 1.74	<0.04
H10	8S, 41W	1.0	1.55 ± 0.36	<0.25	1.16 ± 0.56	<0.04
		Surface	0.91 ± 0.20	<0.21	2.98 ± 1.23	0.04 ± 0.08
		0.5	0.88 ± 0.19	<0.29	1.59 ± 1.71	<0.04
H11	13S, 23W	1.0	1.08 ± 0.26	<0.24	1.00 ± 0.53	<0.04
		Surface	0.89 ± 0.19	<0.20	0.74 ± 0.65	<0.04
		0.5	0.69 ± 0.25	<0.20	1.39 ± 1.76	<0.04
H12	13S, 19W	1.0	0.89 ± 0.29	<0.23	1.66 ± 1.70	<0.04
		Surface	1.93 ± 0.35	<0.23	2.14 ± 1.09	0.19 ± 0.10
		0.5	0.83 ± 0.29	<0.23	<0.86	<0.04
		1.0	0.92 ± 0.26	<0.23	1.59 ± 1.77	<0.04

TABLE 8, cont.

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.	Grid Location	Depth (m)	Radionuclide Concentrations (pCi/g)			
			Ra-226	U-235	U-238	Cs-137
H13	13S, 9W	Surface	0.18 ± 0.26	<0.18	1.56 ± 1.42	0.06 ± 0.05
		0.5	0.78 ± 0.38	<0.21	2.38 ± 1.78	<0.04
		1.0	0.79 ± 0.24	<0.21	1.01 ± 0.51	<0.03
H14	22S, 10W	Surface	4.34 ± 0.40	0.66 ± 0.45	3.74 ± 0.67	0.23 ± 0.10
		0.5	0.83 ± 0.40	<0.25	1.14 ± 1.80	<0.03
		1.0	1.09 ± 0.23	<0.21	<0.87	<0.03
H15	25S, 25W	Surface	1.08 ± 0.25	<0.20	1.87 ± 1.98	0.06 ± 0.10
		0.5	0.84 ± 0.24	<0.22	1.71 ± 0.66	0.05 ± 0.08
		1.0	0.91 ± 0.24	<0.29	2.81 ± 0.62	<0.04
H16	23S, 41E	Surface	0.99 ± 0.25	<0.23	1.14 ± 0.52	0.09 ± 0.09
		0.5	0.89 ± 0.26	<0.20	<0.85	<0.04
		1.0	0.95 ± 0.24	<0.20	<0.75	<0.03
H17	193S, 46E	Surface	0.84 ± 0.23	<0.28	1.18 ± 1.99	<0.04
		0.5	0.84 ± 0.28	<0.24	1.05 ± 1.69	<0.04
		1.0	1.04 ± 0.23	<0.27	2.34 ± 0.62	<0.05

a Refer to Figure 4.

b Errors are 2σ based on counting statistics.

TABLE 9
 RADIONUCLIDE CONCENTRATIONS IN WATER SAMPLES

Sample No.	Sample Type	Grid Location	Radionuclide Concentrations (pCi/l)		
			Gross Alpha ^a	Gross Beta	Ra-226
W1	Surface ^b (Drainage Ditch)	35S, 54W	15.1 ± 2.1 ^d	41.4 ± 3.1	0.27 ± 0.06
W2	Subsurface (Borehole H1) ^c	27S, 220W	6.87 ± 3.17	26.3 ± 3.7	0.28 ± 0.06
W3	Subsurface (Borehole H2) ^c	16S, 173W	2.52 ± 2.66	<2.75	---
W4	Subsurface (Borehole H3) ^c	32S, 97W	4.21 ± 2.32	19.7 ± 3.8	---
W5	Subsurface (Borehole H4) ^c	25S, 52W	3.49 ± 3.20	7.70 ± 3.69	---
W6	Subsurface (Borehole H5) ^c	22S, 30E	<3.32	15.6 ± 7.5	---
W7	Subsurface (Borehole H7) ^c	296S, 45E	<1.70	7.99 ± 4.12	---

a Large amounts of dissolved solids resulted in relatively poor detection sensitivities.
 b Refer to Figure 5.
 c Refer to Figure 4.
 d Errors are 2σ based on counting statistics.
 e Dash indicates the analysis was not performed.

TABLE 10

RADIONUCLIDE CONCENTRATIONS IN SEDIMENT SAMPLES FROM DRAINAGE DITCHES

Sample ^a No.	Grid Location	Radionuclide Concentrations (pCi/g)			
		Ra-226	U-235	U-238	Cs-137
S1	35S, 54W	0.81 ± 0.23 ^b	<0.49	0.57 ± 1.36	0.08 ± 0.10
S2	35S, 0	1.19 ± 0.29	0.08 ± 0.11	<0.83	0.15 ± 0.07
S3	118S, 95W	0.69 ± 0.24	<0.39	0.49 ± 0.51	0.25 ± 0.06
S4	118S, 120W	0.99 ± 0.26	<0.23	<0.99	1.27 ± 0.20

^a Refer to Figure 5.

^b Errors are 2σ based on counting statistics.

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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 levels ($\mu\text{R}/\text{h}$) 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 Niagara Falls Storage Site and off-site properties.

Beta-Gamma Dose Rate Measurements

Measurements were performed using Eberline "Rascal", Model PRS-1, scaler/ratemeters with Model HP-260 thin-window, pancake G-M, beta probes. Dose rates ($\mu\text{rad}/\text{h}$) were determined by comparing the response of a Victoreen Model 440 ionization chamber survey meter to that of the G-M probes.

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 mm 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. The borehole was scanned and measurements were performed at intervals of 15-30 cm to identify regions of possible residues and guide the selection of subsurface soil sampling locations. Due to the varying ratios of Ra-226, U-235, U-238, and Cs-137 on the NFSS properties there was no attempt to estimate soil radionuclide concentrations directly from the logging results.

Soil and Sediment Sample Analysis

Soil and sediment samples were dried, 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 ranged from 600 to 800 g of soil. Net soil weights were determined and samples counted using solid state 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:

- Ra-226 - 0.609 MeV from Bi-214 (corrected for equilibrium conditions)
- U-235 - 0.143 MeV
- U-238 - 0.093 MeV from Th-234 (secular equilibrium assumed)
- Cs-137 - 0.662 MeV

Water Sample Analysis

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

Analysis for Ra-226 was performed using the standard technique EPA 600/4-75-008 (revised).

Calibration and Quality Assurance

With the exception of exposure and dose rate conversion factors for portable survey gamma and beta-gamma meters, all survey and laboratory instruments were calibrated with NBS-traceable standards. The calibration procedures for these portable instruments are described above.

Quality control procedures on all instruments included daily background and check-source measurements to confirm lack of malfunctions and nonstatistical deviations in equipment. The ORAU laboratory participates in the EPA Quality Assurance Program.

APPENDIX B

SUMMARY OF RADIATION GUIDELINES
APPLICABLE TO OFF-SITE PROPERTIES AT THE
NIAGARA FALLS STORAGE SITE

U. S. DEPARTMENT OF ENERGY

RESIDUAL CONTAMINATION AND WASTE CONTROL CRITERIA
FOR
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM (FUSRAP)
AND
REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM (SFMP) SITES

Presented here are the residual contamination cleanup and waste control criteria of general applicability to the FUSRAP project and remote SFMP sites^{1/}.

With the exception of limits for radium-226, the soil residual contamination criteria were developed on the basis of limiting maximum individual radiation exposure to DOE limits specified in DOE Order 5480.1A exclusive of exposure from natural background radiation or medical procedures. The aggregate of the contribution from all major pathways, based on scenarios for permanent intrusion, e.g., establishing residences on the site, has been assumed. In most circumstances, the probability is low that such an intrusion will occur. Also, conservative assumptions were used in deriving these criteria to ensure that a particular dose limit would not be exceeded. Use of these criteria is additionally conservative because the pathways considered in the derivation of the criteria assume all water intake and most food intake is from the site. Also, the sites often have limited agricultural capability and the contamination is generally not homogeneous. The combined effect of these factors is such that the probable radiation exposure to the average population on, or in the vicinity of, FUSRAP sites decontaminated to these criteria limits will not be appreciably different from that normally received from natural background radiation.

The residual contamination criteria for surface contamination of structures were developed from a proposed ANSI standard^{2/} modified as appropriate to be consistent with DOE Order 5480.1A and the specific needs of FUSRAP for cost-effective, workable guidelines which provide an adequate safety margin. The waste control criteria are consistent with applicable DOE Orders and EPA's regulations for inactive uranium milling sites, 40 CFR 192.

^{1/} A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE R&D or production area. Remote sites are more likely to be released to the public or excessed to other government agencies after decontamination than are sites located with major R&D or production areas.

^{2/} ANSI N13.12 (proposed) -- an adaptation to be applied, as appropriate.

A. RESIDUAL CONTAMINATION CRITERIA FOR FORMERLY UTILIZED SITES AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

The following criteria represent the maximum residual contamination limits for unrestricted use of land and structures contaminated with radionuclides related to the nuclear fuel cycle at FUSRAP and remote SFMP sites. It is the policy of DOE to decontaminate sites to contamination levels at or below the limits and in a manner consistent with DOE's as-low-as-is-reasonably-achievable (ALARA) policy. Residual contamination limits for other nuclides will be developed when required using the same methodology^{1/} as was used for those represented here.

1. Soil (Land) Criteria (Maximum Limits for Unrestricted Use)

<u>Radionuclide</u>	<u>Soil Criteria^{2/,3/,4/} (pCi/g above background)</u>
U-Natural ^{5/}	75
U-238 ^{5/}	150
U-234 ^{6/}	150
Th-230 ^{7/}	15
Ra-226	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15 cm thick soil layers more than 15 cm below the surface and less than 1.5m below the surface.
U-235 ^{6/}	140
Pa-231	40
Ac-227	190
Th-232	15
Am-241	20
Pu-241 ^{8/}	800
Pu-238, 239, 240	100
Cs-137	80
Sr-90	100
H-3 (pCi/ml soil moisture)	5,200

^{1/} Described in ORO-831 and ORO-832.

^{2/} In the event of occurrence of mixtures of radionuclides, the fraction contributed by each radionuclide to its limit shall be determined, and the sum of these fractions shall not exceed 1. There are two special cases for which this rule must be modified:

- (a) If Ra-226 is present, then the fraction for Ra-226 should not be included in the sum if the Ra-226 concentration is less than or equal to the Th-230 concentration. If the Ra-226 concentration exceeds the Th-230 concentration, then the sum shall be evaluated by replacing the Ra-226 concentration by the difference between the Ra-226 and Th-230 concentrations.
- (b) If Ac-227 is present, then the same rule given in (a) for Ra-226 relative to Th-230 applies for Ac-227 relative to Pa-231.

3/ Except for Ra-226, these criteria represent unrestricted-use residual concentrations above background averaged across any 15 cm thick layer to any depth and over any contiguous 100 m² surface area. The same conditions prevail for Ra-226 except for soil layers beneath 1.5 m; beneath 1.5 m, the allowable Ra-226 concentration may be affected by site-specific conditions and must be evaluated accordingly.

4/ Localized concentrations in excess of these limits are allowable provided that the average over 100 m² is not exceeded.

5/ A curie of natural uranium means the sum of 3.7×10^{10} disintegrations per second (dis/s) from U-238 plus 3.7×10^{10} dis/s from U-234 plus 1.7×10^9 dis/s from U-235. One curie of natural uranium is equivalent to 3,000 kilograms or 6,600 pounds of natural uranium.

6/ Assumes no other uranium isotopes are present.

7/ The Th-230 guideline is 15 pCi/g to account for ingrowth of Ra-226 as Th-230 decays. Ra-226 is a limiting radionuclide because its decay product is Rn-222 gas.

8/ The Pu-241 criterion was derived from the Am-241 concentration.

2. Structure Criteria (Maximum Limits for Unrestricted Use)

a. Indoor Radon Decay Products

A structure located on private property and intended for unrestricted use shall be subject to remedial action as necessary to ensure the annual average concentration of radon decay products is less than 0.03 WL within the structure.

b. Indoor Gamma Radiation

The indoor gamma radiation after decontamination shall not exceed 20 microrentgen per hour (20 μ R/h) above background.

c. Indoor/Outdoor Structure Surface Contamination

<u>Radionuclides</u>	<u>Allowable Surface Residual Contamination^{1/}</u> (dpm/100 cm ²)	
	<u>Total</u>	<u>Removable</u>
<u>Group 1:</u> Radionuclides for which the uncontrolled area concentration guide in air above background ^{2/} is 2×10^{-13} Ci/m ³ or less or for which the uncontrolled area concentration guide in water above background ^{2/} is 2×10^{-7} Ci/m ³ or less; includes Pa-231, Th-228, Th-230, Ac-227, Ra-226, Ra-228, and Pb-210.	100	20
<u>Group 2:</u> Radionuclides not in Group 1 for which the uncontrolled area concentration guide in air above background ^{2/} is 1×10^{-12} Ci/m ³ or less or for which the uncontrolled area concentration guide in water above background ^{2/} is 1×10^{-6} Ci/m ³ or less; includes U-232, U-238, Th-232, Ra-223, and Po-210.	1,000	200
<u>Group 3:</u> Those radionuclides not in Group 1 or Group 2; includes U-234, U-235, and Ra-224 and all other beta-gamma emitters.	5,000	1,000

^{1/}The levels may be averaged over 1 m² provided the maximum activity in any area of 100 cm² is less than 3 times the limit value; dpm = disintegrations per minute. In the event of occurrence of mixtures of radionuclides, the fraction contributed by each radionuclide to its limit shall be determined, and the sum of these fractions shall not exceed 1.

^{2/} Given in Attachment 1 to Chapter XI, Table II, DOE Order 5480.1A.

B. CONTROL OF RADIOACTIVE WASTES AND RESIDUES FROM FUSRAP AND REMOTE SFMP SITES

Specified here are the control requirements (criteria) for radioactive wastes and residues related to the nuclear fuel cycle at FUSRAP and remote SFMP sites.

1. Interim Storage

All operational and control requirements specified in the following DOE Orders shall apply:

- a. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations.
- b. 5480.2, Hazardous and Radioactive Mixed Waste Management.
- c. 5483.1, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities.
- d. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements.
- e. 5484.2, Unusual Occurrence Reporting System.
- f. Control and stabilization features will be designed to ensure, to the extent reasonably achievable, an effective life of 50 years, and in any case, at least 25 years.
- g. Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not (1) exceed 100 pCi/l at any given point, or an average concentration of 30 pCi/l for the facility site, or (2) exceed an average Rn-222 concentration at or above any location outside the facility site of 3.0 pCi/l (above background).
- h. For water protection, use existing state and federal standards; apply site-specific measures where needed.

2. Long-Term Management

- a. All operational requirements specified for Interim Storage Facilities (B.1) will apply.
- b. Control and stabilization features will be designed to ensure to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years. Other disposal site design features shall conform with 40 CFR Part 192 performance guidelines/requirements.

- c. Rn-222 emanation to the atmosphere from facility surfaces or opening shall not (1) exceed an average release rate of 20 pCi/m²/s, or (2) increase the annual average Rn-222 concentration at or above any location outside the-facility site by more than 0.5 pCi/l.
- d. For water protection, use existing state and federal standards; apply site-specific measures where needed.
- e. Prior to placement of any potentially biodegradable contaminated wastes in a Long-Term Management Facility, such wastes will be properly conditioned to (1) ensure that the generation and escape of biogenic gases will not cause the criteria in paragraph 2.c. to be exceeded, and (2) ensure that biodegradation within the facility will not result in premature structural failure not in accordance with the criteria in paragraph 2.b.. If biodegradable wastes are conditioned by incineration, incineration operations will be carried out in compliance with all applicable federal, state, and local air emission standards and requirements, including any standards for radionuclides established pursuant to 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants (NESHAPS).

C. EXCEPTIONS

- 1. Procedure -- Analysis of site-specific conditions.
- 2. Applicability -- Where health and safety would be endangered, or where cost clearly outweighs benefits.

D. CRITERIA SOURCE

<u>Criteria</u>	<u>Source</u>
<u>Residual Contamination Criteria</u> ^{1/}	
Soil Criteria	DOE Order 5480.1A, 40 CFR Part 192 ^{2/}
Structure Criteria	40 CFR Part 192, proposed ANSI N13.12.
<u>Control of Radioactive Wastes and Residues</u>	
Interim Storage	DOE Order 5480.1A
Long-Term Management	40 CFR Part 192

Exceptions

Procedure
Applicability

40 CFR Part 192
40 CFR Part 192

-
- 1/ The bases of the residual contamination criteria are developed in ORO-831 as supplemented and ORO-832.
 - 2/ Based on limiting the concentration of radon-222 decay products to 0.03 WL within structures.

APPENDIX C

REPORT OF GROUND-PENETRATING RADAR SURVEY
OF PROPERTY S
AT THE NIAGARA FALLS STORAGE SITE

DETECTION SCIENCES GROUP

FINAL REPORT
GROUND-PENETRATING RADAR SURVEY
OF AREA S
FORMER LAKE ONTARIO ORDNANCE WORKS
LEWISTON, NEW YORK

DETECTION SCIENCES GROUP

FINAL REPORT
GROUND-PENETRATING RADAR SURVEY
OF AREA S
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LEWISTON, NEW YORK

Prepared for
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DETECTION SCIENCES GROUP

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DETECTION SCIENCES GROUP

INTRODUCTION AND SUMMARY

Beginning April 25, and continuing through April 30, 1983, Detection Sciences Group conducted a ground-penetrating radar survey on Area S, G and F at the former Lake Ontario Ordnance Works, Lewiston, New York. The radar survey was performed in accordance with Oak Ridge Associated Universities, Inc. Purchase Order No. C-29923-001, Letter Release No. 1, dated April 14, 1983, and per field instructions received from O.R.A.U. personnel.

The first area to be surveyed was a site at the northern edge of Area S, just south of "M" Street. The radar survey zone was from 0S to 30S, extending from 0W to 50W. The radar anomalies and the radar survey lines are shown in Figure 1. A total of 17 boreholes were surveyed in Area S. Of these 17 locations, 10 appeared to have possible subsurface obstructions, and were moved to more benign locations no more than 5 meters from the original locations. The results of the borehole surveying and the co-ordinates of relocated boreholes are given in Table I. Not all subsurface targets are drilling obstacles; a ball of clay, for example, will show up as a discrete object, yet it would present no drilling problem. The conservative approach, however, is to regard all such subsurface targets as potential obstacles, and to move the boring to a location where the radar chart is completely benign.

The section within Area S that was grid-surveyed contained a few areas that show up as having a strong contrast to the surrounding natural subsurface strata. Some of the radar signatures appear to be caused by the reinforcing steel used in a concrete slab. There are distinct "edge scars" observed with these rebar-like signatures, further suggesting the presence of buried slabs of reinforced concrete. Because of the former industrial use of the site, it is likely that the signatures are, in fact, due to buried concrete slab foundations.

DETECTION SCIENCES GROUP

DESCRIPTION OF THE SURVEY

For this survey, Detection Sciences Group used the 120 Mhz antenna with its radiation shield. The 120 Mhz antenna provides greater penetration than can be obtained using higher frequency antennas. Because of prevailing ground conditions at the site, the use of a high frequency antenna would not provide sufficient penetration in many cases.

Using the survey vehicle to tow the antenna proved to be impractical on this survey. Much of the area covered by the 10 meter grid system was located in areas of rough terrain containing earth mounds, trees, tall stalky growth, and swampy areas. Towing the antenna with a vehicle requires a relatively smooth, uninterrupted terrain; for these reasons the radar transect lines were done by hand, pulling the antenna across all proposed survey lines.

The borehole surveying was done with our time-saving method employing a knotted rope with a center pivot. The rope is 12 meters long with a loop as a center pivot, and painted knots spaced 2 meters apart. The rope is stretched taut with the center loop, or pivot, over the proposed borehole location. Upon completion of the first survey line, the rope is pivoted 90° to act as a guide for the second, orthogonal survey line without the necessity of laying out a surveyors tape. Orange pin flags had been placed by O.R.A.U. at the sites of proposed boreholes. Upon completion of the radar survey, the pin flags were marked by Detection Sciences Group with the grid coordinates and the borehole designation. The borehole designations assigned by Detection Sciences Group are numbered to show the area and the sequence in which the radar survey was done. (The designation sequence is assigned by Detection Sciences Group for reporting purposes only, and are not O.R.A.U. designations.) The grid coordinates and borehole designations are listed in Table I of this report.

DETECTION SCIENCES GROUP

RESULTS OF THE SURVEY

In Area S a section 50 meters by 30 meters was surveyed in a grid pattern with 5 meter spacing between radar transect lines. This section of Area S was grid-pattern surveyed to locate any concentration of buried materials, and to obtain information about any subsurface disturbances that might interfere with the placement of a number of shallow borings. The charts for this area indicate the presence of what appears to be industrial debris (rebars from concrete foundations, sheet metal, pipes, etc.). The shallow boreholes were therefore located where the radar did not show any potential obstacles and the appearance of the ground was relatively benign. The radar charts showing vertical profiles of the survey transect lines for Area S are bound separately in book form. The radar charts for Area S are labeled #1 through #19, in the sequence in which the data was recorded. (The chart numbers are keyed to the entry numbers in the Field Logs contained in the Appendix of this report.) On the charts, the subsurface anomalies are highlighted with orange marker. A listing of these anomalies is compiled in Table II, together with a description of the anomaly.

Before beginning the radar survey, Detection Sciences Group was presented with a map containing proposed locations for boreholes. The boreholes for this site were designated either "deep" or "shallow" by O.R.A.U. Most of the locations shown on the map were marked in the field by orange pin-flags placed by O.R.A.U., but there were a few locations that had not been flagged. At the locations that had not been previously flagged, Detection Sciences Group placed orange pin-flags at the approximate locations, as scaled from the map. Prior to surveying each borehole, Detection Sciences Group used a waterproof felt-tip marker to write the coordinates and the specific borehole designation on each orange pin-flag. A total of 17 boreholes were surveyed at this site; they were designated S1 through S17. Of these 17 borehole locations, 10 were relocated because of subsurface disturbances. The boreholes were moved if: 1) the drilling rig might possibly encounter difficulty drilling through subsurface materials at the proposed location; 2) there are utilities present; or 3) the proposed location is inaccessible to the radar antenna. A detailed list of the proposed coordinates and the final co-ordinates for the borehole locations is shown in Table I.

RADAR TRANSECT LINES
AND ANOMALIES
AREA S

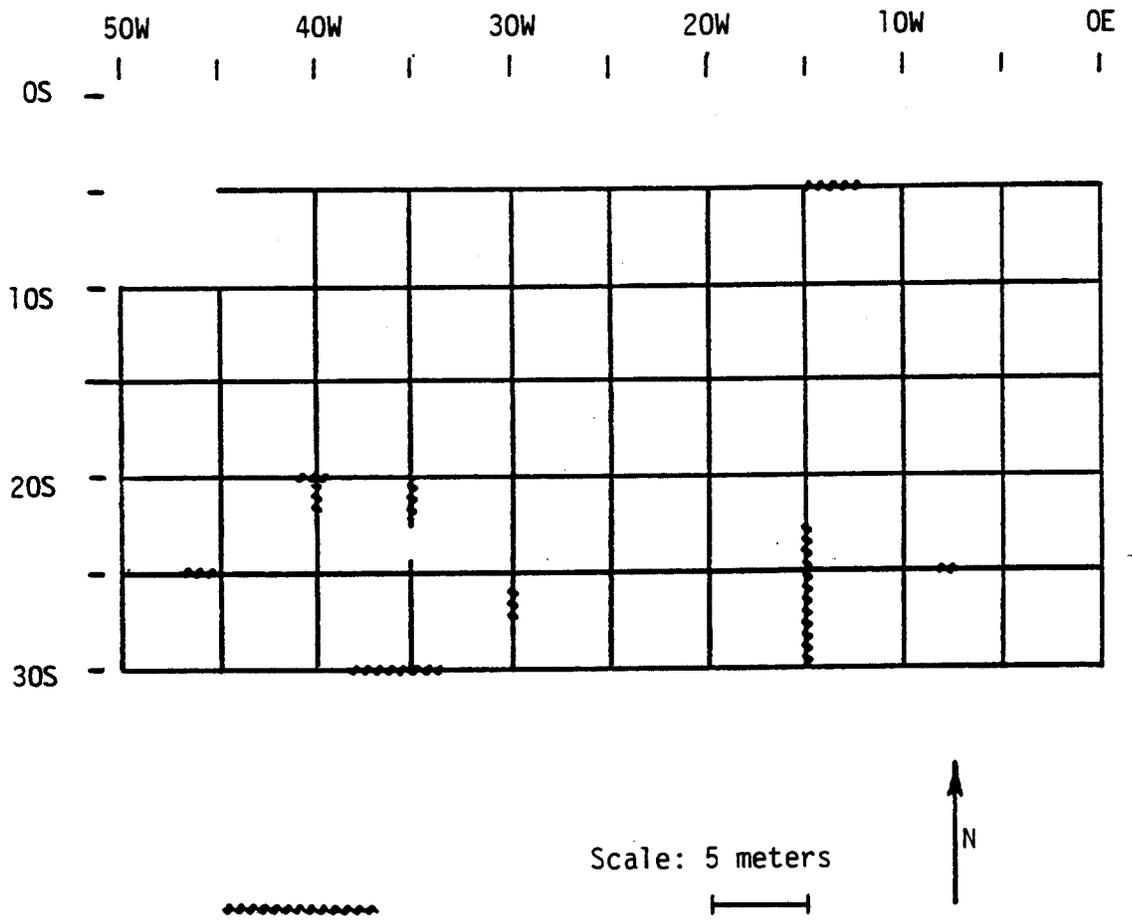


FIGURE 1.

DETECTION SCIENCES GROUP

TABLE I

BORING LOCATIONS DETERMINED BY RADAR

AREA S

<u>Boring Number</u>	<u>Direction of Relocation</u>	<u>Proposed Location</u>	<u>Final Location</u>
S1	-	220W, 27S	220W, 27S
S2	Move 2m West	171W, 16S	173W, 16S
S3	Move 2m South	97W, 30S	97W, 32S
S4	-	52W, 25S	52W, 25S
S5	Move 2m West	41E, 23S	39E, 23S
S6	-	45E, 160S	45E, 160S
S7	-	45E, 295.5S	45E, 295.5S
S8	Move 2m South	40W, 19S	40W, 21S
S9	Move 2m East	39W, 14S	37W, 14S
S10	Move 2m West	39W, 8S	41W, 8S
S11	-	25W, 25S	25W, 25S
S12	Move 2m East	25W, 13S	23W, 13S
S13	Move 4m West	15W, 13S	19W, 13S
S14	-	10W, 22S	10W, 22S
S15	Move 5m South	8.5W, 7.5S	8.5W, 12.5S
S16	-	30E, 22S	30E, 22S
S17	Move 4m North	46E, 193S	46E, 189S

DETECTION SCIENCES GROUP

TABLE II

RADAR ANOMALIES

AREA S

<u>Chart</u>	<u>Line</u>	<u>Coordinates</u>	<u>Depth, Ft.</u>	<u>Notes</u>
#4	40W	20S 22S	3.0	High dielectric
#7	30W	26S 27S	5.4	Concentration of Material
#10	15W	22.5S 30S	Near surface	High dielectric
#14	5S	12.5W 15W	Near surface	Concentration of Material
#17	20S	39W 41W	Near surface	Concentration of Material
#18	25S	5W 6W	4.5	Hyperbola (metal)
#18	25S	45W 47W	3.3	High dielectric
#19	30S	34W 38W	Near surface	Concentration of Material

DETECTION SCIENCES GROUP

RADAR EQUIPMENT

Detection Sciences Group owns a modified SIR SYSTEM-8 radar system with an integral Motorola M6800 microprocessor unit. Our proprietary modifications to the radar system have provided increased range and sensitivity, as well as improving the overall efficiency of the data-gathering process. Detection Sciences Group has also developed special auxiliary equipment to facilitate our radar surveys. The individual components of the radar equipment are:

- GSSI Model 4800 Control Unit. The control unit contains the bulk of all the radar electronics and system controls, and has an oscilloscope display.
- Motorola Model M68MM01A/1A2 Monoboard Microcomputer. The microcomputer has real-time processing capability for background removal, digital filtering, running averages, and other radar signal-processing algorithms.
- Hewlett-Packard Model 3964A Instrumentation Tape Recorder. This high quality, four-channel tape recorder provides master tapes of all data recorded in the field.
- EPC Laboratories, Inc. Model 2800 Chart Recorder. This scanning chart recorder generates the hard-copy radar graphic charts (vertical profiles) used to interpret the radar data.
- GSSI Radar Antenna Units. The radar antennas operate at different frequencies; the depth requirements of the survey determine the operating frequency selected for the survey:
 900 MHz 600 MHz 300 MHz (120 MHz 80 MHz 10 MHz
- Sears 500VA Solid State Inverter. This power supply unit provides both 120 volt ac power as well as 12 volt dc power for operating all field equipment from the survey vehicle's electrical system.
- Honda 500VA Generator. This gasoline-powered generator is used for surveys in remote locations where vehicle access is not possible.
- Remote Stop/Start Unit. The remote stop/start feature allows the operator to control the radar system from the antenna location.
- Odometer Wheel Assembly. This "fifth wheel" attached to the survey vehicle provides automatic logging of incremental distance traveled along the survey path, and automatically logs the ground stations on the radar charts.
- Support Equipment. The various support equipment includes the Micro-computer Control Box, the Remote Control/Market Unit, Hand-held Market Unit, towing sleds, towing harnesses and miscellaneous electrical cables and connectors.

DETECTION SCIENCES GROUP

APPENDIX

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SVS. CLIENT: O.R.A.U.
 DATE: 4/25/83 LEWISTON NY AREAS S, G, & F

RANGE ADJ	RANGE MULTIPLY			RANGE GAIN	FILTER			SENSI-TIVITY	SCAN SETTING				TAPE SPEED	TAPE CHANNEL	COMMENTS					
	X1	X2	X4		H	M	L		51.2	25.6	12.8	6.4				3.2	SLOW	15	3 3/4	15
702				9	12.5			250												J152-83
GRID		MARKER CODE		TAPE COUNT			FIRST MARK		LAST MARK		COMMENTS									
NO.	LINE	START	FINISH	START	FINISH	START	FINISH	FIRST MARK	LAST MARK											
1	95W	000	093	000	093	000	093	105	305	AREA S 5M GRID										
2	50N		089	043	089	043	089	"	"	N-PS 10.5M START 8S TEST W/RYE										
3	95W	2#0	122	083	122	083	122	"	"											
4	40N	3#0	167	122	167	122	167	55	"	START 3S										
5	35W	4#0	203	167	203	167	203	"	225	" " 2 @ SLIA NISS-200										
6	"	5#0	231	203	231	203	231	~255	305	" " START 235 START RT ABSTRACTION "										
7	30W	7#0	271	231	271	231	271	55	"	" " START 3S										
8	25W	8#0	316	271	316	271	316	"	"	" " " "										
9	20W	2#0	362	316	362	316	362	"	"	" " " "										
10	15W	3#0	407	362	407	362	407	"	29.55	" " SURFACE NO VISIBLE REASON FOR DISTURB										
11	10W	4#0	498	407	498	407	498	"	305	" " " "										
12	5W	5#0	486	498	486	498	486	"	"	" " " "										
13	0W	6#0	523	486	523	486	523	"	"	" " " "										
14	5S	7#0	578	523	578	523	578	0W	45W	" " " " 60 CM W										
										" " " " 60 CM N										
										" " " " OFFSET IN 0-501										
										" " " " E-70										

RADARVISION

TAPE NO.: 8252 LOCATION: SOA CHEMICAL SYS. CLIENT: O.R.A.U.
 DATE: 4/25/83 LEWISTON NY AREAS S.G. & F

RANGE ADJ	RANGE MULTIPLY			RANGE GAIN	FILTER			SENSI- TIVITY	SCAN SETTING					TAPE SPEED	TAPE CHANNEL	COMMENTS				
	X1	X2	X4		H	M	L		51.2	25.6	12.8	6.4	3.2				SLOW	15	3 3/4	15/16
702				9	12.5			250												J152 -83
GRID	MARKER CODE			TAPE COUNT			FIRST MARK	LAST MARK	COMMENTS											
NO. LINE	START	FINISH	START	FINISH	START	FINISH														
15	109	8 #0	579	635			6W	50W	START 3E AREA S 5M GRID STOP 520											
16	159	2 #0	635	686			"	"	E-W 10.5M START 3E 60CMN											
17	209	3 #0	686	744			"	"	" " " " " "											
18	259	4 #0	744	789			"	"	" " " " " " " " " " " "											
19	309	5 #0	789	842			"	"	" " " " " " " " " " " "											
20	51	6 #0	842	879			6E	6W	E-W 10.2M 200W X 27S 20 PWT											
21	"	7 #0	879	909			6N	4S	N-TS " " " " " "											
22	52	8 #0	909	930			6N	6S	N-TS " " " " " " " " " " " "											
23	"	2 #0	930	966			6E	6W	E-W 171W X 16S " " " " " "											
24	53	3 #0	966	989			6N	6S	N-TS " " " " " " " " " " " "											
25	"	4 #0	989	1013			6E	6W	E-W 97W X 30S " " " " " "											
26	54	5 #0	1013	1038			6N	6S	N-TS " " " " " " " " " " " "											
27	"	6 #0	1038	1063			6E	6W	E-W 52W X 25S " " " " " "											

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SVS. CLIENT: O.R.A.U.
DATE: 4/26/83 LENIXTON NY

RANGE ADJ	RANGE MULTIPLY		RANGE GAIN	FILTER			SENSI-TIVITY	SCAN SETTING				TAPE SPEED	TAPE CHANNEL			COMMENTS				
	X1	X2		X4	H	M		L	51.2	25.6	12.8		6.4	3.2	SLOW		15	3 3/4	15/16	1
702			8.5 12.5				250													J152-83
GRID NO.	LINE	MARKER CODE	TAPE COUNT	START	FINISH	FIRST MARK	LAST MARK	COMMENTS												
28	S8	7#0		1063	1085	6N	6S	AREA S												
29	"	8#0		1085	1107	6E	6N	N-PS 102M 90W X 19S												
30	S9	2#0		1107	1132	6N	6N	E-PS " SUBTO 4M												
31	"	3#0		1132	1157	6E	6N	N-PS 39W X 19S												
32	S10	1#0		1157	1176	6N	6N	E-PS "												
33	"	5#0		1176	1204	6E	6W	N-PS 39W X 8S												
34	S11	6#0		1204	1231	6N	6S	E-PS "												
35	S11	7#0		1231	1258	6E	6W	N-PS 25W X 25S SUB TO 2M												
36	S12	8#0		1258	1287	6N	6S	E-PS "												
37	"	2#0		1287	1311	6E	6W	N-PS 25W X 13S												
38	S13	3#0		1311	1337	6N	6S	E-PS " SUB TO 3M S												
39	"	1#0		1337	1363	6E	6W	N-PS 15W X 13S SUB TO 4M S												
40	S14	5#0		1363	1387	6N	6S	E-PS "												
41	"	6#0		1387	1410	6E	3W	N-PS 10W X 22S												

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SVS. CLIENT: O.R.A.U.
 DATE: 4/26/83 LEWISTON NY

RANGE ADJ	RANGE MULTIPLY		RANGE GAIN	FILTER			SENSITIVITY	SCAN SETTING				TAPE SPEED	TAPE CHANNEL		COMMENTS				
	X1	X2		X4	H	M		L	51.2	25.6	12.8		6.4	3.2		SLOW	15	3 3/4	16
702			8.5				250												J152-83
GRID	MARKER CODE		TAPE COUNT			FIRST MARK	LAST MARK	COMMENTS											
NO.	LINE	START	FINISH	START	FINISH														
42	S/5	7#0	1410	1431	6N	6S	N→S	1024	8.5	24	7.5	5	24	24	RD				
43	"	8#0	1431	1457	6E	6W	E→W												
44	S/6	2#0	1457	1477	6N	4S	N→S												
45	"	3#0	1477	1496	6E	6W	E→W												
46	S/5	4#0	1496	1512	6N	2S	N→S												
47	"	5#0	1512	1529	6E	6W	E→W												
48	S/6	6#0	1529	1550	6N	6S	N→S												
49	"	7#0	1550	1569	6E	6W	E→W												
50	S/7	8#0	1569	1591	6N	6S	N→S												
51	S/7	2#0	1591	1609	6E	5W	E→W												
52	G/1	3#0	1609	1627	6N	4S	N→S												
53	"	1#0	1627	1646	6E	6W	E→W												
54	62		000	055	6N	6S	N→S												
55	"	2#0	055	099	6E	6W	E→W												

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SUS. CLIENT: O.R.A.U.
DATE: 4/26/83 LENISTON NY

RANGE ADJ	RANGE MULTIPLY		RANGE GAIN	FILTER			SENSI-TIVITY	SCAN SETTING					TAPE SPEED	TAPE CHANNEL		COMMENTS			
	X1	X2		X4	H	M		L	51.2	25.6	12.8	6.4		3.2	SLOW		15	3 3/4	15
702			8.0				250												J152-83
GRID		MARKER CODE		TAPE COUNT			FIRST MARK	LAST MARK	COMMENTS										
NO.	LINE	START	FINISH																
56	S17	099	198	6N	198	6S	N→S	10 2M	20	BRING	16E	X	198						
57	"	198	186	6E	186	6W	E→W												
58	G5	186	225	6N	225	6S	N→S												
59	G5	225	267	6E	267	6W	E→W												
60	G7	267	300	6N	300	2S	N→S												
61	G7	300	338	6E	338	6W	E→W												
62	G13	338	379	6N	379	6S	N→S												
63	"	379	419	6E	419	6W	E→W												
64	G8	419	451	6N	451	6S	N→S												
65	"	451	481	6E	481	6S	N→S												
66	G12	481	504	6N	504	6S	N→S												
67	"	504	538	6E	538	6W	E→W												
68	G14	538	572	6N	572	6S	N→S												
69	"	572	621	6E	621	6S	N→S												

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SVS CLIENT: O.R.A.U.
 DATE: 4/26/83 LEWISTON NY

RANGE ADJ	RANGE MULTIPLY		RANGE GAIN	FILTER			SENSITIVITY	SCAN SETTING				TAPE SPEED	TAPE CHANNEL			COMMENTS				
	X1	X2		X4	H	M		L	51.2	25.6	12.8		6.4	3.2	SLOW		15	3 3/4	15/16	1
702			8				250													J152-83
GRID		MARKER CODE		TAPE COUNT			FIRST MARK	LAST MARK	COMMENTS											
NO.	LINE	START	FINISH	START	FINISH	START			FINISH											
70	G4	5#0	621	696	674	702	727	6N	6S	N→S	20	24	20	24	20	24	72E X 195S			
71	"	1#0	646	674	702	727	751	6E	6W	E→W							"			
72	G6	5#0	674	702	727	751	778	6N	6S	N→S							73E X 181S			
73	"	6#0	702	727	751	778	805	6E	6W	E→W							"			
74	G9	7#0	727	751	778	805	833	6N	6S	N→S							125E X 170S			
75	"	8#0	751	778	805	833	856	6E	6W	E→W							"			
76	G10	2#0	778	805	833	856	882	6N	6S	N→S							190E X 207S			
77	"	3#0	805	833	856	882	907	6E	6W	E→W							"			
78	G11	4#0	833	856	882	907	931	6N	6S	N→S							SWAMP 157E X 240S			
79	"	5#0	856	882	907	931	950	6E	6W	E→W							"			
80	G8	6#0	882	907	931	950	986	6N	6S	N→S							100E X 19S			
81	"	7#0	907	931	950	986		6E	6W	E→W							"			
82	G15	8#0	931	950	986			6N	2S	N→S							206E X 30S			
83	"	2#0	950	986				6E	6W	E→W							"			

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SIS. CLIENT: OR. A. U.
DATE: 9/27/83 LEWISTON NY

RANGE ADJ	RANGE MULTIPLY		RANGE GAIN	FILTER			SENSI-TIVITY	SCAN SETTING				TAPE SPEED		TAPE CHANNEL		COMMENTS			
	X1	X2		X4	H	M		L	51.2	25.6	12.8	6.4	3.2	SLOW	15		3 3/4	15/16	1
702			9.0				250												J152-83
GRID		MARKER CODE		TAPE COUNT			FIRST MARK	LAST MARK	COMMENTS										
NO.	LINE	START	FINISH																
84	G16	3 #0	986	1014	1035	6N	6S	N→S 102N 330E X 70S 2 @ BOWING											
85	G16	1 #0	1014	1035	6E	4W	E→W												
86	G17	5 #0	1035	1059	6N	6S	N→S 390E X 200S 7 3												
87	"	6 #0	1059	1076	6E	2W	E→W " 9 9												
88	G18	7 #0	1076	1103	6N	6S	N→S 390E X 342S MUDDY												
89	"	8 #0	1103	1124	6E	4W	E→W " " "												
90	F1	2 #0	1124	1147	6N	6S	N→S 399E X 249S												
91	"	3 #0	1147	1168	6E	6W	E→W " " "												
92	F2	4 #0	1168	1191	6N	6S	N→S 357E X 108S												
93	"	5 #0	1191	1210	6E	2W	E→W " " "												
94	F3	6 #0	1210	1233	6N	6S	N→S 361E X 21S												
95	"	7 #0	1233	1257	6E	6W	E→W " " "												
96	F4	8 #0	1257	1287	6N	6S	N→S 500E X 16S												
97	"	2 #0	1287	1315	6E	6W	E→W " " "												

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SIS. CLIENT: O.R.A.U.
 DATE: 4/27/83 LEWISTON N.Y.

RANGE ADJ	RANGE MULTIPLY			RANGE GAIN	FILTER			SENSI-TIVITY	SCAN SETTING				TAPE SPEED	TAPE CHANNEL				COMMENTS	
	X1	X2	X4		H	M	L		51.2	25.6	12.8	6.4		3.2	SLOW	15	3 3/4		15
702				9.6				250											J152-83
GRID		MARKER CODE		TAPE COUNT				FIRST MARK		LAST MARK		COMMENTS							
NO.	LINE			START	FINISH														
98	F5	3#0		1315	1345	6N		6S		N→S		10 24 20 BEING 79E X 14S							
99	"	4#0		1345	1372	6E		6W		E→W		30 BEING "							
100	F6	5#0		1372	1393	6N		4S		N→S		992E X 10S							
101	"	6#0		1393	1419	6E		6W		E→W		"							
102	F7	7#0		1419	1443	6N		6S		N→S		1000E X 287S WET.							
103	"	8#0		1443	1464	2E		6W		E→W		"							
104	F8	2#0		1464	1485	6N		6S		N→S		1015E X 341S WET							
105	"	3#0		1485	1507	6E		6W		E→W		MOVE EAST " ON ASSEMBLY							
106	50E	—			063	190S		210S		N→S		10 5M 10 20M CHANNEL 4							
107	60E	2#0		063	154	"		"		N→S		"							
108	70E	3#0		154	227	"		"		"		"							
109	80E	4#0		227	295	"		"		"		"							
110	90E	5#0		295	364	"		"		"		"							
111	100E	6#0		364	422	"		"		"		"							

RADARVISION

TAPE NO.: 8252 LOCATION: SCA CHEMICAL SVS. CLIENT: O.R.A.U.
DATE: 4/20/83 LEWISTON NY

RANGE ADJ	RANGE MULTIPLY		RANGE GAIN	FILTER			SENSI-TIVITY	SCAN SETTING				TAPE SPEED		TAPE CHANNEL		COMMENTS			
	X1	X2		X4	H	M		L	51.2	25.6	12.8	6.4	3.2	SLOW	15		3 3/4	15/16	1
70Z			9.0				250												J152-83
GRID		MARKER CODE		TAPE COUNT			FIRST MARK	LAST MARK	COMMENTS										
NO.	LINE	START	FINISH																
112	110E	7#0	422	492	492	519	140S	210S	N-PS 10.5M 20 20M QUAD TRAE NSE										
113	120E	8#0	492	549			"	"	"										
114	130E	2#0	549	611			"	"	"										
115	140E	3#0	611	668			"	"	"										
116	150E	4#0	668	726			"	"	"										
117	160E	5#0	726	779			145S	"	"										
118	140S	6#0	779	845			158E	50E	E-W 10 5M 20 20										
119	150S	7#0	845	905			160E	50E	"										
120	160S	8#0	905	988			"	"	"										
121	170S	2#0	988	1043			"	"	"										
122	180S	3#0	1043	1099			"	"	"										
123	190S	4#0	1099	1145			"	"	"										
124	200S	5#0	1145	1193			"	"	"										
125	210S	6#0	1193	1242			"	"	"										

RADARVISION

TAPE NO.: 8253 LOCATION: SCA CHEMICAL SUS. CLIENT: O.R.A.U.
DATE: 9/29/83 LEAKSTON NY

RANGE ADJ	RANGE MULTIPLY		RANGE GAIN	FILTER			SENSITIVITY	SCAN SETTING				TAPE SPEED	TAPE CHANNEL		COMMENTS				
	X1	X2		X4	H	M		L	51.2	25.6	12.8		6.4	3.2		SLOW	15	3 3/4	15/16
702			?	6			250												J52-83
GRID		MARKER CODE		TAPE COUNT			FIRST MARK	LAST MARK	COMMENTS										
NO.	LINE	START	FINISH																
154	305S	4#0	183	333	170E	80E	E-W	10	54	20	204								1MN
155	285S	5#0			150E	145E	"												1MN
156	265S	6#0	333	373	155E	120E	"												"
157	120E	7#0	373	408	265S	290S	N-S												1ME
158	130E	8#0	408	436	"	282S	"												"
159	305S	2#0	436	505	200E	120E	E-W												1MN
160	160E	3#0	505	530	285S	365S	N-S												1ME
161	170E	4#0	530	560	285S	305S	"												1ME
162	200E	5#0	560		280S	300S	"												1MN
163	295S	6#0			200E	182E	E-W												1MN
164	265S	7#0		652	"	180E	"												" 145