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VERIFICATION SURVEY OF THE ELZA GATE SITE OAK RIDGE, TENNESSEE

T. J. VITKUS AND T. L. BRIGHT

Prepared for the Office of Environmental Restoration
U.S. Department of Energy

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

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VERIFICATION SURVEY
OF THE
ELZA GATE SITE
OAK RIDGE, TENNESSEE

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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
BNI	Bechtel National Inc.
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EGS	Elza Gate Site
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
FSRD	Former Sites Restoration Division
ft	foot
ft^2	square foot
FUSRAP	Formerly Utilized Sites Remedial Action Program
GM	Geiger-Mueller
h	hour
ha	hectares
km	kilometer
m	meter
m^2	square meter
MED	Manhattan Engineer District
mg/kg	milligram per kilogram
mi	mile
mrem	millirem
mrem/yr	millirem per year
NaI	sodium iodide
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
μR/h	microroentgens per hour
pCi/g	picocuries per gram
PIC	pressurized ionization chamber
PMC	Project Management Contractor
ppm	parts per million
yr	year
ZnS	zinc sulfide

VERIFICATION SURVEY
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INTRODUCTION AND SITE HISTORY

The Manhattan Engineer District (MED) developed a storage facility at the Elza Gate Site (EGS), located in Oak Ridge, Tennessee, in the early 1940's. The MED established five warehouses at the site, three of which were used for the containerized storage of pitchblende (a high-grade uranium ore) as well as sludges, tailings, and other residues from the uranium refining processes taking place at MED operated plants in Oak Ridge. Historical documentation indicates that some of these containers deteriorated during storage and released part of the contents. The materials released contained natural uranium, radium, and thorium.

Ownership of the site was transferred to the Atomic Energy Commission (AEC), predecessor organization to the Department of Energy (DOE), in 1946. The AEC/DOE continued to use the site for the storage of radioactively contaminated materials as well as other types of equipment generated at the Oak Ridge National Laboratory (ORNL) and the Oak Ridge Y-12 Plant until the early 1970's when site use was discontinued. The AEC performed radiological surveys and decontamination activities in 1972 in accordance with guidelines and criteria which were current at that time. The site was then released for unrestricted use and the property title transferred to the City of Oak Ridge. The City then sold the property to a metal plating company, Jet Air, Inc. In 1987 Oak Ridge Associated Universities (ORAU), now known as the Oak Ridge Institute for Science and Education (ORISE), performed a survey of the site to determine if any site contamination was caused by the metal plating operations. This survey identified polychlorinated biphenyls (PCBs) in soil samples, believed to be the result of contaminated electrical equipment storage, and uranium concentrations in excess of background levels in the southern portion of the property. The property was sold to the current owner, MECO, Inc., in 1988. At the request of the DOE, ORNL performed a preliminary radiological survey of the site in October 1988 to determine if the site met the current, more stringent residual contamination guidelines; the residual radioactive contamination present at EGS was determined to be in excess of the current DOE guidelines for release to unrestricted use.[1] Based on these findings, EGS was designated into the Formerly Utilized Sites Remedial Action Program (FUSRAP).

FUSRAP was developed by DOE to identify and clean up or otherwise control sites where residual radioactivity remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy. From 1989 to 1990, Bechtel National, Inc. (BNI) the FUSRAP project management contractor (PMC) conducted radiological and chemical characterizations at EGS. The site investigation results published in the characterization report identified radiological contamination on four of the original warehouse concrete pads and elevated concentrations in soils of natural uranium, Th-230, Th-232, Ra-226, lead, and PCBs.[2]

The remedial actions necessary to release the site for unrestricted use began in March 1991. Parcel 1A was remediated in three phases during the period March to May, 1991 by the removal of Pad 1, excavation of contaminated soils beneath the pad, and excavation of soil at five exterior locations. The portion of the concrete pad that was removed within the building was restored and the exterior excavations were backfilled. Remediation of Parcels 1B-9 began in October 1991 and continued through January 1992. Remedial actions included the removal of concrete and soil associated with Pads 2, 3 and 4, and excavation of radiologically and/or chemically contaminated soils from the south property. All concrete rubble and soils generated by remedial actions were disposed of off-site. In addition, Pad 5 was found to have isolated locations of residual surface contamination during the characterization survey. These locations were remediated by BNI and the remainder of Pad 5 left in place. The site restoration included backfilling excavations with clean soil, grading, and reseeding.

It is the policy of the DOE to perform independent verifications of the effectiveness of remedial actions conducted within FUSRAP. The Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Associated Universities/Oak Ridge Institute for Science and Education (ORAU)/(ORISE) was designated by the DOE as the organization responsible for this task at the Elza Gate Site.

PROJECT ORGANIZATION AND RESPONSIBILITY

DOE Headquarters provides overview and coordination for all FUSRAP activities. DOE Oak Ridge (DOE-OR) is responsible for implementation of FUSRAP and the Former Sites Restoration Division

(FSRD) of DOE-OR, manages the daily activities. Under the standard FUSRAP protocol, an initial investigation of a potential site is performed by ORISE or Oak Ridge National Laboratory (ORNL), under contract to DOE Headquarters. If appropriate, DOE Headquarters designates the site into FUSRAP based upon the results provided by the initial investigation. DOE's Project Management Contractor for FUSRAP is BNI. BNI is responsible for the planning and the implementation of FUSRAP activities and managing the site characterization and remedial actions. The final phase for a FUSRAP site is independent verification which is provided by ORISE or ORNL after remedial action is complete. The purposes of the verification are to confirm that remedial actions at the site have been effective in meeting current guidelines and that documentation accurately and adequately describes the post-remedial action radiological condition of the site. DOE Headquarters uses the information developed by the remedial and verification activities to certify that a site can be released for unrestricted use.

SITE DESCRIPTION

The 8.1 hectare (20 acre) Elza Gate Site is located in the eastern portion of the City of Oak Ridge and is bounded by the L & N railroad tracks to the north, Melton Lake Dr. to the east, and the Clinch River (Melton Hill Reservoir) to the south and west (Figure 1). Presently, the site is comprised of nine different parcels. Additionally, Parcel 1 was subdivided into Parcels 1A and 1B. Four of these parcels previously contained the five concrete pads from the original MED warehouses. The only building on the site is located on Parcel 1A and was constructed over Pad 1. The site plot plan, which indicates the building, the previous locations of the five concrete pads, and parcel divisions is shown on Figure 2.

Parcel 1A contains an area of approximately 0.8 hectares (1.9 acres). The existing building is a single-story structure with floor space of 1,800 m^2 (20,000 ft^2) of which Pad 1 comprises 980 m^2 (10,500 ft^2) of the floor area (Figure 3). The remaining 7.3 ha (18.1 ac) land area is divided among Parcels 1B through 9. Parcels 1A - 4 are located to the north of the site access road, Antwerp Lane, and Parcels 5 - 9 are to the south of the road. Pad 5 is located within Parcel 4.

OBJECTIVES

The objectives of the verification activities were to provide independent document reviews and radiological data. These evaluations may then be used to validate that the procedures and methods utilized by the remedial action contractor were adequate. In addition, independent verification provides assurance that the post-remedial action data are sufficient, accurate, and demonstrate that remedial actions were accomplished in accordance with the DOE guidelines and authorized limits. This report describes the procedures and results of the verification activities.

DOCUMENT REVIEW

BNI's characterization report, field data, and post-remedial action report were reviewed for general thoroughness, accuracy, completeness, and consistency between documents.[2,3] Characterization data were evaluated to assure that those areas where contamination levels were in excess of the guidelines had been identified as such and remediated, and that the post-remedial action data supported that remedial objectives had been met.

PROCEDURES

ESSAP personnel conducted independent measurement and sampling activities on Parcel 1A between March 25 and May 31, 1991 and for the remainder of the site between November 25, 1991 and January 31, 1992. Survey activities were performed concurrently with remedial actions in accordance with the site-specific survey plan using procedures and instruments described in the ESSAP Survey Procedures Manual and summarized in Appendices A and B.

INTERIOR PORTIONS OF PARCEL 1A

Reference Grid

ESSAP used the grid established by BNI to reference measurement and sampling locations within the Pad 1 excavation. The grid consisted of 10 m by 10 m blocks and was independent of the main site grid system (Figure 4).

Surface Scans

Gamma surface scans of the soil beneath Pad 1 were performed as each phase (phase 1, 2, and 3 remedial activities areas on Figure 4) of the pad removal was completed. In addition, beta surface scans were performed on the exposed subsurface pad edges, adjacent floor level portions of the remaining pad, and all sides of twenty (20) randomly selected 1 m^2 blocks of the Pad 1 concrete rubble that were identified as releasable without radiological restrictions. Scans were performed using either NaI gamma or GM beta detectors that were coupled to either ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation, identified by scans, were marked for further investigation.

Surface Activity Measurements

Natural uranium emits both alpha and beta radiations in approximately equal proportions; beta levels may, therefore, be considered representative of uranium surface activity. Because rough, dirty, or damp surfaces may selectively attenuate alpha radiation, beta activity was also measured, and used for comparison to the guidelines. For each of the 20 sections of concrete from Pad 1 that were selected for survey, five direct measurements for total alpha and beta activity were made on the side which exhibited the highest activity as indicated by surface scans. Direct measurements were performed using ZnS alpha and GM beta detectors coupled to ratemeter-scalers. A smear sample, for determining removable activity, was obtained at the location on each concrete section corresponding to the maximum direct measurement.

Exposure Rate Measurements

Exposure rate measurements at 1 m, were made at four (4) locations within the excavated Pad 1 area using a pressurized ionization chamber (PIC) (Figure 4).

Soil Sampling

Five surface (0-15 cm) soil samples were collected from within each of six (6) randomly selected 100 m^2 grid blocks. Seven (7) additional soil samples were collected from areas of elevated direct radiation (Figure 4).

EXTERIOR AREAS

Reference Grid

BNI established both an English and metric unit site reference grid system. The initial grid, used to reference excavation, measurement, and sampling locations within Parcel 1A, consisted of 100 ft x 100 ft (30 m x 30 m) grid blocks (Figure 5). The grid established for the activities conducted within Parcels 1B-9 consisted of 20 m x 20 m (65 ft x 65 ft) grid blocks (Figure 6). Remedial actions, measurement, and sampling locations were referenced to either a 3 m by 3 m (10 ft x 10 ft), (Pad 2 and Pad 5 areas) or 5 m by 5 m (16 ft x 16 ft), (Pad 3, Pad 4, and the south property) grid system subdivisions.

Surface Scans

Gamma radiation surface scans were conducted within all excavations as well as unremediated portions of the site using NaI gamma detectors. Pad 5 surfaces were scanned for alpha-beta activity using a gas proportional detector. All detectors were coupled to ratemeters or ratemeter-scalers with audible indicators. Areas of elevated contact radiation were marked for further investigation.

Surface Activity Measurements

Direct measurements to determine total alpha and beta activity were performed in twenty (20) randomly selected grid blocks on Pad 5 (Figure 7). Measurements were made at the center and four points equidistant from the center and grid block corners. Direct measurements were made using ZnS alpha and GM beta detectors coupled to ratemeter-scalers. Smear samples, to determine

removable activity levels, were collected from each grid block at the location corresponding to the highest direct measurement.

Exposure Rate Measurements

Background exposure rates measurements were made at 5 locations within 0.5 to 10 km (0.3 to 6 mi) of the site (Figure 8). Exposure rate measurements were made at ten (10) site locations (Figure 9). All exposure rates measurements were made with a pressurized ionization chamber (PIC) positioned 1 m above surfaces.

Soil Sampling

Background soil samples were collected from five locations within 0.5 to 10 km of the site (Figure 8). Five surface soil samples, maintained individually or field composited, were collected from seventeen (17) 100 m^2 areas located within excavations or undisturbed portions of the site. Sample areas were either randomly selected or chosen based on the surface scans results. Individual surface or subsurface soil samples were also collected from 6 additional locations of elevated direct gamma radiation detected during surface scans. Four (4) separate composite samples were collected from two areas identified during site characterization as having PCB contamination greater than 50 ppm. Figures 10 through 17 show general sample areas and specific sampling locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and direct measurement data were returned to ESSAP's Oak Ridge laboratory for analysis and interpretation. All soil samples were analyzed by solid-state gamma spectrometry for U-238, Th-232 and Ra-226. Selected composite samples were analyzed by alpha spectrometry for Th-230. The four samples collected from remediated PCB locations were transferred to a commercial laboratory for PCB analysis by gas chromatography/electron capture detection. Soil sample analytical results were reported in units of pCi/g for radionuclides and mg/kg (ppm) for PCBs. Smear samples were analyzed for gross alpha and gross beta activity using a low background proportional counter. Smear sample results and direct measurements were converted to units of disintegrations per minute (dpm) per 100 cm^2. Exposure rates were reported in units of μR/h.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP's review of the EGS documentation indicates that the site was adequately characterized to identify types and areal extent of contaminants and that remedial actions were effective in reducing contamination to levels below the DOE guidelines and authorized limits.

INTERIOR PORTIONS OF PARCEL 1A

Surface scans

Gamma scans of the soil beneath Pad 1 detected several small areas (< 1 m^2) of elevated direct radiation. ESSAP identified each location to BNI contractor personnel for appropriate action. BNI's further investigation determined that the majority of the locations of elevated direct radiation were the result of small pieces of contaminated concrete scattered within the soil. BNI removed the concrete, and ESSAP's follow-up scans indicated that gamma activity was comparable to background levels. The remaining area of elevated direct gamma radiation was identified adjacent to a concrete footer within the Phase 1 excavation area at coordinate 4.5N, 13W (Figure 4). BNI excavated additional soil and provided ESSAP a post-remedial action sample for verification. All other gamma scans were in the range of ambient background levels.

Beta scans of the exposed edges of the remaining concrete pad did not identify any areas of elevated direct radiation. Beta scans of the Pad 1 concrete rubble identified areas of elevated direct radiation on several blocks. As a result of these findings, BNI performed additional surveys of the concrete rubble in order to insure that the material was releasable or resegregated as necessary.

Surface Activity Levels

Surface activity measurements performed on the 1 m^2 sections of Pad 1 concrete rubble are summarized below. Individual direct measurements ranged from <66 to 150 dpm/100 cm^2 and <910 to 6800 dpm/100 cm^2 for alpha and beta, respectively. The average activity levels over 1 m^2 sections of concrete, were <83 dpm/100 cm^2 for alpha and ranged from <910 to 3400 dpm/100 cm^2 for beta.

Removable activity levels were less than the minimum detectable activity (MDA) of <6 dpm/100 cm^2 for alpha and <13 dpm/100 cm^2 for beta.

Exposures Rates

Exposure rates are summarized in Table 1. Exposure rates inside the building ranged from 8 to 10 μR/h.

Radionuclide Concentrations in Soil

Radionuclide concentrations in soils beneath Pad 1 are summarized in Tables 2 and 3. Concentration ranges, following final remediation, were: U-238, 1.2 to 17.7 pCi/g; Ra-226, 0.6 to 4.1 pCi/g; Th-230, 0.9 to 2.5 pCi/g; Th-232, 0.8 to 1.8 pCi/g.

EXTERIOR AREAS

Surface Scans

Gamma scans of Parcel 1A identified one area of elevated direct radiation on the southern portion of the parcel at coordinate 38848N, 82041E. After the completion of ESSAP's on-site activities, BNI excavated soil from the area (South Excavation on Figure 11), and provided ESSAP with a post-remedial action soil sample for verification analysis. Gamma scans of Parcels 1B - 9 identified four small areas of elevated direct gamma radiation, 1.5 to 2 times background levels, located in the

Pad 2 excavation, the Pad 3 excavation, and two of the south property excavations. Further investigations determined that the elevated direct radiation was not distributed, but rather contained in an area of less than 1 m^2. Each of the locations identified were sampled individually and/or as part of the respective composite sample area. Alpha-beta scans of Pad 5 did not identify any areas of elevated direct radiation.

Surface Activity Levels

The Pad 5 grid block measurements were all less than the detection sensitivities of the instrumentation which were <72 dpm/100 cm^2 for alpha and <940 dpm/100 cm^2 for beta. Removable activity levels were <12 dpm/100 cm^2 for gross alpha and <15 dpm/100 cm^2 for gross beta.

Exposure Rates

Background exposure rates, summarized in Table 4, for the Oak Ridge area ranged from 9 to 12 μR/h. Exterior exposure rate measurements, summarized in Table 1, ranged from 6 to 11 μR/h.

Radionuclide and PCB Concentrations in Soil

Radionuclide concentrations in background samples are presented in Table 4. Background concentration ranges were as follows: U-238, 2.2 to 3.7 pCi/g; Ra-226, 0.5 to 1.3 pCi/g; Th-232, 0.7 to 1.3 pCi/g. The Th-230 background concentrations, provided in the site characterization report ranged from <0.6 to 1.4 pCi/g.[2] Concentrations of radionuclides in soil samples collected from Parcel 1A exterior locations and Parcels 1B - 9 are summarized in Tables 5 and 6. The radionuclide concentration ranges, averaged over 100 m^2 areas, were: U-238, <1.7 to 16.7 pCi/g; Ra-226, 0.5 to 1.2 pCi/g; Th-230, 0.6 to 1.4 pCi/g; Th-232, <0.1 to 1.7 pCi/g. The maximum concentrations in samples collected from locations of elevated gamma radiation were: U-238, 13.5 pCi/g; Ra-226, 3.3 pCi/g; Th-232,1.7 pCi/g.

PCB analyses of the four samples identified two commercial PCB mixtures, which were Aroclor 1254 and Aroclor 1260. The concentrations ranged from 0.60 to 2.20 mg/kg and 0.64 to

1.40 mg/kg for Aroclor 1254 and Aroclor 1260, respectively. All other Aroclors were below the quantitation limits of the procedures which ranged from <0.45 to <1.0 mg/kg.

COMPARISON OF RESULTS WITH GUIDELINES

Measurement and sampling data were compared to the DOE radiological protection requirements and guidelines for cleanup of residual radioactive material and release of property.[4] These guidelines are summarized in Appendix C.

The controlling contaminant at Elza Gate was uranium. The uranium residual surface contamination guidelines are:

Total Activity

5000 α dpm/100 cm^2, averaged over 1 m^2

15,000 α dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1000 α dpm/100 cm^2

The exposure rate guideline for a building or habitable structure is 20 μR/h above background.

The generic guidelines for thorium and radium in soil are as follows:

5 pCi/g	averaged over the first 15 cm of soil below the surface
15 pCi/g	averaged over 15 cm thick layers of soil more than 15 cm below the surface

The site-specific guideline for U-238 in soil is 35 pCi/g.[5] The EPA PCB and lead industrial use cleanup guidelines for the site were 25 mg/kg and 1000 mg/kg for PCBs and lead respectively.

All final independent data reviews performed and/or measurements and samples collected by ESSAP indicated that the guidelines had been met and verified the data provided by BNI.

SUMMARY

At the request of the U. S. Department of Energy the Oak Ridge Institute for Science and Education's Environmental Survey and Site Assessment Program conducted a verification survey of the Elza Gate Site. The surveys were performed in phases during the period March 1991 to January 1992. Verification activities included document reviews, surface scans, surface activity measurements, exposure rate measurements, and soil sampling and analysis.

The documentation prepared by BNI provides an adequate radiological and chemical contamination description of the site prior to and following remedial actions. The results of ESSAP's independent measurements and sampling data were within generic and site-specific guidelines and support BNI's post-remedial action survey results. It is therefore ESSAP's opinion that the site conditions satisfy the DOE requirements for release without radiological restrictions.

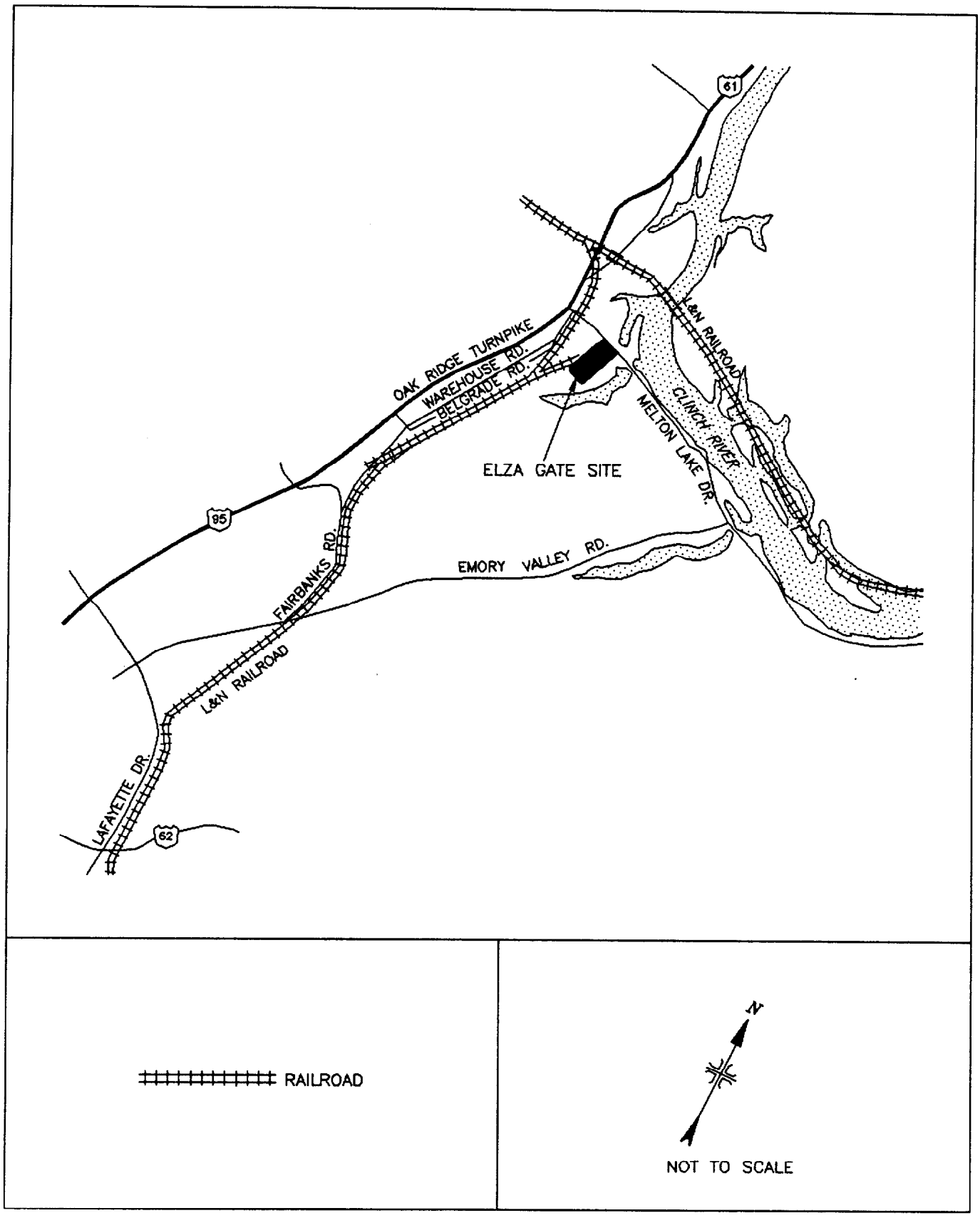

FIGURE 1: Location of the Elza Gate Site – Oak Ridge, Tennessee

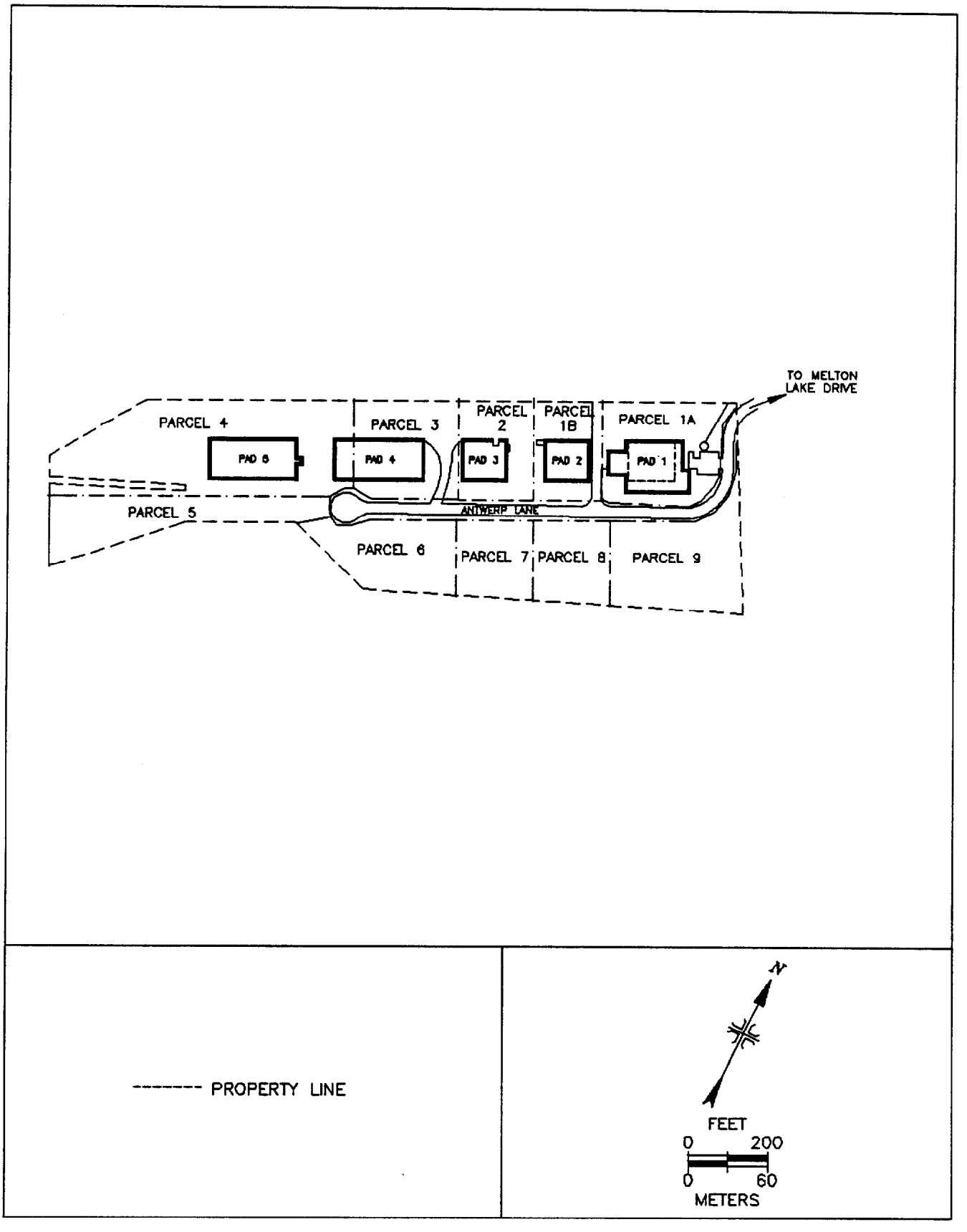

FIGURE 2: Plot Plan of the Elza Gate Site

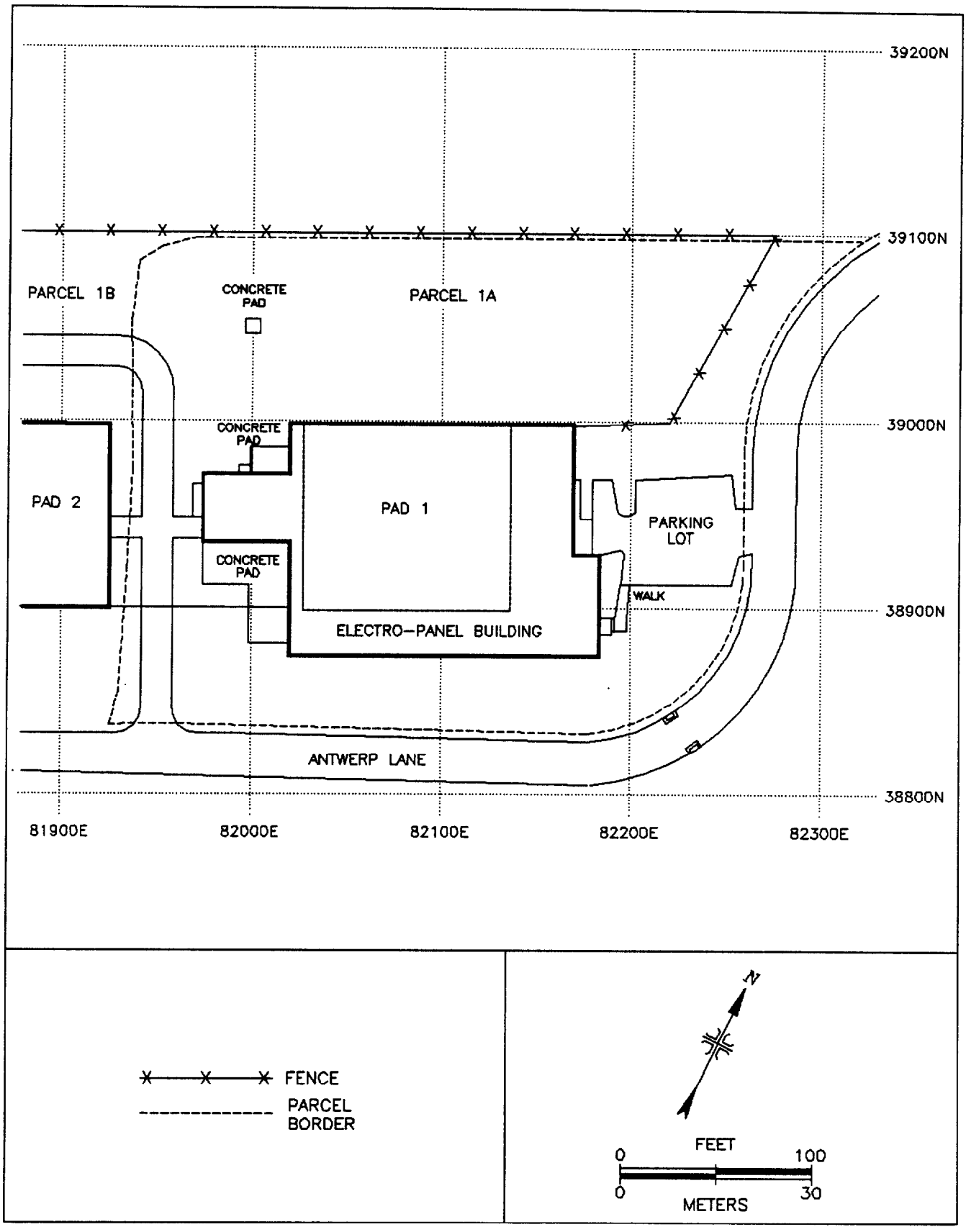

FIGURE 3: Plot Plan of Parcel 1A

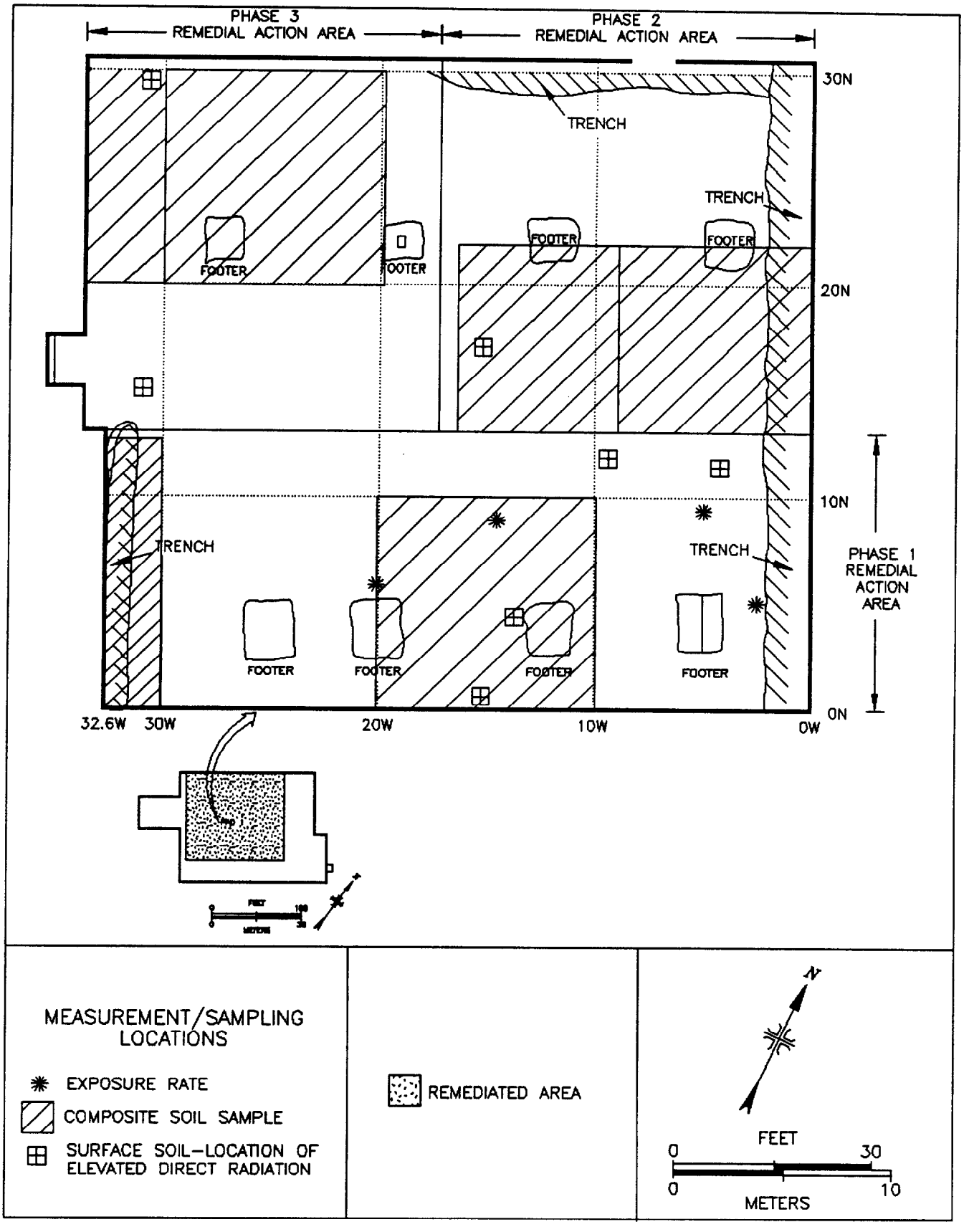

FIGURE 4: Pad 1 – Remediated Areas and Measurement and Sampling Locations

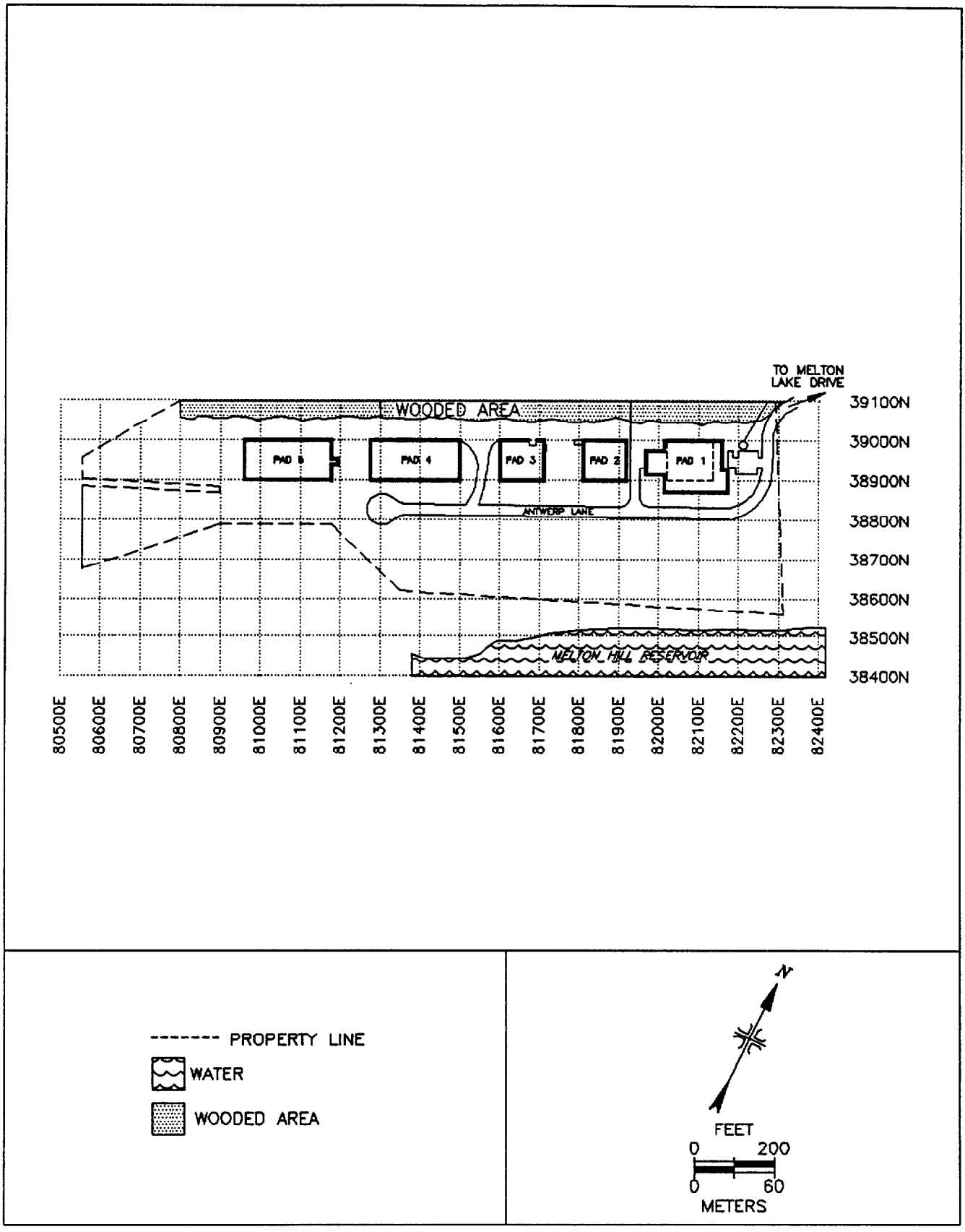

FIGURE 5: Elza Gate Site – Original Site Reference Grid

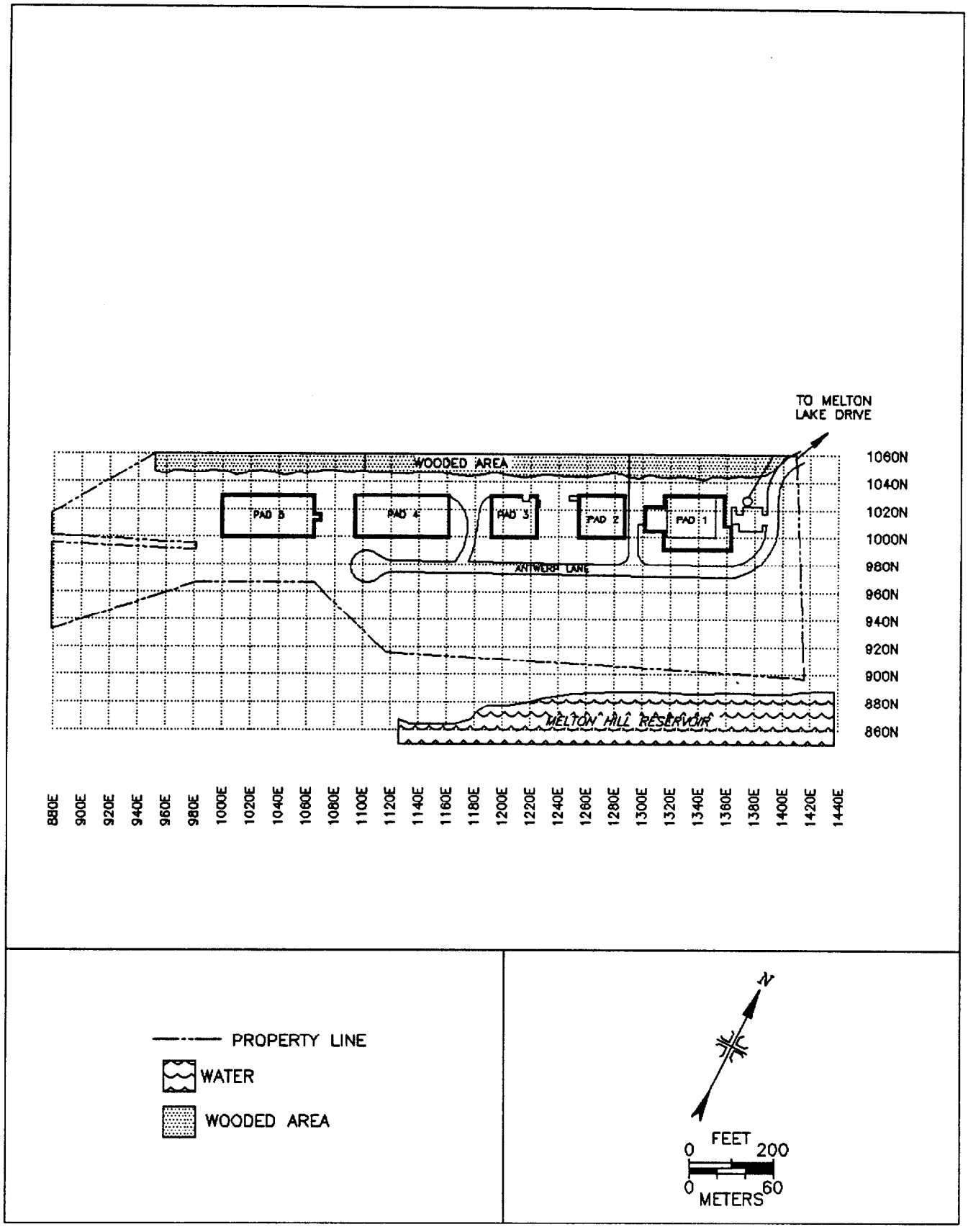

FIGURE 6: Elza Gate Site – Metric Reference Grid

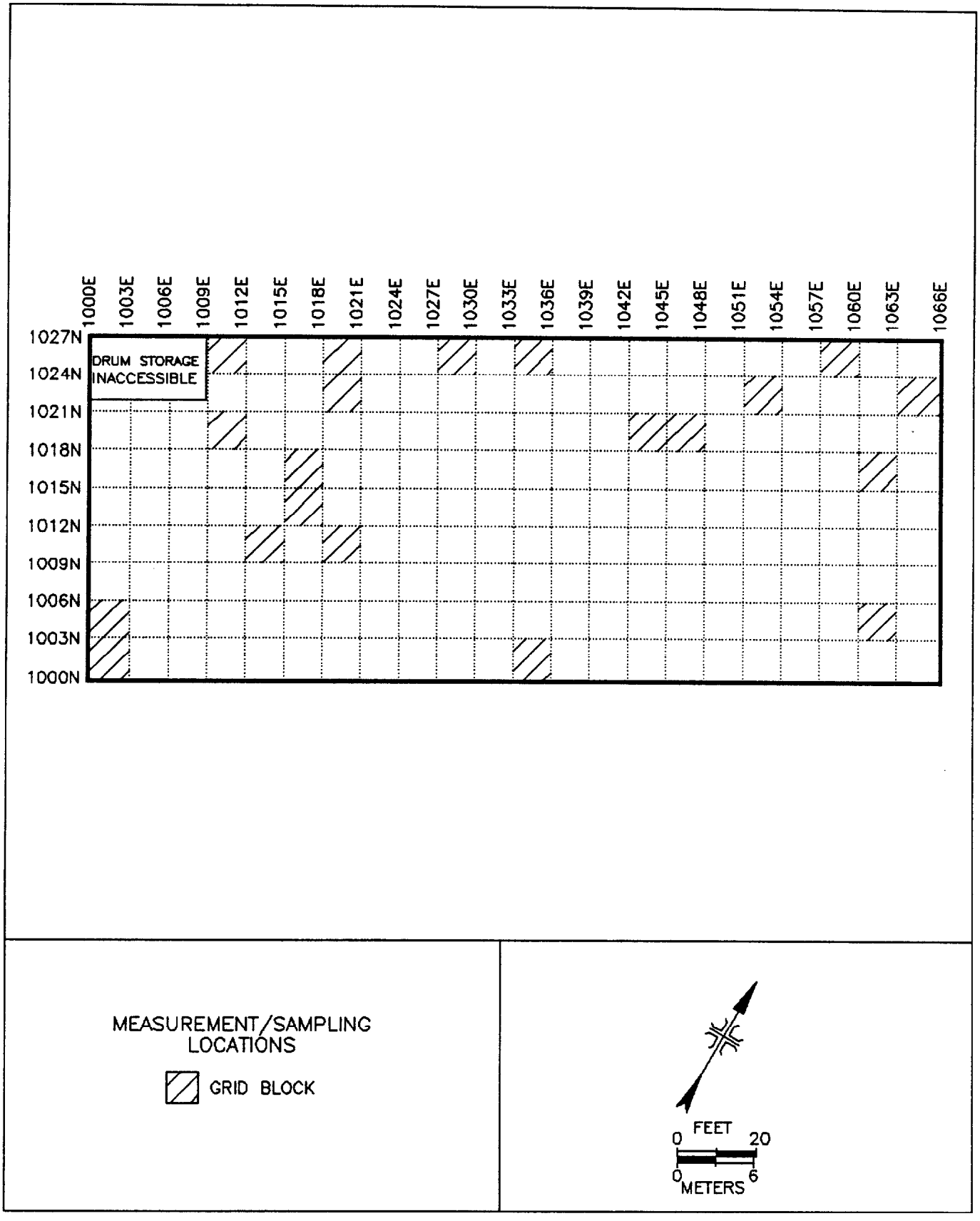

FIGURE 7: Pad 5 – Measurement and Sampling Locations

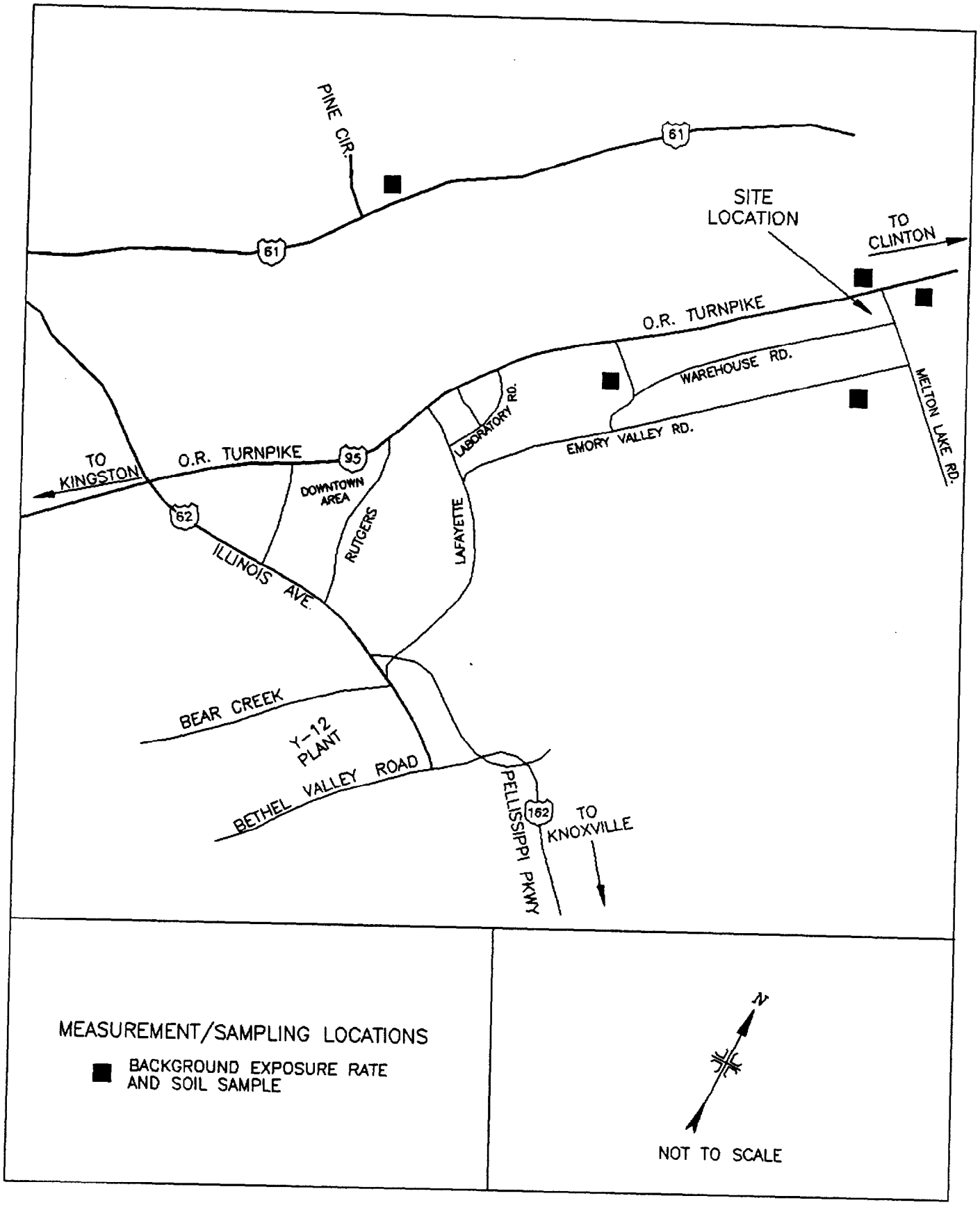

FIGURE 8: Oak Ridge, Tennessee – Background Measurement and Sampling Locations

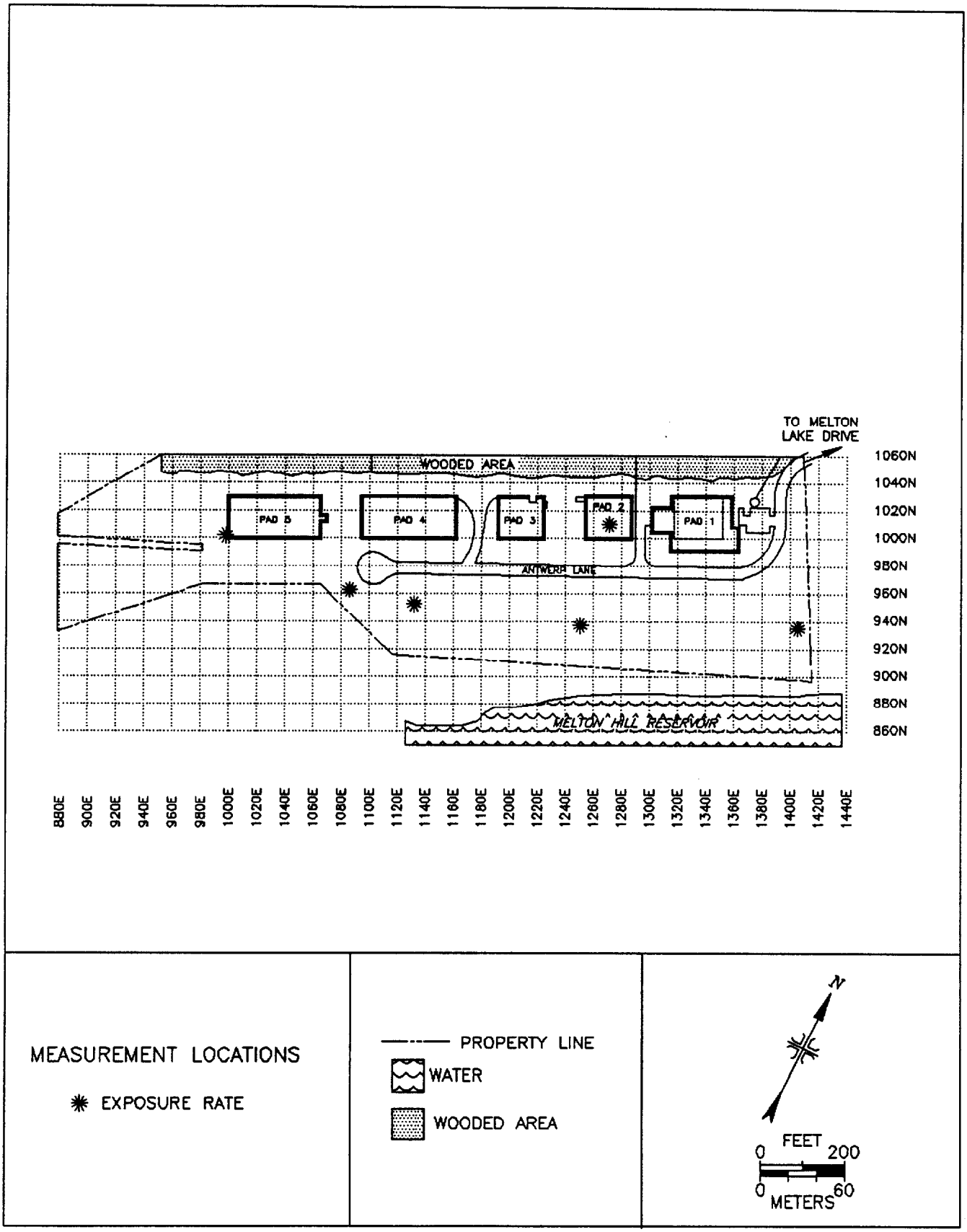

FIGURE 9: Elza Gate Site – Exposure Rate Measurement Locations

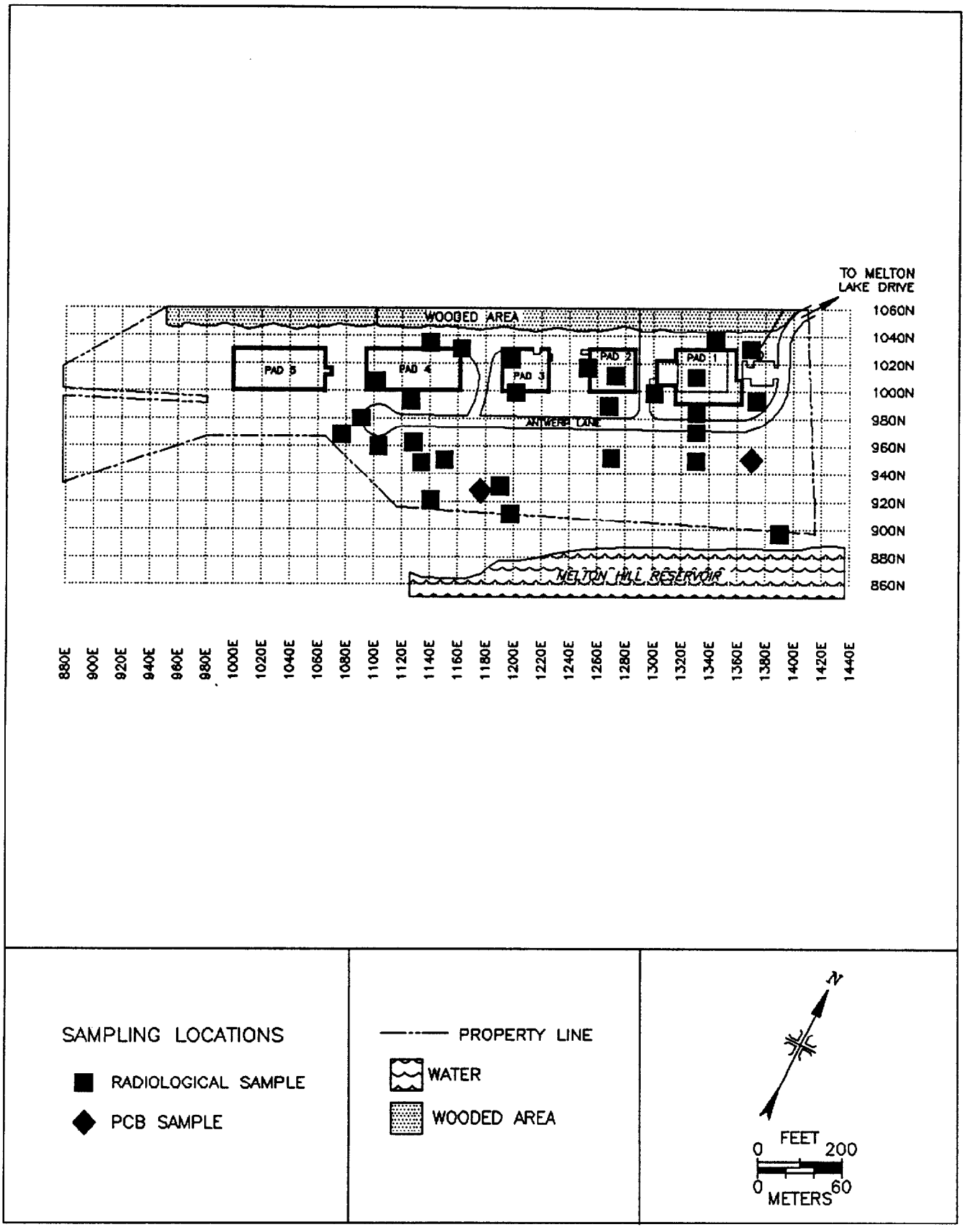

FIGURE 10: Elza Gate Site – Overview of Sampling Locations

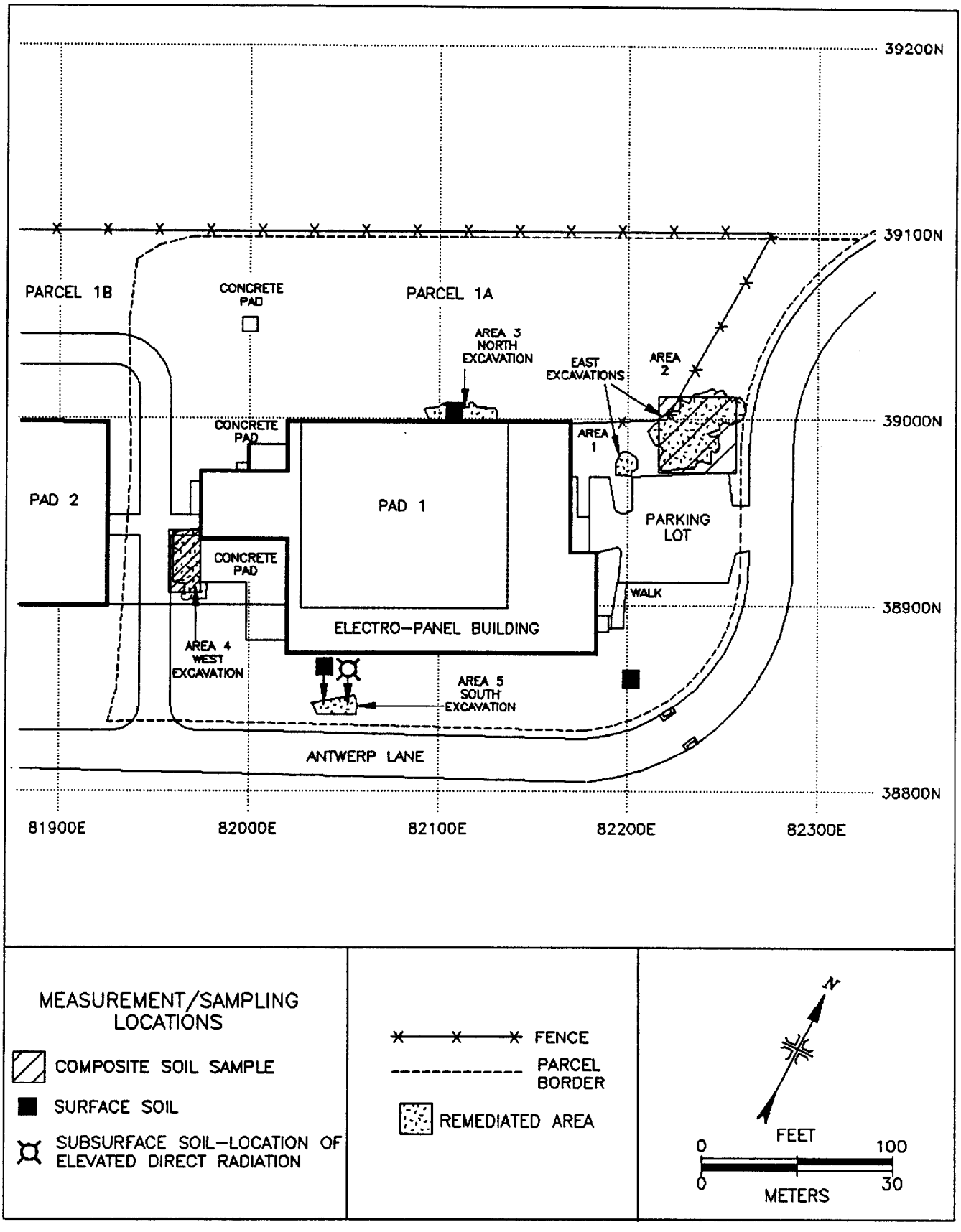

FIGURE 11: Parcel 1A – Remediated Areas and Measurement and Sampling Locations

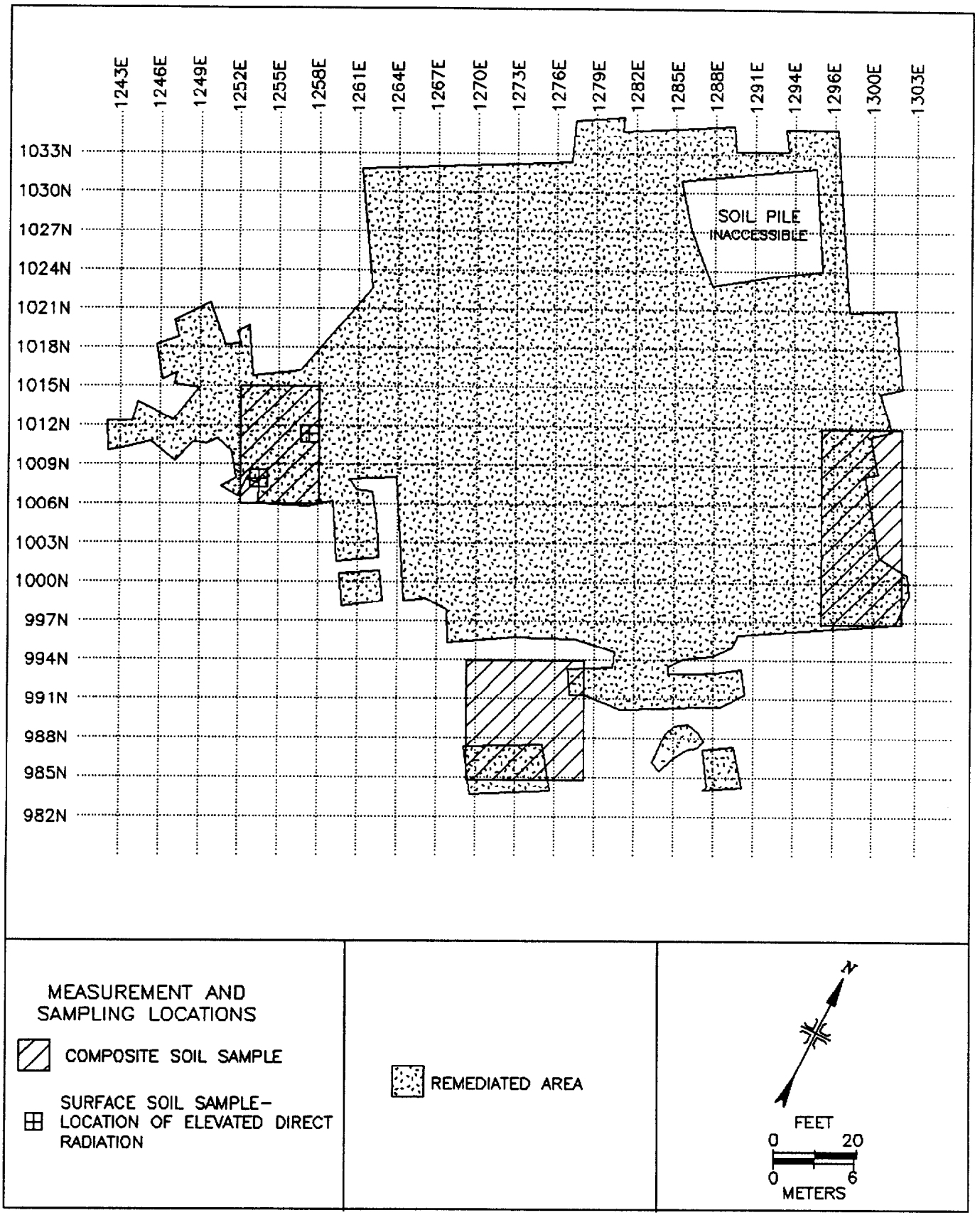

FIGURE 12: Pad 2 – Remediated Areas and Measurement and Sampling Locations

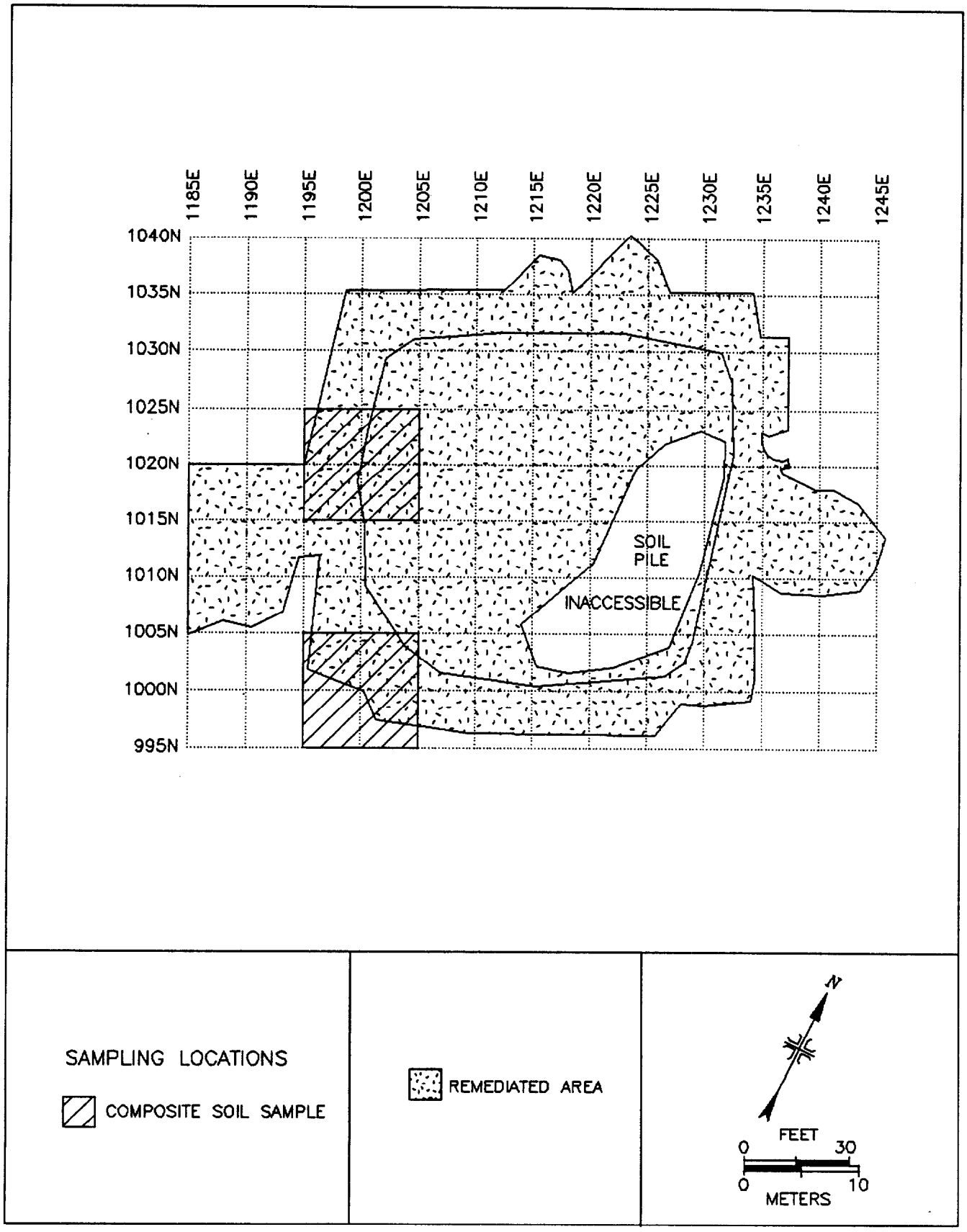

FIGURE 13: Pad 3 – Remediated Areas and Sampling Locations

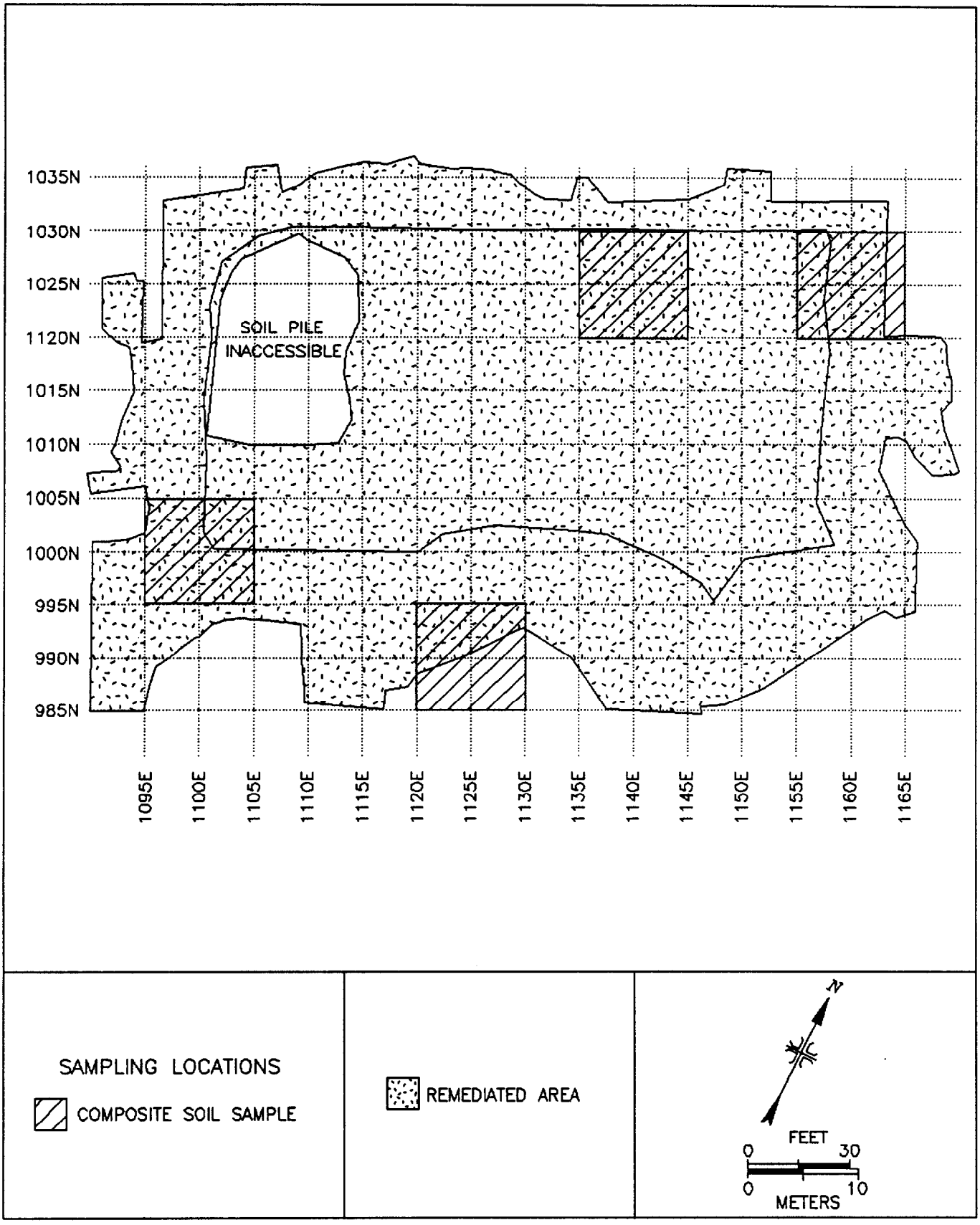

FIGURE 14: Elza Gate Pad 4 – Remediated Areas and Sampling Locations

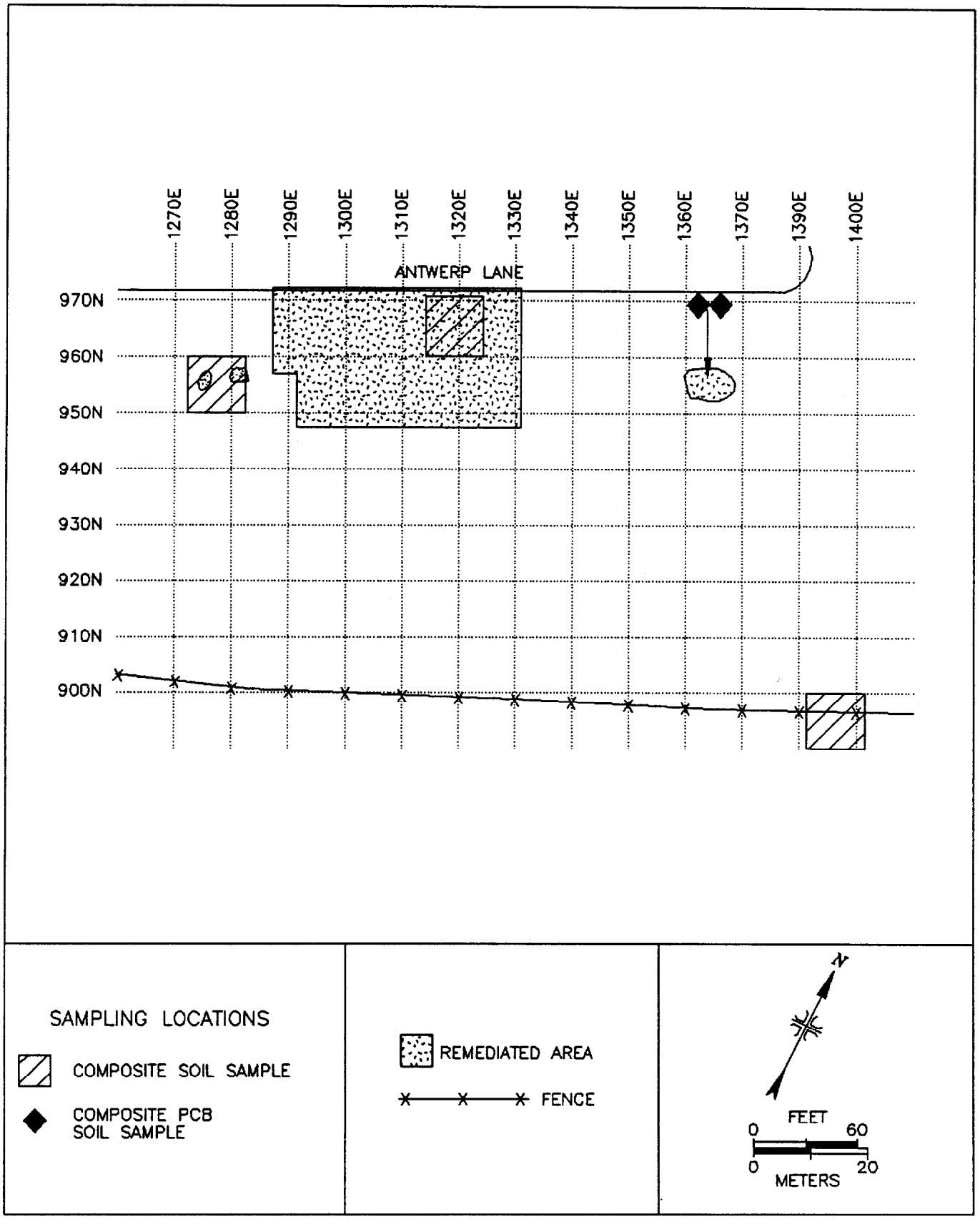

FIGURE 15: Southeast Property – Remediated Areas and Sampling Locations

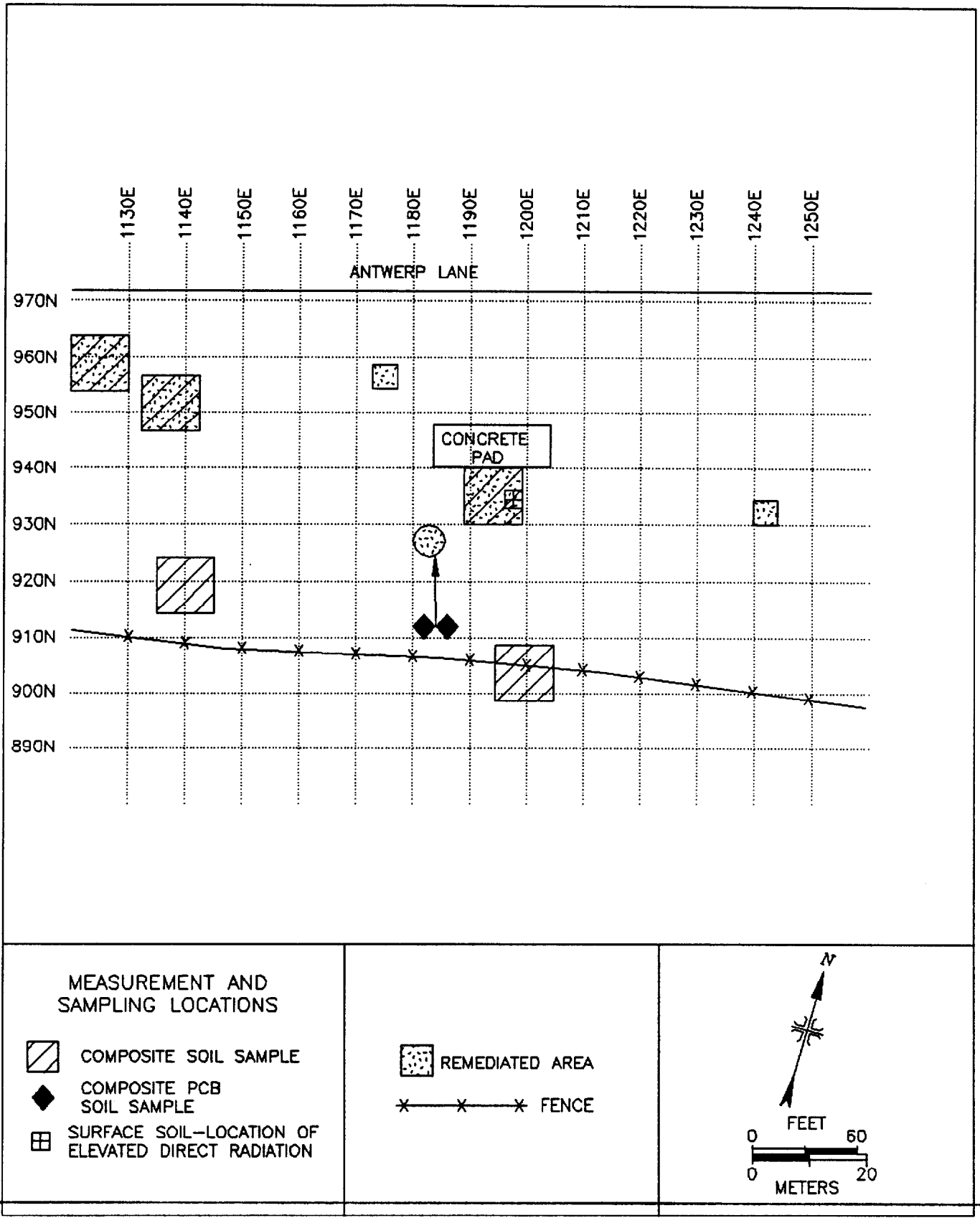

FIGURE 16: Southeast Property — Remediated Areas and Measurement and Sampling Locations

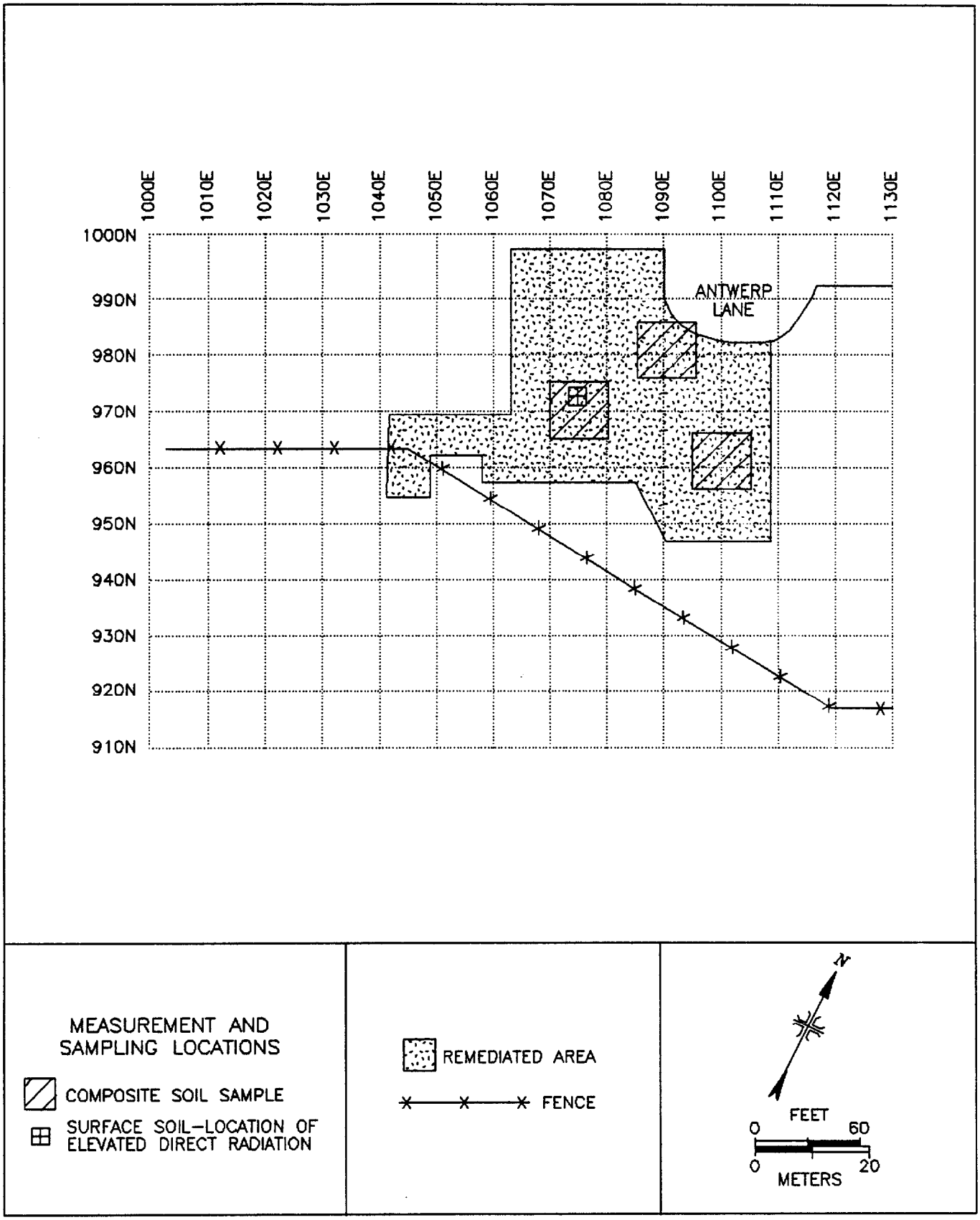

FIGURE 17: Southwest Property – Remediated Areas and Measurement and Sampling Location

TABLE 1

EXPOSURE RATES
ELZA GATE SITE
OAK RIDGE, TENNESSEE

Location[a]	Exposure Rate (μR/h) at 1 m above surface
Interior	
5N, 2W	8
9N, 5W	8
12.5N, 14W	10
6N, 20W	8
Exterior	
930N, 1410E	9
940N, 1255E	10
950N, 1135E	10
960N, 1090E	9
985N, 1331E	8
1000N, 1000E	8
1000.7N, 1303.5E	6
1000.7N, 1380E	8
1015N, 1276E	11
1043N, 1349.3E	7

[a]Refer to Figures 4 and 9.

TABLE 2

RADIONUCLIDE CONCENTRATIONS IN SOIL BENEATH PAD 1
ELZA GATE SITE
OAK RIDGE, TENNESSEE

Grid Block Location[a]	Radionuclide Concentrations (pCi/g)			
	U-238	Ra-226	Th-230	Th-232
0N, 32.6W	2.4 ± 1.7[b]	0.6 ± 0.2	0.9 ± 0.2	1.2 ± 0.4
0N, 20W	5.1 ± 1.8	0.6 ± 0.2	1.2 ± 0.2	0.9 ± 0.4
13N, 10W	5.2 ± 1.3	1.0 ± 0.2	1.2 ± 0.2	1.5 ± 0.4
13N, 17W	5.6 ± 1.2	0.9 ± 0.2	1.6 ± 0.2	1.1 ± 2.0
20N, 30W	3.6 ± 1.4	1.0 ± 0.3	---[c]	1.6 ± 0.5
20N, 33W	1.2 ± 1.2	0.7 ± 0.2	---	1.3 ± 0.4

[a]Refer to Figure 4.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]--No analysis performed.

TABLE 3

RADIONUCLIDE CONCENTRATIONS IN SOIL FROM LOCATIONS OF ELEVATED DIRECT RADIATION BENEATH PAD 1 ELZA GATE SITE OAK RIDGE, TENNESSEE

Grid Block Location[a]	Radionuclide Concentrations (pCi/g)			
	U-238	Ra-226	Th-230	Th-232
11N, 4W	6.7 ± 1.9[b]	1.6 ± 0.3	1.7 ± 0.2	1.4 ± 0.4
12N, 9.5W	13.8 ± 1.0	1.6 ± 0.3	2.5 ± 0.3	1.6 ± 0.5
4.5N, 13W Pre-Remediation	77.0 ± 5.0	1.0 ± 0.3	---[c]	1.3 ± 0.5
4.5N, 13W Post-Remediation	7.6 ± 2.9	1.1 ± 0.6	---	1.8 ± 1.0
3N, 15W	7.8 ± 1.6	4.1 ± 0.4	1.1 ± 0.1	1.2 ± 0.5
17N, 15W	17.7 ± 2.4	1.1 ± 0.2	---	1.6 ± 0.4
30.4N, 31W	2.7 ± 1.2	1.3 ± 0.1	---	1.5 ± 0.4
15N, 4.4W	3.4 ± 0.4	3.4 ± 0.4	---	0.8 ± 0.4

[a]Refer to Figure 4.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]--No analysis performed.

TABLE 4

BACKGROUND EXPOSURE RATES AND RADIONUCLIDE CONCENTRATIONS IN SOIL ELZA GATE SITE OAK RIDGE, TENNESSEE

Measurement Location[a]	Exposure Rate (μR/h) at 1 m above surface	Radionuclide Concentrations (pCi/g)		
		U-238	Ra-226	Th-232
1-Highway 61, 1/4 east of Pine Rd.	10	2.2 ± 1.5[b]	0.7 ± 0.2	1.0 ± 0.4
2-Warehouse Rd. at JJHS	11	3.7 ± 1.6	1.3 ± 0.3	1.2 ± 0.4
3-Highway 95 at Melton Lake Dr.	9	2.2 ± 1.5	0.5 ± 0.2	0.7 ± 0.3
4-Highway 95 1 mi E of Melton Lake Dr.	9	2.2 ± 1.5	0.9 ± 0.3	0.8 ± 0.3
5-Emory Valley Rd.	12	3.2 ± 2.2	1.0 ± 0.3	1.3 ± 0.5

[a]Refer to Figure 8.

[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SOIL
ELZA GATE SITE
OAK RIDGE, TENNESSEE

LOCATION[a]	RADIONUCLIDE CONCENTRATIONS (pCi/g)			
	U-238	Ra-226	Th-230	Th-232
Parcel 1A 39,002N, 81,960E	3.0 ± 1.7[b]	0.9 ± 0.3	---[c]	1.3 ± 0.4
38,897N, 82,217E	3.5 ± 1.6	1.0 ± 0.3	---	1.0 ± 0.4
38,996N, 82,004E	<1.7	0.7 ± 0.1	---	1.7 ± 0.4
PAD 2 1006N, 1252E	4.4 ± 1.4	1.2 ± 0.3	---	1.0 ± 0.4
985N, 1195E	1.8 ± 1.1	0.8 ± 0.2	---	0.8 ± 0.3
997N, 1294E	2.8 ± 0.7	0.8 ± 0.2	---	0.9 ± 0.2
PAD 3 995N, 1195E	15.7 ± 1.2	0.9 ± 0.2	0.6 ± 0.2	0.9 ± 0.3
1015N, 1195E	3.9 ± 1.9	0.6 ± 0.2	---	1.4 ± 0.4
PAD 4 990N, 1120E	3.0 ± 1.0	0.9 ± 0.2	1.4 ± 0.2	1.7 ± 0.4
1000N, 1095E	2.7 ± 1.1	1.0 ± 0.3	---	1.4 ± 0.4
1020N, 1135E	2.4 ± 1.6	0.9 ± 0.2	1.3 ± 0.2	1.4 ± 0.4
1020N, 1155E	2.9 ± 1.4	1.0 ± 0.2	---	1.1 ± 3.2
South Property 890N, 1392E	2.1 ± 1.0	1.0 ± 0.2	---	0.8 ± 0.4
908N, 1198E	4.4 ± 0.9	1.1 ± 0.2	1.3 ± 0.2	1.2 ± 0.4
915N, 1135E	2.6 ± 1.5	0.7 ± 0.2	---	1.0 ± 0.4
930N, 1190E	11.3 ± 1.2	1.0 ± 0.2	1.4 ± 0.2	1.2 ± 0.4
950N, 1130E	4.1 ± 0.9	0.6 ± 0.2	---	0.8 ± 0.4
950N, 1150E	2.9 ± 1.2	0.7 ± 0.2	---	1.0 ± 0.3
950N, 1272E	10.7 ± 0.8	1.0 ± 0.2	---	0.7 ± 0.3
955N, 1095E	3.4 ± 1.3	0.6 ± 0.2	---	1.1 ± 0.3

TABLE 5 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL
ELZA GATE SITE
OAK RIDGE, TENNESSEE

LOCATION	RADIONUCLIDE CONCENTRATIONS (pCi/g)			
	U-238	Ra-226	Th-230	Th-232
South (Cont.)				
955N, 1095E	3.5 ± 1.3	0.8 ± 0.2	---	0.8 ± 0.3
955N, 1120E	16.7 ± 2.5	0.5 ± 0.2	---	0.8 ± 0.3
960N, 1315E	2.5 ± 1.4	0.9 ± 0.2	1.4 ± 0.2	1.3 ± 0.4
965N, 1070E	8.6 ± 1.1	0.9 ± 0.2	---	0.8 ± 1.1
975N, 1085E	4.6 ± 1.1	1.0 ± 0.2	---	1.0 ± 0.3

[a]Refer to Figures 10 through 17.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]---No analysis performed.

TABLE 6

RADIONUCLIDE CONCENTRATIONS IN SOIL FROM LOCATIONS OF ELEVATED DIRECT RADIATION ELZA GATE SITE OAK RIDGE, TENNESSEE

LOCATION[a]	RADIONUCLIDE CONCENTRATIONS (pCi/g)			
	U-238	Ra-226	Th-230	Th-232
38848N, 82041E	2.4 ± 1.7[b]	1.0 ± 0.2	---[c]	0.4 ± 0.3
38848N, 82041E[d] Pre-Remediation	22.1 ± 3.8	15.8 ± 0.8	---	0.5 ± 0.8
38848N, 82040E Pre-Remediation	19.2 ± 2.8	26.9 ± 0.3	---	<0.1
38851N, 82053E Post-Remediation	1.7 ± 0.8	1.2 ± 0.3	---	0.6 ± 0.3
38861N, 82200E	1.6 ± 0.8	1.2 ± 0.2	---	0.6 ± 0.3
965N, 1077E	4.3 ± 1.8	0.9 ± 0.2	---	0.9 ± 0.3
934N, 1198E	13.5 ± 3.3	1.0 ± 0.3	---	1.7 ± 0.4
1007.5N, 1253E	8.8 ± 1.4	3.3 ± 0.4	---	1.2 ± 0.4
1011.5N, 1258E	<2.0	1.0 ± 0.3	---	1.5 ± 0.5

[a]Refer to Figures 11, 12, 16, and 17.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]---No analysis performed.
[d]Depth 15-30 cm.

REFERENCES

1. Oak Ridge National Laboratory, "Preliminary Site Survey Report for the Former Elza Gate Warehouse Area," Oak Ridge, Tennessee, September 1989.

2. Bechtel National, Inc. "Characterization Report for the Elza Gate Site, Oak Ridge, Tennessee," April 1991.

3. Bechtel National, Inc. " Draft Post-Remedial Action Report for the Elza Gate Site, Oak Ridge, Tennessee," July 1992.

4. U.S. Department of Energy, Order 5400.5, "Radiation Protection of the Public and the Environment," February 1990.

5. U.S. Department of Energy, Letter from J.W. Wagoner II (Headquarters) to L.K. Price (Oak Ridge Field Operations Office), "Uranium Cleanup Guidelines for the Elza Gate, Tennessee, FUSRAP Site," February 6, 1991.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

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

DIRECT RADIATION MEASUREMENT INSTRUMENTATION

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

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

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Detectors

Bicron NaI Scintillation Detector
Model G5 "Fidler"
(Bicron, Corporation, Newburg, OH)

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 59 cm^2
(Eberline, Santa Fe, NM)

Ludlum Gas Proportional Detector
Model 43-37
Effective Area, 550 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

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

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

Alpha Spectrometry System
Tennelec Electronics Model
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Surface Barrier Detectors
(EG&G ORTEC, Oak Ridge, TN) and
Multichannel Analyzer

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Coaxial Well Detector
Model GWL-110210-PWS-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Applied Physical Technology, Atlanta, GA) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Intrinsic Germanium Detector
Model IGC25, 25% Eff.
(Princeton Gamma-Tech, Princeton, NJ)
Used in conjunction with:
Lead Shield
(Nuclear Data, Schaumburg, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

Low Background Gas Proportional Counter
Model LB-5110
(Tennelec, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans 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. A large surface area, gas proportional floor monitor was used to scan the concrete pad. Other surfaces were scanned using small area (15.5 cm^2 or 59 cm^2) hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Alpha	-	ZnS scintillation detector with ratemeter-scaler
Alpha-Beta	-	gas proportional detector with ratemeter-scaler
Beta	-	GM detector with ratemeter-scaler
Gamma	-	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were performed using ZnS alpha scintillation and GM detectors with portable ratemeter-scalers. Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. The alpha activity background countrates for the ZnS scintillation detectors averaged approximately 1 cpm. Alpha efficiency factors ranged from 0.17 to 0.19 for the ZnS scintillation detectors. The beta activity background count rates for the GM detectors averaged approximately 52 cpm.

Efficiency factors ranged from 0.23 to 0.26 for the GM detectors. The effective window areas for the ZnS scintillation and GM detectors were 59 cm^2 and 15.5 cm^2, respectively.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber (PIC).

Soil Sampling

Approximately 1 kg of soil was collected at each radiological sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures. Composite soil samples were collected from the PCB sample locations in accordance with the "Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup", EPA, May 1986.

ANALYTICAL PROCEDURES

Radiological Analyses

Removable Activity

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity.

Gamma Spectrometry

Soil Samples

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry and ranged from 500 to 1000 g of material. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a 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 reviewed for determination of radionuclides of concern were:

Ra-226	0.609 MeV from Bi-214*
Th-232	0.911 MeV from Ac-228*
U-238	0.063 MeV and 0.093 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Alpha Spectrometry

Soil Samples

Soil samples were crushed, homogenized and analyzed for isotopic thorium. Samples were dissolved by potassium fluoride and pyrosulfate fusion and the elements of interest were precipitated with barium sulfate. Barium sulfate precipitate was redissolved and the specific elements of interest were individually separated by liquid-liquid extraction and re-precipitated with a cerium fluoride carrier. The precipitate was then counted using surface barrier and ion implanted detectors, alpha spectrometers and a multichannel analyzer.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties 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 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedures. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents:

-Survey Procedures Manual Revision 6 (February 1991)
-Laboratory Procedures Manual Revision 5 (February 1990) and Revision 6 (April 1991)
-Quality Assurance Manual Revision 3 (February 1990) and Revision 4 (April 1991)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6B for Quality Assurance and contain measures to assess processes during their performance.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization was used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.

- Participation in EPA and EML laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.

- Periodic internal and external audits.

POLYCHLORINATED BIPHENYL ANALYSIS

Soil Samples

Soil samples were analyzed for PCBs under a subcontract agreement with ORISE by International Technology Corporation (IT) Knoxville, Tennessee, according to the following methodology.

The samples were analyzed for Target Compound List (TCL) polychlorinated biphenyls (PCBs) by gas chromatography/electron capture detection (GC/ECD) in accordance with the EPA CLP 2/88 Statement of Work.

The samples were analyzed for pesticides/PCBs using an SP2250/2401 column on a Varian 3740 GC. Confirmation analyses were performed using an SPB5 column on a Varian 3700 GC. Matrix spike/matrix spike duplicate analyses were performed using sample EGSPCB001A with acceptable results. The samples and associated method blanks were treated to remove sulfur interferences.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

Elza Gate - December 4, 1992

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5[1]

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonable achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

Indoor/Outdoor Structure Surface Contamination

Radionuclides[a]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[b] Average[c,d]	Maximum[d,e]	Removable[f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129 [g]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above [h]	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SOIL GUIDELINES

Radionuclides	Soil Concentration (pCi/g) Above Background[i,j,k]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Uranium	Soil guidelines are calculated on a site-specific basis, using the DOE manual developed for this use.

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

[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 measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

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

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

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

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques

to measure removable contamination levels, if direct scan surveys indicate that total residual surface contamination levels are within the limits for removable contamination.

[g] Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[h] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90, which has been separated from the other fission products, or mixtures where the Sr-90 has been enriched.

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

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

[k] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{1/2}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901.[2] In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

REFERENCES

1. "Radiation Protection of the Public and the Environment", DOE Order 5400.5, U.S. Department of Energy, February 8, 1990.

2. Argonne National Laboratory, "A Manual for Implementing Residual Radioactive Material Guidelines", DOE/CH/8901, June 1989.