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ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

May 29, 1996

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SUBJECT: DRAFT REPORT—VERIFICATION SURVEY OF THE FORMER BAKER BROTHERS, INC. SITE, TOLEDO, OHIO

Dear Dr. Williams:

Enclosed for your review and comment is the draft report discussing the verification activities that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed for the subject facility. Comments you may have will be incorporated into the final report.

Please contact me at (423) 576-5073 or William L. (Jack) Beck at (423) 576-5031 should you have any questions or require additional information.

Sincerely,

Timothy J. Vitkus
Survey Projects Manager
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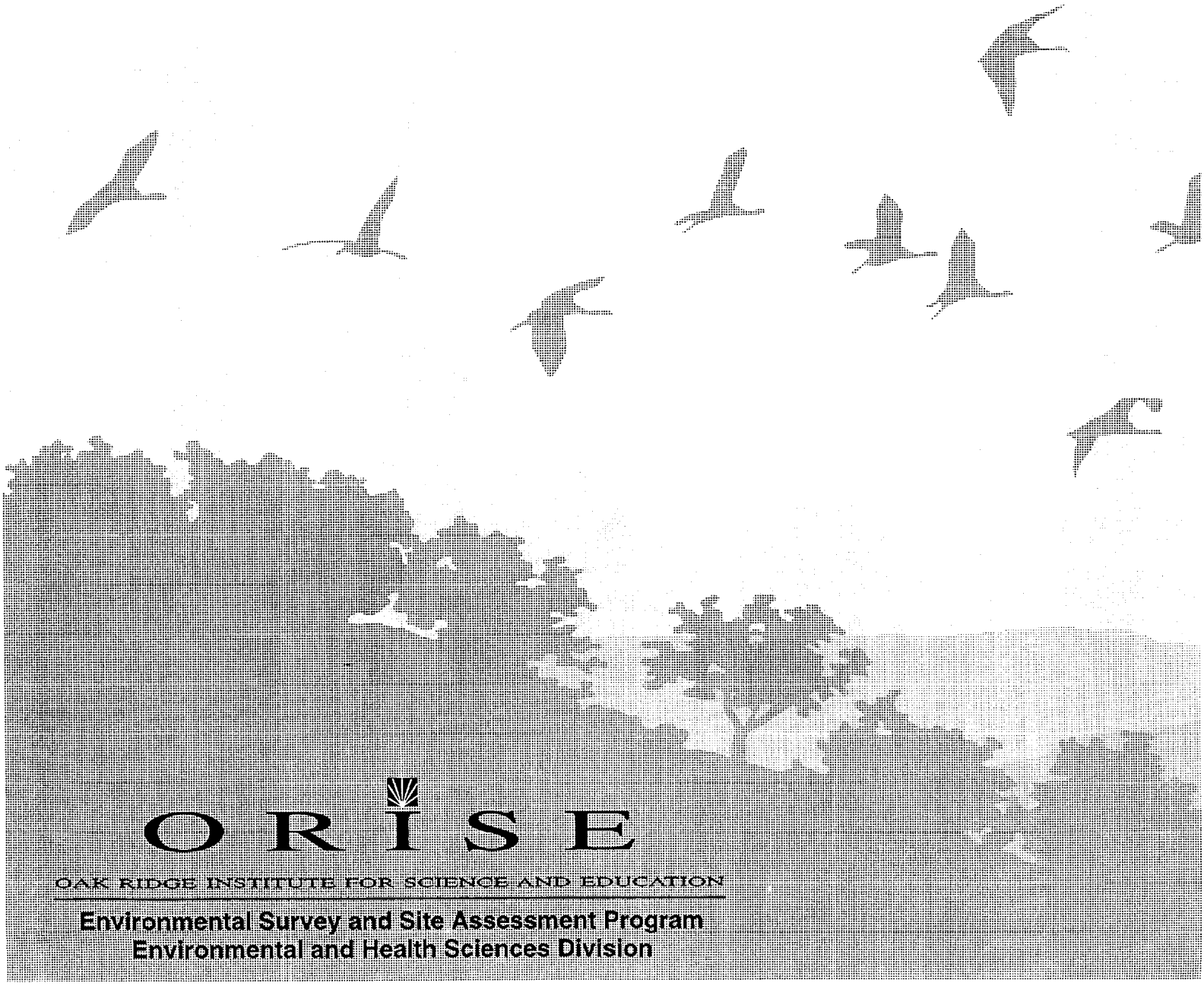
DRAFT REPORT

VERIFICATION SURVEY OF THE FORMER BAKER BROTHERS, INC. SITE TOLEDO, OHIO

J.R. MORTON and T. J. VITKUS

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
Environmental and Health Sciences Division

VERIFICATION SURVEY
OF THE
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Prepared by

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Prepared for

Office of Environmental Restoration
U.S. Department of Energy

DRAFT REPORT

MAY 1996

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ACKNOWLEDGMENTS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

PAGE

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

µR/h	microroentgens per hour
µrem/h	microrem per hour
BNI	Bechtel National, Inc.
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	U.S. Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
FUSRAP	Formerly Utilized Sites Remedial Action Program
GM	Gieger-Mueller
IVC	independent verification contractor
kg	kilogram
km	kilometer
m	meter
m^2	square meter
MDC	minimum detectable concentration
MED	Manhatten Engineer District
NaI	sodium iodide
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
PIC	pressurized ionization chamber
pCi/g	picocuries per gram
PMC	project management contractor
post-RA	post - remedial action
ZnS	zinc sulfide

VERIFICATION SURVEY
OF THE
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

INTRODUCTION AND SITE HISTORY

From mid-1943 to July 1944 Baker Brothers, Inc. of Toledo, Ohio machined natural uranium metal rods into slugs to be used as feed material for both the Clinton Semi-Works and the Hanford Pile under a contract with the Manhattan Engineer District (MED), a predecessor to the U.S. Department of Energy (DOE). The MED contract was temporary and activities were discontinued when the Hanford facilities were installed in 1944. During the contract period, Baker Brothers, Inc. machined 90 to 300 tons of uranium rods.

Uranium machining was performed within the site's North Building in a location referred to as Area 7. Four lathes, housed in the North Building, were used in the machining process. While machining the rods, the lathes produced heavy fumes which later required the installation of an electrostatic precipitator. In addition, the lathes also produced pyrophoric uranium chips that would spontaneously ignite in the lathe pans or storage containers that held the scrap metal and turnings. These storage vessels were kept within the machining or grinding room and other areas of the plant for days or weeks before shipment.

Upon termination of the contract in 1944, the site was decontaminated to the guidelines current at that time. However, no data or information regarding the cleanup activities or final inspection have been located. As a result, preliminary surveys of the North, South, East, and West Buildings were conducted by the DOE and Argonne National Laboratory in April 1981 which revealed contamination above current DOE guidelines. This information led to a more comprehensive investigation of the radiological conditions present on the site by the Oak Ridge National Laboratory (ORNL) in 1989 and 1990. ORNL's radiological survey and sampling efforts addressed both indoor and outdoor areas. The results indicated that several interior and exterior areas of the site were contaminated with levels of U-238 exceeding guidelines (ORNL 1992). Therefore, the Former Baker Brothers, Inc. site was designated into the Formerly Utilized Sites Remedial Action Program

(FUSRAP). FUSRAP was created in 1974 to identify, investigate, and cleanup or control sites where contamination above current guidelines remains from the early years of the Nation's atomic energy program. Bechtel National, Inc. (BNI), the project management contractor for FUSRAP, completed site characterizations in 1995 (BNI 1995). The characterization identified areas of contamination above guidelines on interior surfaces of two buildings, subfloor soils of one building, the roof of one building, and four outdoor soil areas. In order to authorize the site for use without restrictions due to residual radioactive material, BNI planned to remediate the contaminated surfaces and soils. It is the policy of the DOE to perform independent verification of remedial actions conducted under FUSRAP. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has been designated as the independent verification contractor (IVC) for the Former Baker Brothers, Inc. site.

SITE DESCRIPTION

Located at the intersection of Harleau Place and Post Street in a developed section of Toledo, Ohio, the Former Baker Brothers site contains approximately 8 hectares (19 acres) (Figures 1 and 2). Commercial and residential properties lie to the north, south, and east boundaries of the site. The western edge of the property is bordered by railroad tracks. There is a fence along the southern boundary and a portion of the eastern property line. The exterior surfaces are asphalt and concrete with the exception of the courtyard area, where the soil has been previously excavated and backfilled with gravel. Figure 2 shows the site plot plan. Presently four buildings are located on the site. Three of the four buildings are owned by Romanoff Industries and are leased to either the Doug Beat Company or REMS, Inc. The fourth building is owned by John Rehkopt, but is also leased to the Doug Beat Company. Both tenants have offices, electric motor shops, and storage areas within the buildings and site grounds.

The South Building, located at 1000 Post Street, has a floor space of approximately 4,180 m^2; the North Building has 3,720 m^2 of floor space and is located at 2555 Harleau Place; the 740 m^2 East Building is located at 2551 Harleau Street; and the West Building, formerly called the Powerhouse or Boilerhouse, has 930 m^2 of floor space. The buildings are constructed of brick with saw-tooth

roof design and concrete floors. However, the South Building has since been externally covered with aluminum siding and wooden floors have been installed in areas 3A, 4, and 5. Areas 3 and 6 in the South Building have been remodeled due to a fire that occurred after Baker Brothers' ownership.

The primary areas of building surface or subfloor soil contamination were identified in the North Building; specifically, Areas 7, 7A (Grinding Room), 8E, 8W, and the West Corridor. A number of isolated locations of surface contamination were also found in the South Building. BNI remediated these locations during characterization activities. Exterior areas of soil contamination included two small areas (referred to as Excavations A and B) at the southeast boundary of the site adjacent to Post Street, a third location near the southeast corner of the North Building (Excavation C), and the East and West Courtyards. Figure 2 shows the location of each of these areas.

PROJECT ORGANIZATION AND RESPONSIBILITY

DOE Headquarters provides overview and coordination for all FUSRAP activities. The DOE Oak Ridge Operations (DOE-ORO) is responsible for implementation of FUSRAP and the Former Sites Restoration Division (FSRD) of DOE-ORO manages the daily activities.

Under the standard FUSRAP protocol, an initial investigation/survey of a potential site is performed by ORISE or 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 (PMC) 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. This verification process provides independent (third party) data to assist DOE in evaluating the accuracy of the post-remedial action status of the site, as presented by the PMC, and in assuring that the documentation accurately and adequately describes the condition of the site. DOE Headquarters uses the information developed by the remediation and verification activities to certify that a site can be released for use, without radiological restrictions.

OBJECTIVES

The objectives of the verification process were to ensure that the post-remedial action (post-RA) survey, sample analyses, and supporting documentation provided by BNI gave an accurate and complete description of the radiological condition of the former Baker Brothers, Inc. site and confirmed that all applicable DOE guidelines had been met for release of the site for use without radiological restrictions.

DOCUMENT REVIEW

ESSAP reviewed BNI's post-RA survey plan, post-RA survey results, and other supporting documentation concerning site remediation activities and the draft post-remedial action report (BNI 1995, 1996). Information was evaluated to assure that areas identified as exceeding guidelines had undergone decontamination and that residual activity levels satisfied the established guidelines.

PROCEDURES

A survey team from ESSAP visited the former Baker Brothers, Inc. site on five occasions during the period of July 18 through September 19, 1995 to perform visual inspections and independent measurements and sampling. Survey activities were conducted in accordance with a plan dated August 7, 1995 submitted to and approved by the DOE (ORISE 1995). This report summarizes the procedures and results of these surveys.

SURVEY PROCEDURES: INTERIOR

The following procedures were used for the surveys of building interior surfaces and subfloor excavations.

Reference Grid

Interior measurements and sampling locations were referenced to a 1 m x 1 m reference grid system established by BNI, when it was available. Measurement and sampling locations on any ungridded surfaces were referenced to prominent building features.

Surface Scans

Surface scans for beta and gamma activity were performed over 100 percent of the remediated floor and lower walls, and 25 to 50 percent of remediated overhead surfaces. Remaining portions of the affected areas (i.e., Areas 7, 7A, 8E, 8W, and the West Corridor) were scanned at a frequency of 75 to 100 percent for floors and lower walls and one to five percent for upper surfaces. Interior surfaces were scanned using NaI scintillation, GM, and gas proportional detectors. All detectors were coupled to ratemeters or ratemeter-scalers with audible indicators. Particular attention was given to cracks and joints in the floor and walls, ledges, ducts, drains, and other locations where radioactive material may have accumulated. Locations of elevated direct radiation were marked for further investigation.

Surface Activity Measurements

Background measurements of surface activity on wood, poured concrete, concrete blocks, and bricks were performed at building locations that did not have a history of radioactive materials use.

Direct measurements for total beta activity were performed at 43 locations in the South Building and 190 locations in the North Building (Figures 3 through 13). In addition, measurements were performed within three grid blocks in the North Building at the center and four points equidistant from the center and grid block corners to determine the 1 m^2 average activity levels. Direct measurements were performed using gas proportional detectors connected to ratemeter-scalers. Smear samples for determining removable activity levels were collected from each single-point location and one from the location of maximum direct radiation in each of the three grid blocks.

Exposure Rate Measurements

Background exposure rates were performed at six locations without a history of radioactive materials use in the South Building (Figure 14).

A total of 25 exposure rate measurements were made at various locations throughout the facility (Figures 3 through 13). Measurements were taken at a distance of 1 m above the surface using a pressurized ionization chamber (PIC) or micro-rem meter.

Subfloor Soil Sampling

Subfloor soil samples were collected from three locations in Area 7A, two locations in Area 8W, and one location in the West Corridor (Figures 10, 12, and 13).

SURVEY PROCEDURES: EXTERIOR

The following procedures were used for surveys of Excavations A, B, and C; the courtyard; conrail area; and the cistern area.

Reference Grid

Measurement and sampling locations were referenced to either the existing grid established by BNI or to prominent site features.

Surface Scans

Surface scans for gamma activity were performed over 100 percent of remediated soil areas. In addition to gamma scans, exterior North Building surfaces, paved areas adjacent to the North Building, and the walls surrounding the courtyard and cistern area were scanned for beta activity. Scan coverage was varied, dependent upon proximity to previously contaminated areas and findings

as the survey progressed. The minimum coverage was 50 percent of the selected exterior building surfaces and 50 percent of exterior paved areas. Scans were performed using NaI scintillation and gas proportional detectors coupled to ratemeters and ratemeter-scalers with audible indicators. Locations of elevated radiation, suggesting the presence of residual surface or soil contamination, were marked and identified for further investigation.

Surface Activity Measurements

Direct measurements for total beta surface activity were made at 51 exterior locations including the courtyard and cistern area walls, paved areas of the courtyard, and the area adjacent to the removed wall of Area 7 (Figures 15 through 17) . Measurements were performed using gas proportional detectors coupled to ratemeter-scalers. Smear samples for the determination of removable activity were collected at each direct measurement location.

Exposure Rate Measurements

Background exposure rate measurements were made at six locations within 0.5 to 5 km of the site (Figure 18). Site exposure rate measurements were made at 27 locations (Figures 14 and 16 through 20). All exposure rates were measured at 1 m above the surface using a PIC or micro-rem meter.

Soil Sampling

Soil samples were collected from the six background exposure rate measurement locations (Figure 18). Soil samples were collected by ESSAP personnel from 48 locations within excavations and adjacent areas. Samples were taken at suspect locations identified during surface scans and at randomly selected locations within remediated areas (Figures 15 and 19 through 23). Samples from excavations were referenced as to their depth at the backfilled/normal grade for averaging purposes.

Four additional soil samples were obtained from BNI for confirmatory analysis.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Soil samples were analyzed by solid state gamma spectroscopy. The radionuclide of interest was natural uranium; however, spectra were reviewed for other identifiable photopeaks. Soil sample results were reported in units of picocuries per gram (pCi/g). Smears were analyzed for gross alpha and gross beta using a low-background gas proportional counter. Direct measurement and smear data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Exposure rates were reported in units of microroentgens per hour (μR/h).

The data were compared to the generic and the site-specific DOE guidelines established for the former Baker Brothers, Inc. site. (DOE 1990, DOE 1995)

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP's review of BNI's project documentation indicated that areas identified as contaminated were remediated or otherwise addressed. The post-remedial action data adequately reflects the radiological status of the property relative to the guidelines for release to unrestricted use. Comments on the documentation were provided to BNI and DOE (ORISE 1996). BNI's resolution of the comments is currently pending.

INTERIOR

Results of the verification surveys of the South and North Buildings' interior areas are provided below.

Surface Scans

Surface scans of the South Building identified elevated activity at two locations—one each on the floor of Areas 2A and Area 3. Scans of all remaining areas of the South Building did not identify any additional locations of elevated direct radiation.

Surface scans of the North Building revealed elevated beta radiation at one location on the lower wall of Area 7A, four locations on the floor and lower walls of the West Corridor, and several isolated locations on the floor and lower walls of 8W. The remaining portions revealed no elevated direct radiation.

Surface Activity Levels

Prior to additional remediation, the surface activity ranges of direct beta radiation in the South Building were less than 250 to 16,000 dpm/100 cm^2. It was determined that two locations of the floor within Area 2A of the South Building exceeded guidelines. The locations were brought to the immediate attention of the BNI site supervisor. BNI remediated both locations and performed post-remedial action surveys. ESSAP then performed surface scans and direct measurements of the suspect areas to confirm that remedial actions had been effective in reducing contamination to acceptable levels. None of the areas identified within the North Building required additional remediation.

Final verification survey surface activity levels are summarized in Table 1. The total activity levels in the South Building ranged from less than 250 to 2,000 dpm/100 cm^2. Locations in the North Building ranged from less than 250 to 12,000 dpm/100 cm^2, with 1 m^2 average activity levels of 630 to 890 dpm/100 cm^2. The 1 m^2 average values were determined for direct measurement locations with a surface activity that exceeded 5000 dpm/100 cm^2, but were less than 15,000 dpm/100 cm^2.

Removable activity levels at all measurement locations were less than the minimum detectable concentrations of 12 and 16 dpm/100 cm^2 for gross alpha and gross beta, respectively.

Exposure Rates

for the interior of the South Building

Background exposure rates ranged from 12 to 15 μR/h, with an average of 13 μR/h (Table 4) . The exposure rates, including background, ranged from 10 to 14 μR/h in the South Building and from 9 to 13 μR/h in the North Building. Site exposure rates are summarized in Table 2.

Radionuclide Concentrations in Subfloor Soils

A summary of the radionuclide concentration in soil samples is provided in Table 3. The sample collected in the West Corridor contained a total uranium concentration of 7.6 pCi/g. The total uranium concentration were 2.6 and 2.8 pCi/g in Area 8W, and ranged from 2.9 to 12.7 pCi/g for Area 7A.

EXTERIOR

The verification survey results for remediated exterior areas are discussed below.

Surface Scans

Gamma surface scans identified one area of elevated direct radiation less than 200 cm^2 in size in the east courtyard soils. Beta scans of the exterior walls revealed several areas of elevated beta surface activity along the North Building walls on the west side of the courtyard area and two locations on the exterior portion of Area 7. One of the Area 7 locations of elevated direct radiation was on the west wall, while the other was within the trench created by the removal of the south wall.

Surface Activity Levels

Prior to additional remediation, the surface activity level ranges of direct beta radiation in the exterior of Area 7 of the North Building were less than 210 to 68,000 dpm/100 cm^2 with removable activity ranges for gross alpha of less than 12 to 155 dpm/100 cm^2 and gross beta of less than 16 to

174 dpm/100 cm^2. One location exceeding guidelines was brought to the immediate attention of the BNI site supervisor. BNI remediated the area and performed additional surveys. ESSAP personnel then performed surface scans and direct measurements of the suspect areas to confirm that remedial actions had been effective in reducing contamination to acceptable levels.

Final verification survey surface activity levels are summarized in Table 1. The total activity levels for the courtyard walls ranged from less than 220 to 6,400 dpm/100 cm^2. For direct measurement locations exceeding 5,000 dpm/100 cm^2, the 1 m^2 average activity levels were 1,400 to 3,000 dpm/100 cm^2. For the exterior portions of Area 7, the beta activity range was from less than 210 to 4,200 dpm/100 cm^2. The remaining surface activity levels were less than 220 dpm/100 cm^2 for the cistern area walls and less than 220 to 1,300 dpm/100 cm^2 for the sidewalk and manholes located in the courtyard. All removable activity levels were below the minimum detectable concentrations of 12 and 16 dpm/100 cm^2 for gross alpha and gross beta, respectively.

Exposure Rates

Background exposure rate measurements are summarized in Table 4 and ranged from 7 to 11 μR/h. Site exposure rate measurements are summarized in Table 2. Exposure rates, including background, ranged from 8 to 15 μR/h for all exterior areas.

Radionuclide Concentrations in Soil

Background radionuclide concentrations in soils are summarized in Table 4. The total uranium concentration ranged from less than 2.1 to 2.7 pCi/g. Prior to additional remediation, one location each in Excavation A, the East Courtyard, and the West Courtyard were identified as exceeding the site-specific soil concentration guideline. Total uranium concentrations in samples for these areas ranged from 1.3 to 2,429 pCi/g.

Due to its small size, the location within the East Courtyard was immediately remediated by BNI and ESSAP collected a post-remedial action soil sample. Additional samples were collected

adjacent to, and at the same depth of the initial samples in the remaining two areas in order to determine the average total uranium concentration over a 100 m^2 area. For the location in the west courtyard, the average activity for the 100 m^2 area was in excess of the guideline. As a result, BNI was notified and the contamination boundaries were determined by results from the other samples taken within the 100 m^2 area. BNI removed the top 15 cm of soil from an approximate 5 m by 5 m area. The area was resurveyed and samples collected by BNI showed no elevated uranium concentrations. ESSAP personnel performed additional scans and took three post-RA verification soil samples.

Final verification radionuclide soil concentration ranges for total uranium (Table 3) were as follows: 1.3 to 61.5 pCi/g, with a 100 m^2 average of 19.8 pCi/g for Excavation A; 3.7 to 9.7 pCi/g for Excavation B; 1.7 to 11.3 pCi/g for Excavation C; 1.7 to 27.3 pCi/g for the west courtyard; 1.9 to 33.6 pCi/g for the east courtyard; 6.1 to 11.4 pCi/g for the Conrail Area; and 2.3 pCi/g for the manhole in the sidewalk area; and 30.9 pCi/g for the exterior of Area 7.

In addition to the 48 facility samples collected by ESSAP, four split-samples collected by BNI were analyzed (Table 5). The overall soil concentration results were comparable, within the acceptable statistical deviation.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity levels for the former Baker Brothers site were compared to the residual surface contamination guidelines found in DOE Order 5400.5 (DOE 1990). The applicable surface contamination guidelines were those for uranium which are as follows:

Total Activity

5,000 α dpm/100 cm^2, averaged over a 1 m^2 area

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

Removable Activity

1,000 α dpm/100 cm^2

Because natural uranium emits both alpha and beta radiations in a 1:1 ratio and surface conditions, such as the presence of dirt on surfaces, may selectively attenuate the alpha radiation, the beta activity was considered the most representative for comparison to guidelines. All final verification direct measurements satisfied the guidelines.

The exposure rates were compared to the 20 μR/h above background guideline (DOE 1990). All interior and exterior exposure rates were below this guideline.

The site-specific soil concentration guideline was 35 pCi/g for total uranium (DOE 1995). Total uranium is calculated based on a U-234 to U-238 activity ratio of 1:1. Final soil sample activities were below the site-specific soil guideline over all 100 m^2 areas for both interior and exterior areas.

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 verification surveys of remediated areas at the former Baker Brothers, Inc. site in Toledo, Ohio. Verification activities included document and post-remedial action data reviews, surface scans, direct measurements, exposure rate measurements, and soil sampling.

The verification survey identified one area of residual surface contamination and two areas of soil concentrations that exceeded guidelines. All three areas were remediated and resurveyed by BNI. Post-remedial action surveys by ESSAP confirmed that the surface contamination and soil concentrations had been reduced to acceptable levels. The final verification results support those of BNI which indicate that site structures and soil areas satisfy the guidelines for release without restrictions due to residual radioactive material.

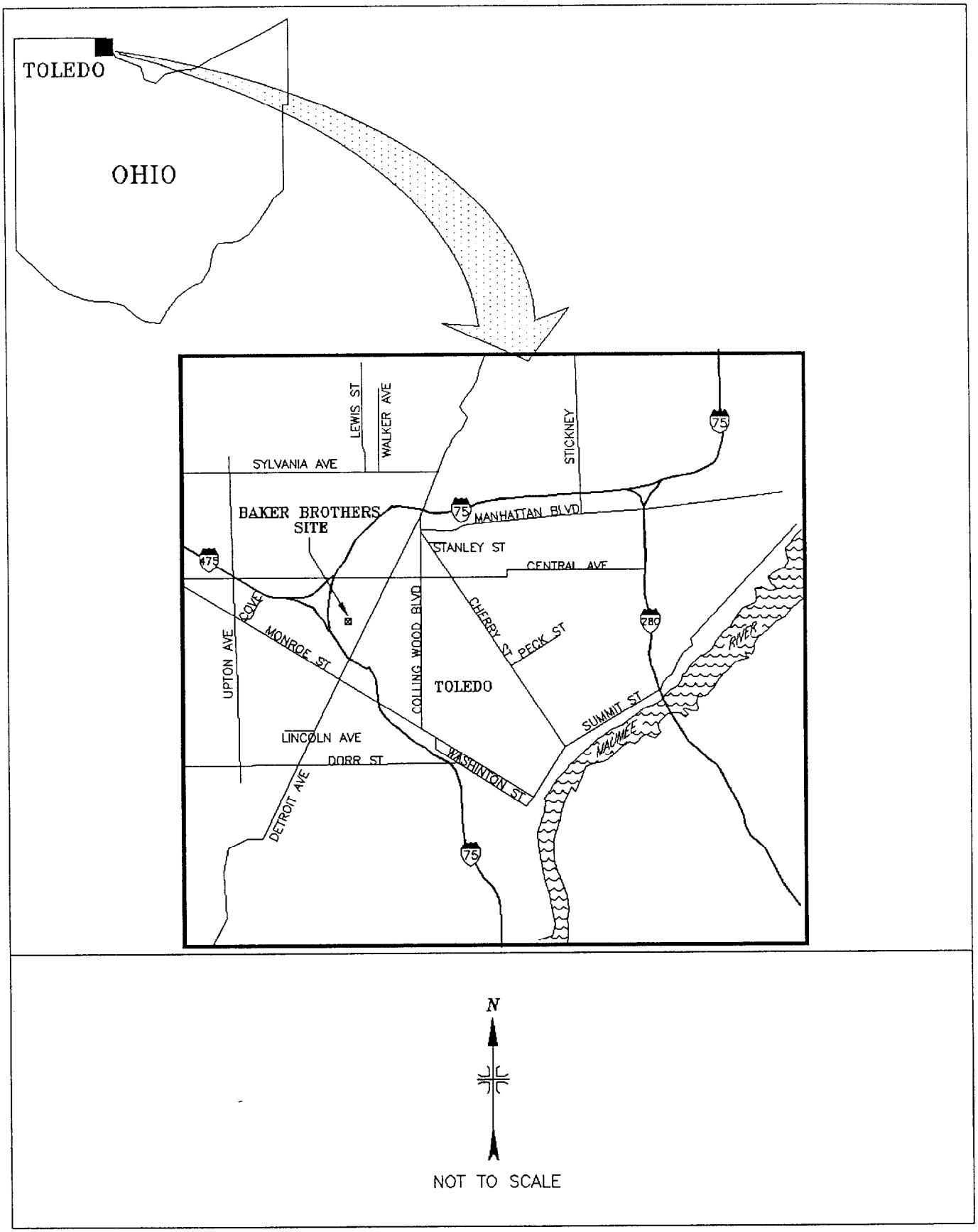


FIGURE 1: Toledo, Ohio – Location of Former Baker Brothers Site

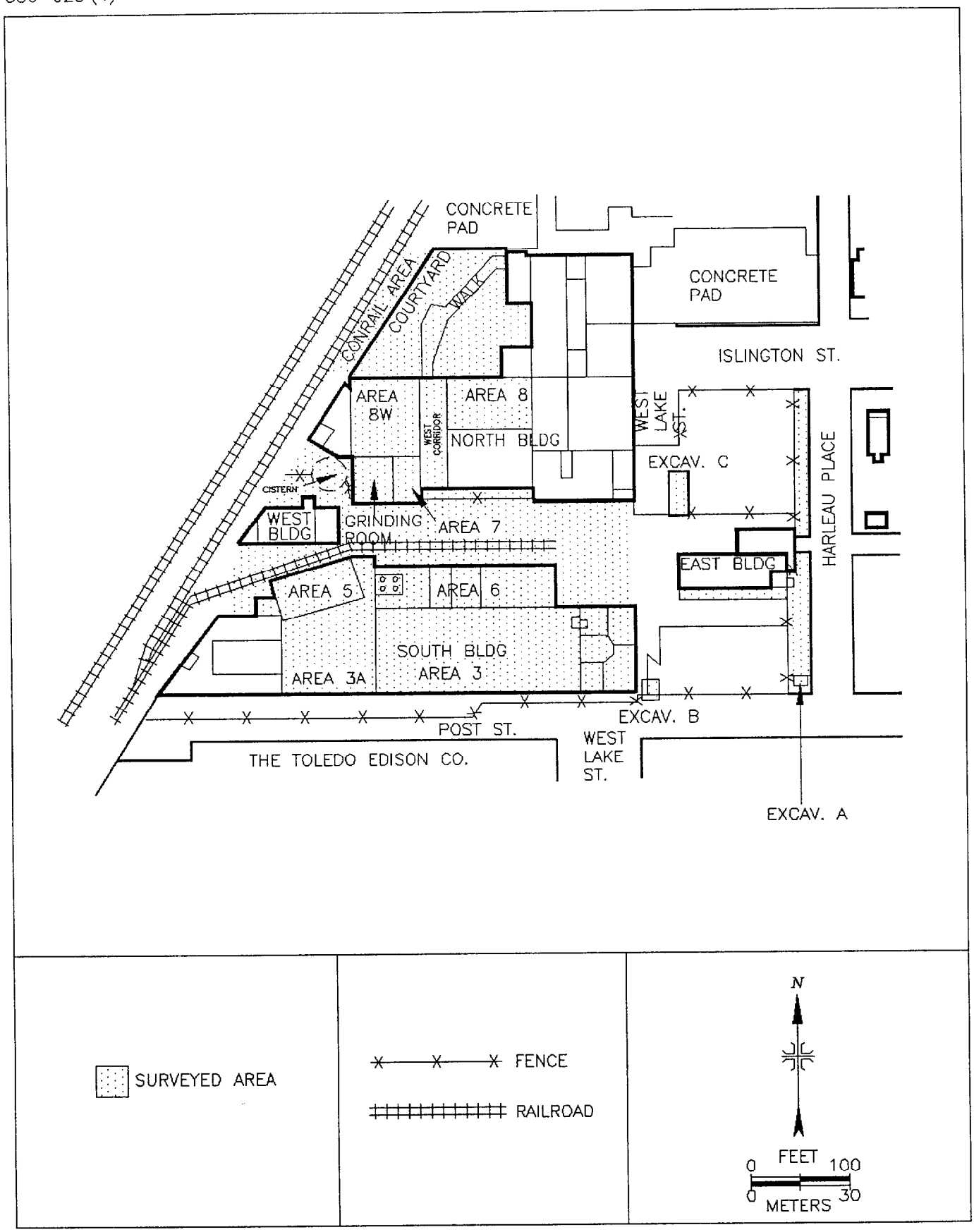


FIGURE 2: Former Baker Brothers Site – Plot Plan and Surveyed Areas

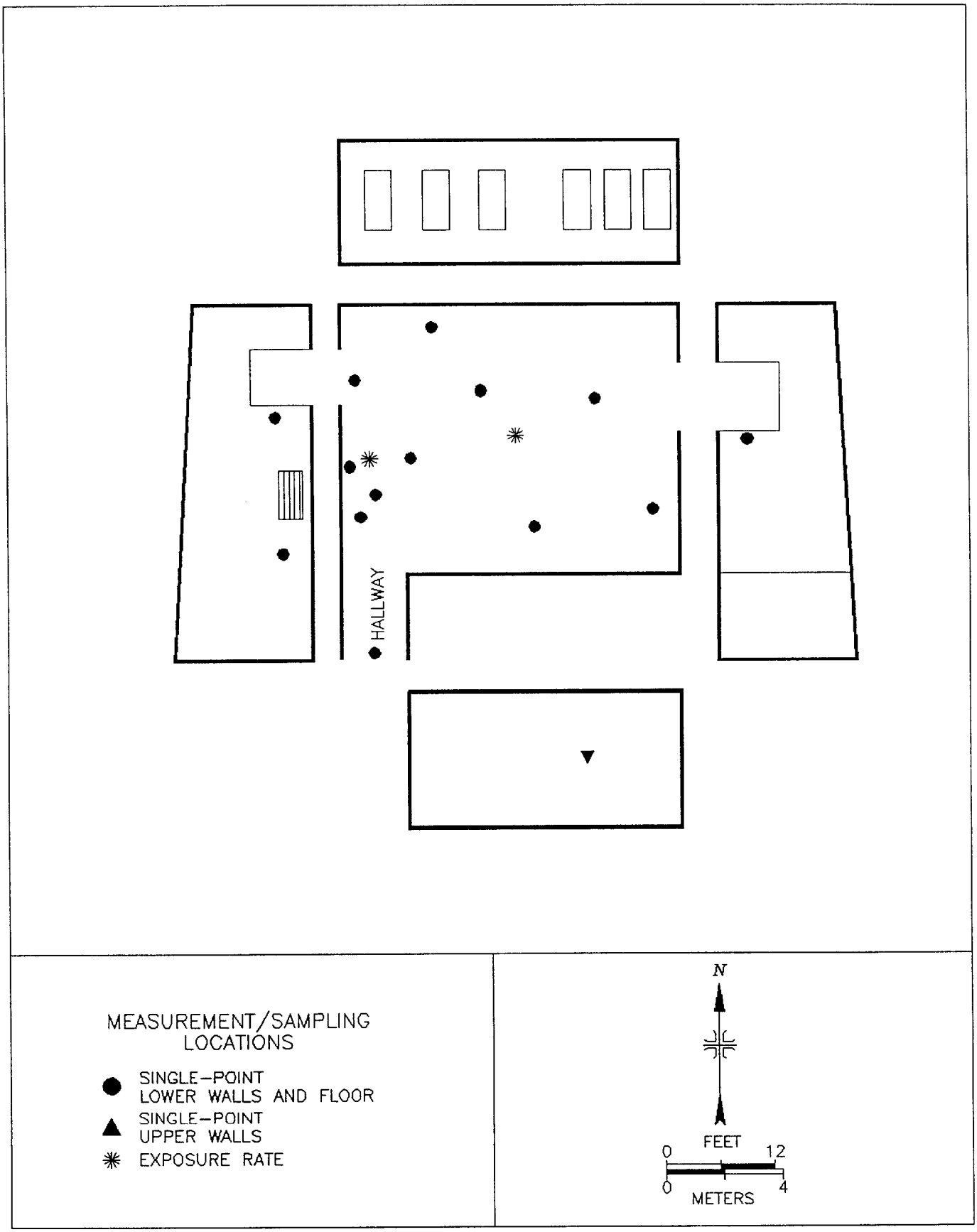


FIGURE 3: South Building, Area 2A – Measurement and Sampling Locations
(Shown in Fig 14)

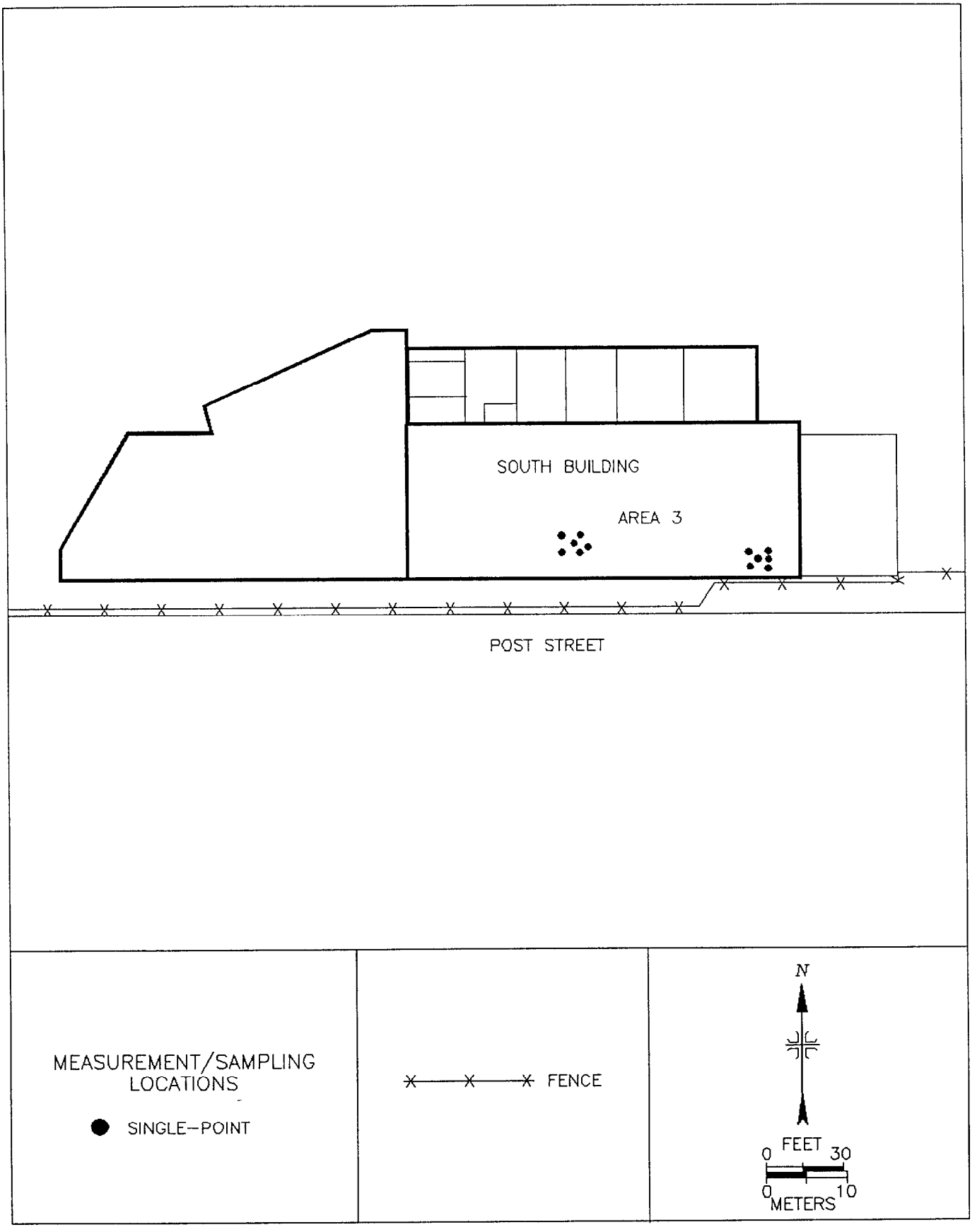


FIGURE 4: South Building, Area 3 – Measurement and Sampling Locations

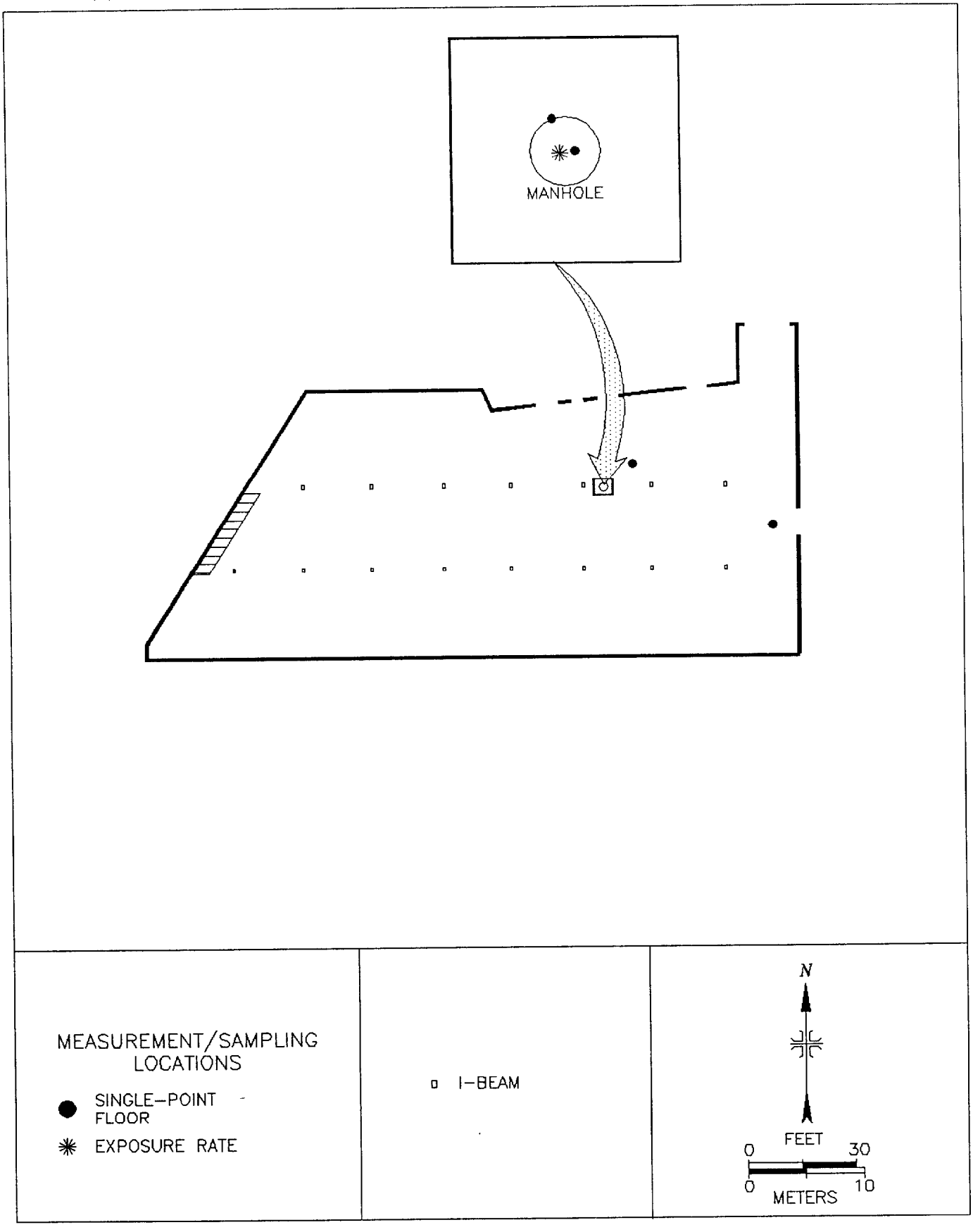
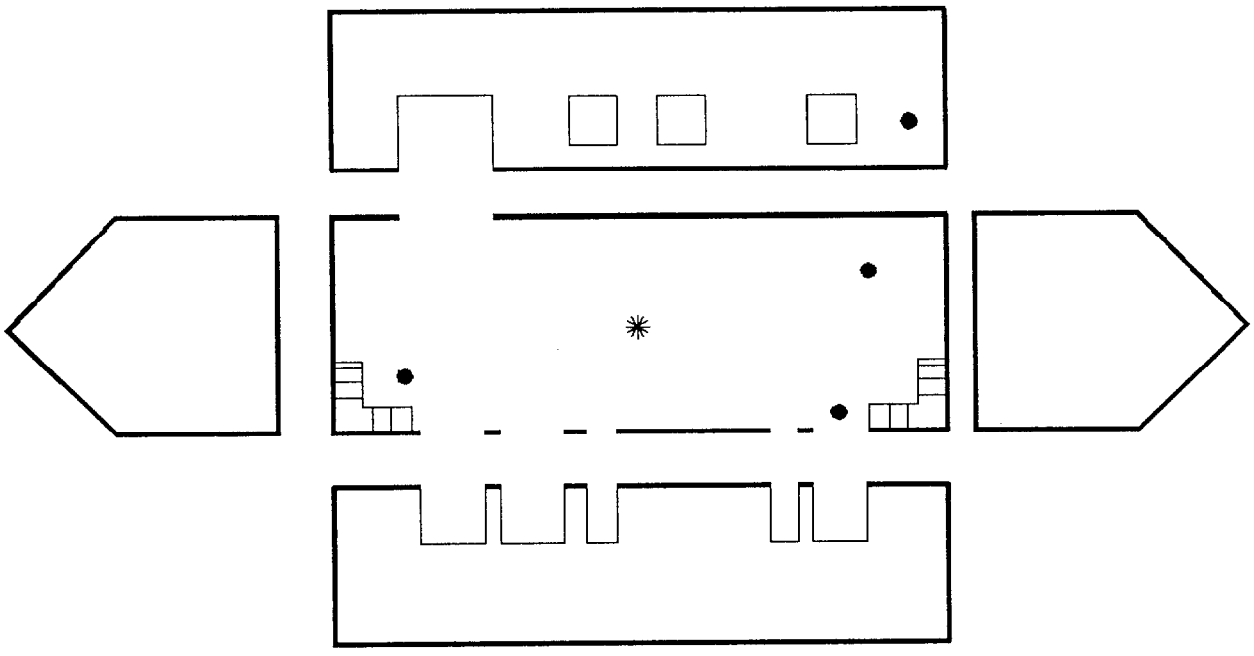


FIGURE 5: South Building, Area 3A – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE-POINT FLOOR AND LOWER WALLS
- EXPOSURE RATE

N

0 FEET 24

0 METERS 8

FIGURE 6: South Building, Area 5 – Measurement and Sampling Locations

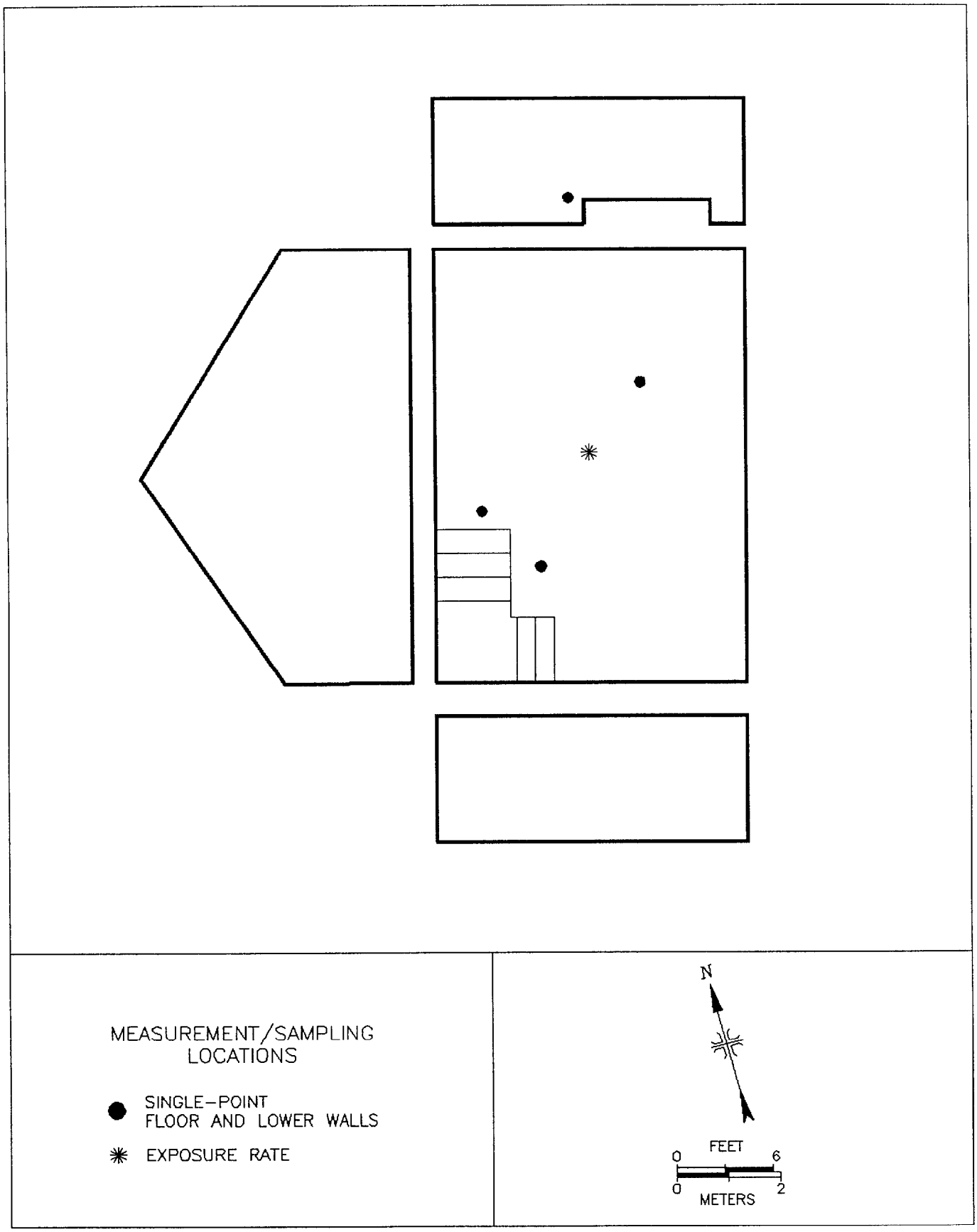


FIGURE 7: South Building, Area 5, West Mezzanine (Loft) – Measurement and Sampling Locations

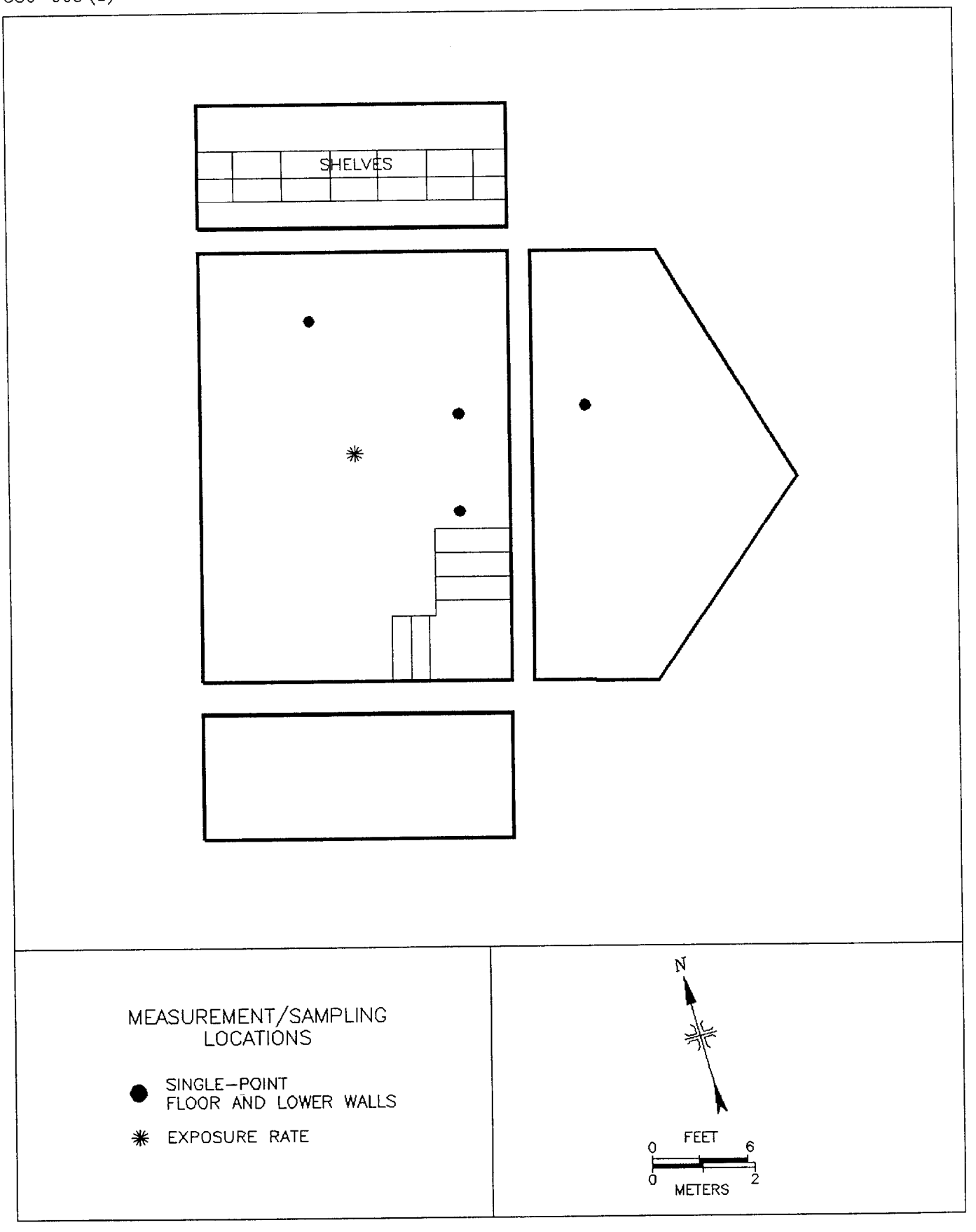


FIGURE 8: South Building, Area 5, East Mezzanine (Loft) – Measurement and Sampling Locations

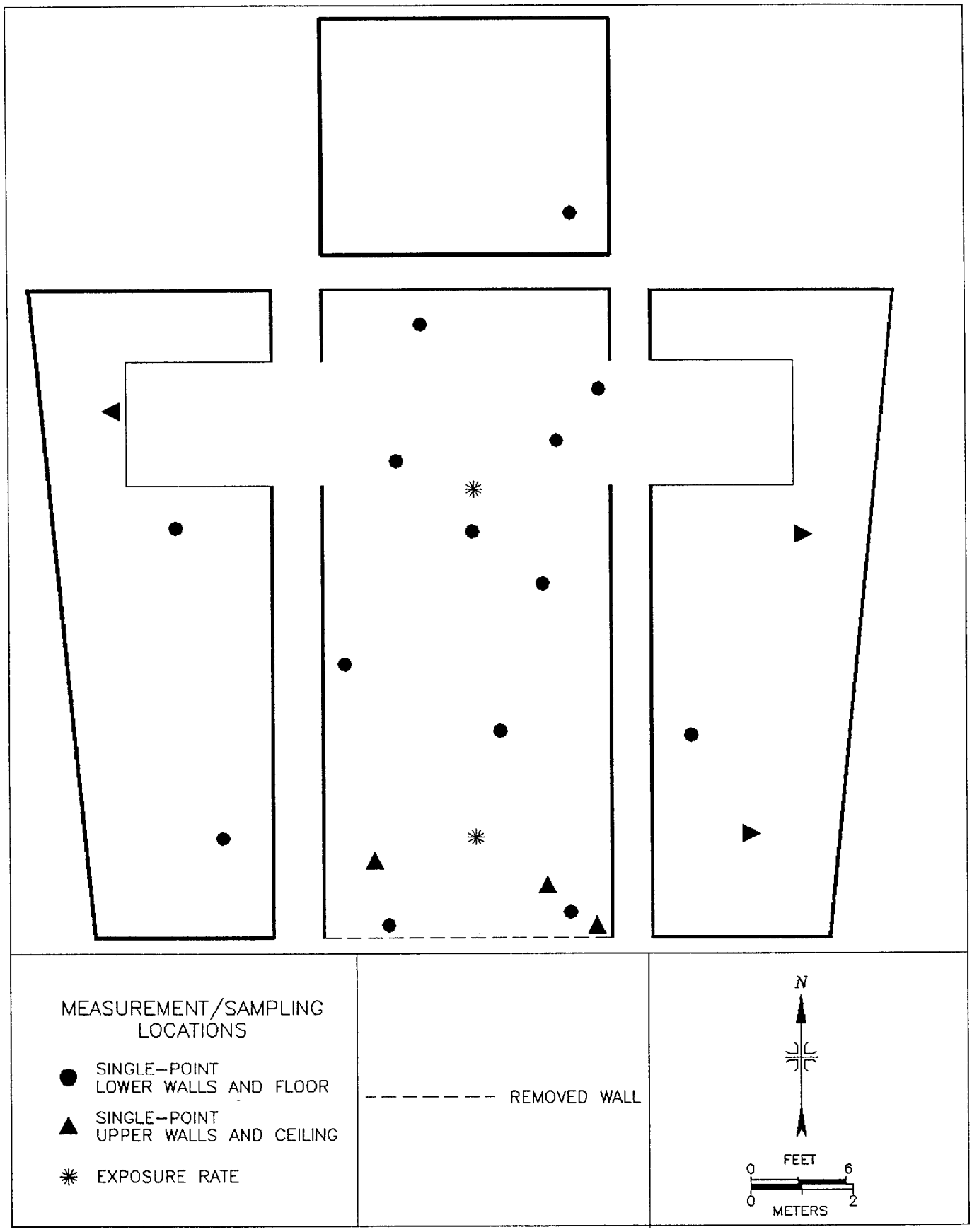


FIGURE 9: North Building, Area 7 – Measurement and Sampling Locations

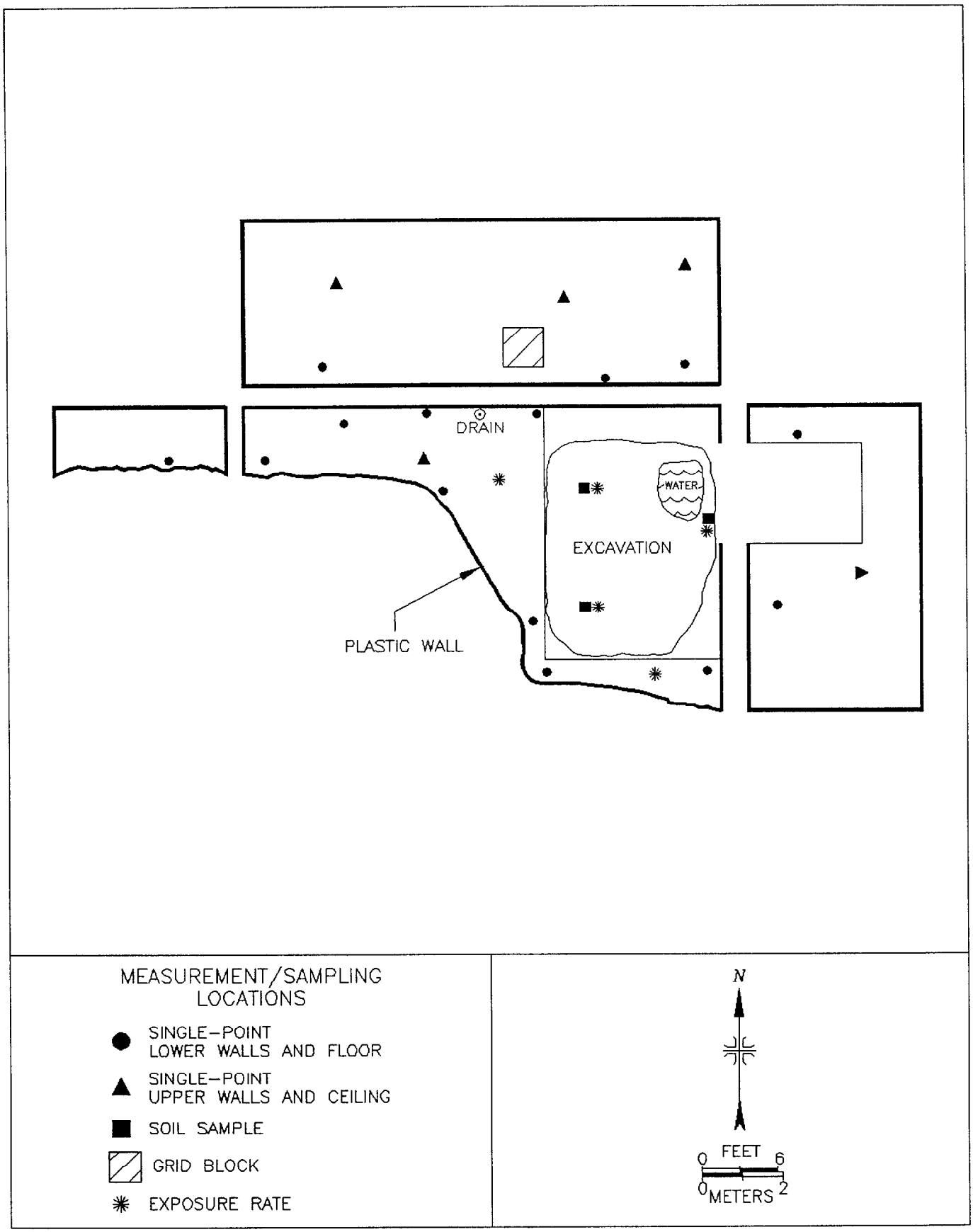


FIGURE 10: North Building, Area 7A – Measurement and Sampling Locations

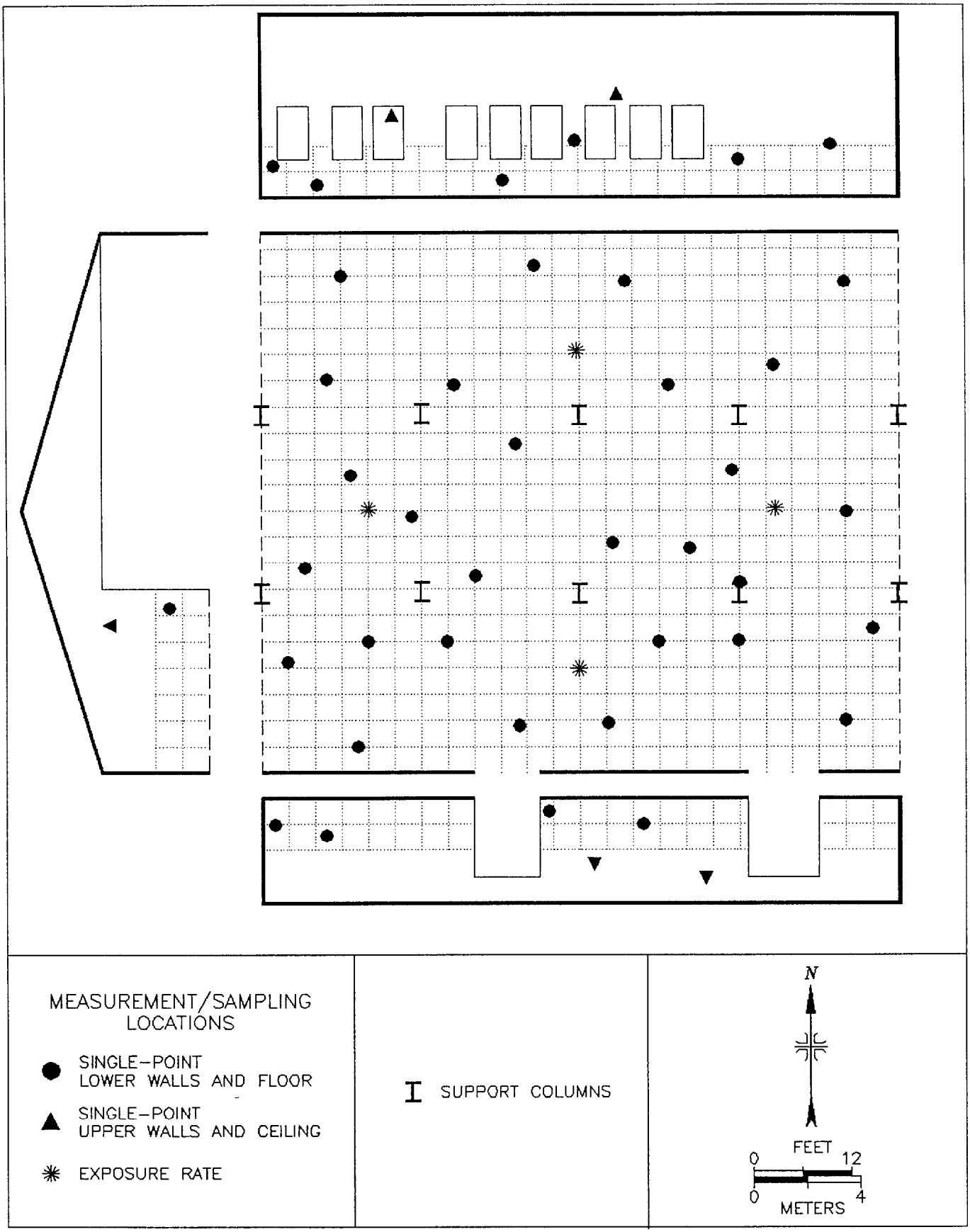


FIGURE 11: North Building, Area 8E – Measurement and Sampling Locations

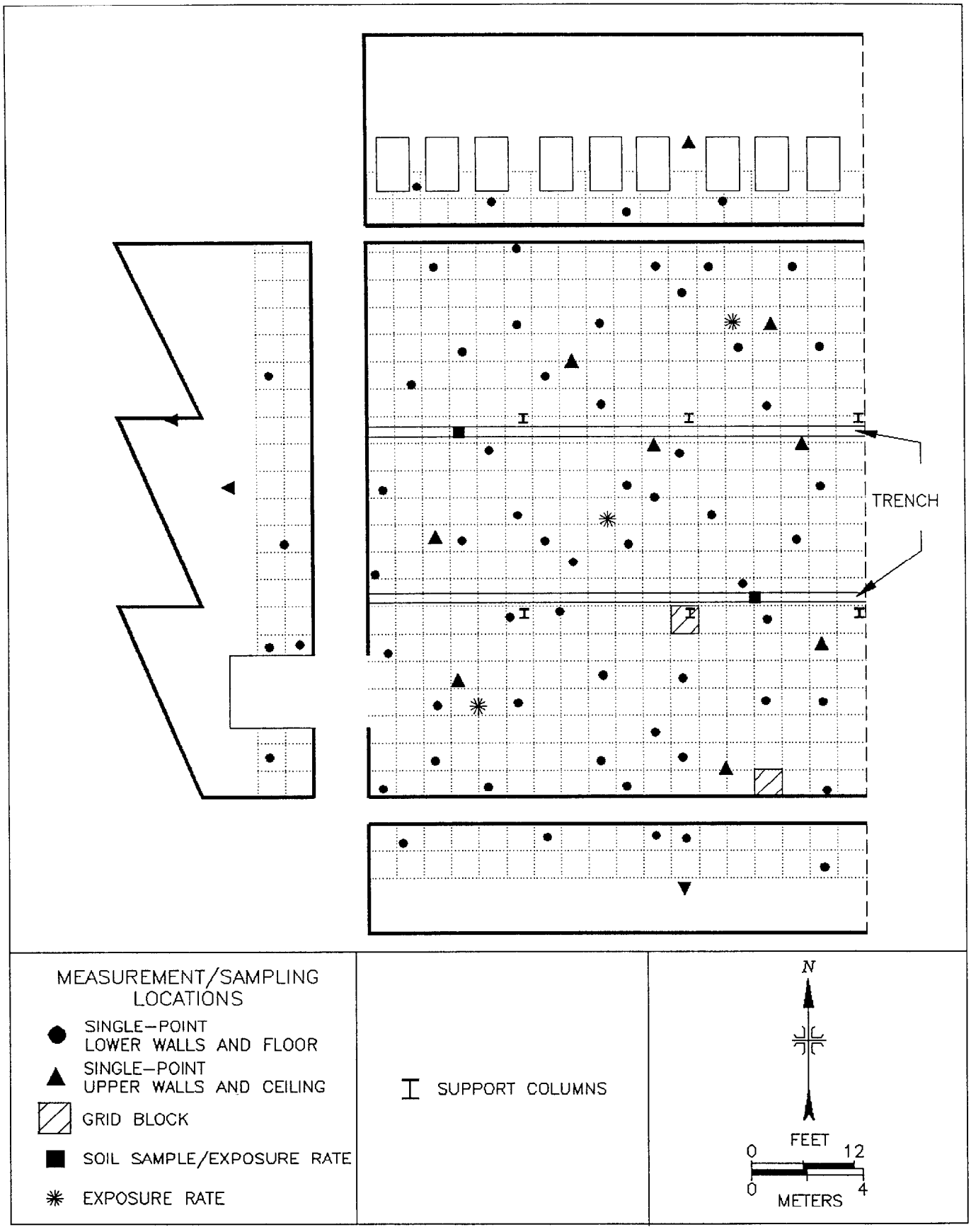


FIGURE 12: North Building, Area 8W – Measurement and Sampling Locations

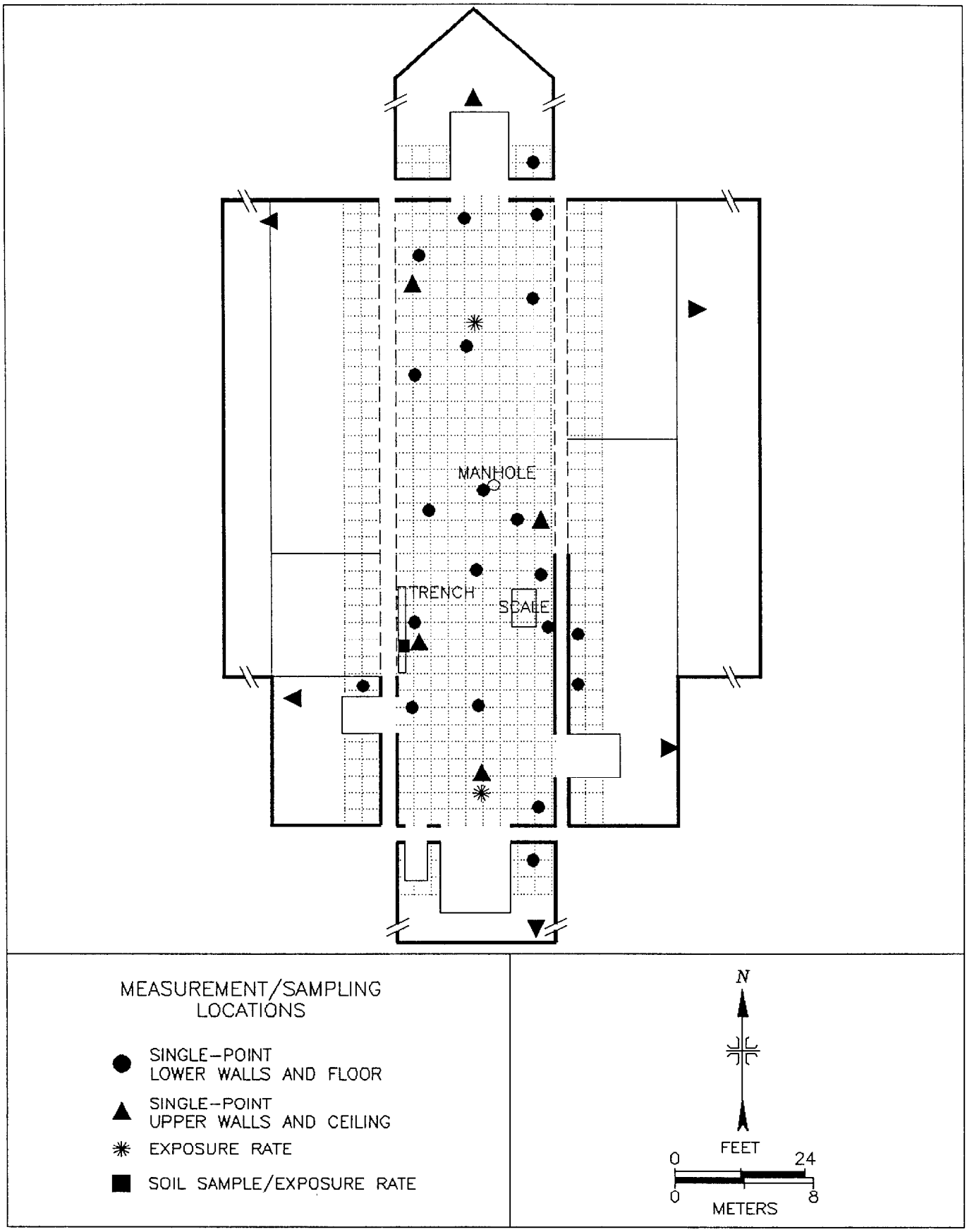
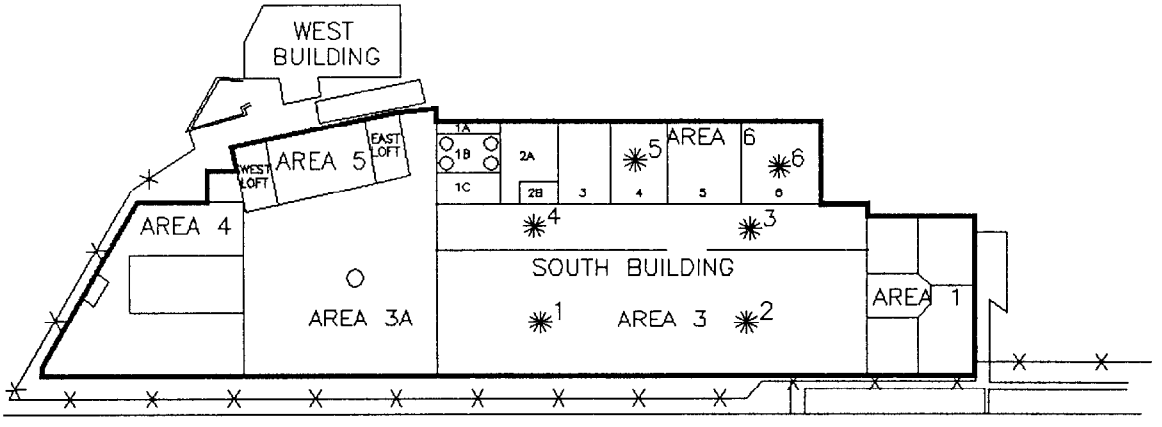


FIGURE 13: North Building, West Corridor – Measurement and Sampling Locations



MEASUREMENT LOCATIONS

EXPOSURE RATE

FENCE

N

FEET

0 60

0 20

METERS

FIGURE 14: Baker Brothers Site, South Building – Interior Background Exposure Rate Measurement Locations

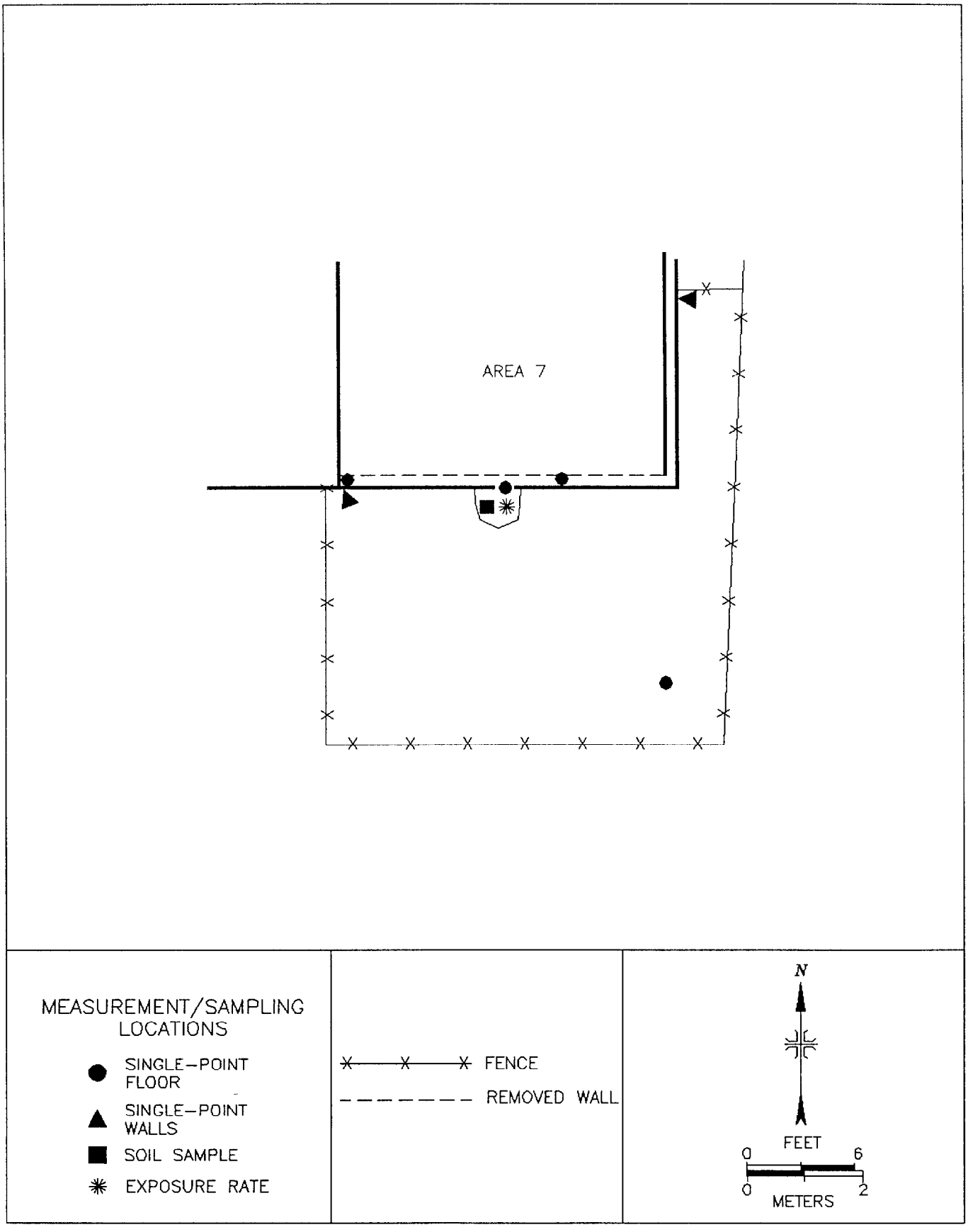


FIGURE 15: Area 7, Exterior – Measurement and Sampling Locations

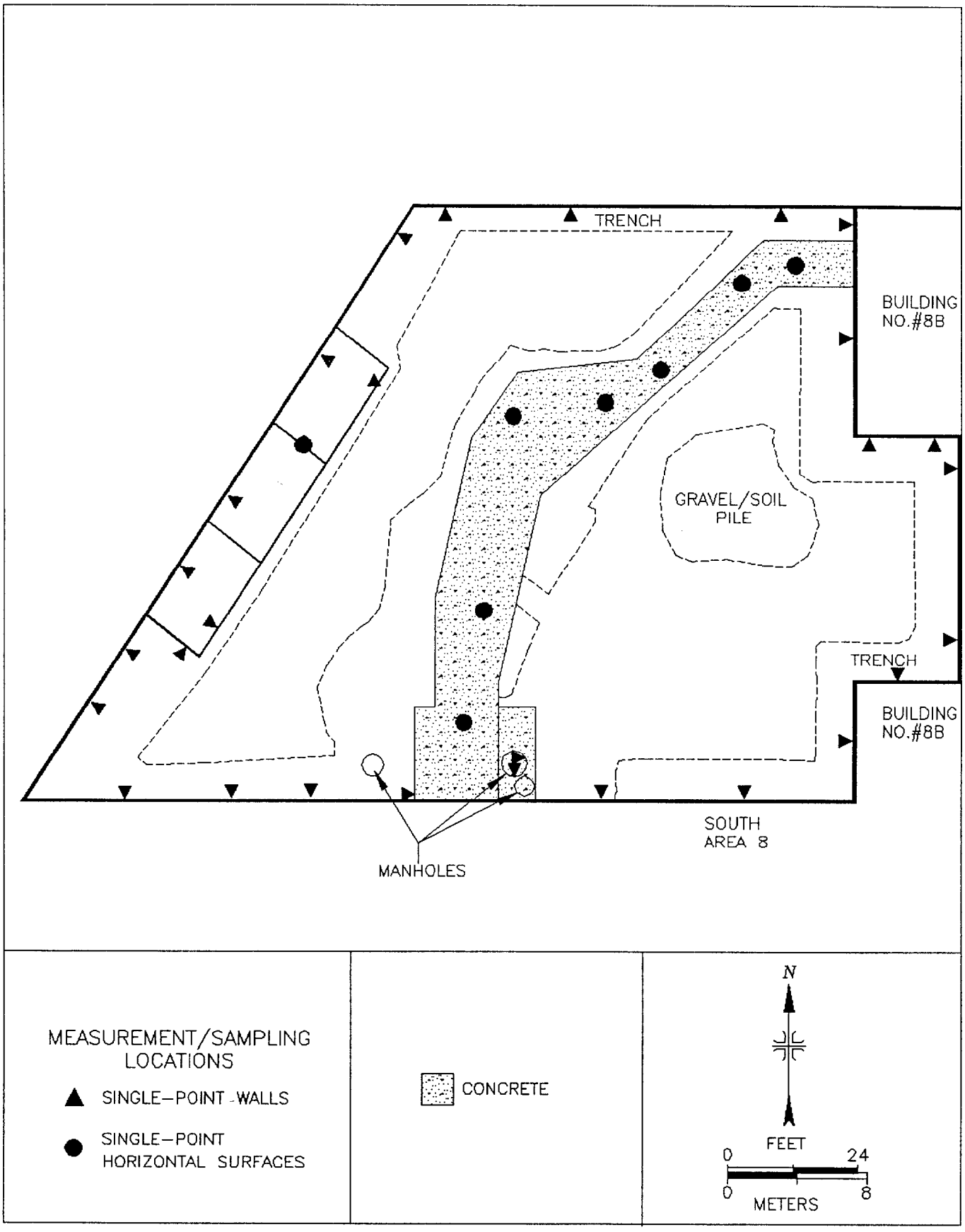


FIGURE 16: Courtyard - Measurement and Sampling Locations

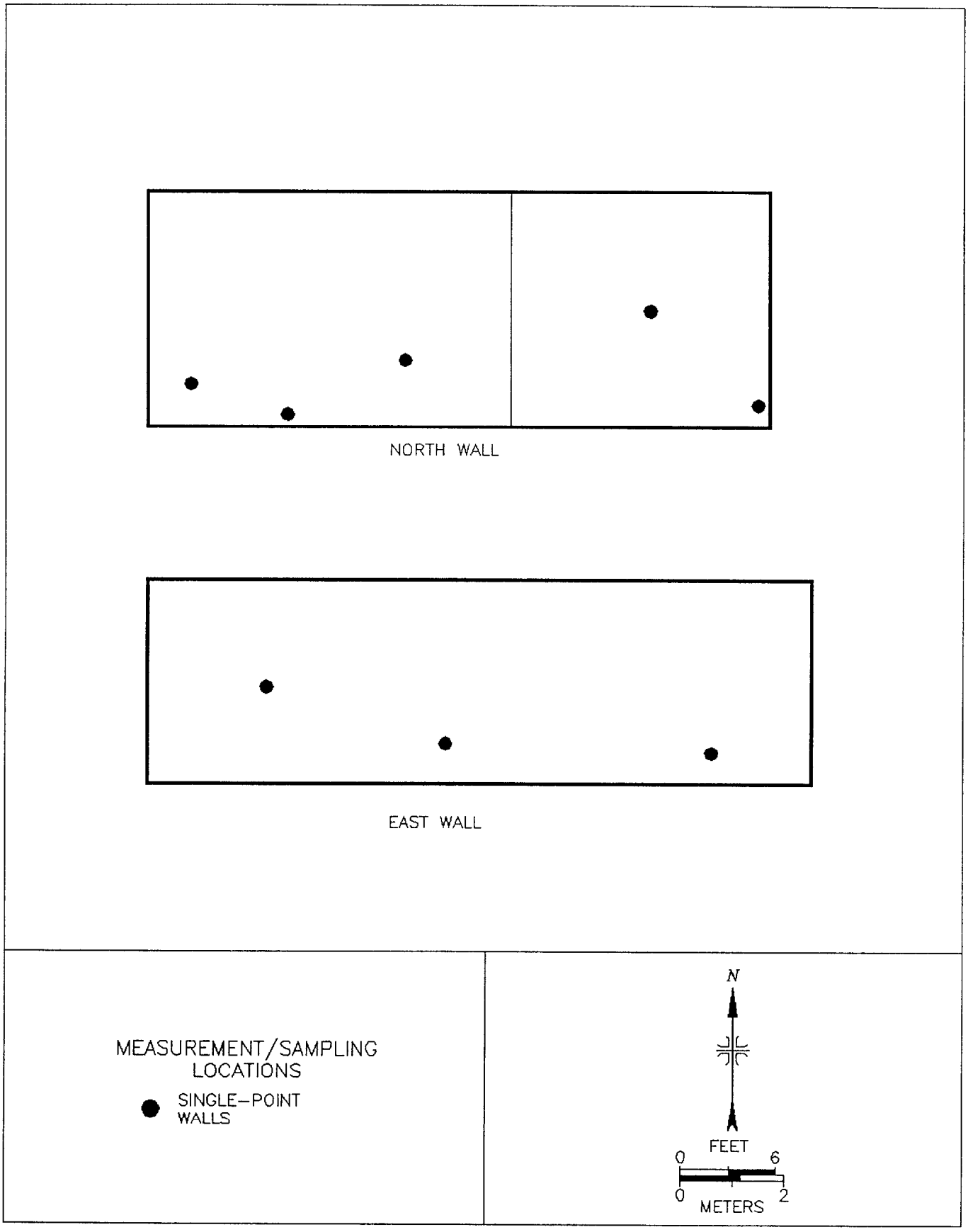


FIGURE 17: Cistern Area Walls – Measurement and Sampling Locations

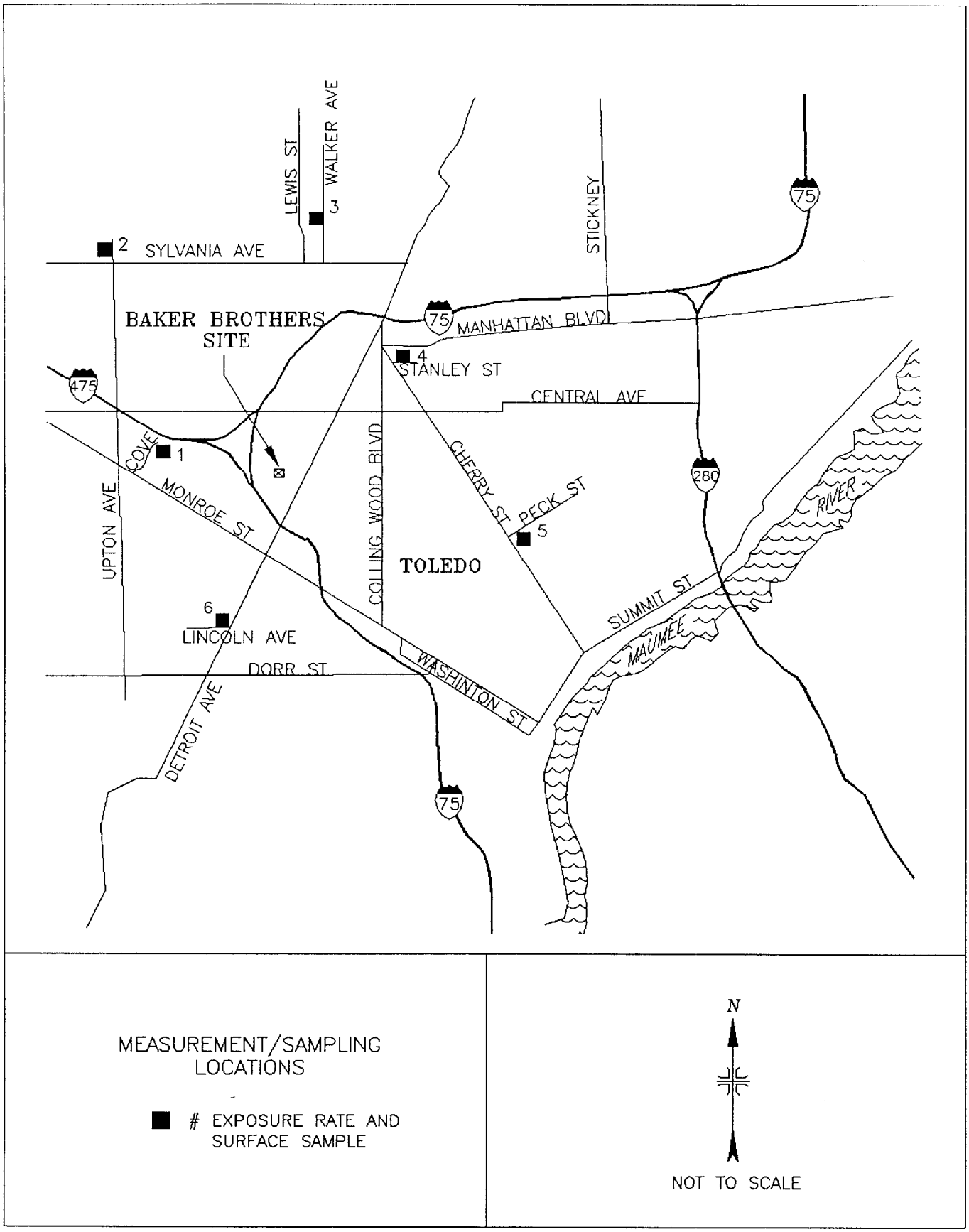


FIGURE 18: Toledo, Ohio Area – Background Measurement and Sampling Locations

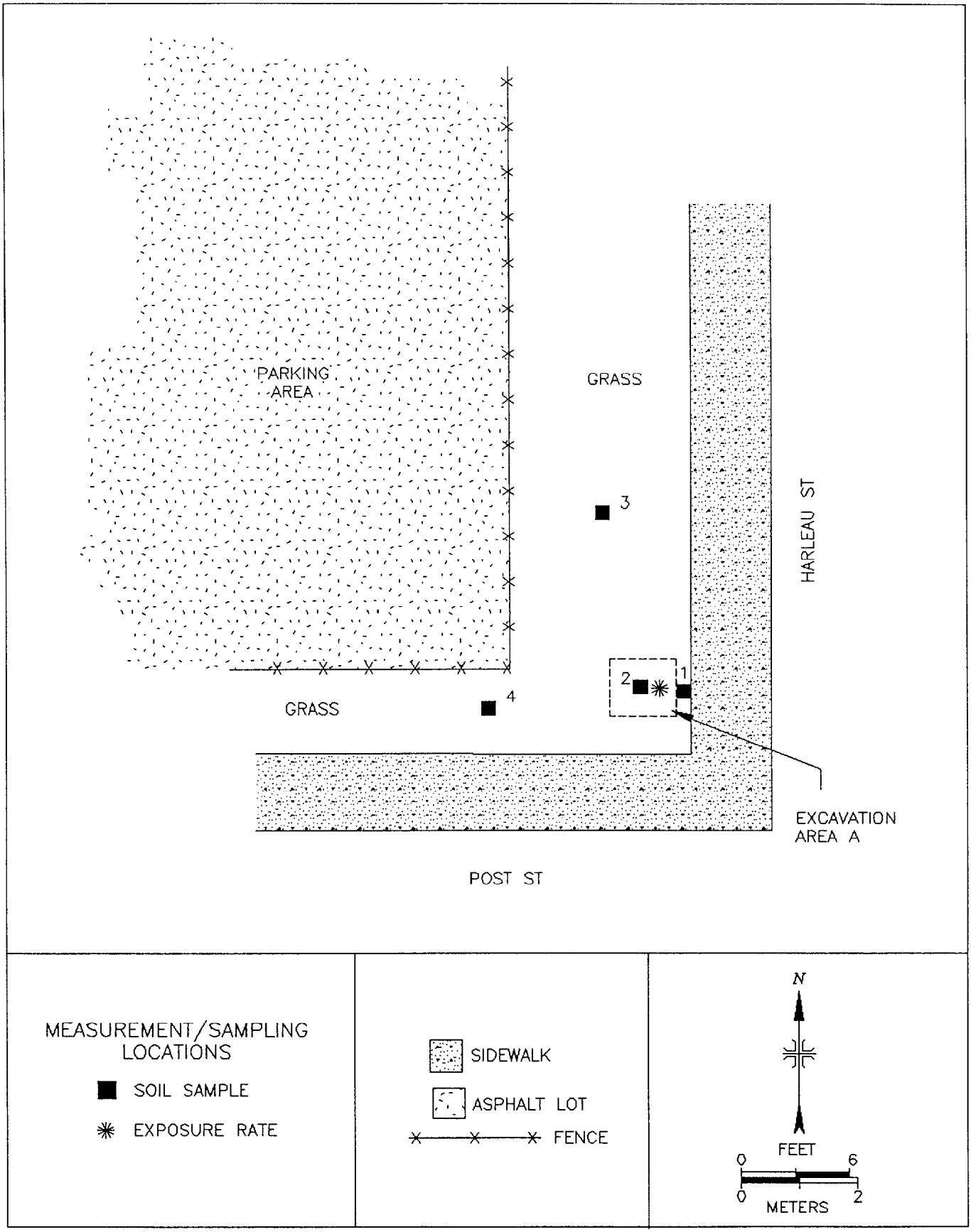


FIGURE 19: Excavation A – Measurement and Sampling Locations

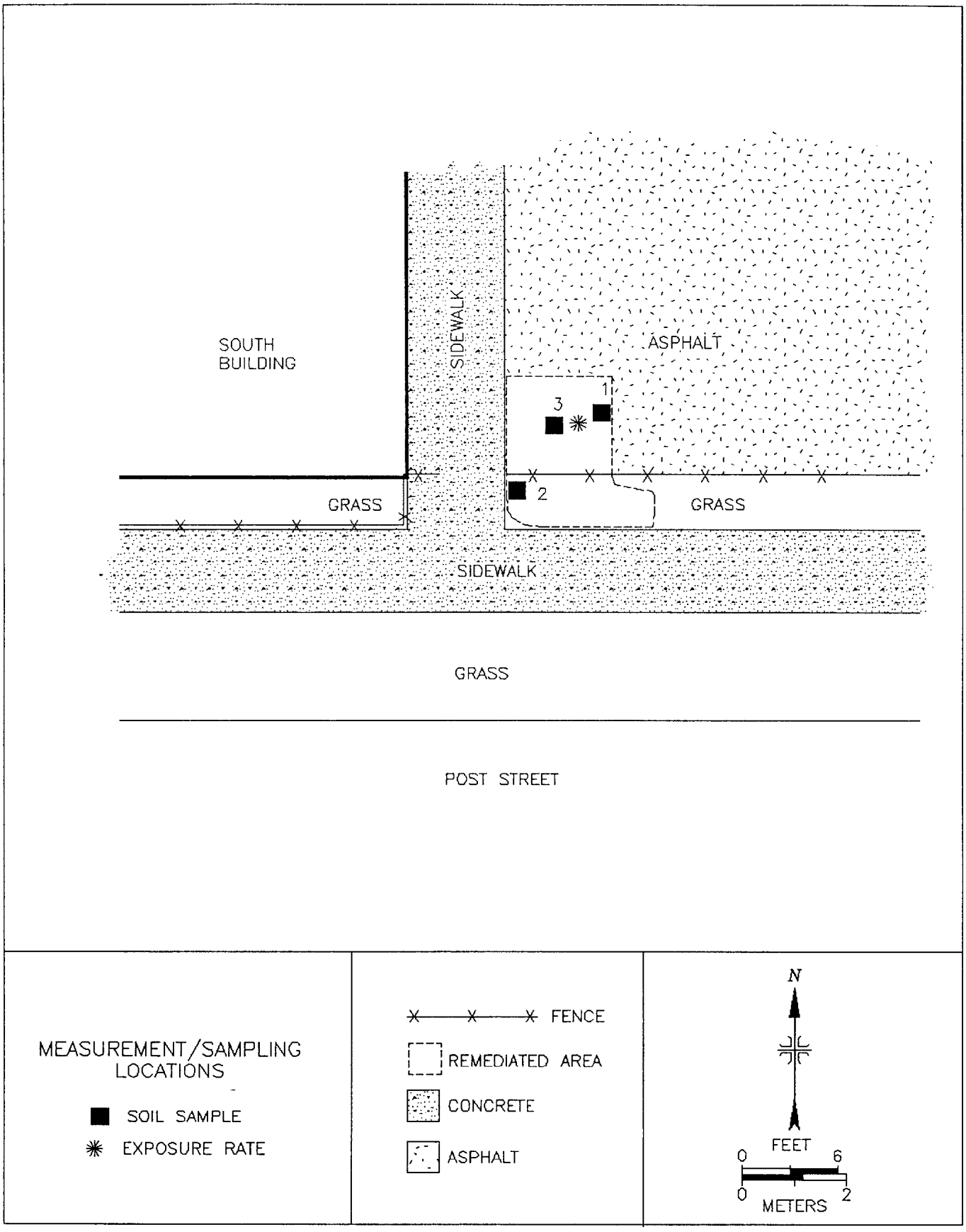


FIGURE 20: Excavation B – Measurement and Sampling Locations

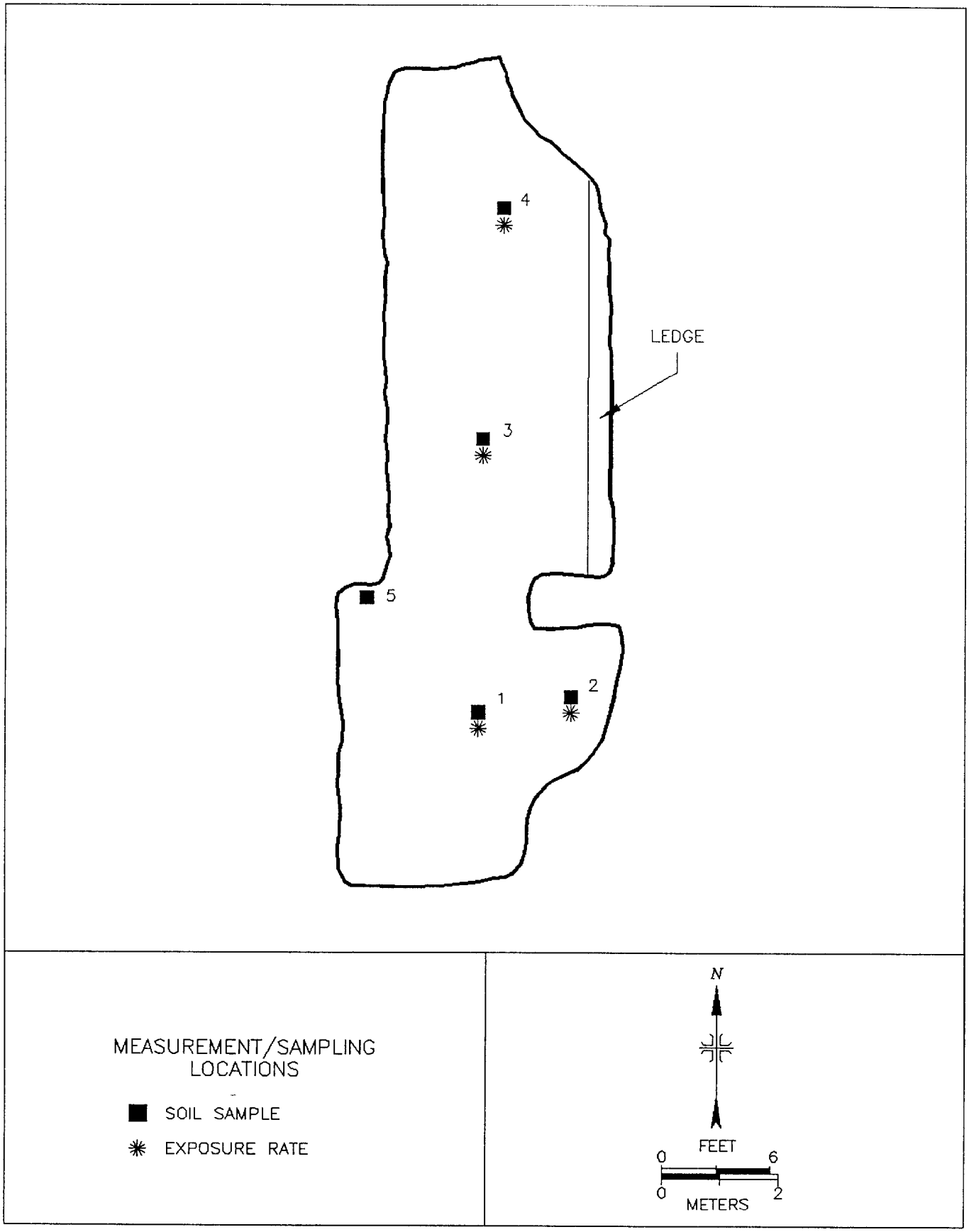


FIGURE 21: Excavation C – Measurement and Sampling Locations

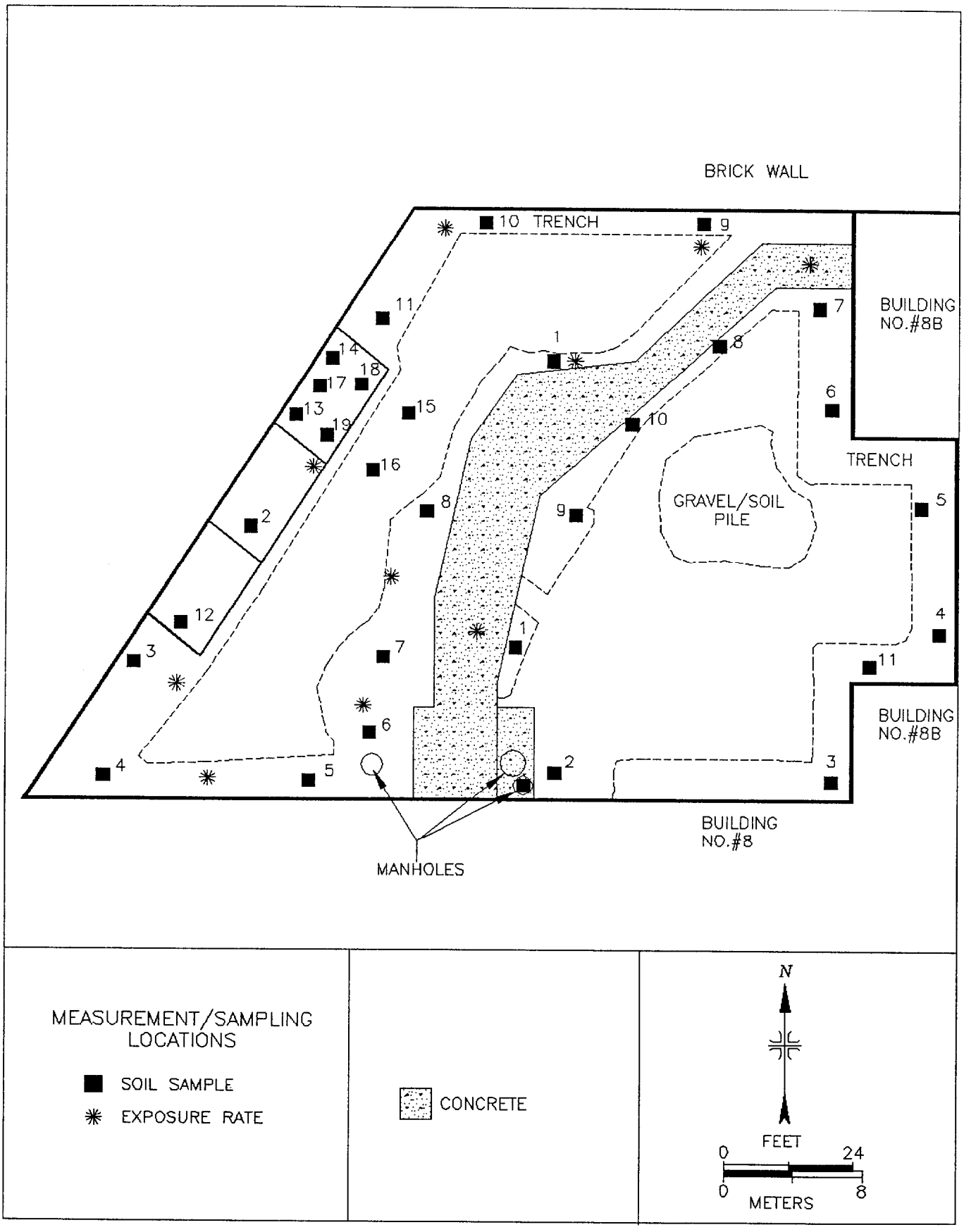


FIGURE 22: Courtyard – Measurement and Sampling Locations

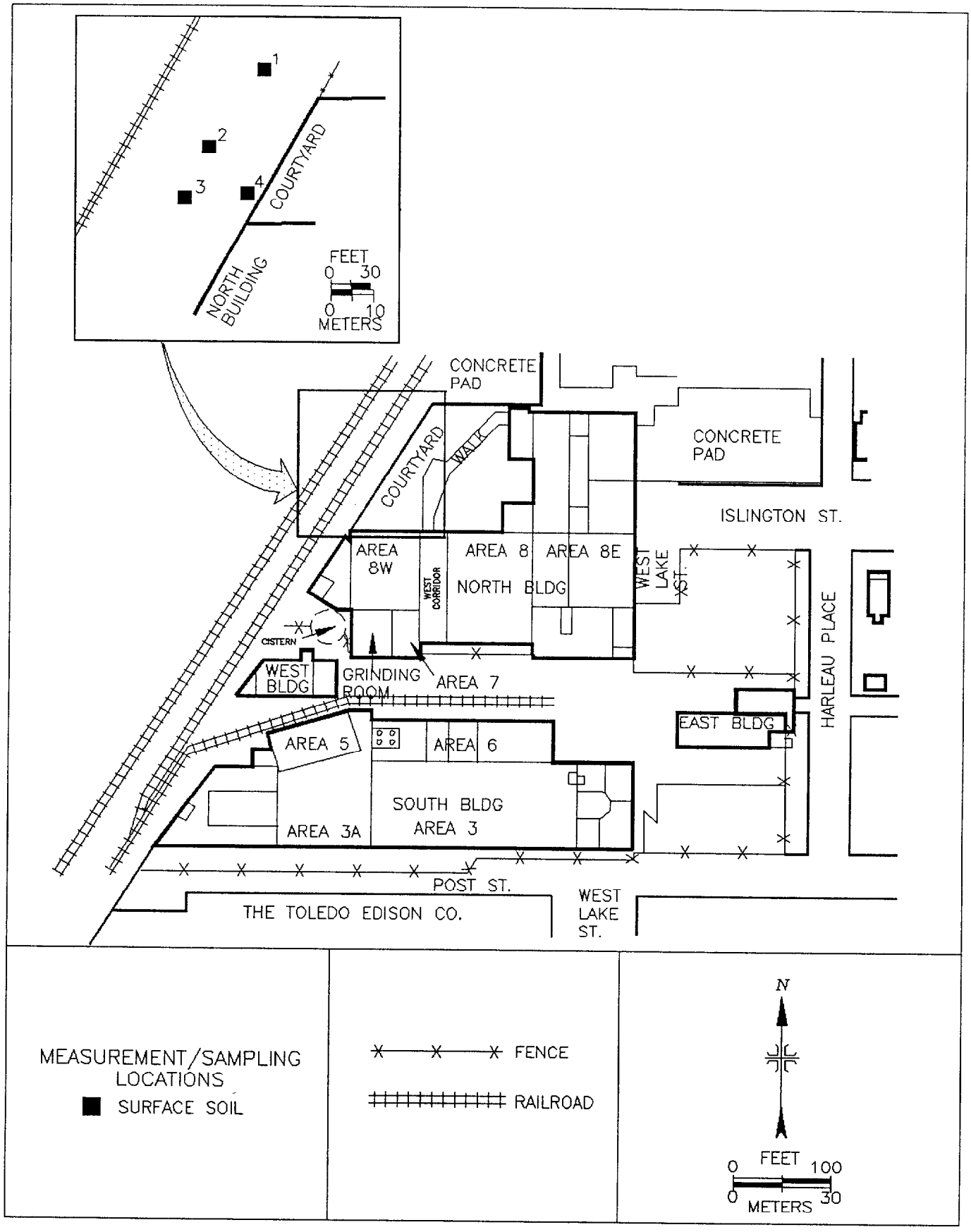


FIGURE 23: Former Baker Brothers Site, Conrail Area – Measurement and Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm^2)		Removable Activity Range (dpm/100cm^2)	
			Single Measurement	1 m^2 Average		
	Single-Point	Grid Blocks	Beta		Alpha	Beta
SOUTH BUILDING						
AREA 2A						
Floor	11	NA[b]	<210 - 2,000[c]	NA	<12	<16
Lower Walls	3	NA	260 - 1,000	NA	<12	<16
Upper Walls	1	NA	<250	NA	<12	<16
AREA 3						
Floor	12	NA	<220 - 1,900	NA	<12	<16
AREA 3A						
Floor	4	NA	<220 - 240	NA	<12	<16
AREA 5						
Floor	9	NA	<220	NA	<12	<16
Lower Walls	3	NA	<220	NA	<12	<16
NORTH BUILDING						
AREA 7						
Floor	10	NA	<210 - 230	NA	<12	<16
Lower Walls	4	NA	<210	NA	<12	<16
Upper Walls and Ceilings	6	NA	<210 - 920	NA	<12	<16
AREA 7A						
Floor	8	NA	<210 - 1,300	NA	<12	<16
Lower Walls	6	1	<210 - 12,000	680	<12	<16
Upper Walls	4	NA	<210	NA	<12	<16
Overheads	1	NA	<210	NA	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm²)		Removable Activity Range (dpm/100cm²)	
			Single Measurement	1 m² Average		
	Single-Point	Grid Blocks	Beta		Alpha	Beta
AREA 8E						
Floor	28	NA	<220 - 1,000	NA	<12	<16
Lower Walls	11	NA	<180 - 640	NA	<12	<16
Upper Walls	5	NA	<180 - 350	NA	<12	<16
AREA 8W						
Floor	48	2	<220 - 12,000	630 - 890	<12	<16
Lower Walls	14	NA	<250 - 4,000	NA	<12	<16
Upper Walls and Ceilings	4 9	NA	<250 - 450	NA	<12	<16
Overheads	3 2	NA	<220	NA	<12	<16
WEST CORRIDOR						
Floor	16	NA	<220 - 2,300	NA	<12	<16
Lower Wall	5	NA	<250 - 2,600	NA	<12	<16
Upper Walls and Ceiling	6 7	NA	<220 - 540	NA	<12	<16
Overheads	4 3	NA	<220	NA	<12	<16
Equipment (scale)	3	NA	<220 - 260	NA	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm^2)		Removable Activity Range (dpm/100cm^2)	
			Single Measurement	1 m^2 Average		
	Single-Point	Grid Blocks	Beta		Alpha	Beta
EXTERIOR AREAS						
Area 7	6	NA	<210 - 4,200[b]	NA	<12[b]	<16[b]
Courtyard Walls	25 16	2	<220 - 6,400	1,400 - 3,000	<12	<16
Cistern Area Walls	8	NA	<220	NA	<12	<16
Sidewalk and Manholes	12	NA	<220 - 1,300	NA	<12	<16

[a]Refer to Figures 3 through 13 and 15. 16

[b]NA=Not Applicable

[c]Post remedial action activities.

TABLE 2

EXPOSURE RATES
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Location[a]	Exposure Rate Range (μR/h)
Exterior Areas	
Area A	8
Area B	8
Area C	10
West Courtyard	9 to 11
East Courtyard	7 to 15
Sidewalk	9 to 11
Conrail Area	NA[b]
Interior Areas	
South Building	10 to 14
Area 7	10 to 12
Area 7A	9 to 13
Area 8W	12 to 13
Area 8E	11 to 12
West Corridor	11 to 12

[a]Refer to Figures 3 through 15 and 19 through 23.
[b]NA=Not Applicable

TABLE 3

URANIUM CONCENTRATIONS IN SOIL SAMPLES
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Location[a]	U-235	U-238	Total U[b]
INTERIOR AREAS			
Area 7A			
1	0.2 ± 0.1[c]	3.8 ± 1.6	7.8
2	0.5 ± 0.1	6.1 ±1.7	12.7
3	<0.1	1.4 ± 1.1	2.9
Area 8W			
1	<0.1	1.3 ± 0.5	2.6
2	<0.1	2.2 ± 1.3	2.8
West Corridor	<0.1	3.4 ± 1.1	7.6
EXTERIOR AREAS			
Excavation A			
1	<0.1	6.8 ± 1.4	13.7
2	<0.1	30.7 ± 2.4	61.5
3	<0.1	<1.2	2.5
4	<0.1	0.6 ± 0.8	1.3
			Ave. 16.6
Excavation B			
1	<0.1	1.8 ± 1.1	3.7
2	0.3 ± 0.1	4.7 ± 1.7	9.7
3	1.8 ± 0.1	2.7 ± 1.1	7.2
Excavation C			
1	0.3 ± 0.1	5.5 ± 1.2	11.3
2	<0.1	3.9 ± 1.7	7.9
3	<0.1	4.6 ± 1.5	9.3
4	<0.1	1.2 ± 0.9	2.5
5	<0.1	0.8 ± 0.8	1.7
Area 7	0.9	15.4 ± 1.9	30.9

TABLE 3 (Continued)

URANIUM CONCENTRATIONS IN SOIL SAMPLES
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Location[a]	U-235	U-238	Total U[b]
WEST COURTYARD			
1	<0.1	2.9 ± 1.1	5.9
2	<0.1	0.9 ± 0.6	1.9
3	<0.1	2.7 ± 1.1	5.5
4	<0.1	2.3 ± 1.1	4.7
5	<0.1	1.2 ± 0.9	2.5
6	<0.1	1.8 ± 1.2	3.7
7	<0.1	0.9 ± 0.8	1.9
8	0.5 ± 0.1	8.4 ± 1.7	17.3
9	<0.1	<0.9	1.9
10	<0.1	1.3 ± 0.9	2.7
11	0.5 ± 0.1	10.0 ± 1.8	20.5
12	<0.1	3.5 ± 1.1	7.1
13	<0.1	2.8 ± 0.8	5.7
14	0.6 ± 0.1	9.6 ± 0.9	19.8
15	0.4 ± 0.1	4.5 ± 0.9	9.4
16	<0.1	2.6 ± 0.8	5.3
17	0.7 ± 0.1	13.3 ± 1.9	27.3
18	<0.1	0.8 ± 1.0	1.7
19	0.4 ± 0.1	7.1 ± 1.3	14.6

TABLE 3 (Continued)

URANIUM CONCENTRATIONS IN SOIL SAMPLES
FORMER BAKER BROTHERS, INC. SITE
TOLEDO, OHIO

Location[a]	U-235	U-238	Total U[b]
EAST COURTYARD			
1	0.8 ± 0.1	16.4 ± 2.5	33.6
2	0.6 ± 0.1	13.0 ± 1.9	26.6
3	<0.1	1.4 ± 0.7	2.9
4	<0.2	15.0 ± 2.4	30.2
5	<0.1	3.2 ± 1.5	6.5
6	<0.1	1.2 ± 1.0	2.5
7	<0.1	<1.6	3.3
8	<0.1	<1.1	2.3
9	<0.1	0.9 ± 1.0	1.9
10	<0.1	<1.4	2.9
11	<0.1	2.4 ± 1.1	4.9
CONRAIL AREA			
1	<0.2	4.0 ± 2.0	8.2
2	<0.2	3.1 ± 0.9	6.4
3	<0.2	5.6 ± 2.3	11.4
4	<0.1	3.0 ± 0.9	6.1
SIDEWALK MANHOLE	<0.1	1.1 ± 1.0	2.3

[a]Refer to Figures 10, 12 through 13, 15, and 19 through 23.
[b]Total Uranium concentrations are calculated based on a U-234 to U-238 activity ratio of 1:1 and U-235.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.

TABLE 4

BACKGROUND EXPOSURE RATES AND RADIONUCLIDE CONCENTRATION IN SOIL SAMPLES FORMER BAKER BROTHERS, INC. SITE TOLEDO, OHIO

Location[a]	Exposure Rate at 1 m (μR/h)	Radionuclide Concentration (pCi/g)		
		U-235	U-238	Total Uranium
EXTERIOR				
Cove Boulevard	7	<0.1	0.9 ± 0.5[b]	2.1
Upton Avenue	8	<0.1	<0.9	<1.9
Whittiel School	11	<0.1	1.1 ± 0.9	2.3
Stanley Court	11	<0.1	1.3 ± 1.0	2.7
Peck Street	11	<0.1	1.7 ± 0.7	1.3
Lincoln School	7	<0.1	1.2 ± 0.5	1.5
INTERIOR, SOUTH BUILDING				
#1	12	NA[c]	NA	NA
#2	14	NA	NA	NA
#3	12	NA	NA	NA
#4	14	NA	NA	NA
#5	15	NA	NA	NA
#6	13	NA	NA	NA

[a]Refer to Figures 14 and 18.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]NA = Not Applicable

TABLE 5

COMPARISON OF URANIUM CONCENTRATIONS IN SPLIT SOIL SAMPLES FORMER BAKER BROTHERS, INC. SITE TOLEDO, OHIO

Location	U-235		U-238		Total Uranium	
	BNI	ESSAP	BNI	ESSAP	BNI	ESSAP
Excavation A	0.6 ± 0.1	0.6 ± 0.1[a]	10.51	10.3 ± 1.6	21.02	21.2
West Courtyard	0.6 ± 0.1	0.9 ± 0.1	---[b]	16.5 ± 1.1	---	33.9
Area 8W (North)	0.1 ± 1.0	<0.1	<1.53	1.8 ± 1.2	<3.06	3.7
Area 8W (South)	0.2 ± 0.1	<0.1	1.67	3.6 ± 1.0	<3.34	7.3

[a]Uncertainties represent the 95% confidence level, based only on counting statistics.
[b]---Data not provided.

REFERENCES

Bechtel National, Inc. (BNI). Characterization Report for the Former Baker Brothers Site, Toledo, Ohio. Oak Ridge, TN; 1995.

Bechtel National, Inc. Post-remedial Action Report for the Former Baker Brothers Site, Toledo, Ohio. Oak Ridge, TN; February 1996.

Oak Ridge Institute for Science and Education (ORISE). Revised Verification Survey Plan for the Former Baker Brothers, Inc. Site, Toledo, Ohio. Oak Ridge, TN; August 1995.

Oak Ridge Institute for Science and Education (ORISE). Comments on the Draft Post-Remedial Action Report for the Former Baker Brothers Site, Toledo, Ohio. Oak Ridge, TN; April 1996.

Oak Ridge National Laboratory (ORNL). Radiological Survey of the Former Baker Brothers, Inc. Site 2551-2555 Harleau Place, Toledo, Ohio (BY0001). Oak Ridge, TN; March 1992.

U.S. Department of Energy (DOE). Radiation Protection of the Public and Environment. Washington, DC: DOE Order 5400.5; February 1990.

U.S. Department of Energy (DOE). Memorandum from J. Wagoner to L. Price, "Uranium Guidelines for the Baker Brothers Site, Toledo, Ohio." July 10, 1995.

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 employers.

DIRECT RADIATION MEASUREMENT

Instruments

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

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

Detectors

Eberline GM Detector
Model HP-260
Effective Area, 20 cm^2
(Eberline, Santa Fe, NM)

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

Ludlum Gas Proportional Detector
Model 43-68
Effective Area, 126 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ion Chamber
Model RSS-111 and RSS-112
(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

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)

Low Background Gas Proportional Counter
Model LB-5100-W
(Oxford, 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 floors of the surveyed areas. Other surfaces were scanned using small area (20 cm^2 or 126 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-Beta - gas proportional detector with ratemeter-scaler

Beta-Gamma - GM detector with ratemeter-scaler

Gamma - NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were primarily performed using gas proportional 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. Because different building materials (poured concrete, brick, wood, steel, etc.) may have very different background levels, average background counts were determined for each material encountered in the surveyed area at a location of similar construction and having no

known radiological history. The beta activity background countrates for the gas proportional detectors averaged 385 for concrete, 343 for wood, 485 for brick, and 252 for concrete block. Beta efficiency factors ranged from 0.33 to 0.35 for the gas proportional detectors calibrated to Tl-204. The beta minimum detectable activity (MDC) was 213 to 221 dpm/100cm^2. The effective window for the gas proportional detectors was 126 cm^2.

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) and a bicron microrem meter at 1 m above the surface. While the PIC measurements were read directly in μR/h, the bicron displays data in μrem/h - the conversion to μR/h is essentially unity.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

RADIOLOGICAL ANALYSES

Removable Activity

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

Gamma Spectrometry

Soil samples 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. 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. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Energy peaks used for determining the activities of radionuclides of concerns were:

U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

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. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 2.71 plus 4.65 times the standard deviation of the background count [$2.71 + (4.65\sqrt{BKG})$]. When the activity was determined to be less than the MDC of the measurement procedure, the result was reported as less than MDC. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclide in samples, the detection limits differ from the sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

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 were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revision 9 (April, 1995)
- Laboratory Procedures Manual, Revision 9 (January, 1995)
- Quality Assurance Manual, Revision 7 (January, 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

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.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

The basic dose limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr.[2] In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

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.

SURFACE CONTAMINATION GUIDELINES

	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[a]		
Radionuclides[b]	Average[c,d]	Maximum[d,e]	Removable[d,f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	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	5,000β-γ	15,000β-γ	1,000β-γ

[a] 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.

[b] 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.

[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. The numbers in this column are maximum amounts.

SOIL GUIDELINES

Radionuclides	**Soil Concentration (pCi/g) Above Background[a,b,c]**
Radium-226, Radium-228, Thorium-230, Thorium-232	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.
Total Uranium	35 pCi/g, calculated on a site-specific basis, using the DOE manual developed for this use.

[a] 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").

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

[c] 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 $(100/A)^{½}$, 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.[3,4] 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

"Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," U.S. Department of Energy, Revision 2, March 1987.

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

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