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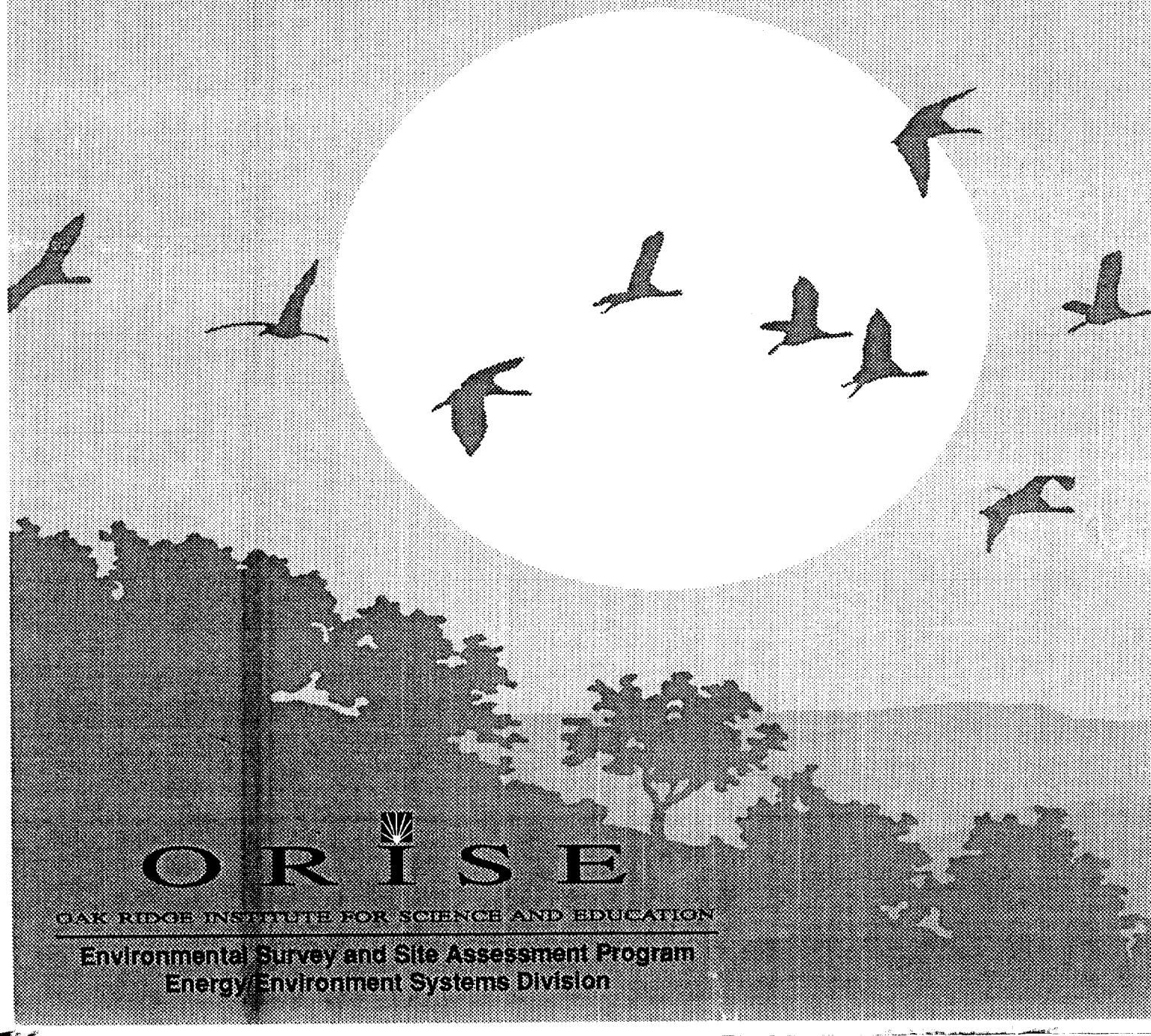
VERIFICATION SURVEY OF BUILDINGS 3 AND 8 ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

E. W. ABELQUIST

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



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ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
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July 28, 1995

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SUBJECT: FINAL REPORT-VERIFICATION SURVEY OF BUILDINGS 3 AND 8, ALIQUIPPA FORGE SITE, WEST ALIQUIPPA, PENNSYLVANIA

Dear Dr. Williams:

Enclosed are five copies of the subject document. Your comments have been incorporated into the final report. Please do not hesitate to contact me at (615) 576-3740 or William L. (Jack) Beck at (615) 576-5031 should you have any questions.

Sincerely,

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VERIFICATION SURVEY OF BUILDINGS 3 AND 8 ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Prepared by

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Prepared for

Office of Environmental Restoration
U.S. Department of Energy

FINAL REPORT

JULY 1995

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

VERIFICATION SURVEY
OF BUILDINGS 3 AND 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

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ACKNOWLEDGEMENTS

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ABBREVIATIONS AND ACRONYMS

μR/h	microroentgens per hour
AEC	Atomic Energy Commission
ANL	Argonne National Laboratory
ASME	American Society of Mechanical Engineers
BNI	Bechtel National, Inc.
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	U.S. Department of Energy
DOE-ORO	DOE Oak Ridge Operations
dpm/100 cm^2	disintegrations per minute/100 square centimeters
EML	Environmental Measurement Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
FSRD	Former Sites Restoration Division
FUSRAP	Formerly Utilized Sites Remedial Action Program
GM	Geiger-Mueller
h	hour
kg	kilogram
km	kilometer
m	meter
m^2	square meter
MDA	minimum detectable activity
NaI	sodium iodide
NIST	National Institute of Standards and Technology
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
pCi/g	picocuries per gram
PIC	Pressurized Ionization Chamber
PMC	Project Management Contractor
post-RA	post-remedial action
RSC	Radiological Support Contractor
ZnS	zinc sulfide

VERIFICATION SURVEY
OF BUILDINGS 3 AND 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

INTRODUCTION AND SITE HISTORY

From July 1948 to late 1949, Vulcan Crucible Steel Company operated a uranium-rolling process for the Atomic Energy Commission (AEC), predecessor agency to the Department of Energy (DOE), in Building 3 of the facility formerly owned by Universal Cyclops Specialty Steel Division of the Cyclops Corporation and currently owned by Aliquippa Forge, Inc. Processed natural uranium billets were sent to the Vulcan facility, where, during the rolling operation, the billets were formed into rods and finished rods were boxed and shipped to other AEC facilities. The site was decontaminated in 1950 following completion of AEC operations.[1]

In 1978, a radiological survey performed in and around Building 3 by Argonne National Laboratory (ANL), identified radioactive contamination above current guidelines on floors and walls and on overhead beams above the furnaces that were used to heat the billets.[1] In addition, contaminated steel flooring was found outside the building, alongside the cooling tower.

Radiological surveys that have been conducted since 1978 have identified other areas of residual uranium contamination, both within Building 3 and on the surrounding grounds. The residual contamination exceeded current guidelines for release to unrestricted use; therefore, the property was included in DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP) in August 1983. FUSRAP was established in 1974, and major remedial actions began at FUSRAP sites in 1981.

In December 1987, a limited radiological characterization survey, performed by Bechtel National, Inc. (BNI), identified 14 areas of contamination in and around Building 3.[2] Interim remedial activities were conducted by BNI in 1988 to allow restricted use of the building by Aliquippa Forge, Inc. Most of the building was remediated by removing contaminated

materials/equipment, and placing a barricade around the remaining contaminated area. Post-remedial action surveys of Building 3 indicated that contamination was successfully removed from a large portion of the building.

During the period of May 17 through 22, 1992 , the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Institute for Science and Education (ORISE) performed a radiological survey of the buildings and grounds (excluding Building 3) to determine the radiological status of the entire site, prior to characterization and remediation activities in Building 3.[3] During the period of June 8 through 12, 1992, ESSAP performed an initial characterization survey of Building 3, Building 8, and the outdoor area along the west side of Building 3.[4] Additional characterization of areas within and adjacent to Buildings 3 and 8, that were inaccessible during the initial characterization efforts, was performed during the periods of July through October, 1993.[5] Verification survey activities commenced in late August 1993 and were completed in late September 1994. Verification activities were conducted in areas that were characterized both during the previous characterization surveys and during the recent additional characterization surveys.

While most of the residual contamination at the Aliquippa Forge Site has been removed by remedial actions conducted under FUSRAP, residual radioactive material in excess of the surface contamination guidelines remains in place on the ceiling roof panels, between the purlins and roof panels, and in the overlapping roof panel joints in Building 3. Residual activity is also present on the concrete support pedestals located along the east/west bay centerline in Building 3. This contamination is the subject of a hazard assessment performed by BNI. The hazard assessment recommended the use of supplemental limits for the above areas of residual contamination because the exposure risk to workers and members of the public is very low relative to the high cost of performing remedial action.[6]

SITE DESCRIPTION

The Aliquippa Forge Site is located in a mixed industrial/residential area on a 3.2 hectare (8 acre) parcel of land along the Ohio River in West Aliquippa, Pennsylvania (Figure 1). The

property, which is approximately 25 km (15 miles) northwest of Pittsburgh, Pennsylvania currently contains 11 buildings, 8 of which are interconnected; 2 water towers; a cooling tower, and a small water basin (Figure 2).

Building 3 (Figure 3) is divided into two bays: the west bay, which was roped-off and posted as a controlled area during remedial activities, has a medium pitch corrugated aluminum roof topped by two large turret ventilators and three round ventilators (turrets and ventilators later removed during remediation). Figure 4 shows the overhead plan for the trusses and purlins in the west bay. The east bay has an off-center corrugated aluminum roof characterized with skylights and topped with an elliptical ventilator that extends along the ridge. The two roof apexes are approximately 11 m in height. Roof drains extend from the gutter between the apexes to the concrete floor. Building 3 contains approximately 2,400 m^2 of floor space. It is constructed primarily of sheet-metal with steel structural beams and has a raised concrete foundation. The floor is mostly concrete with small areas of brick over dirt around the furnaces and bare dirt (where brick has been removed) or gravel. Pallets of fire brick and dismantled equipment cover large areas at the south end of the building. Two furnaces (now dismantled) and the cutter pit (removed) were also located within the west bay. An area identified as a "suspected mica pit," allegedly used for cooling the rolled uranium billets, is located in the east bay.

Building 8, which extends from the north end of Building 3, houses two large 2-piston air compressors. Building 8, also posted as a controlled area during remedial activities, consists of 4 areas, designated rooms A-D (Figure 5) and has a total floor space of approximately 500 m^2. Wall and ceiling construction are the same as in Building 3. Two round ventilators are present on the roof apex. The floor is mostly concrete with the exception of Room B, which is mainly brick over dirt. The mezzanine above Room D (Tool Room) has a wooden floor. The wall separating Buildings 3 and 8 is constructed of corrugated sheet-metal.

The outdoor area along the west side of Building 3 (adjacent to the loading dock) is bare soil, approximately 42 m in length and averages 6 m in width. A small loading dock area is located immediately south of the west bay of Building 3. A cooling tower and water basin, surrounded

by a chain link fence, border the area to the north; a packed dirt and gravel parking area borders to the west. A drain line extends along the west side of Building 3 and fourteen pipe penetrations exist on this same side of the building.

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 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 (PMC) for FUSRAP is Bechtel National, Inc. (BNI). BNI is responsible for the planning and the implementation of FUSRAP activities and managing the site characterization and remedial actions. BNI's radiological support contractor (RSC) for this project was Thermo Analytical, Inc./Eberline. Their primary function was to conduct the post-remedial action survey. 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 may be released for use, without restrictions.

The Aliquippa Forge Site was selected for remediation under a proposed expedited protocol being considered within FUSRAP. In contrast to the standard protocol, under the expedited protocol, the designation contractor, for this site ORISE, functions as the organization responsible for the characterization and verification activities, while BNI is responsible for

conducting the remedial action and post-remedial action survey. Since the Aliquippa Forge Site had been designated previously, ORISE functioned as the organization responsible for characterization and verification only.

OBJECTIVES

The objectives of the verification process were to provide independent document reviews and radiological data to the DOE. These independent evaluations may then be used to determine whether procedures and methods, used by the remedial action contractor, were adequate. In addition, independent verification provides assurance that the post-remediation data is sufficient, accurate and demonstrates that remedial actions were accomplished in accordance with appropriate standards and guidelines, and that authorized limits were met.

DOCUMENT REVIEW

BNI's survey data, drafts of the hazard assessment report, and the predecisional draft of the post-remedial action report were reviewed for general thoroughness, accuracy, and consistency.[6,7] Remedial action data were evaluated to assure that areas previously identified as exceeding guidelines by ESSAP had undergone remediation. Post-remedial action survey results were compared with guidelines to ensure that the remedial action objectives had been met.

PROCEDURES

During the period from August 1993 through September 1994, ESSAP performed verification survey activities for Buildings 3 and 8, and outdoor areas on the site. These survey activities were performed over seven visits to the Aliquippa Forge Site (August 23 through 28, 1993; September 8 through 15, 1993; September 27 through October 2, 1993; October 18 through 27, 1993; January 10 through 13, 1994; February 24, 1994; and September 28 through 30, 1994). The verification survey activities were conducted in accordance with a survey plan dated August 19, 1993 submitted to and approved by the DOE.[8] This report summarizes the procedures and results of the verification surveys.

SURVEY PROCEDURES: INTERIOR

ESSAP used the following procedures for the interior portions of the survey.

Reference Grid

Measurements from the overhead purlins and trusses in Buildings 3 and 8 were referenced to purlin and truss maps established by the PMC and/or to prominent building features. A 1 m^2 reference grid was established by ESSAP on the floors and lower walls (up to 2 m) of the Basement, Tool Room and Mezzanine in Building 8 and the east bay floor of Building 3. Ceilings, upper walls and areas smaller than 10 m^2 (e.g., pipe chase manhole, compressor pits, etc.) were not gridded. ESSAP used the 10 m^2 reference grid system established by the PMC for survey reference in the Building 3 west bay excavated soil area. Measurements and samples from ungridded surfaces were referenced to the floor grid or to prominent building/equipment surfaces.

Surface Scans

Surface scans for beta and gamma activity were performed on 10 to 50% of the floors, walls, overhead purlins and trusses, equipment, ceilings, and excavated soil areas using GM and NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation identified by surface scans were marked for further investigation.

Surface Activity Measurements

The radionuclide of concern is processed natural uranium, i.e. uranium separated from its long lived progeny, but in its naturally occurring isotopic abundances. Processed natural uranium emits both alpha and beta radiation in approximately equal proportions; either beta activity levels or alpha activity levels may, therefore, be measured for determining uranium surface activity levels.

Measurements for beta activity levels, rather than alpha activity, provide a more accurate representation of uranium surface activity because rough, dirty or damp surfaces may selectively attenuate alpha radiation. Therefore, beta activity was measured to determine residual uranium levels.

Measurements to determine total beta surface activity levels were performed on randomly selected grid blocks on the Building 3 west wall, Building 8 Basement, and Tool Room floor (Figures 51 through 53). Single-point measurements were performed on all other surfaces; including trusses and purlins, floors, walls, ceilings, equipment, and at locations of elevated direct radiation by surface scans. Grid block averaging was also performed at locations where the single-point measurement indicated that the average surface contamination guideline was exceeded.

The PMC performed additional remediation and post-RA surveys at locations ESSAP identified as exceeding guidelines. ESSAP resurveyed each of these locations as part of the verification survey activities (these survey measurements were termed "post-additional RA" measurements in Table 1). The number of single-point or grid block measurements exceeding guidelines for a particular location is indicated in parentheses next to the total beta activity range. The total beta activity range for these post-additional RA measurements is provided immediately following the initial measurement range. Thus, the "post-additional RA" notation on the figures indicates that a minimum of two independent measurements were performed at these locations.

Thirty-nine (39) grid block measurements were performed in the Tool Room, Basement, and on the Building 3 west wall (including 2 post-additional RA grid block measurements performed on the Building 3 west wall). Four hundred and seventy-nine (479) single-point direct measurements and eighty-one (81) grid block measurements were performed on the overhead trusses and purlins in Buildings 3 and 8 (Figures 6 through 46). In addition, the following single-point measurements were performed on interior surfaces in Buildings 3 and 8: 38 measurements on the superstructure and other miscellaneous equipment and structures in Building 3 (Figures 47 through 49); 136 single-point measurements were performed on the east bay floor (Figure 50); 35 measurements on the Tool Room walls and ceiling (Figures 54 and

55); 93 measurements on the Mezzanine floors, walls, and overheads (Figures 56 through 61); 16 measurements on overheads and walls in Room B (Figures 62 through 64); and 64 measurements in the Compressor Room and Pits (Figures 65 throughout 68).

A smear sample for determining removable activity was obtained from each grid block, at the location corresponding to the maximum direct measurement, and from each single-point direct measurement location. Measurement and sampling locations for total and removable activity are illustrated in Figures 6 through 68.

Exposure Rate Measurements

Background exposure rate measurements were performed at 1 m above the surface at 10 site locations in Buildings 1, 2, 9, and 10 during a previous ESSAP visit to the site.[3] These buildings have a similar construction as Buildings 3 and 8, and have no site history indicating the use of radiological materials.

Exposure rate measurements were performed at 1 m above the surface at 16 locations in the Building 8 Tool Room, Basement, Room B excavated soils area, and the Building 3 west bay. All exposure rate measurements were performed using a pressurized ionization chamber (PIC). Measurement locations are shown in Figures 52, 53, 69, and 70.

Soil Sampling

Soil samples were collected from 3 locations in the excavated soils area in Building 8 Room B (Figure 69) and from 4 locations in the suspected mica pit area in Building 3 (Figure 71).

Surface soil samples were also collected from the excavated soil area in the west bay of Building 3. ESSAP performed five-point systematic soil sampling from 2 grid blocks (grid blocks 3A and 4A) randomly selected from the excavated soil area (Figure 72). Nine additional soil samples were collected from locations of elevated direct radiation identified by surface scans in the west bay excavation (these samples are referred to as biased soil samples).

As noted in subsequent discussions of analytical results, the uranium concentrations in these biased samples indicated that localized areas of residual uranium activity remained in the west bay soil excavation. The PMC's post-RA survey results did not include data on these hot spots. Subsequently, the PMC performed beta scans in the west bay and also identified locations of elevated direct radiation. However, the PMC's analysis of these hot spot locations indicated uranium concentrations less than the soil guideline established for the site (100 pCi/g total uranium).[9]

In an attempt to resolve differences in reported uranium concentrations, ESSAP and the PMC collected biased soil samples from 10 locations in the west bay of Building 3 (Figure 73). Each sample was homogenized in an aluminum mixing bowl prior to ESSAP and the PMC collecting sample splits. These analyses, reported subsequently in Table 4 of this report, indicated general agreement between data sets.

Miscellaneous Sampling

Three samples were collected from the crushed brick piles that resulted from waste minimization activities. These crushed brick samples originated from the demolition of the east and west furnaces, and from the brick floor in Building 8 Room B.

Samples were also collected from three locations in the west bay of Building 3, where the concrete floor had been removed and crushed, and then used as backfill (Figure 72).

Confirmatory Analyses

As part of the verification process, ESSAP performed independent confirmatory analyses on post-remedial action soil samples. Five soil samples, collected and analyzed by the PMC's radiological support contractor (RSC), were requested by ESSAP. These soil samples were collected from the west bay soil excavation in Building 3.

SURVEY PROCEDURES: EXTERIOR

ESSAP used the following procedures for outdoor portions of the survey.

Reference Grid

A 1 m x 1 m reference grid was established by ESSAP to reference exterior soil sample locations (Figure 74).

Surface Scans

Surface scans for beta and gamma activity were performed in the soil excavation on the west side of Building 3 (Figure 74) using GM and NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Areas of elevated direct radiation, suggesting the presence of surface contamination, were marked for further investigation.

Exposure Rate Measurements

Background exposure rate measurements were made at 6 off-site locations within 0.5 to 10 km of the site using a PIC. Measurement locations are indicated in Figures 75 and 76.

Exposure rate measurements were performed at 1 m above the surface using a PIC at 5 locations in the outdoor soil excavation on the west side of Building 3. Measurement locations are illustrated in Figures 74.

Soil Sampling

Background soil samples were collected from 6 off-site locations within 0.5 to 10 km of the site. Measurement locations are shown in Figures 75 and 76.

Three surface soil samples were randomly selected from the South Loading Dock area of Building 3. Sampling locations are shown in Figure 72.

Nine surface and subsurface soil samples were collected from 6 locations in the west side soil excavation. These samples were selected both randomly and from locations of elevated direct radiation as identified by surface scans. Sampling locations are shown in Figure 74.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to the ESSAP laboratory in Oak Ridge, Tennessee for analyses and interpretation. Soil and miscellaneous samples were analyzed by gamma spectrometry. Spectra were reviewed for U-235 and U-238, and any other identifiable photopeaks. Soil and miscellaneous samples results were reported in pCi/g. Smears were analyzed for gross alpha and gross beta activity. Direct measurement data and smear data were converted to units of disintegrations per minute/100 cm^2, and exposure rate measurements were reported in units of μR/h. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Results were compared to the DOE guidelines which are provided in Appendix C.

FINDINGS AND RESULTS

DOCUMENT REVIEW

As part of the expedited protocol, ESSAP reviewed the PMC's post-remedial action survey data as it became available. ESSAP directly notified the PMC concerning deficiencies identified in the documentation and of any areas exceeding guidelines following verification survey activities.

The hazard assessment and predecisional draft of the post-remedial action report were reviewed for general thoroughness, accuracy, and consistency, and comments were provided to the DOE.[10,11]

INTERIOR SURVEY

Surface Scans

Surface scans of Buildings 3 and 8 identified elevated direct radiation on overhead trusses and purlins, the superstructure, Room B overhead crane track, Mezzanine walls, Building 3 west wall, and the east and west bay floors. These locations were noted for additional surface activity measurements.

Surface Activity Levels

Measurement results in Table 1 are interpreted as follows: (1) the first entry for a particular area represents the initial measurement range, including values that exceed guidelines, the number of such values are provided in parentheses; (2) the next entry, if necessary, provides the range of the post-additional RA measurements. The final measurement range is summarized in the text. Surface activity measurements performed in Buildings 3 and 8 are presented in Table 1.

Single-point measurements on the Building 3 overheads (purlins and trusses) ranged from $<$1,300 to 24,000 dpm/100 cm^2, and grid block averages ranged from 1,600 to 9,000 dpm/100 cm^2, prior to additional remediation. Following the additional remediation by the PMC, post-additional RA single-point measurements ranged from $<$1,300 to 5,000 dpm/100 cm^2 and grid block averages ranged from 1,600 to 5,000 dpm/100 cm^2. Single-point measurements were also collected on the Building 3 ceiling at 18 locations in Bays 7 through 9 to verify the data used

in the PMC's hazard assessment (Figures 26, 29, and 32).[6] These single-points on the ceiling ranged from <1,300 to 77,000 dpm/100 cm^2. Removable activity levels ranged from <12 to 45 dpm/100 cm^2 for alpha and <16 to 47 dpm/100 cm^2 for beta.

Single-point measurements on the Building 8 overheads (purlins and trusses) ranged from <1,300 to 19,000 dpm/100 cm^2 and the one grid block average was 5,900 dpm/100 cm^2 prior to post-additional RA measurements. Following the additional remediation by the PMC, single-point measurements ranged from <1,300 to 2,300 dpm/100 cm^2. Removable activity levels were <12 and <16 dpm/100 cm^2 for alpha and beta, respectively.

Single-point measurements performed in other areas of Building 3 were as follows: cutter components and oven doors, <1,400 to 4,600 dpm/100 cm^2; superstructure, <1,300 to 53,000 dpm/100 cm^2 prior to additional remediation (≤1,300 dpm/100 cm^2 following post-additional RA measurements); pipe chase manhole, 2,700 to 3,600 dpm/100 cm^2; scale apparatus pit, <1,200 dpm/100 cm^2; and east bay floor, <1,600 to 19,000 dpm/100 cm^2 prior to additional remediation (<1,600 to 4,900 dpm/100 cm^2 following post-additional RA measurements). Grid block averages in other areas of Building 3 ranged from 1,900 to 2,100 dpm/100 cm^2 for the cutter components and oven doors; were 3,000 dpm/100 cm^2 for the east bay floor; and ranged from <1,500 to 3,900 dpm/100 cm^2 on the west wall following post-additional RA measurements (the 1 single-point measurement was 18,000 dpm/100 cm^2, prior to additional remediation). Removable activity levels ranged from <12 to 23 dpm/100 cm^2 for alpha and were <16 dpm/100 cm^2 for beta.

Single-point measurements performed in other areas of Building 8 were as follows: Tool Room walls and ceiling, <1,400 to 4,500 dpm/100 cm^2; Mezzanine trusses and purlins, <1,300 to 15,000 dpm/100 cm^2 prior to additional remediation (<1,300 to 4,300 dpm/100 cm^2 following post-additional RA measurements); Mezzanine floor and walls, <1,300 to 9,200 dpm/100 cm^2 prior to additional remediation (<1,300 to 2,100 dpm/100 cm^2 following post-additional RA measurements); Room B overheads and walls, <1,300 to 25,000 dpm/100 cm^2 prior to additional remediation (<1,300 to 4,900 dpm/100 cm^2 following post-additional RA measurements); east compressor pit, <1,300 to 4,000 dpm/100 cm^2; west compressor pit,

<1,300 to 4,000 dpm/100 cm^2; and compressor room floor and walls, <1,400 to 27,000 dpm/100 cm^2 prior to additional remediation (<1,300 to 2,200 dpm/100 cm^2 following post-additional RA measurements). Grid block averages in other areas of Building 8 were <1,500 for the Basement; ranged from <1,400 to 4,100 dpm/100 cm^2 for the Tool Room floor and walls; ranged from <1,300 to 4,200 dpm/100 cm^2 for the Mezzanine overheads and floor following post-additional RA measurements; ranged from 2,700 to 4,600 dpm/100 cm^2 for Room B; and ranged from 2,600 to 4,500 dpm/100 cm^2 for the Compressor Room and Pits. Removable activity levels were <12 dpm/100 cm^2 for alpha and ranged from <16 to 21 dpm/100 cm^2 for beta.

Exposure Rates

Exposure rate measurements collected from the Building 8 Basement, Tool Room, Room B, and Building 3 west bay soil excavation are summarized in Table 2. Background exposure rates for Buildings 1, 2, 9, and 10 ranged from 7 to 13 μR/h.[3] Interior exposure rates ranged from 8 to 12 μR/h.

Uranium Concentrations in Soil Samples

Uranium concentrations in soil samples collected from the suspected mica pit, Building 3 west bay soil excavation, and Building 8 Room B are presented in Table 3. The total uranium concentrations in the mica pit samples ranged from 2.1 to 11 pCi/g. Total uranium concentrations in soil samples collected from systematic sampling in the west bay soil excavation ranged from 2.7 to 47 pCi/g. Total uranium concentrations in the 9 biased soil samples collected from this area ranged from 76 to 730 pCi/g. The total uranium concentration in Building 8 Room B samples ranged from 1.7 to 30 pCi/g.

The uranium concentrations of the biased soil samples collected and analyzed by both ESSAP and the PMC are summarized in Table 4. Results for only 8 of the 10 sampled locations are reported as 2 of the ESSAP samples did not meet quality assurance requirements on the first analysis, and re-analysis was not warranted since the objective had been met (Figure 73). These

analyses indicate general agreement between both data sets and furthermore, demonstrate that the site-specific soil guideline has been met. It should be noted that the particulate nature of the uranium contaminant prohibited complete homogenization of the sample, and therefore, contributed to the differences in analytical results obtained by ESSAP and the PMC.

Uranium Concentrations in Miscellaneous Samples

Uranium concentrations in miscellaneous samples collected from the crushed brick piles are presented in Table 5. The total uranium concentrations in these samples ranged from 13 to 66 pCi/g.

Uranium concentrations in the crushed concrete floor samples are also provided in Table 5. The total uranium concentration within these samples ranged from 8.2 to 21 pCi/g.

Confirmatory Analyses

The comparative analytical results for the post-remedial action samples indicated discrepancies between ESSAP and the RSC for three of the samples.[12] In each of these cases, the results reported by the RSC were less than ESSAP's by approximately a factor of two. Subsequent discussions with the PMC and the RSC indicated that an improper counting geometry had been used, and upon re-analysis, their analytical results compared reasonably with the ESSAP results.

EXTERIOR SURVEY

Surface Scans

Beta and gamma surface scans of the South Loading Dock area (Figure 72) were within the range of ambient background levels.

Surface scans of the outdoor soil excavation (Figure 74) identified several locations of elevated direct beta radiation. Additional soil was remediated by the PMC. Post-remedial action scans, performed by ESSAP, indicated that residual beta and gamma activity had been reduced to ambient background levels.

Exposure Rates

Background exposure rates collected from the six off-site locations, shown in Table 6, ranged from 7 to 9 μR/h. Exposure rate measurements collected from the Building 3 exterior west side soil excavation are summarized in Table 7 and ranged from 9 to 10 μR/h.

Uranium Concentrations in Soils

Uranium concentrations in background samples are presented in Table 6. The total uranium concentrations in these background samples ranged from 2.3 to 4.7 pCi/g.

Total uranium concentrations in the three soil samples from the South Loading Dock area, summarized in Table 8, ranged from 6.5 to 22 pCi/g.

Table 8 also summarizes the uranium concentration in samples collected from the Building 3 west side soil excavation. The total uranium concentrations in the 3 samples collected from locations of elevated direct radiation as identified from surface scans ranged from 200 to 310 pCi/g. In each case, the contaminated soil was determined to be localized to an area less than 900 cm^2. The contaminated soil was removed by the PMC and post-remedial action samples were taken from the same location to verify the success of the remediation. The total uranium concentrations in these samples ranged from 31 to 51 pCi/g. Total uranium in samples collected from the other 3 locations ranged from 35 to 87 pCi/g (Figure 74).

COMPARISON OF RESULTS WITH GUIDELINES

The DOE guidelines for residual radioactive material are specified in DOE Order 5400.5. These guidelines are summarized in Appendix C. The surface contamination guidelines for processed natural uranium are as follows:[13]

Total Activity

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

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

Removable Activity

1,000 α dpm/100 cm^2

The site-specific uranium guideline for soil is 100 pCi/g for total uranium above background concentrations, averaged over an area of 100 m^2.[9] The DOE exposure rate guideline, measured at 1 m above the surface for habitable or occupiable structures, is 20 μR/h above background.[13]

All of the final ESSAP independent measurements satisfied the surface contamination guidelines once necessary additional remediation was performed by the PMC. One noted exception were the areas to be hazard assessed (i.e., overhead ceiling panels in Building 3). These measurements were consistent with those reported in the hazard assessment, considering the fact that the hazard assessment measurements were taken on the exterior side of the roof panels, while the verification measurements were taken on the interior side of the panels.[6]

Both interior and exterior exposure rates were below the exposure rate guideline.

The systematic soil samples collected within the west bay excavation area satisfied the soil guidelines. Although 6 of the biased soil samples exceed the average soil guideline established for the site, each of the samples collected by ESSAP represented an actual hot spot area less than 1 m^2. For this situation, an acceptable hot spot guideline of 10 times the authorized limit, or a total uranium concentration of 1,000 pCi/g, is applicable.[9,13] ESSAP's data supports that both

the average and hot spot guidelines have been satisfied for the surveyed grid blocks in the west bay of Building 3.

The crushed brick and concrete samples both met the site-specific guideline for total uranium concentration. This material was later used to partially backfill the west bay excavation in Building 3.

Uranium concentrations in soil samples collected from locations in the South Loading Dock area and along the west side of Building 3 were below the site-specific guideline following additional remediation by the PMC.

SUMMARY

During the period from August 1993 through September 1994, the Oak Ridge Institute for Science and Education's Environmental Survey and Site Assessment Program performed verification survey activities for Buildings 3 and 8, and outdoor areas at the Aliquippa Forge Site in West Aliquippa, Pennsylvania. Survey activities included surface scans, surface activity measurements, exposure rate measurements, and soil and miscellaneous sampling.

Direct measurements and smears of the remediated surfaces and samples of the remediated soils areas were compared to the DOE guidelines. The ESSAP survey results identified numerous locations of residual activity that exceeded surface contamination guidelines. Subsequent additional remediation was performed by the PMC and post-additional RA measurements by ESSAP verified that surface activity levels were within the DOE surface contamination guidelines. Exposure rate measurements and soil samples also were in compliance with their respective guidelines.

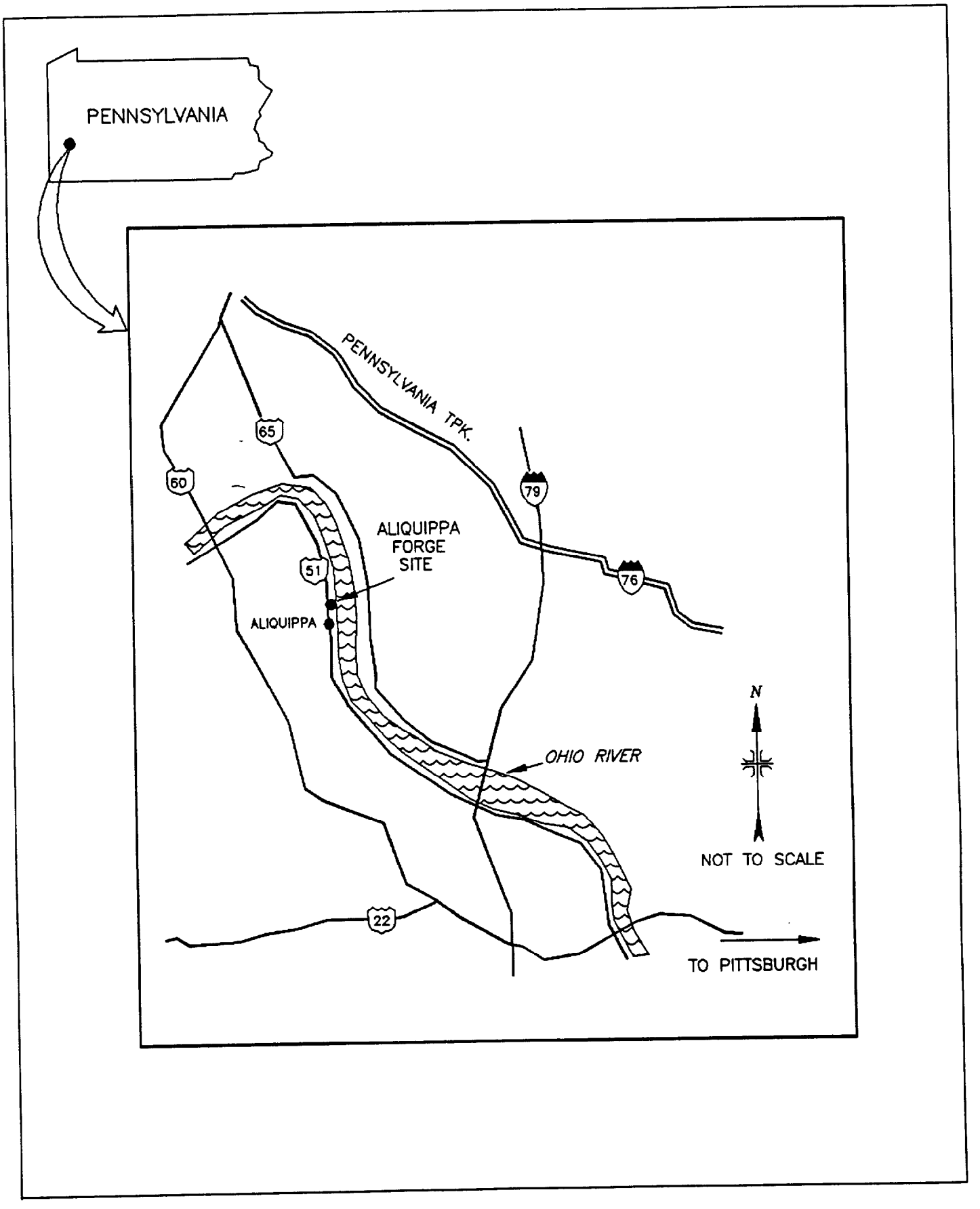


FIGURE 1: Location of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

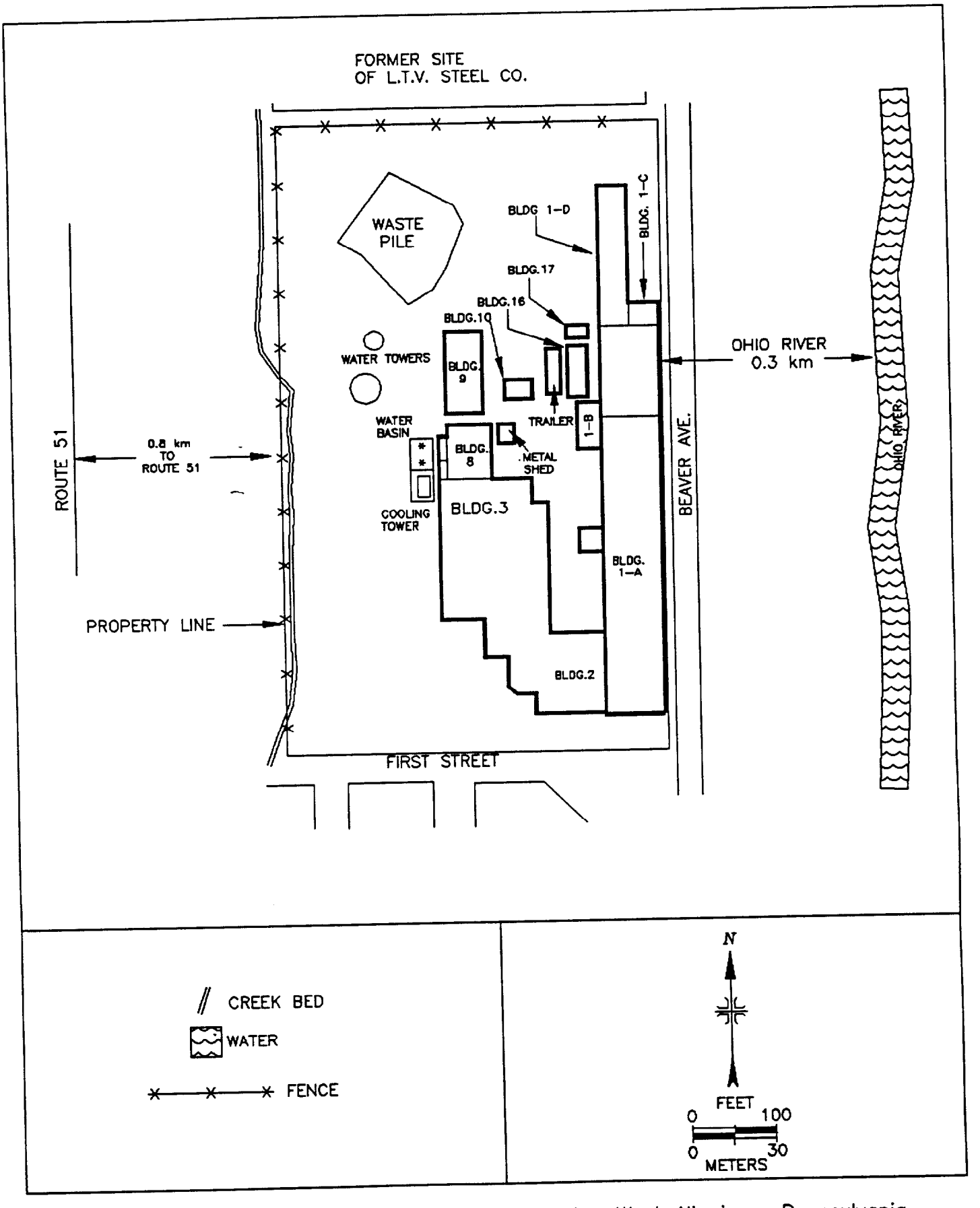


FIGURE 2: Plot Plan of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

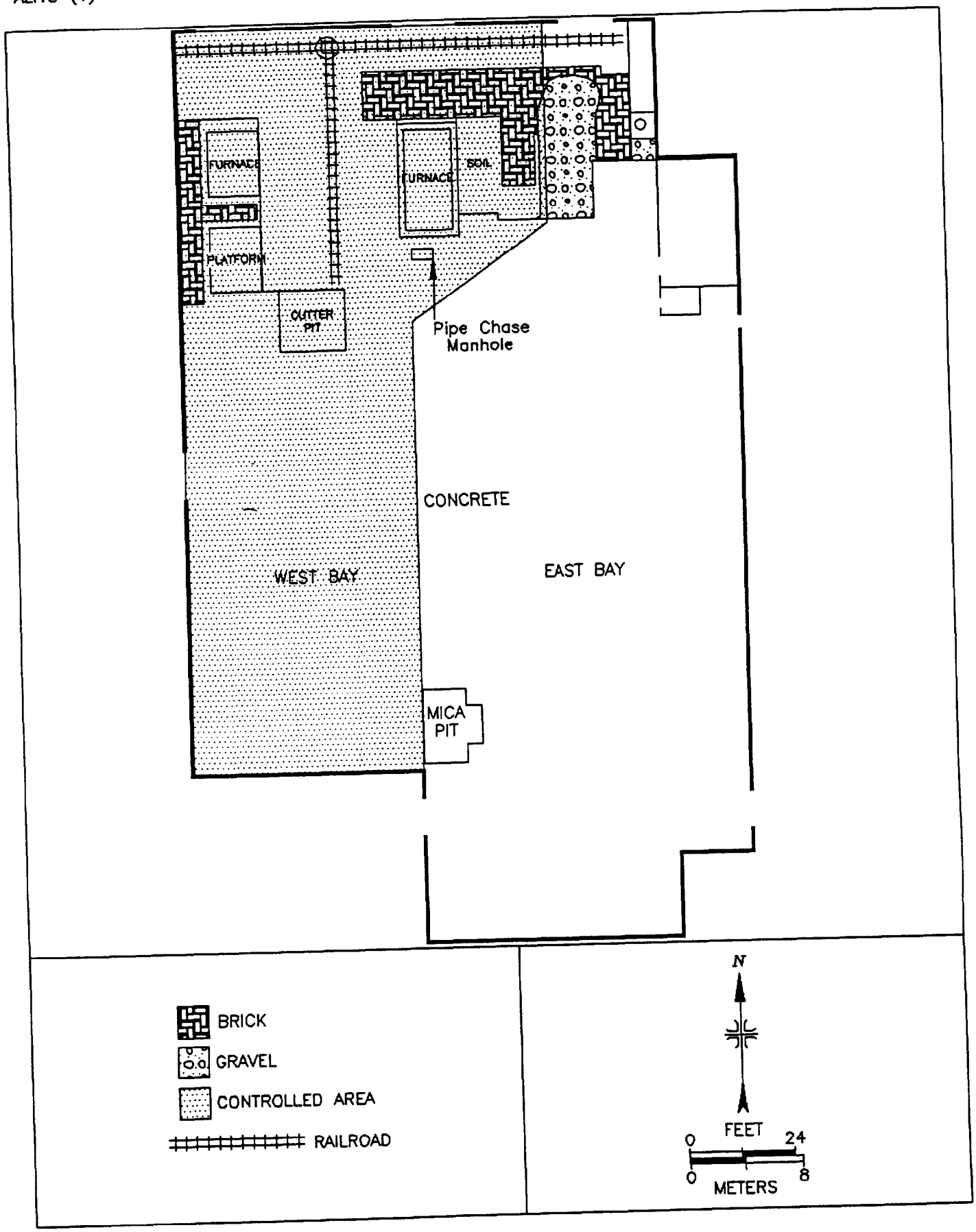


FIGURE 3: Pre-Remedial Action Floor Plan of Building 3

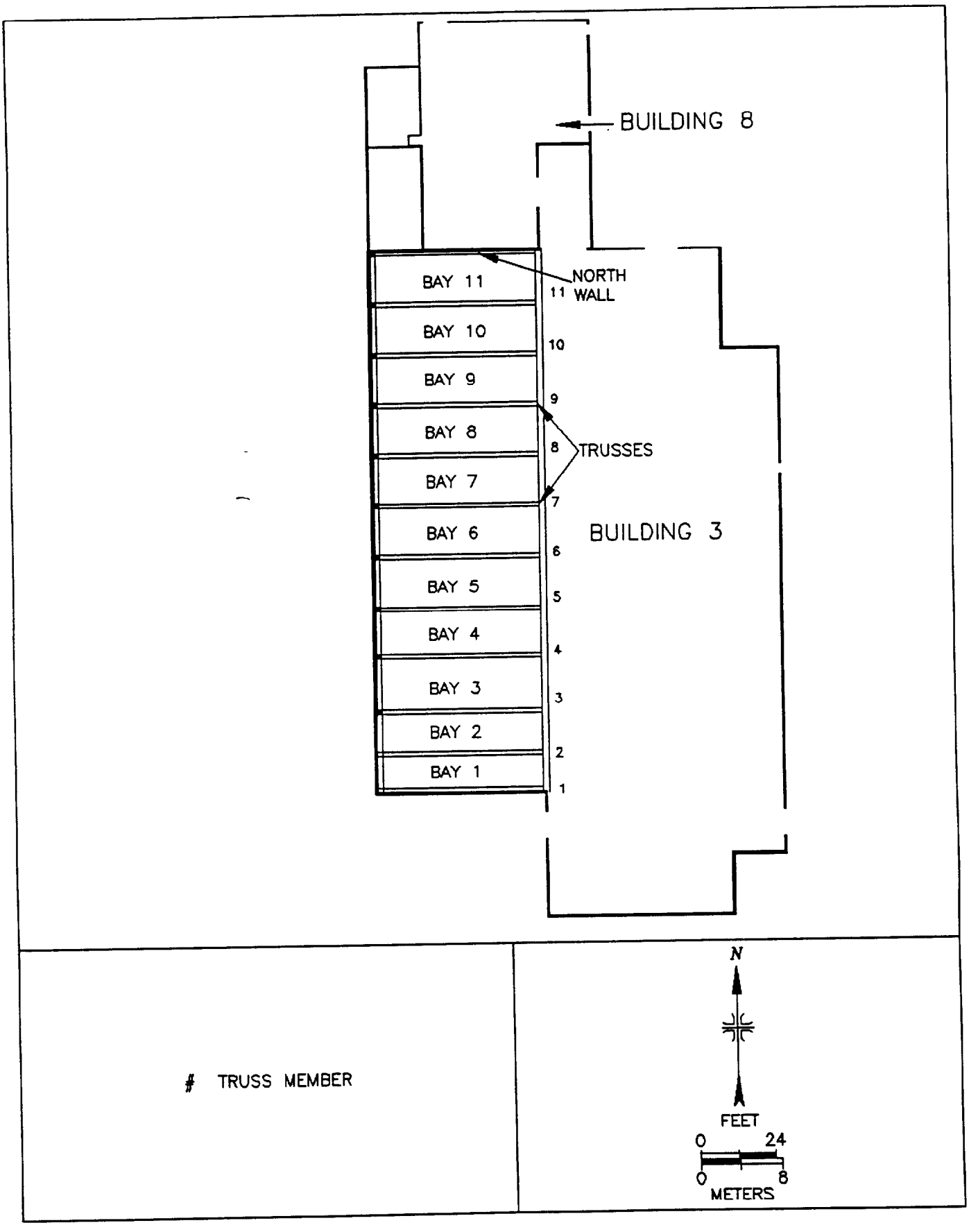


FIGURE 4: Building 3 – West Bay Overhead Plan

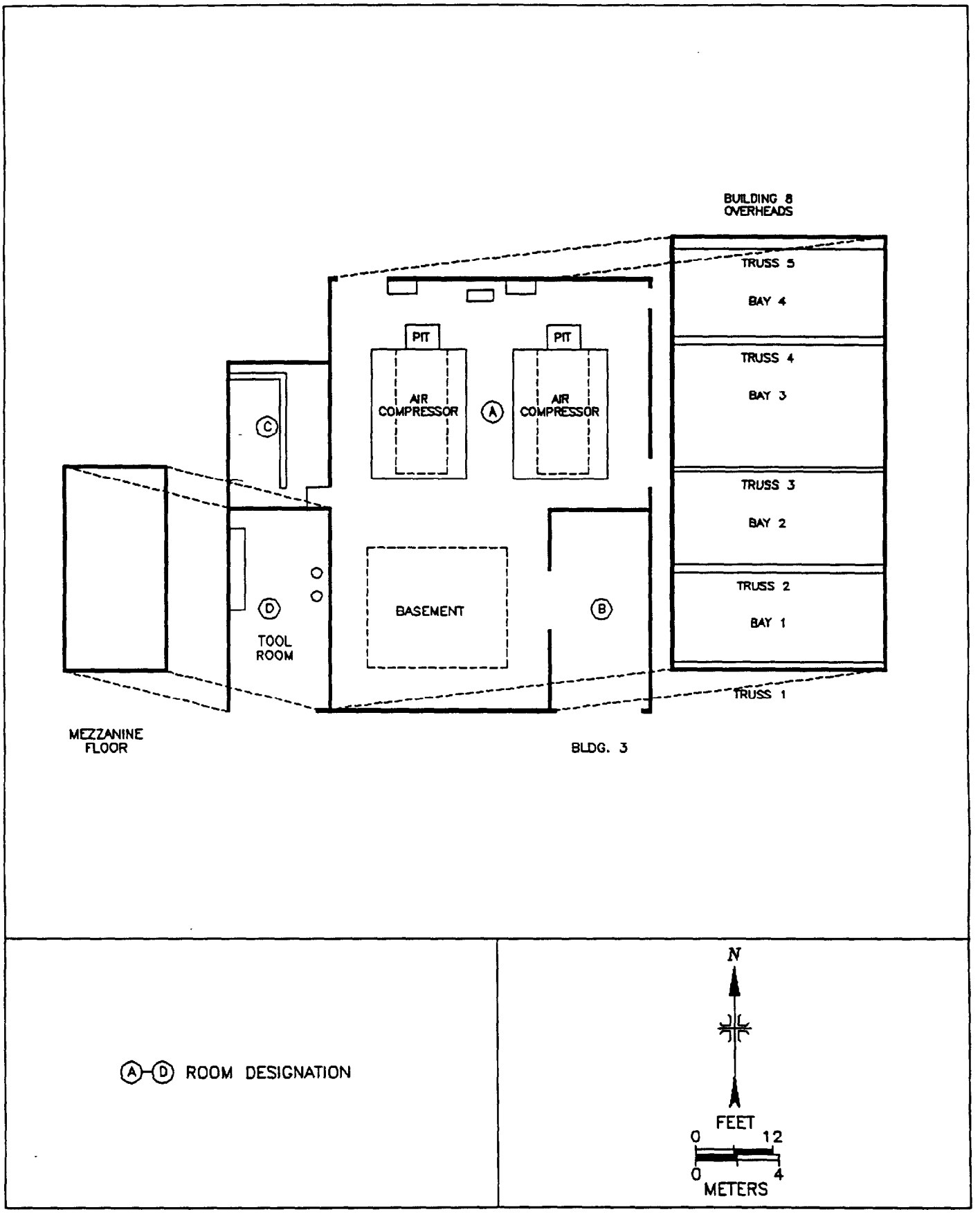


FIGURE 5: Floor Plan of Building 8

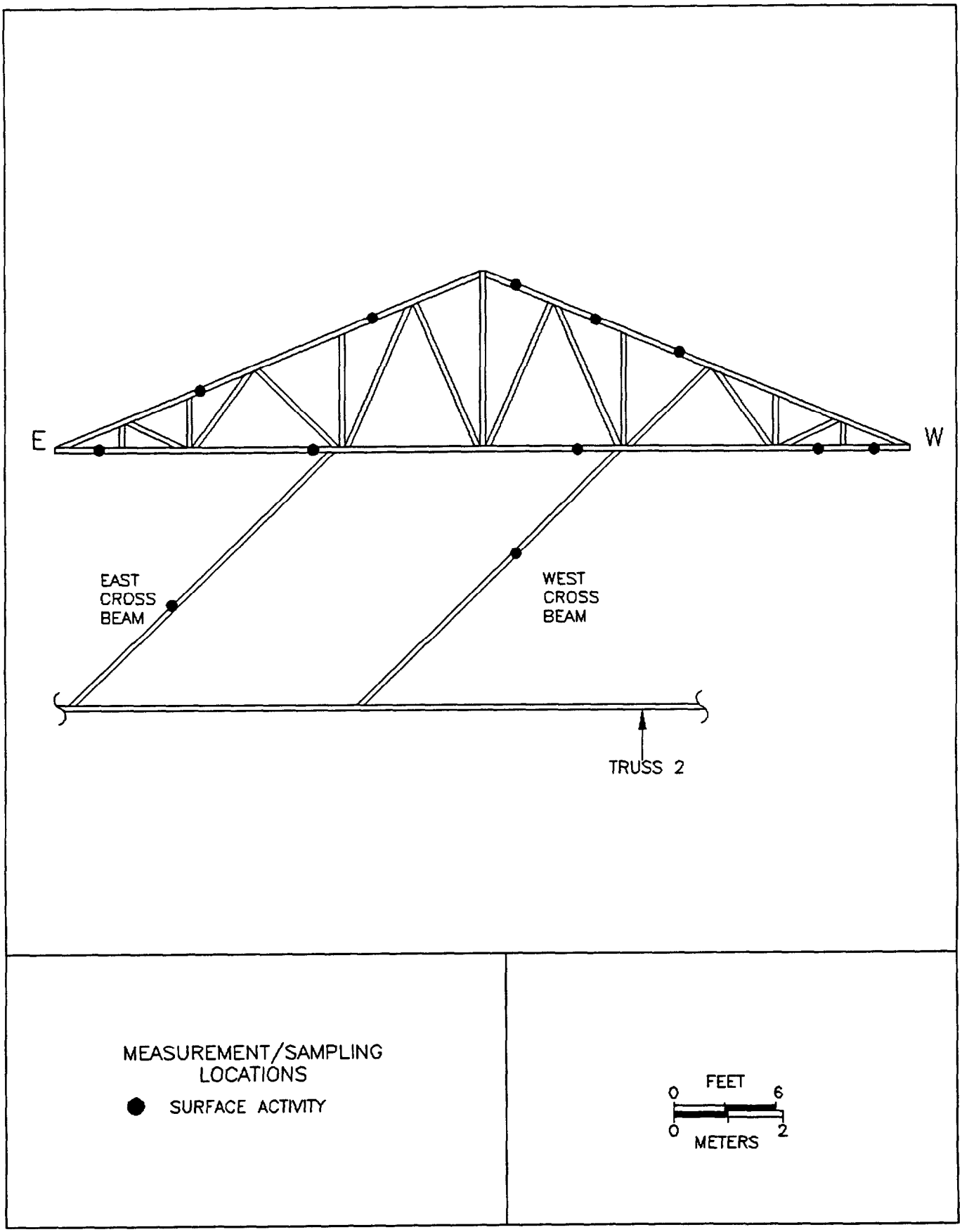
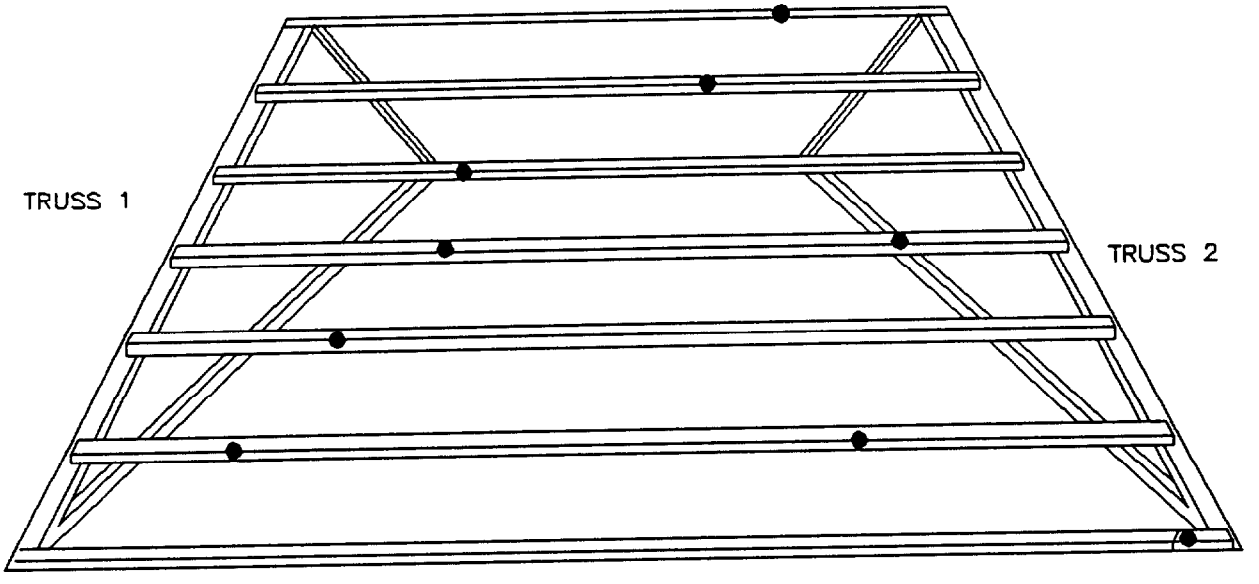


FIGURE 6: Building 3, Truss 1 – Measurement and Sampling Locations



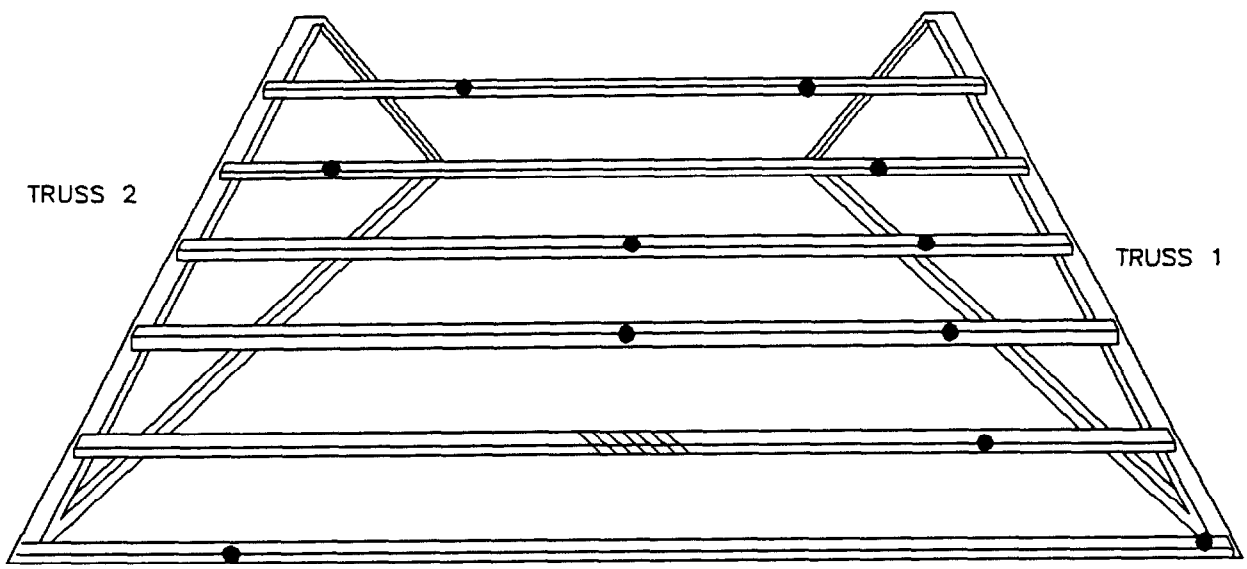
EAST SIDE

MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 7: Building 3, Bay 1, East – Measurement and Sampling Locations



WEST SIDE

MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 8: Building 3, Bay 1, West – Measurement and Sampling Locations

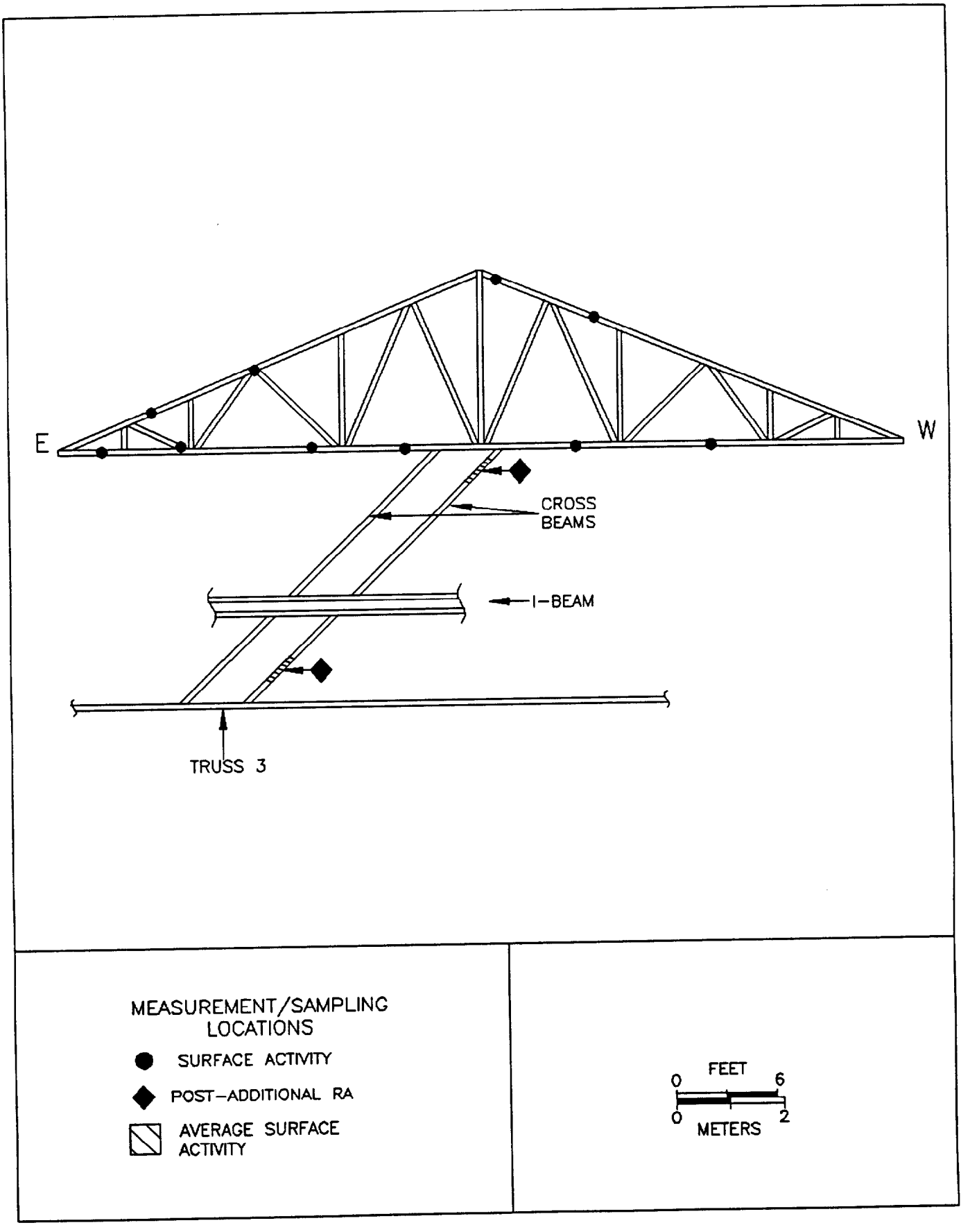


FIGURE 9: Building 3, Truss 2 – Measurement and Sampling Locations

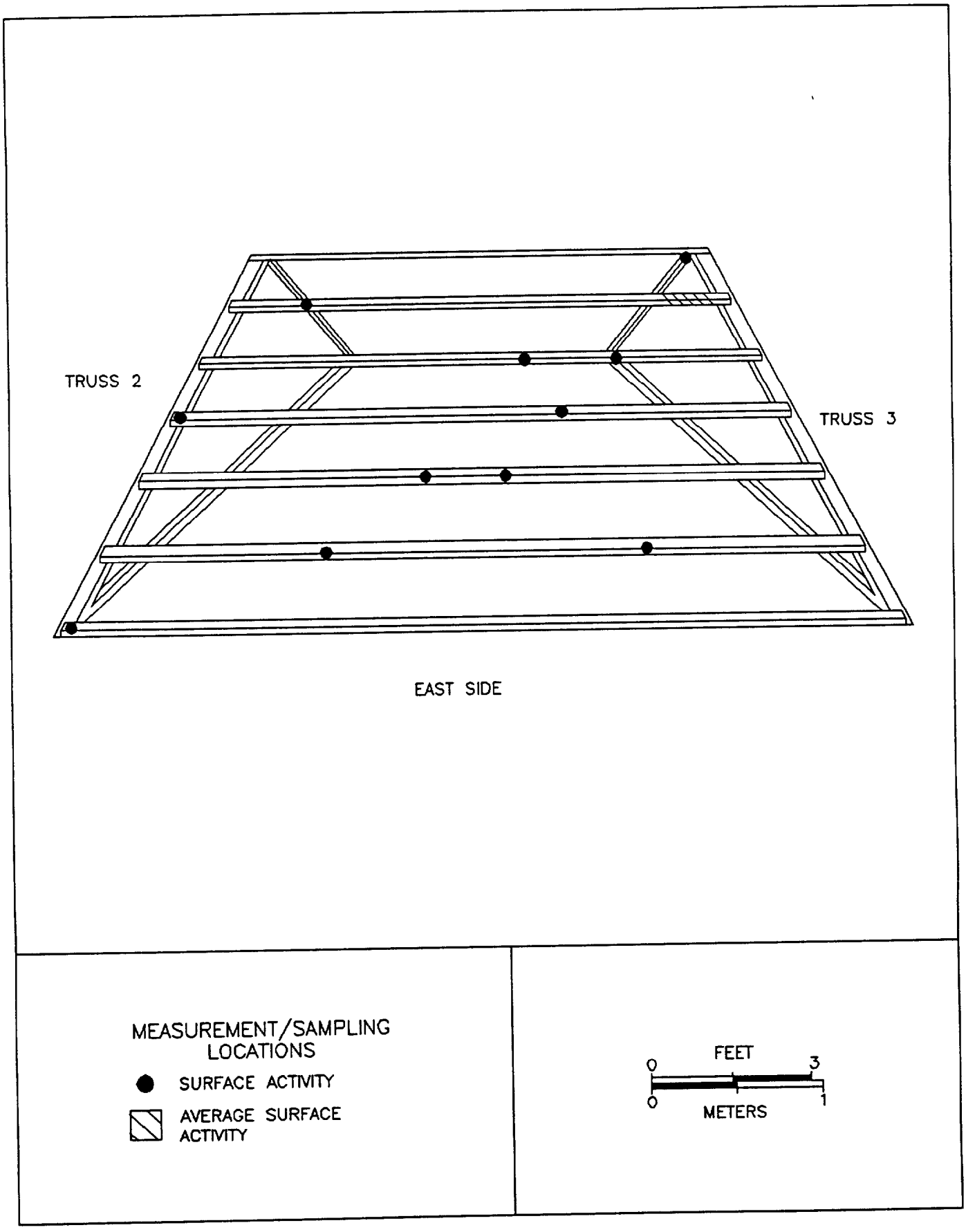
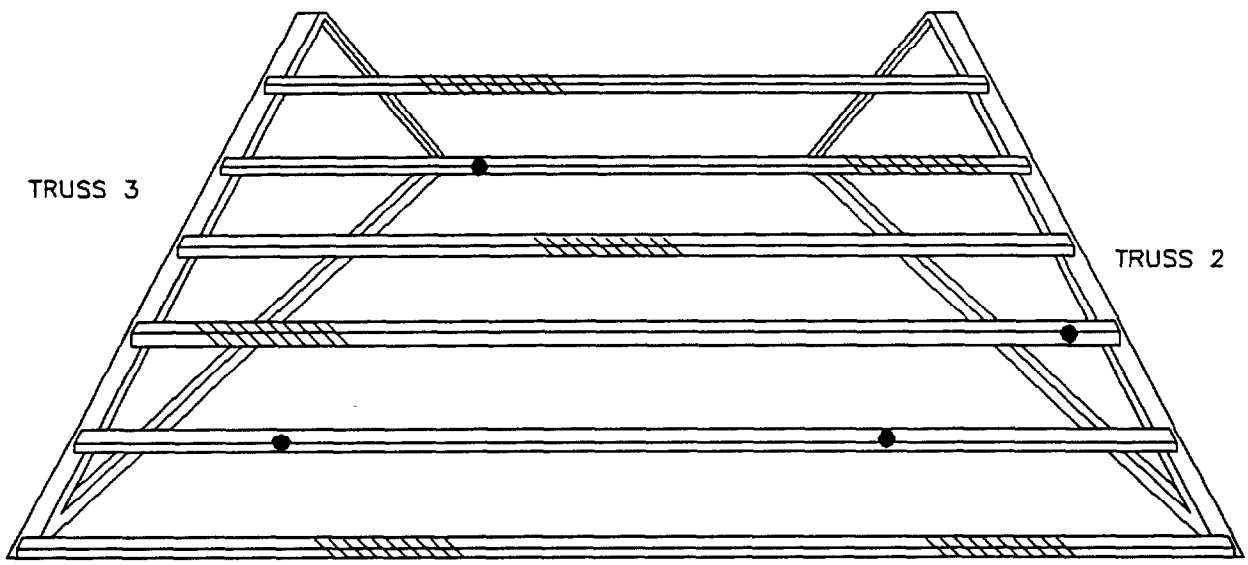


FIGURE 10: Building 3, Bay 2, East – Measurement and Sampling Locations



WEST SIDE

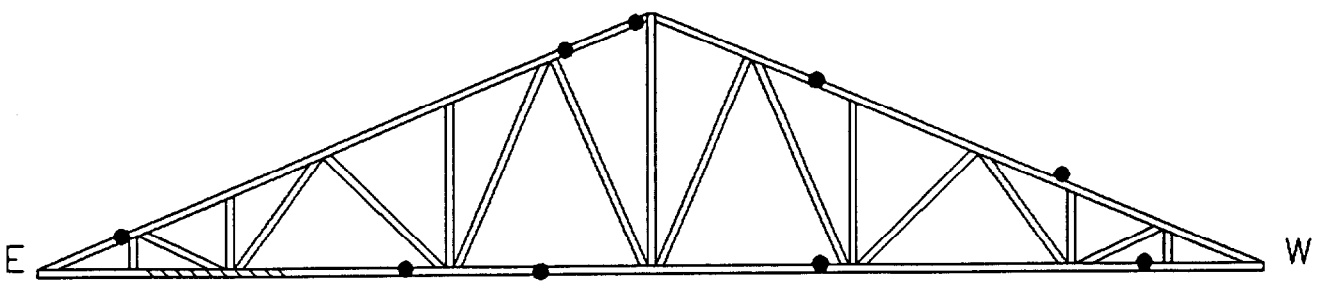
MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

▨ AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 11: Building 3, Bay 2, West – Measurement and Sampling Locations



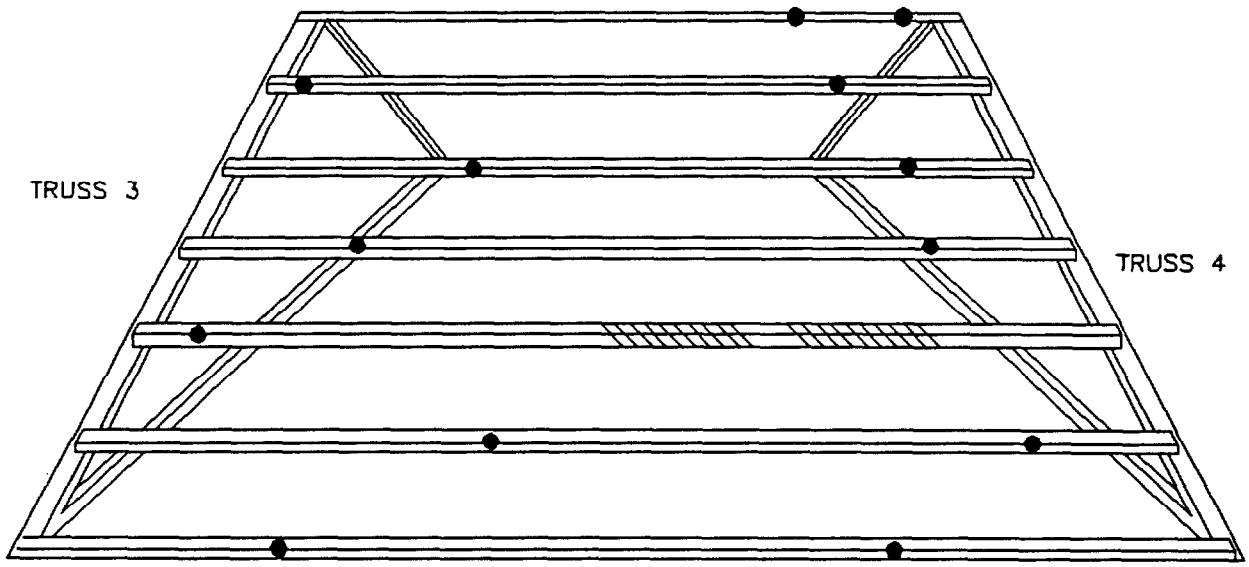
MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

▨ AVERAGE SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 12: Building 3, Truss 3 – Measurement and Sampling Locations



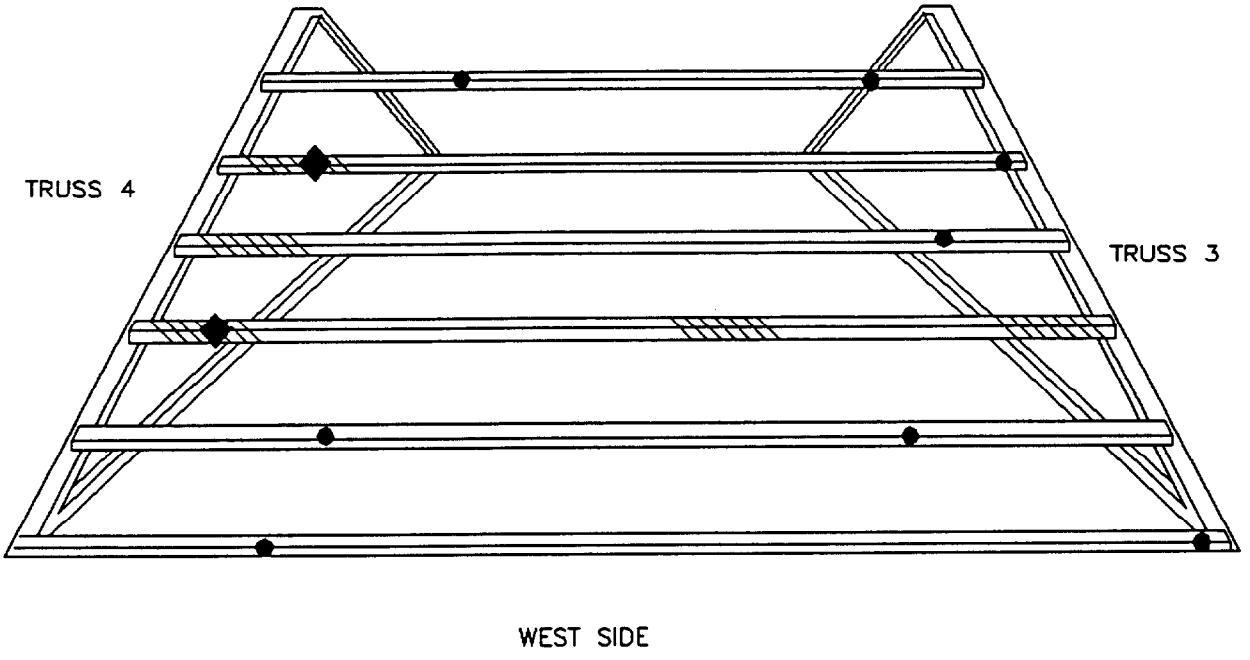
EAST SIDE

MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 13: Building 3, Bay 3, East – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST– ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 14: Building 3, Bay 3, West – Measurement and Sampling Locations

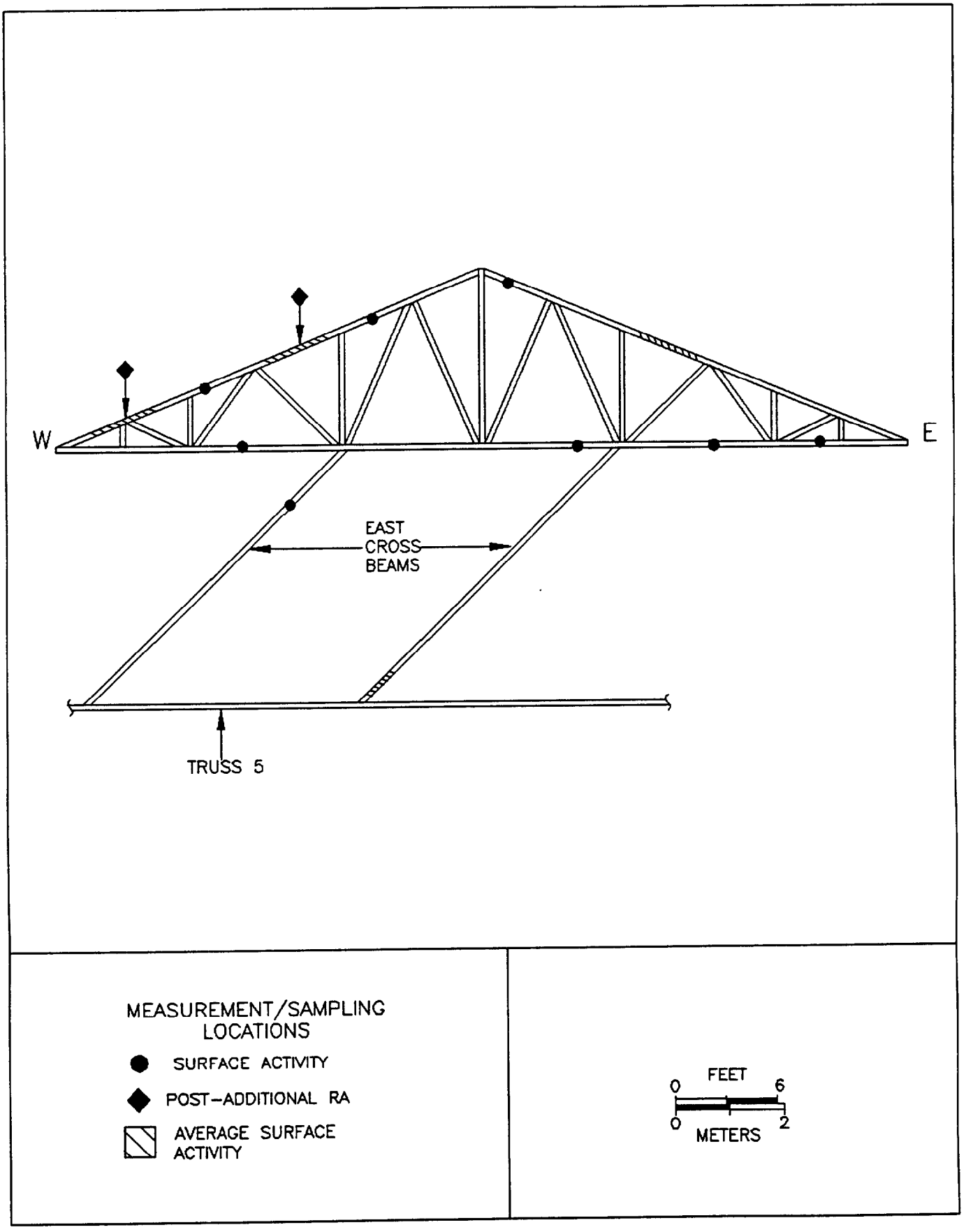
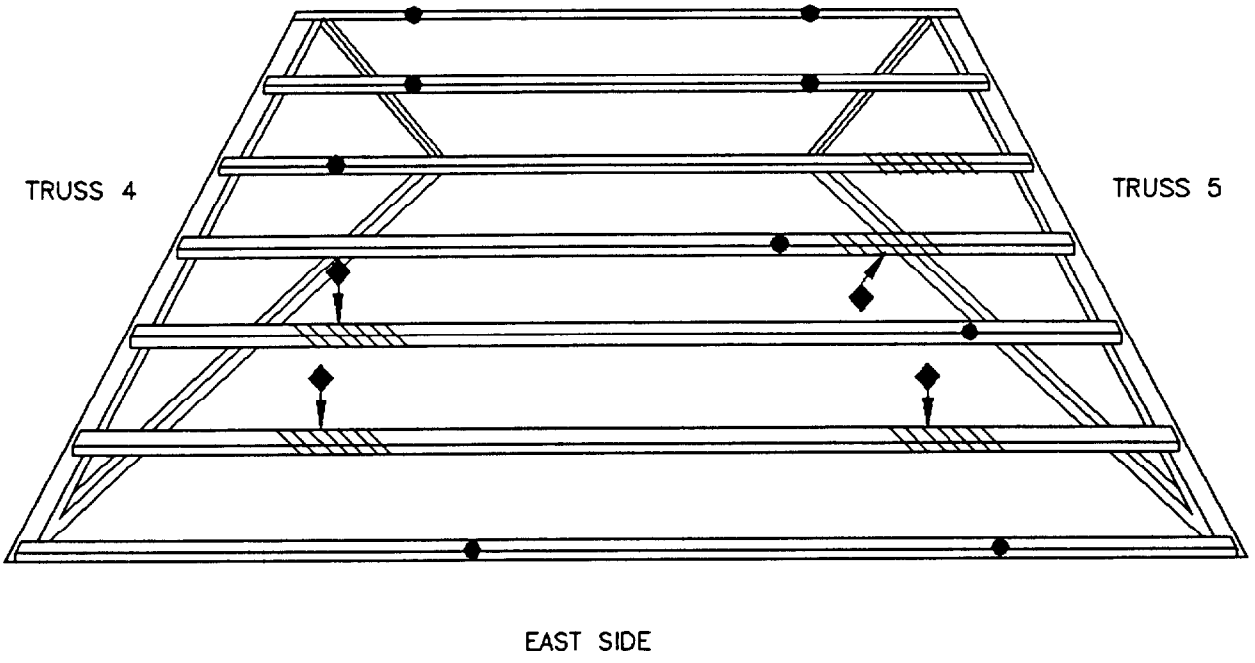


FIGURE 15: Building 3, Truss 4 – Measurement and Sampling Locations

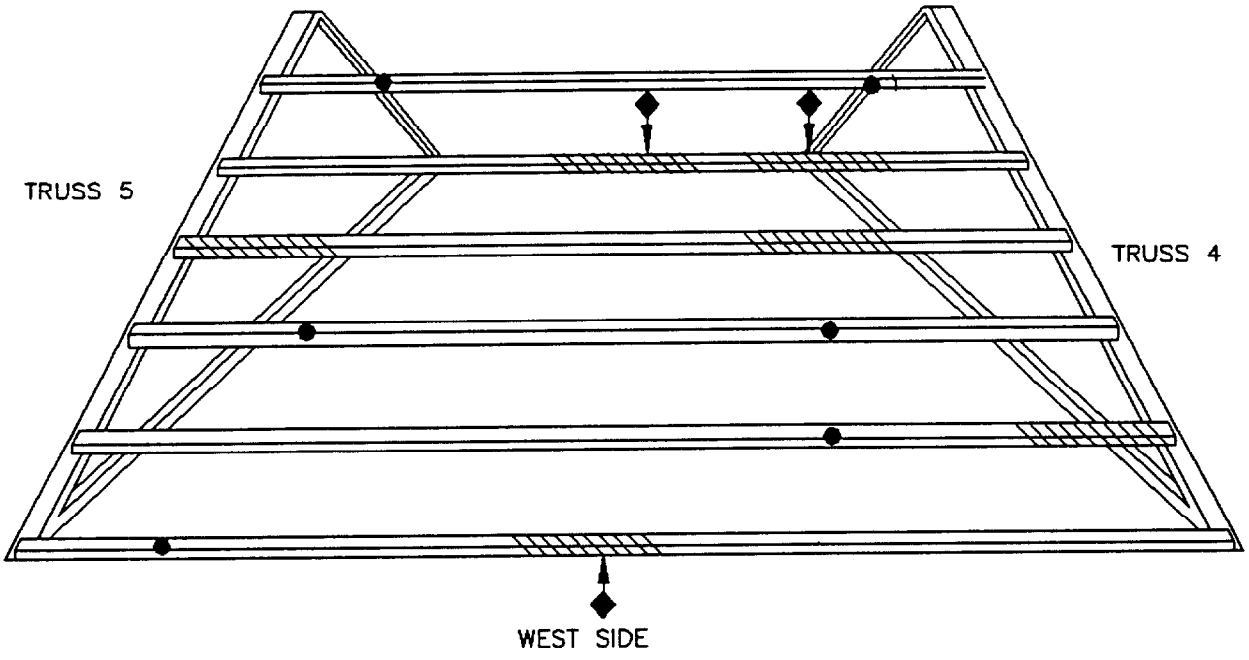


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET 0 3
METERS 0 1

FIGURE 16: Building 3, Bay 4, East – Measurement and Sampling Locations

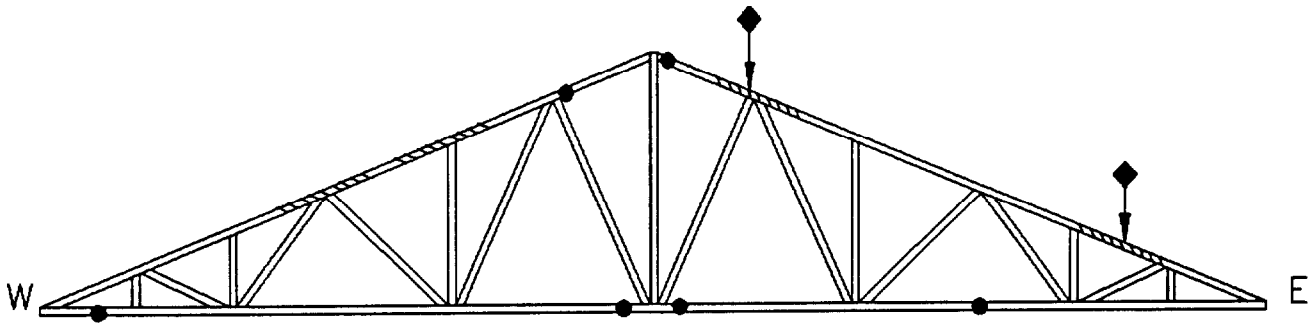


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 17: Building 3, Bay 4, West – Measurement and Sampling Locations

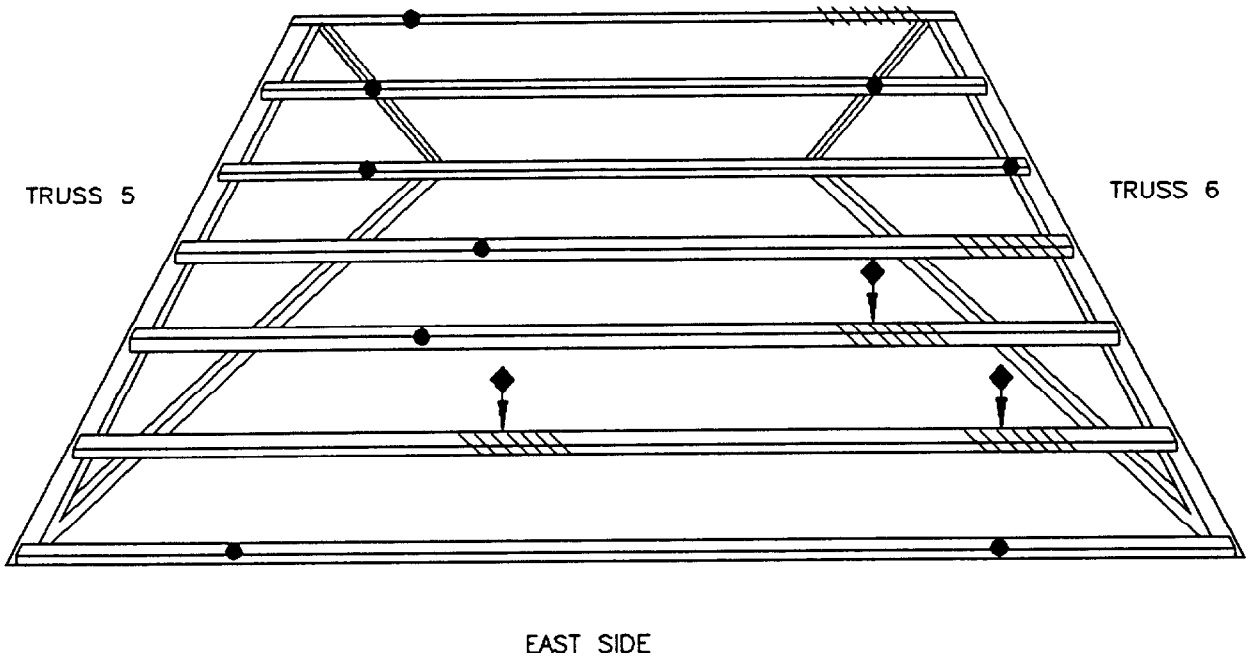


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST-ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 18: Building 3, Truss 5 – Measurement and Sampling Locations



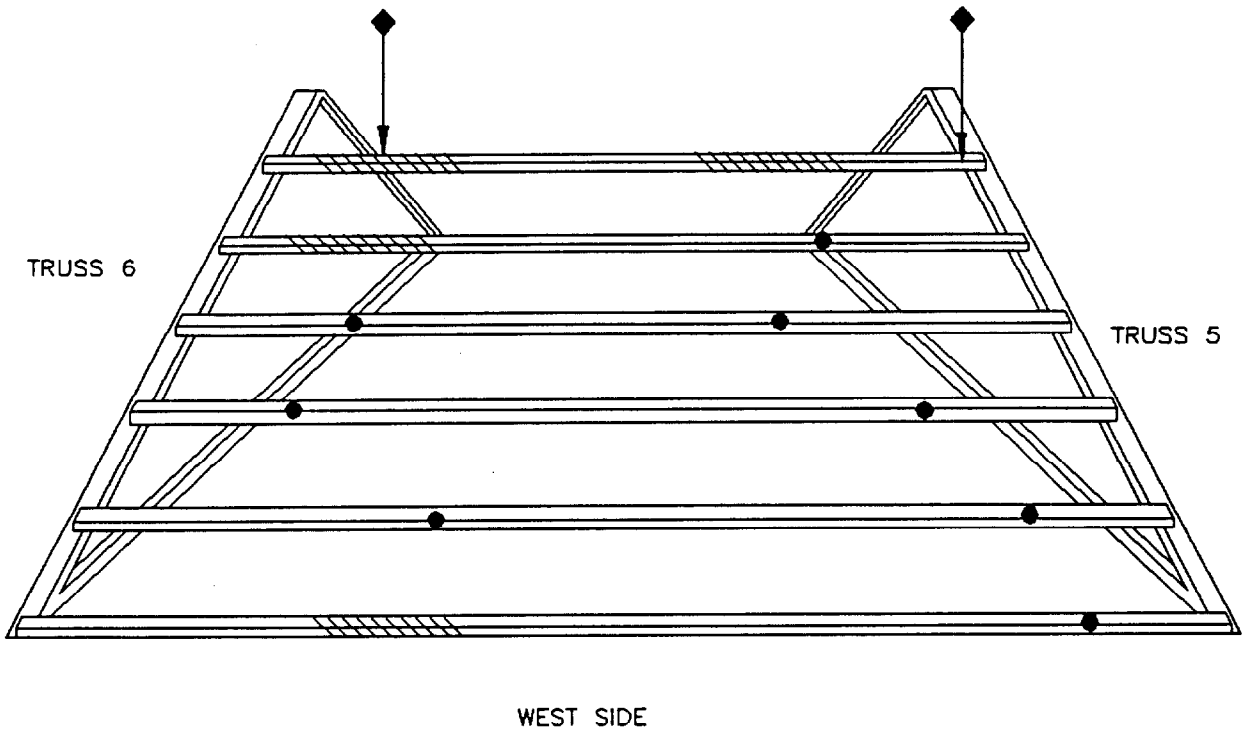
MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST-ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET 0 3

0 1 METERS

FIGURE 19: Building 3, Bay 5, East – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 20: Building 3, Bay 5, West – Measurement and Sampling Locations

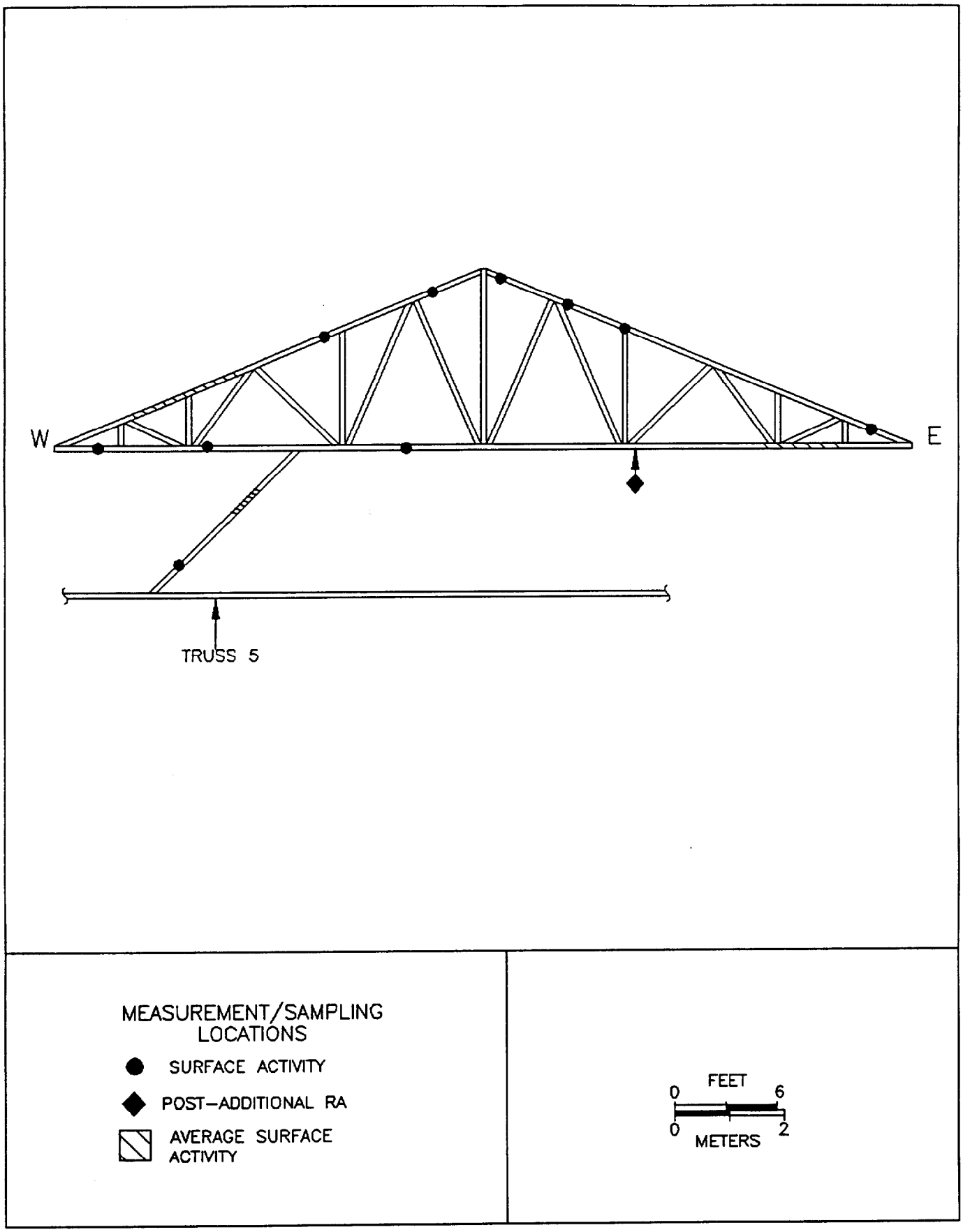
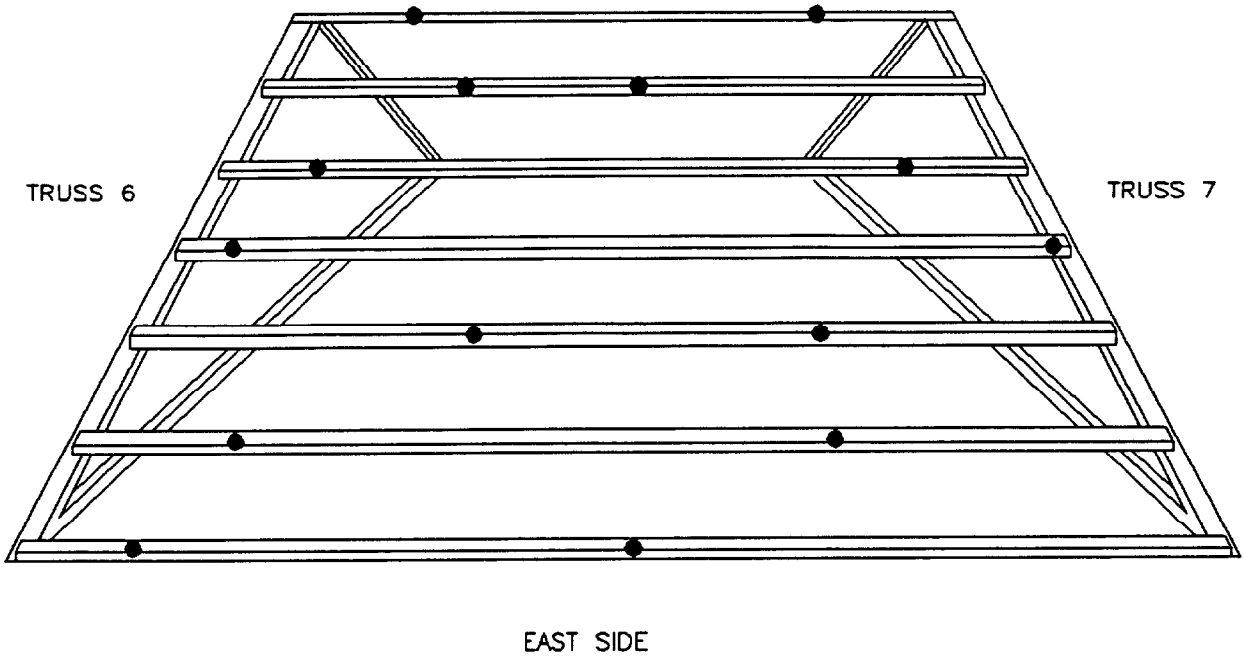


FIGURE 21: Building 3, Truss 6 – Measurement and Sampling Locations

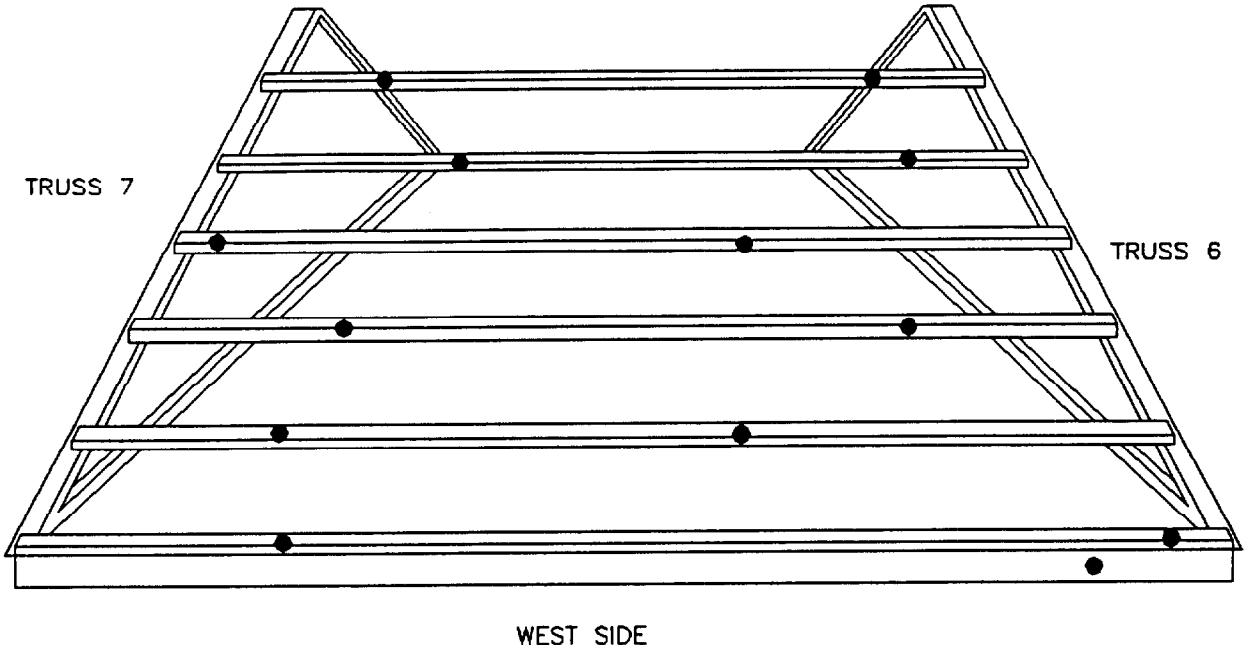


MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 22: Building 3, Bay 6, East – Measurement and Sampling Locations

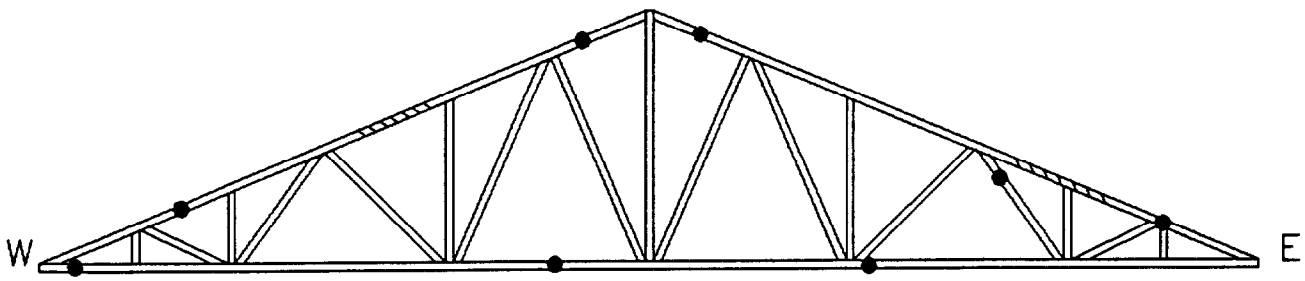


MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 23: Building 3, Bay 6, West – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- AVERAGE SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 24: Building 3, Truss 7 – Measurement and Sampling Locations

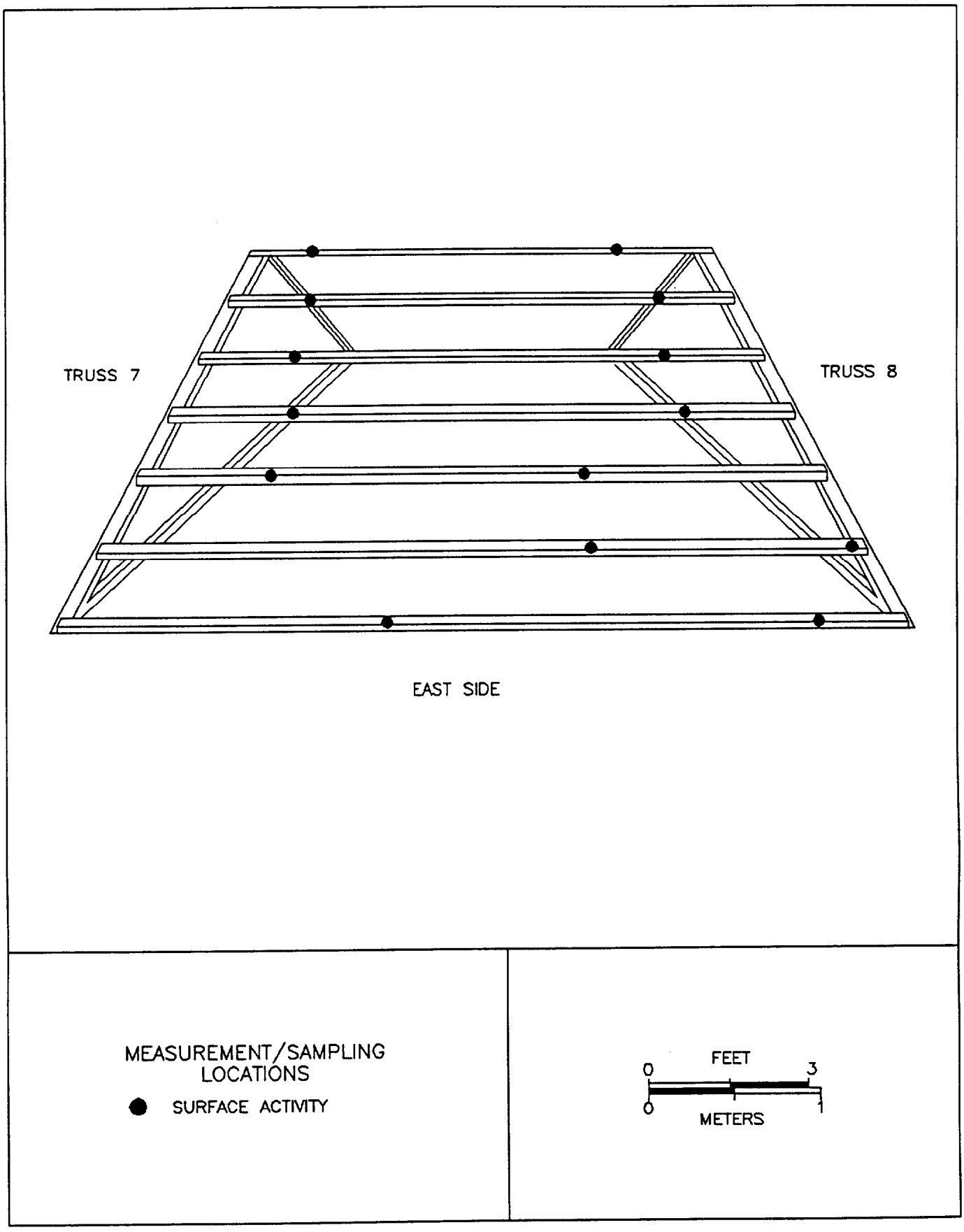
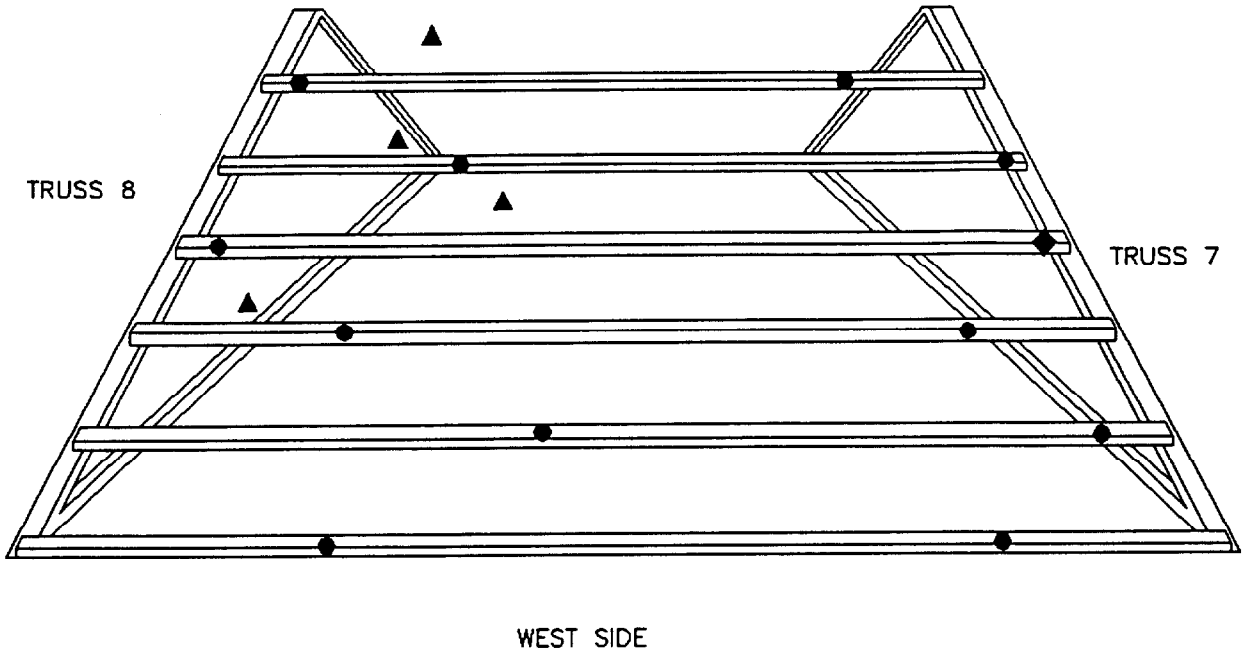


FIGURE 25: Building 3, Bay 7, East – Measurement and Sampling Locations

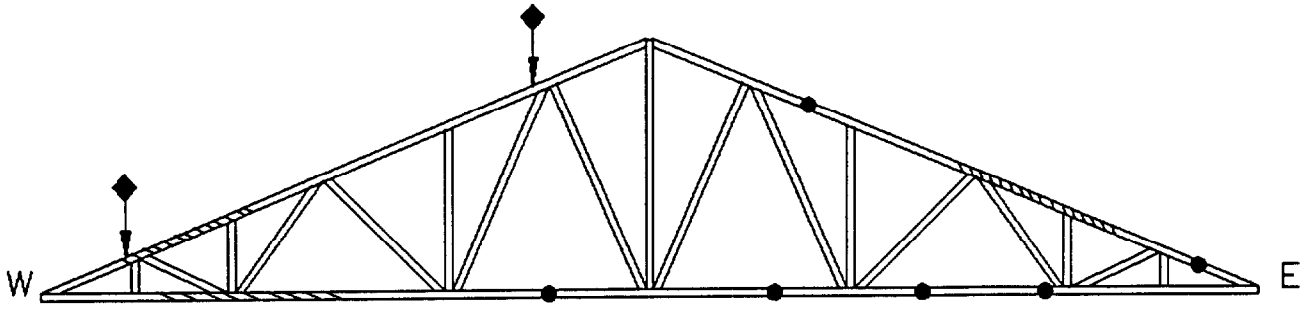


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- SURFACE ACTIVITY, CEILING

FEET
0 3
0 1
METERS

FIGURE 26: Building 3, Bay 7, West – Measurement and Sampling Locations

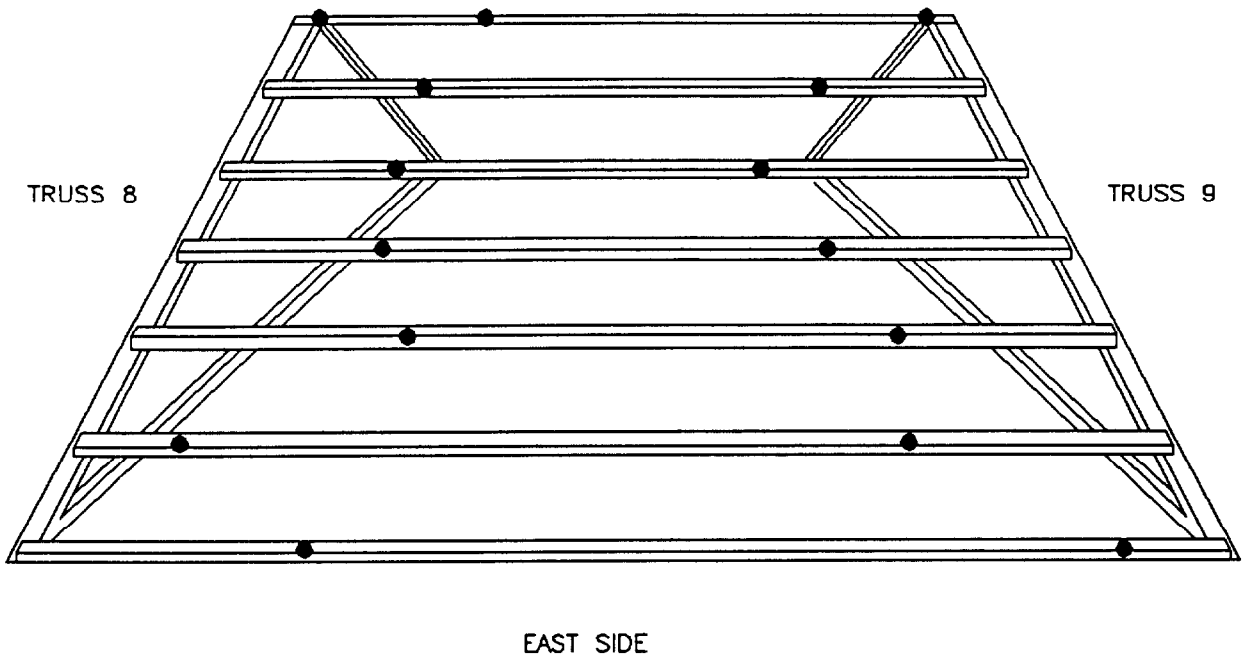


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST-ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 27: Building 3, Truss 8 – Measurement and Sampling Locations

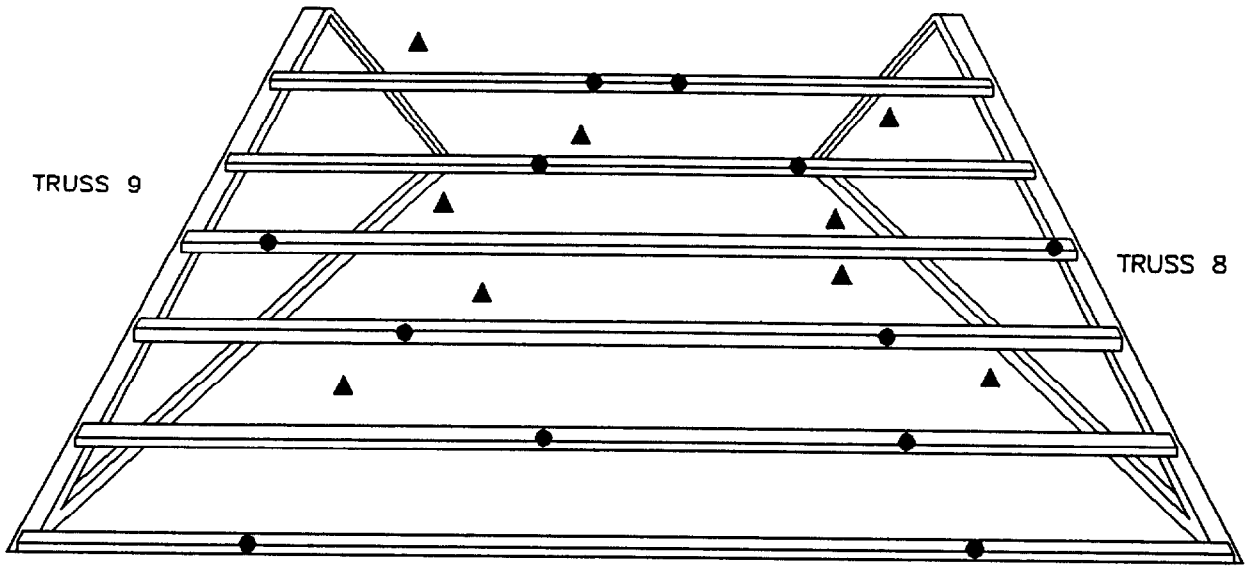


MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 28: Building 3, Bay 8, East – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

▲ SURFACE ACTIVITY, CEILING

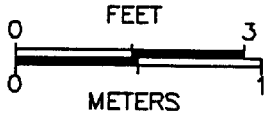
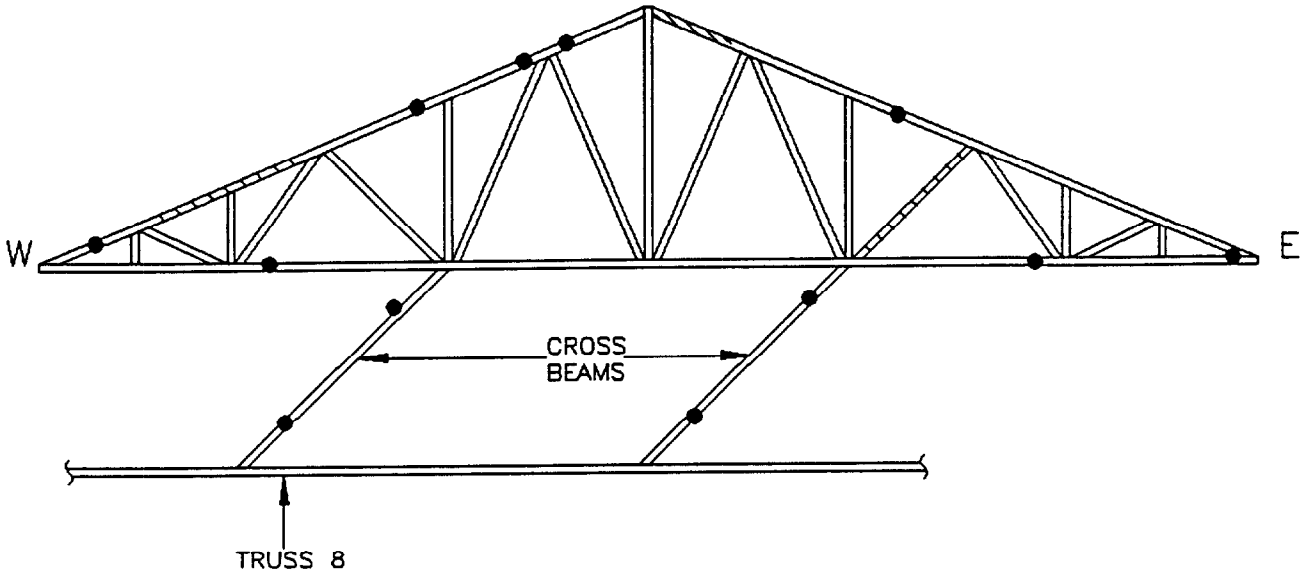


FIGURE 29: Building 3, Bay 8, West – Measurement and Sampling Locations

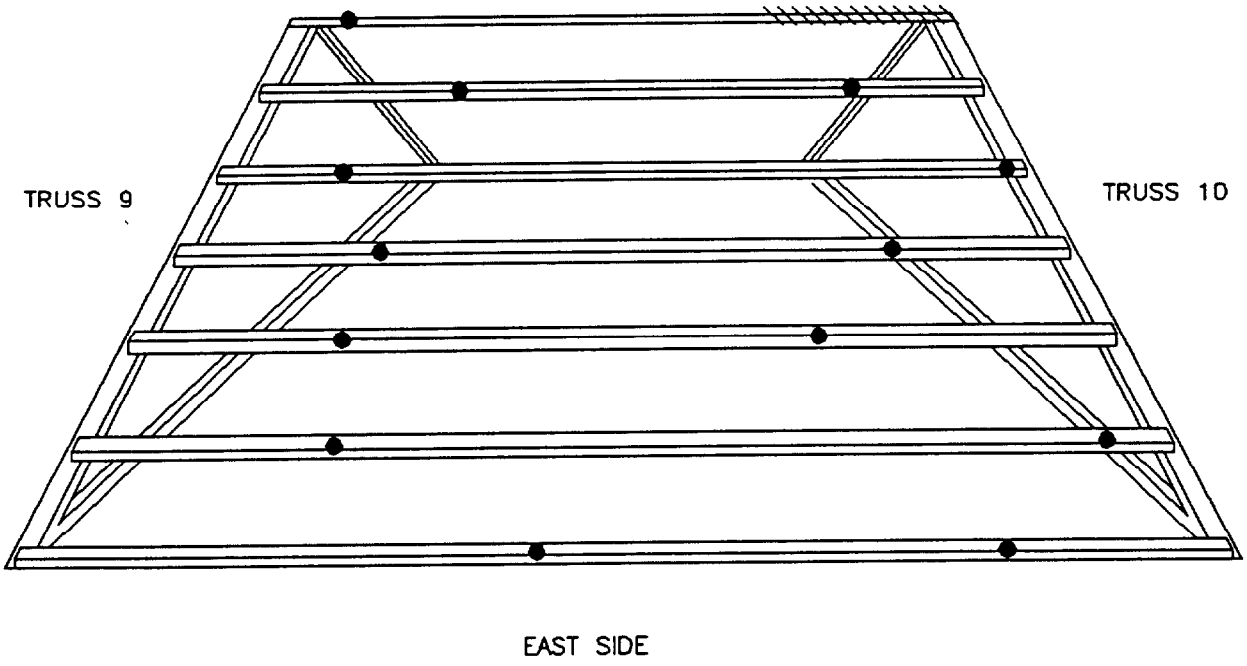


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- AVERAGE SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 30: Building 3, Truss 9 – Measurement and Sampling Locations

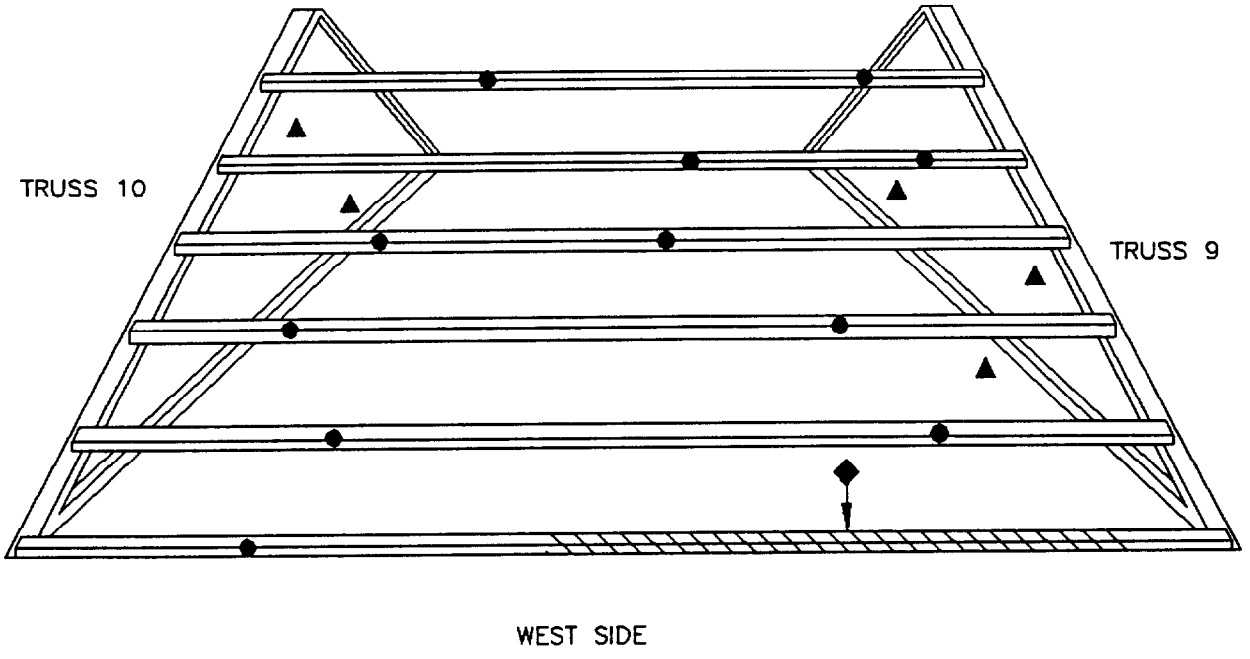


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 31: Building 3, Bay 9, East – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- SURFACE ACTIVITY, CEILING
- AVERAGE SURFACE ACTIVITY

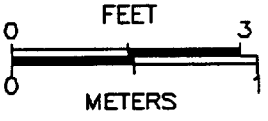
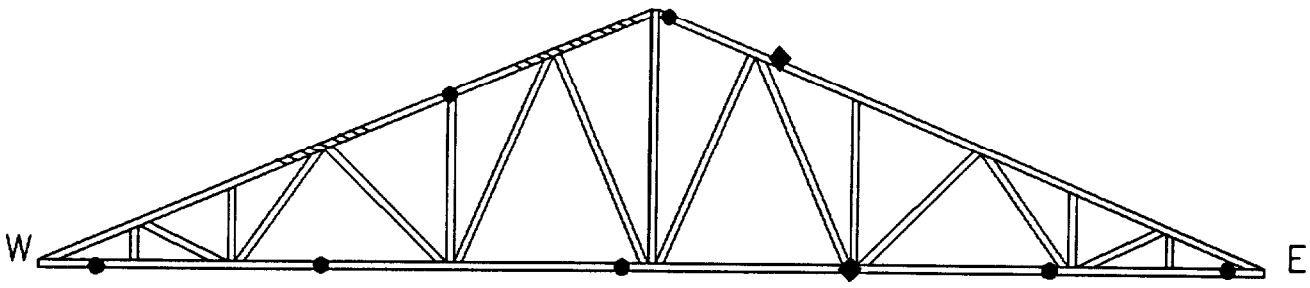


FIGURE 32: Building 3, Bay 9, West – Measurement and Sampling Locations



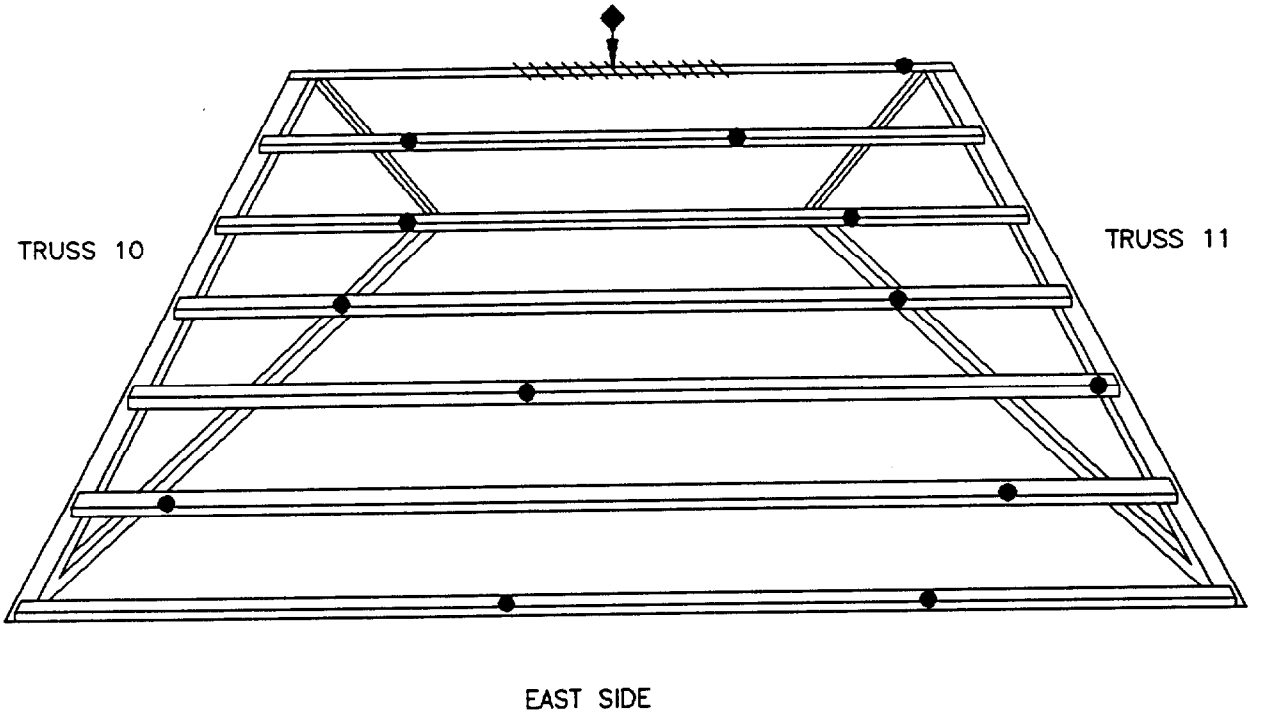
MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET 0 6

METERS 0 2

FIGURE 33: Building 3, Truss 10 – Measurement and Sampling Locations

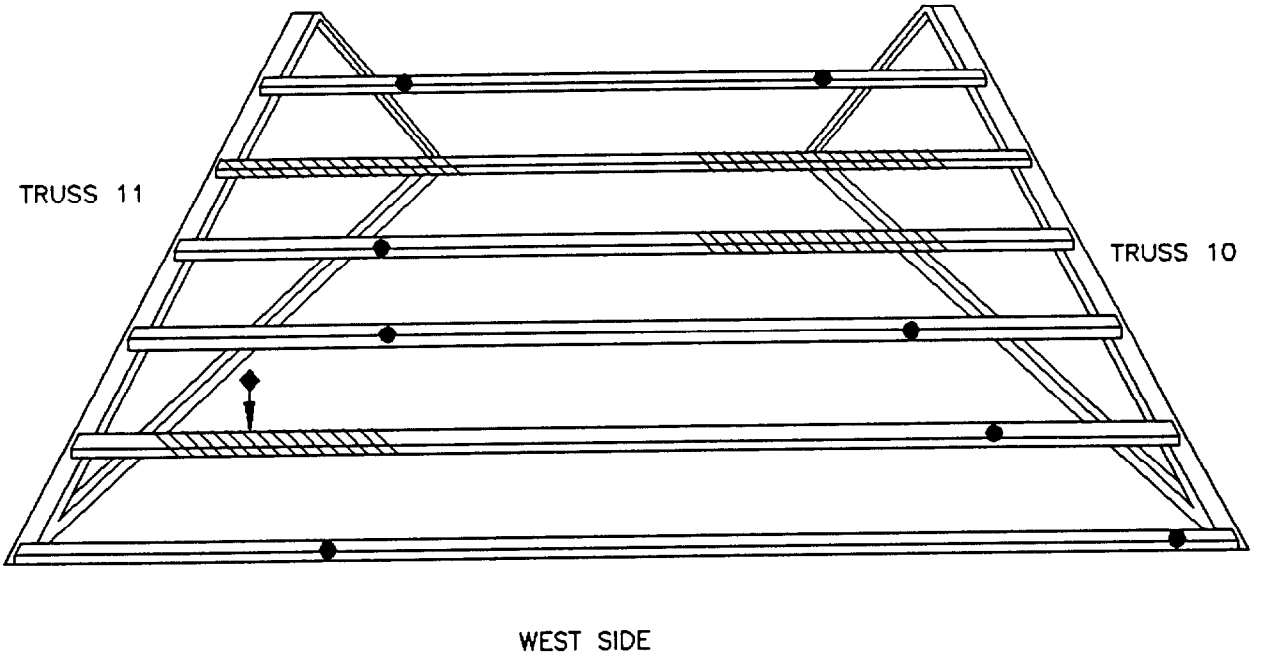


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 34: Building 3, Bay 10, East – Measurement and Sampling Locations

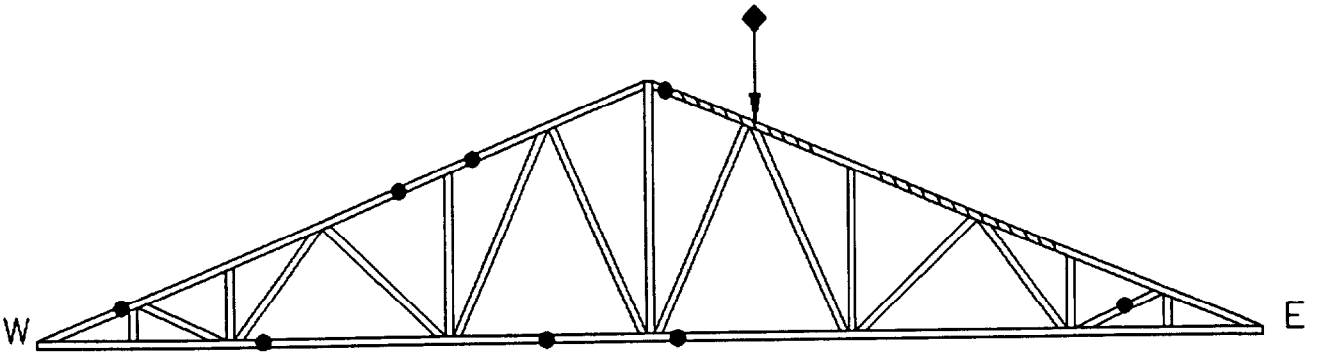


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 35: Building 3, Bay 10, West – Measurement and Sampling Locations

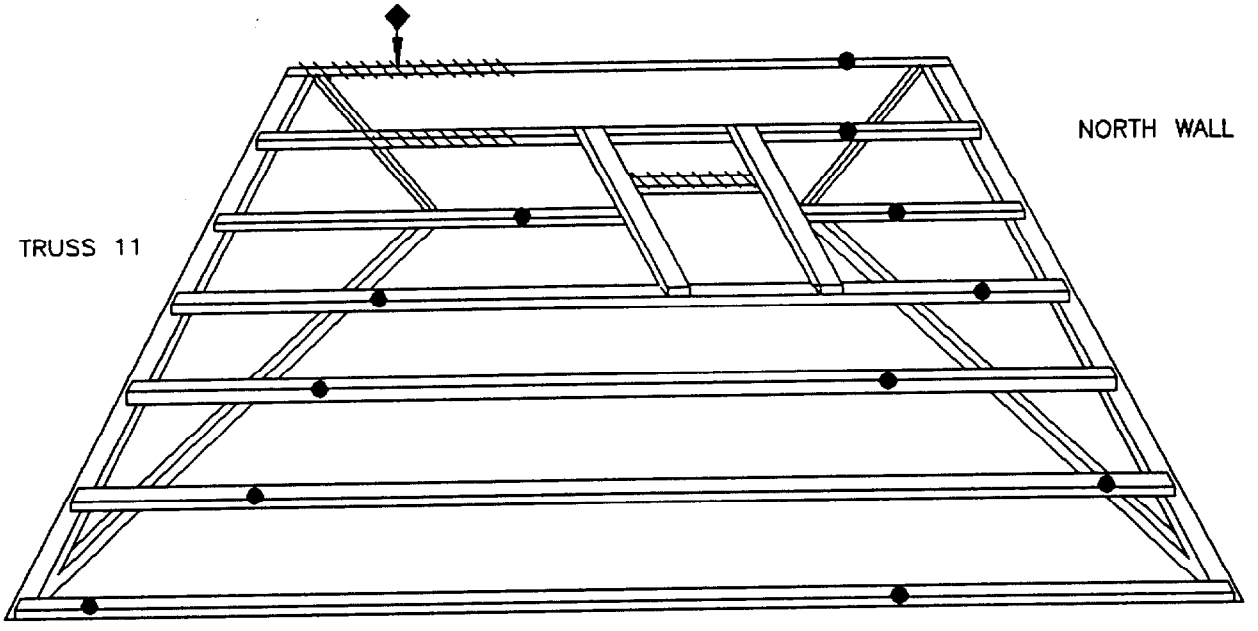


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST-ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 36: Building 3, Truss 11 – Measurement and Sampling Locations

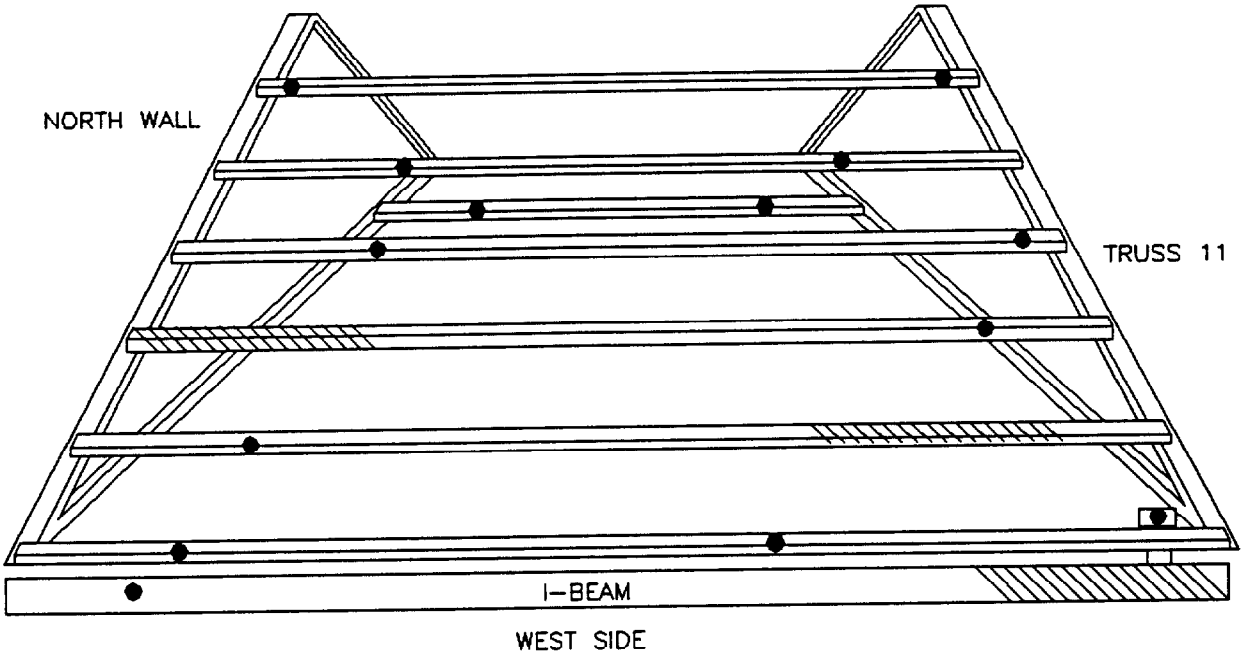


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST-ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 37: Building 3, Bay 11, East – Measurement and Sampling Locations

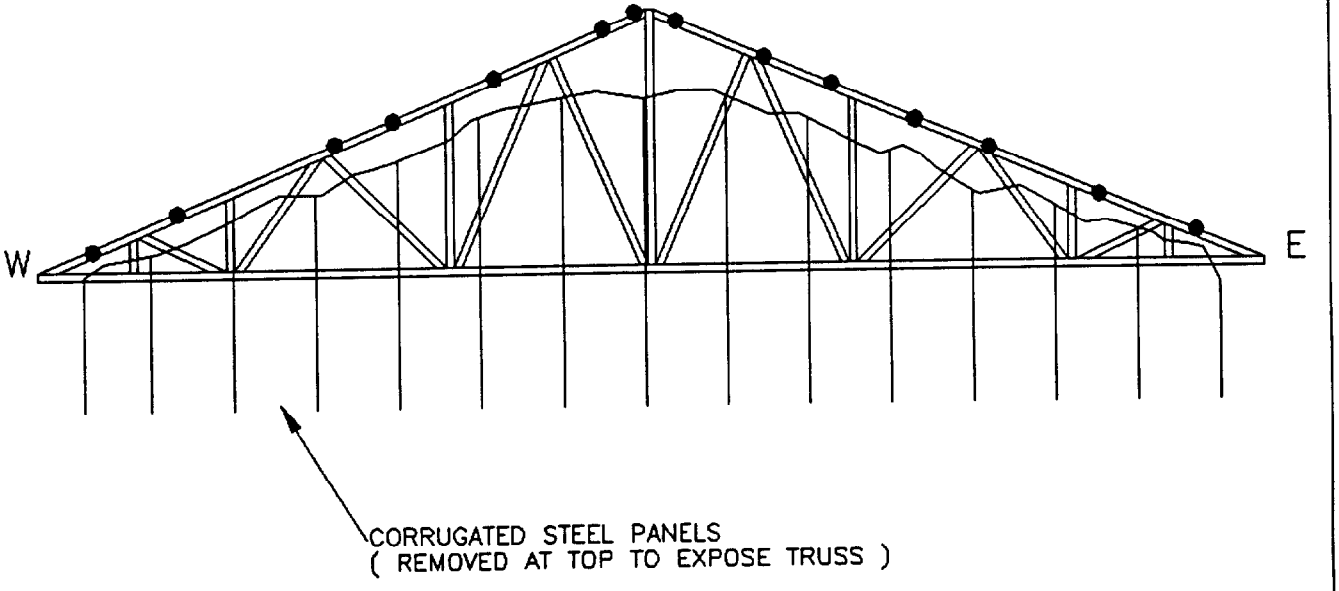


MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- AVERAGE SURFACE ACTIVITY

FEET
0 3
0 1
METERS

FIGURE 38: Building 3, Bay 11, West – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 39: Building 3, North Wall – Measurement and Sampling Locations

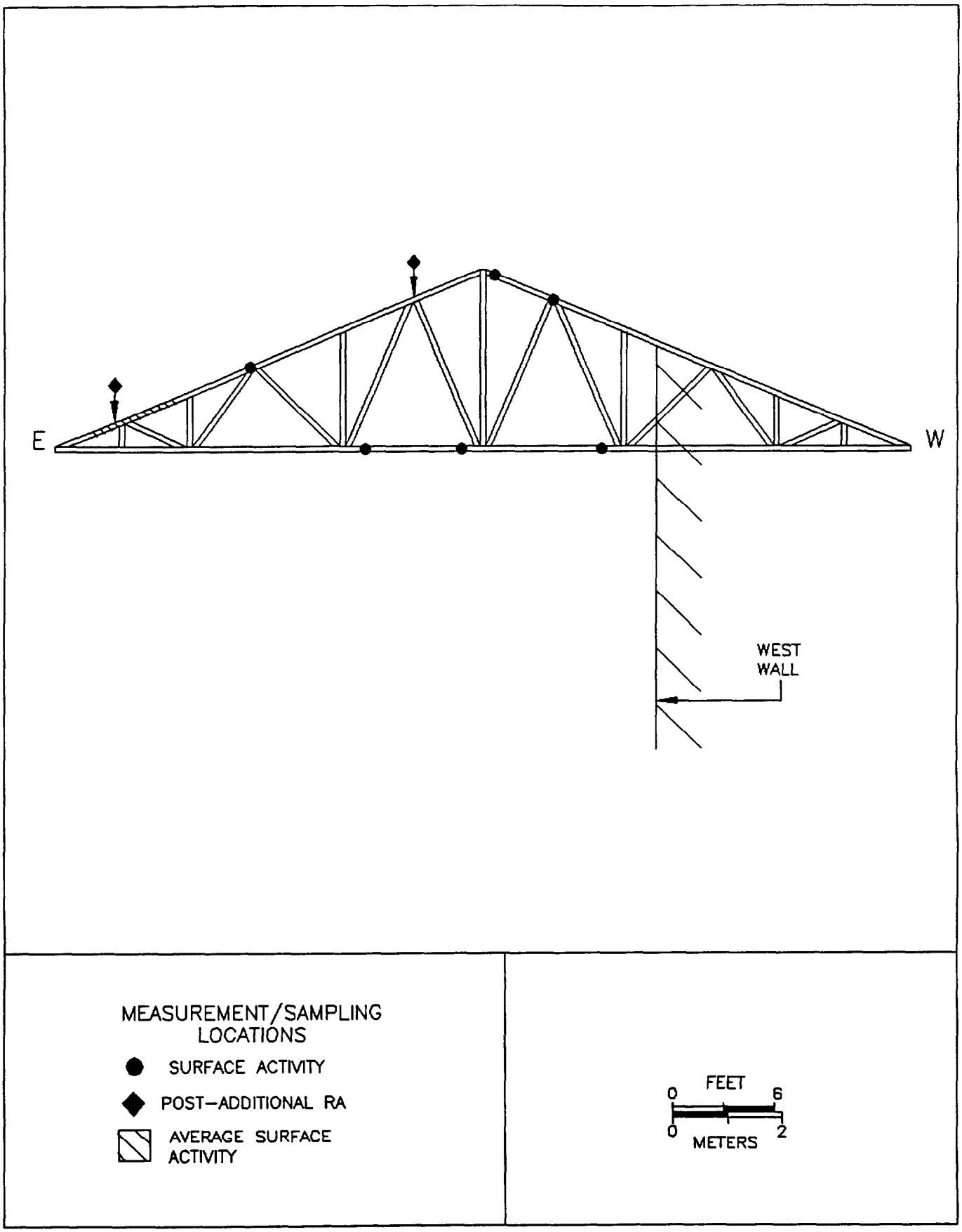
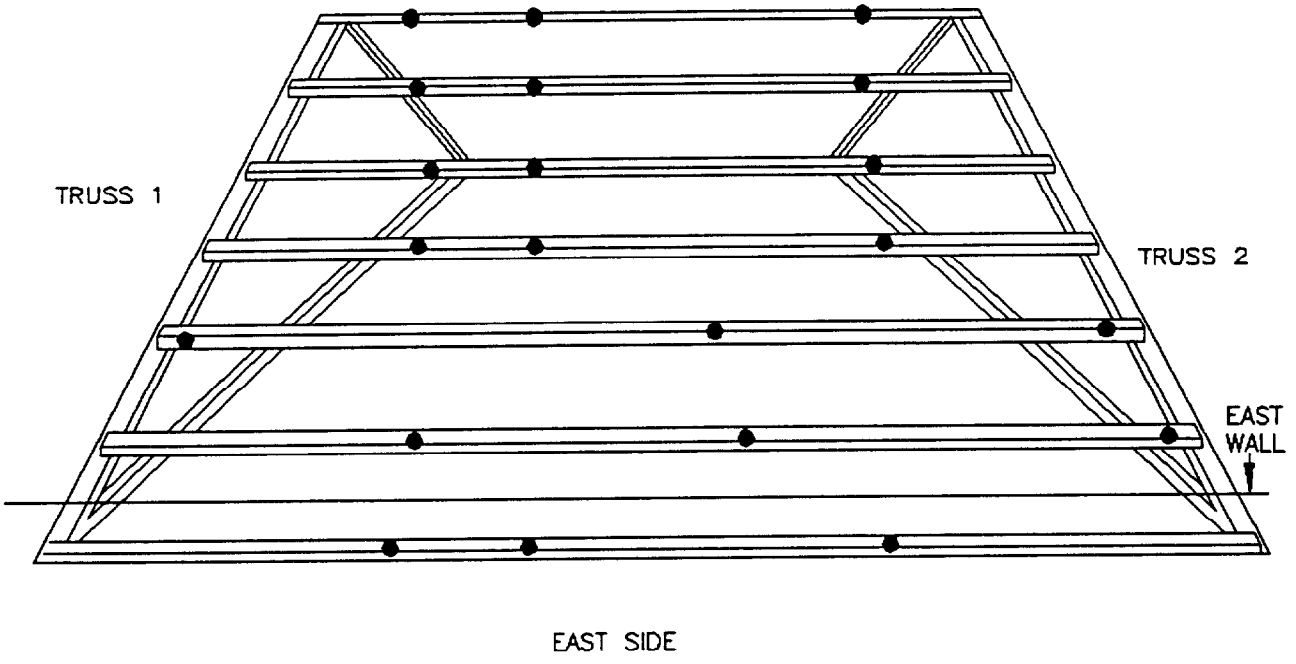


FIGURE 40: Building 8, Truss 1 (South Wall) – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

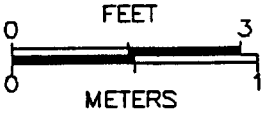


FIGURE 41: Building 8, Bay 1, East – Measurement and Sampling Locations

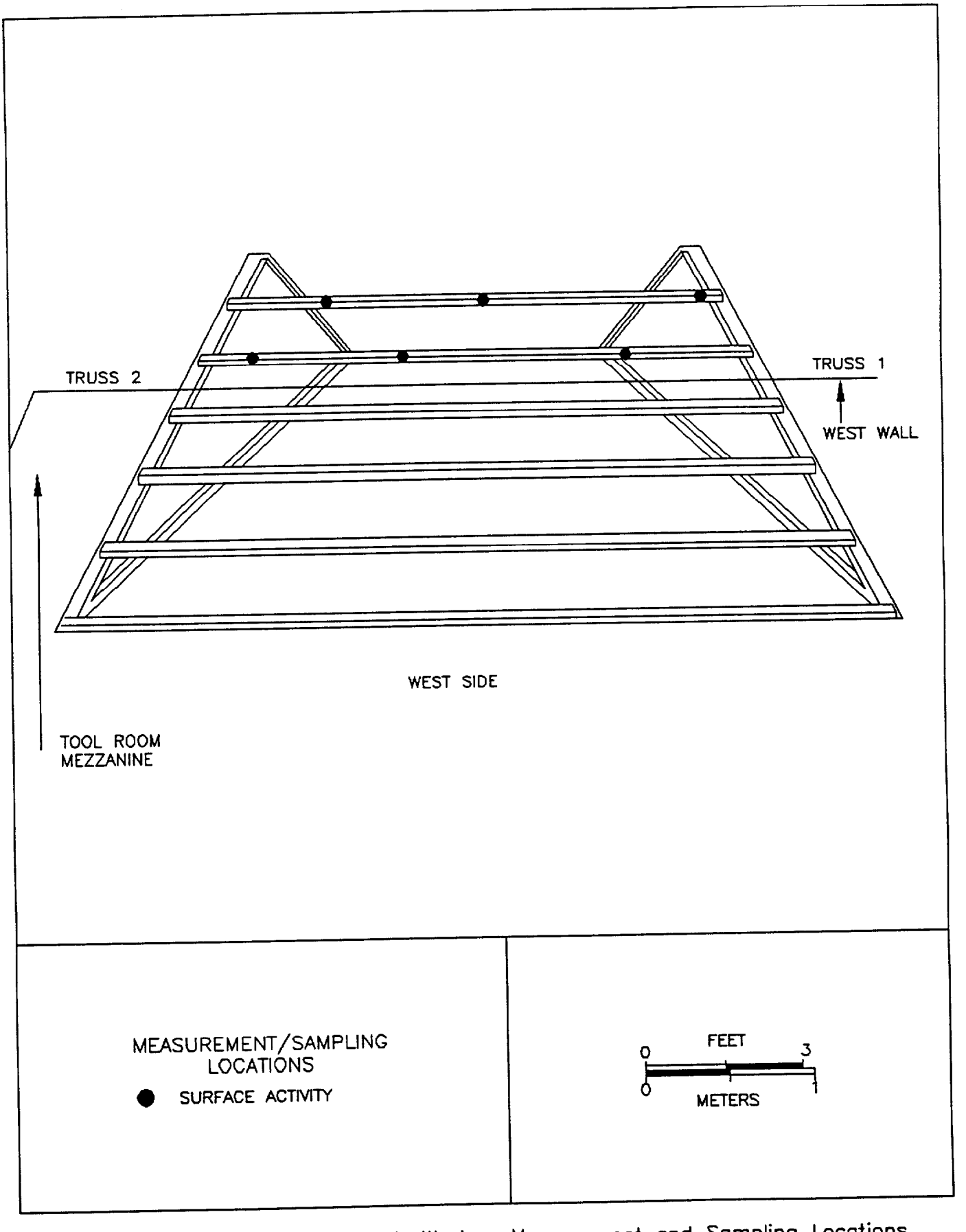


FIGURE 42: Building 8, Bay 1, West – Measurement and Sampling Locations

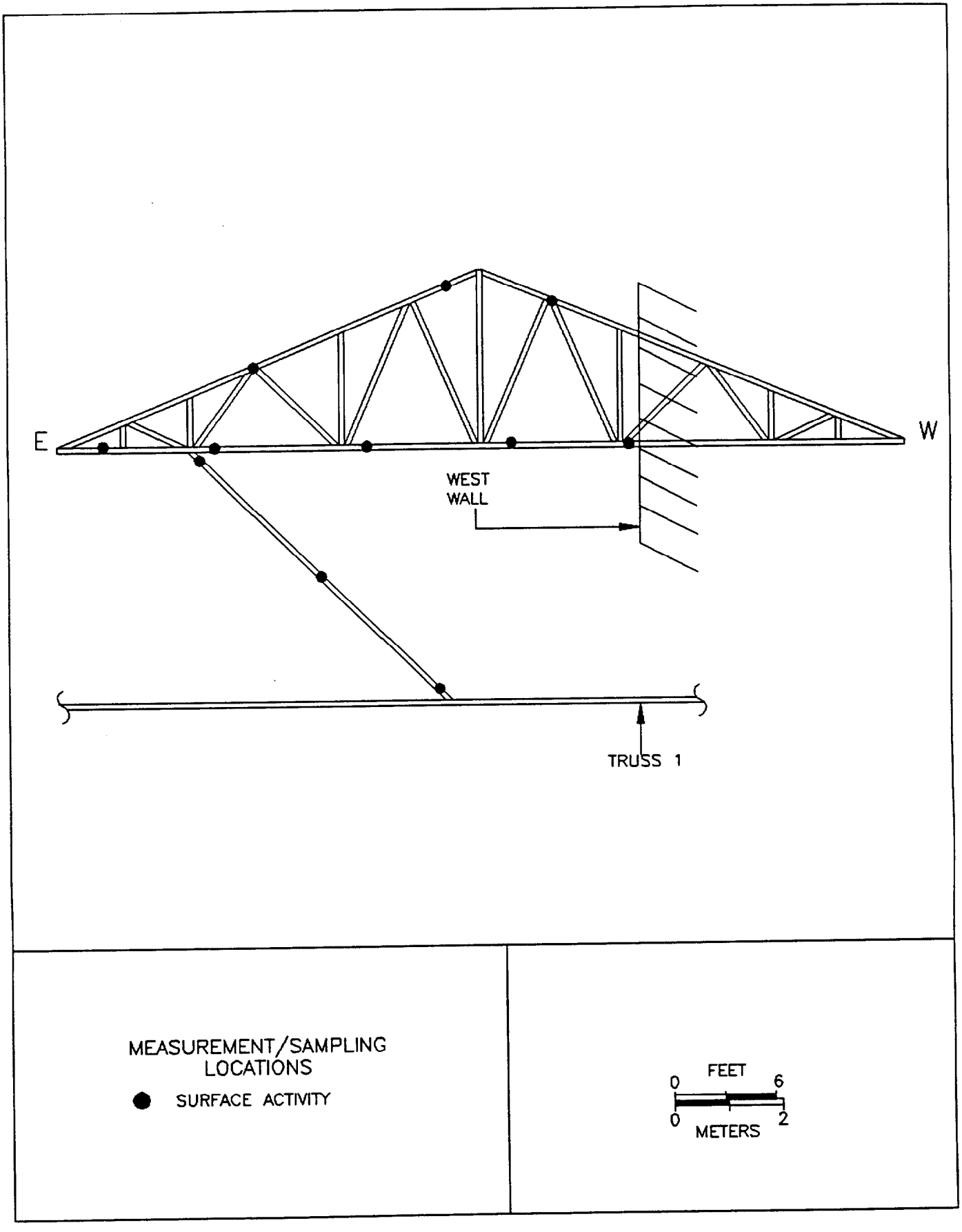
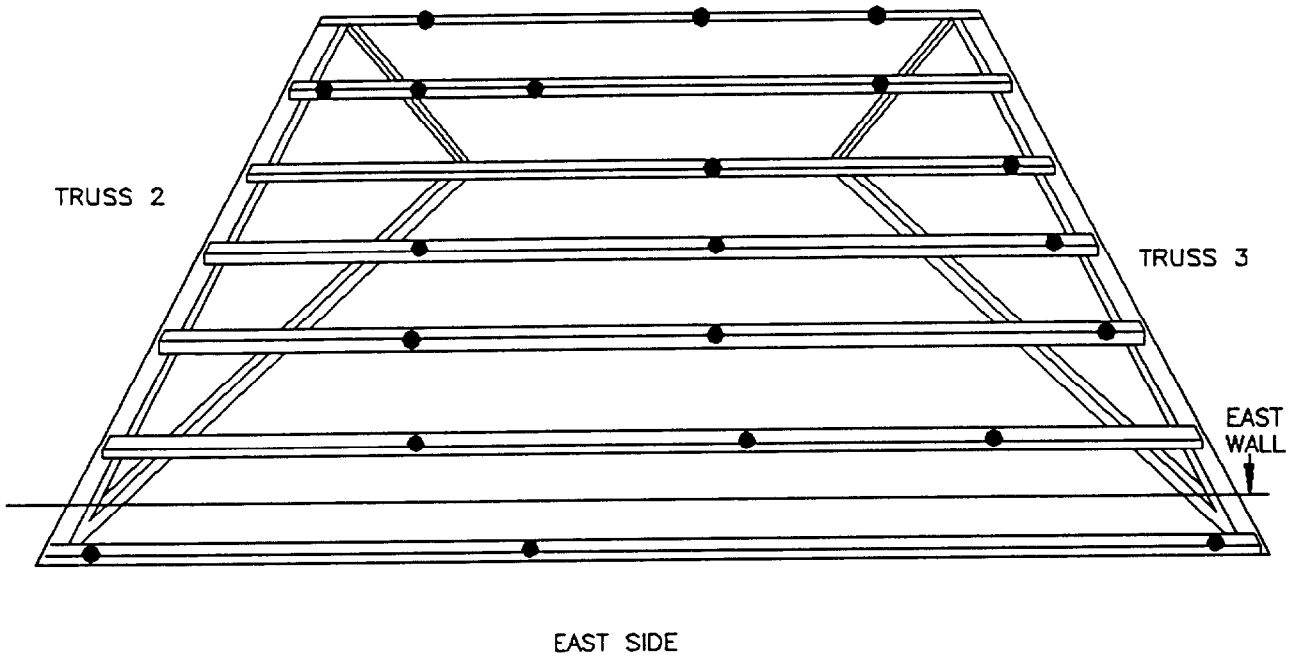


FIGURE 43: Building 8, Truss 2 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

FEET 0 3

0 1 METERS

FIGURE 44: Building 8, Bay 2, East – Measurement and Sampling Locations

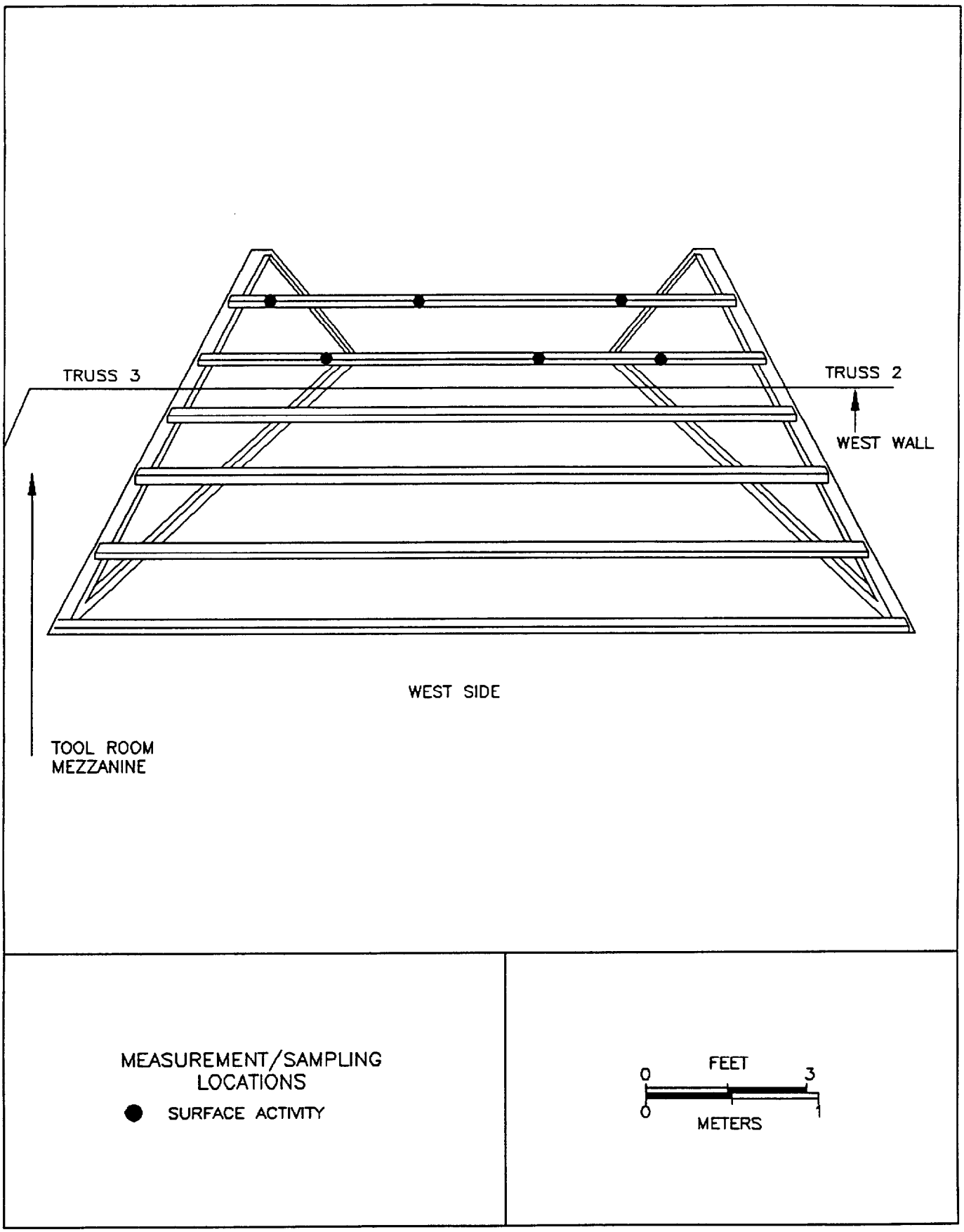


FIGURE 45: Building 8, Bay 2, West – Measurement and Sampling Locations

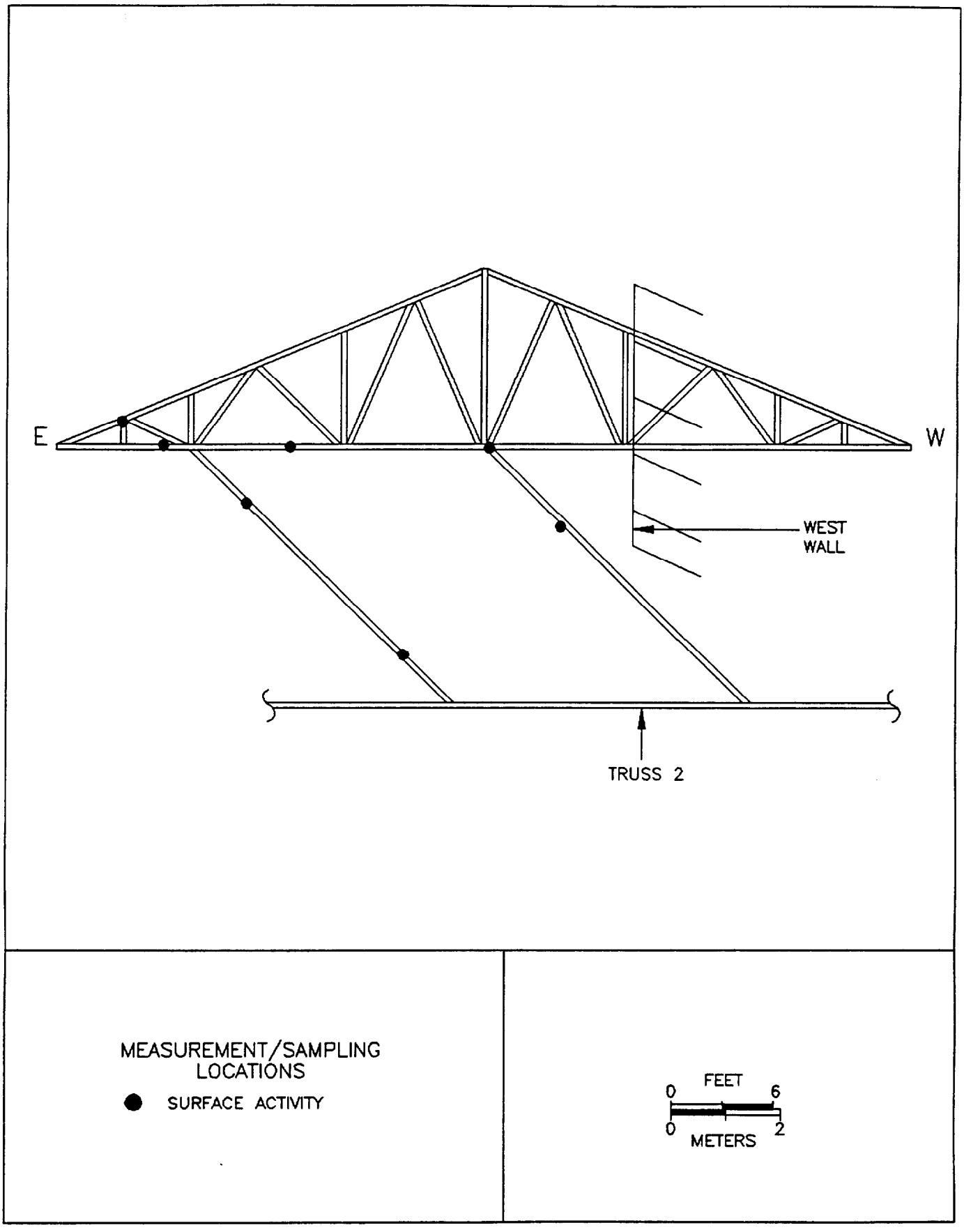
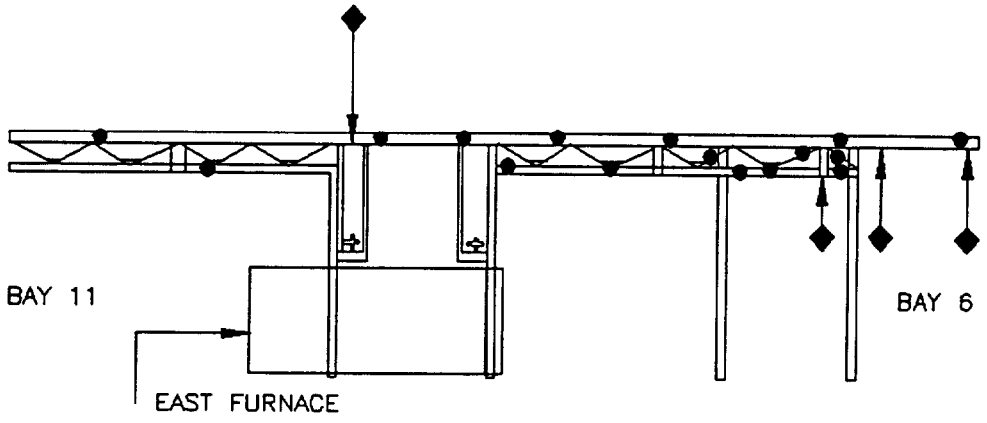


FIGURE 46: Building 8, Truss 3 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST-ADDITIONAL RA

N

FEET
0 15
0 5
METERS

FIGURE 47: Building 3, Superstructure – Measurement and Sampling Locations

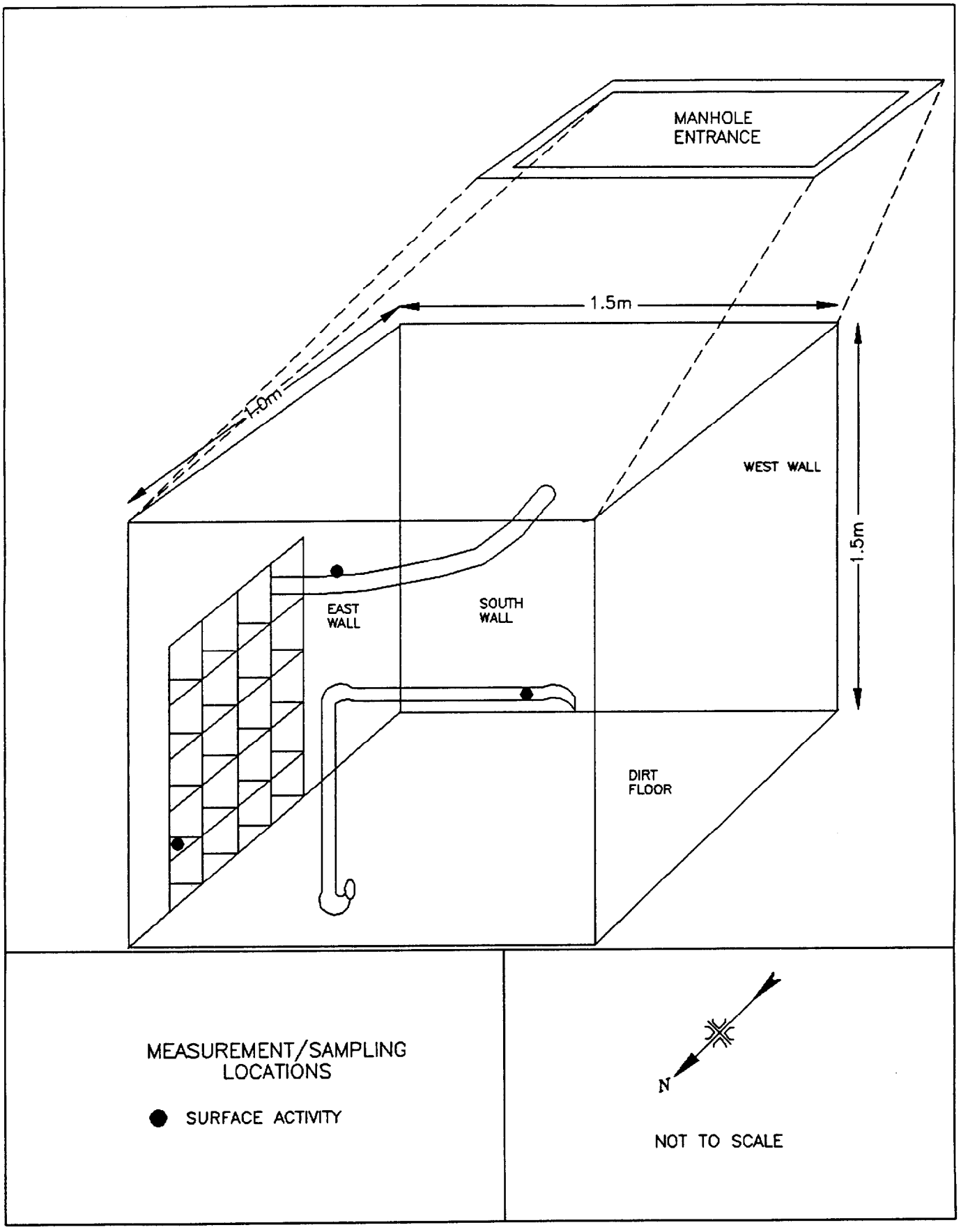


FIGURE 48: Building 3, Pipe Chase Manhole – Measurement and Sampling Locations

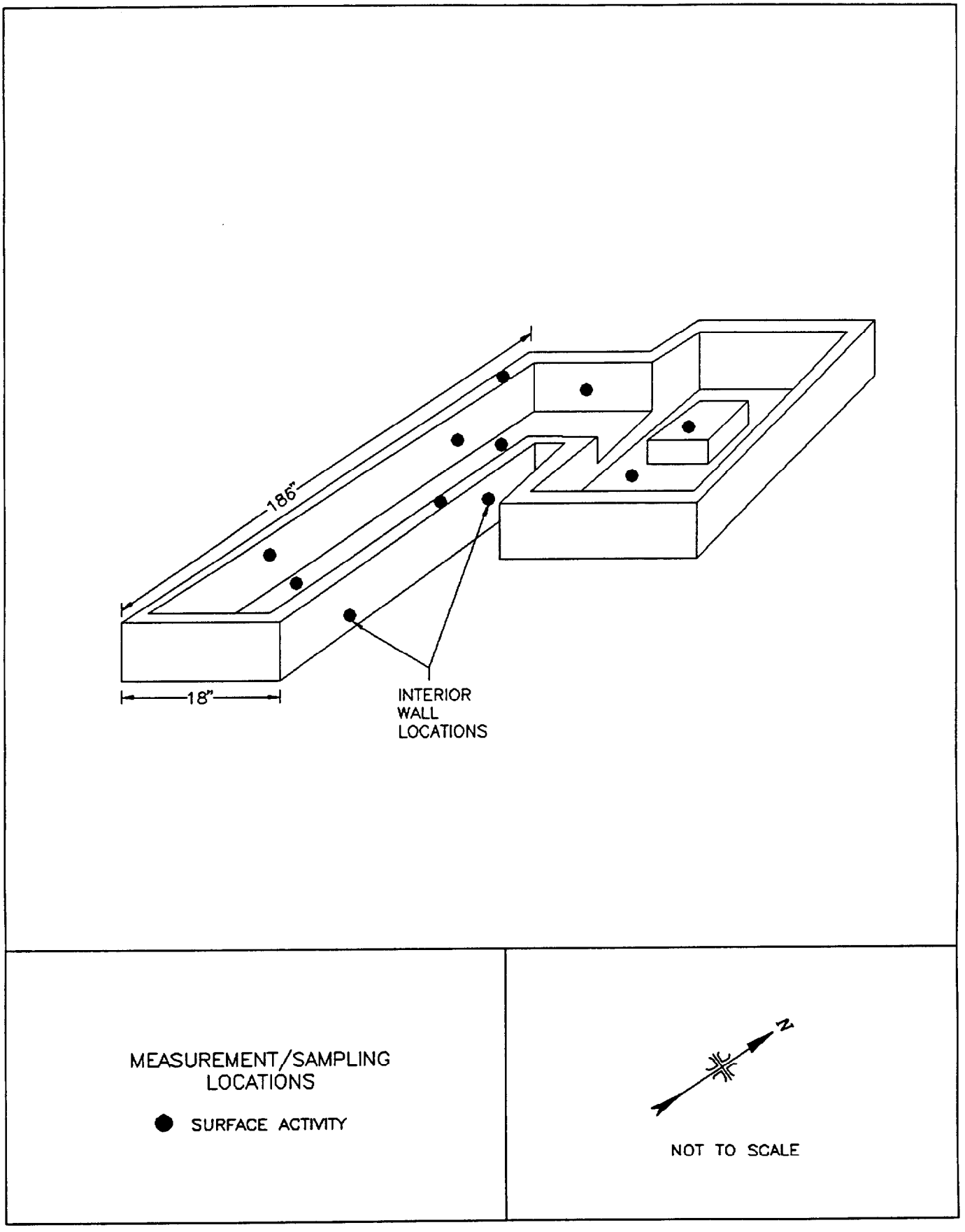
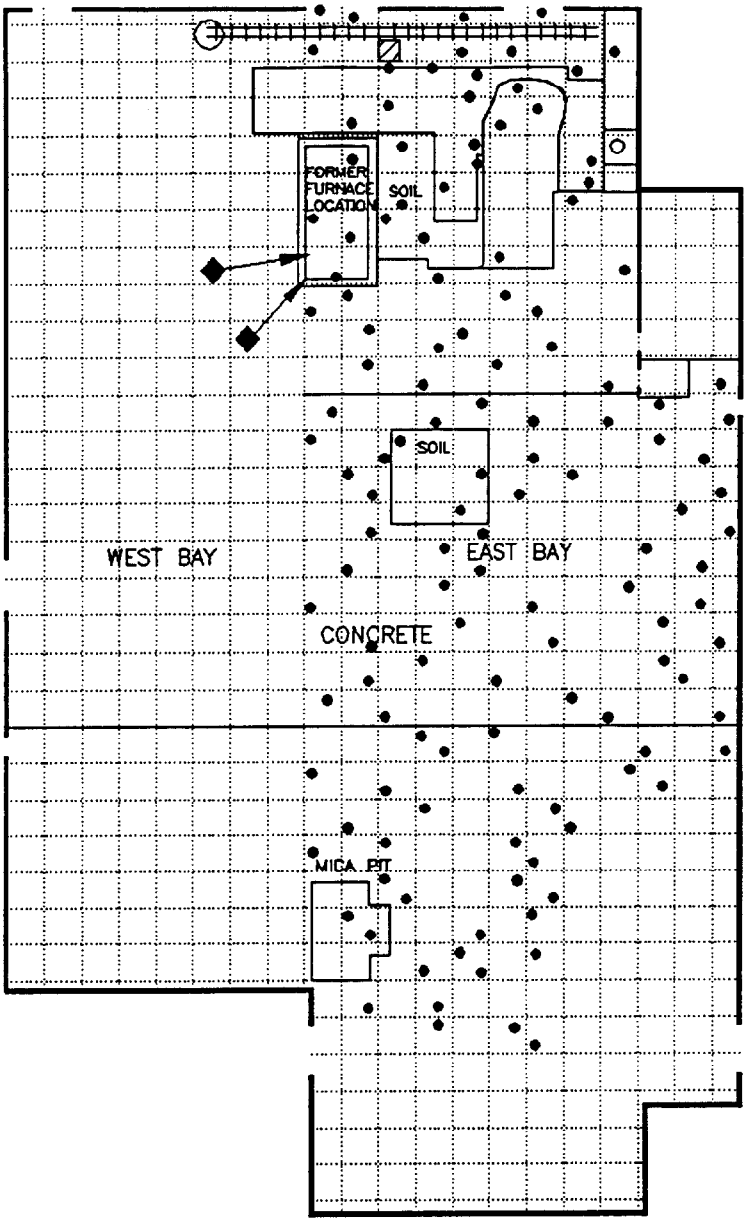


FIGURE 49: Building 3, Scale Apparatus Pit – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST–ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

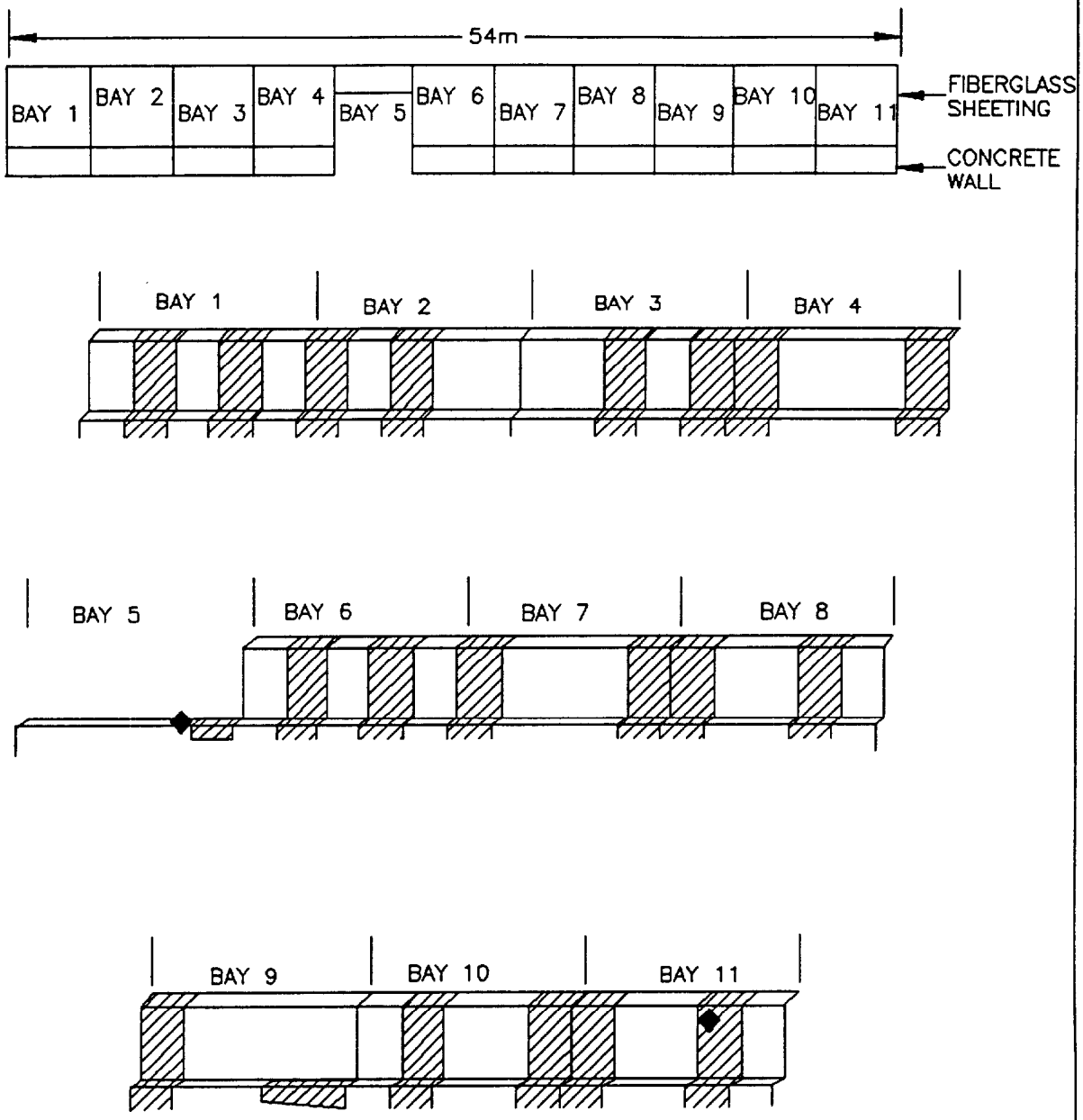
RAILROAD

N

FEET 0 24

METERS 0 8

FIGURE 50: Building 3, East Bay Floor – Measurement and Sampling Locations



SAMPLING LOCATIONS

◆ POST–ADDITIONAL RA

▨ AVERAGE SURFACE ACTIVITY

N

NOT TO SCALE

FIGURE 51: Building 3, West Wall – Measurement and Sampling Locations

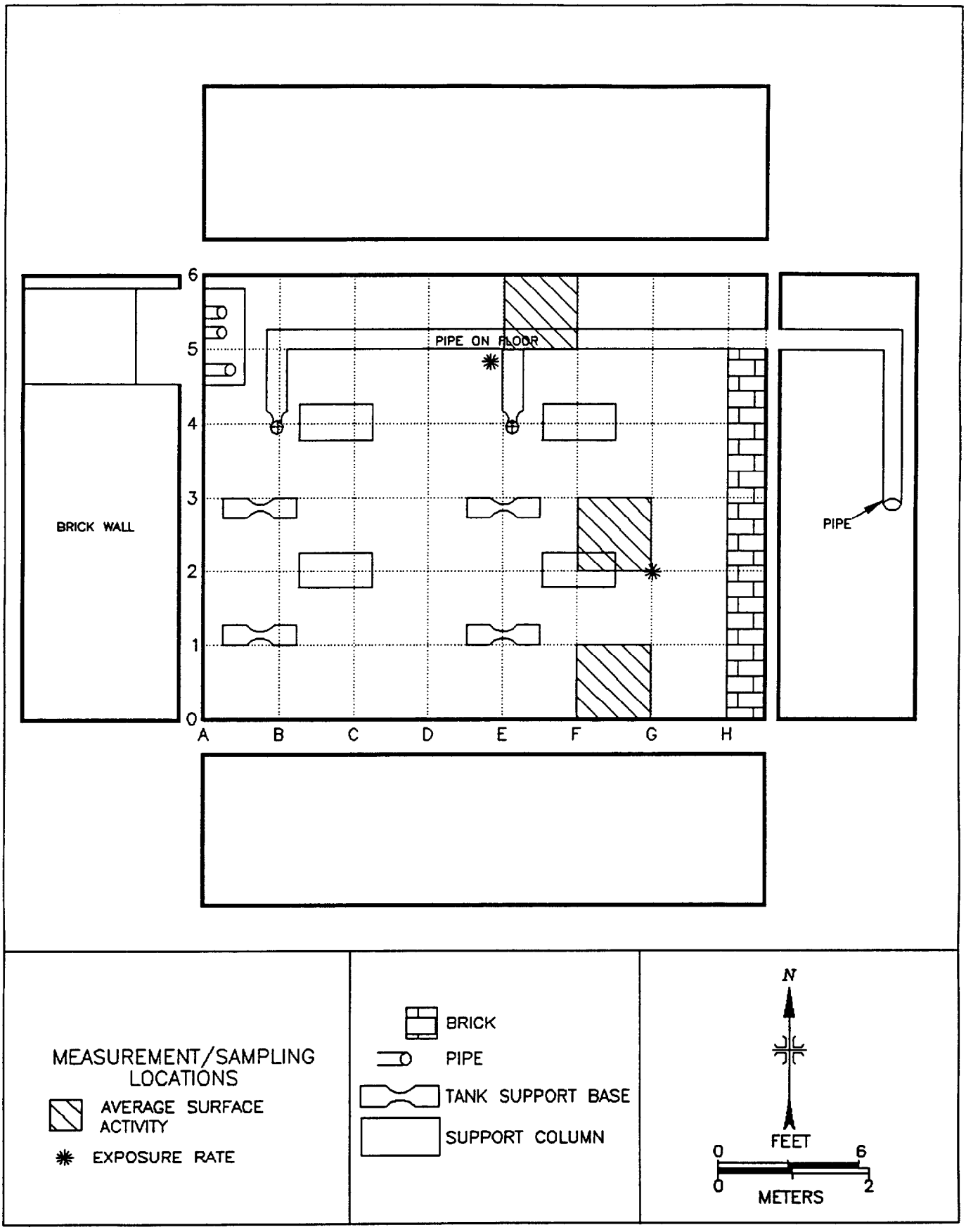


FIGURE 52: Building 8, Basement – Measurement and Sampling Locations

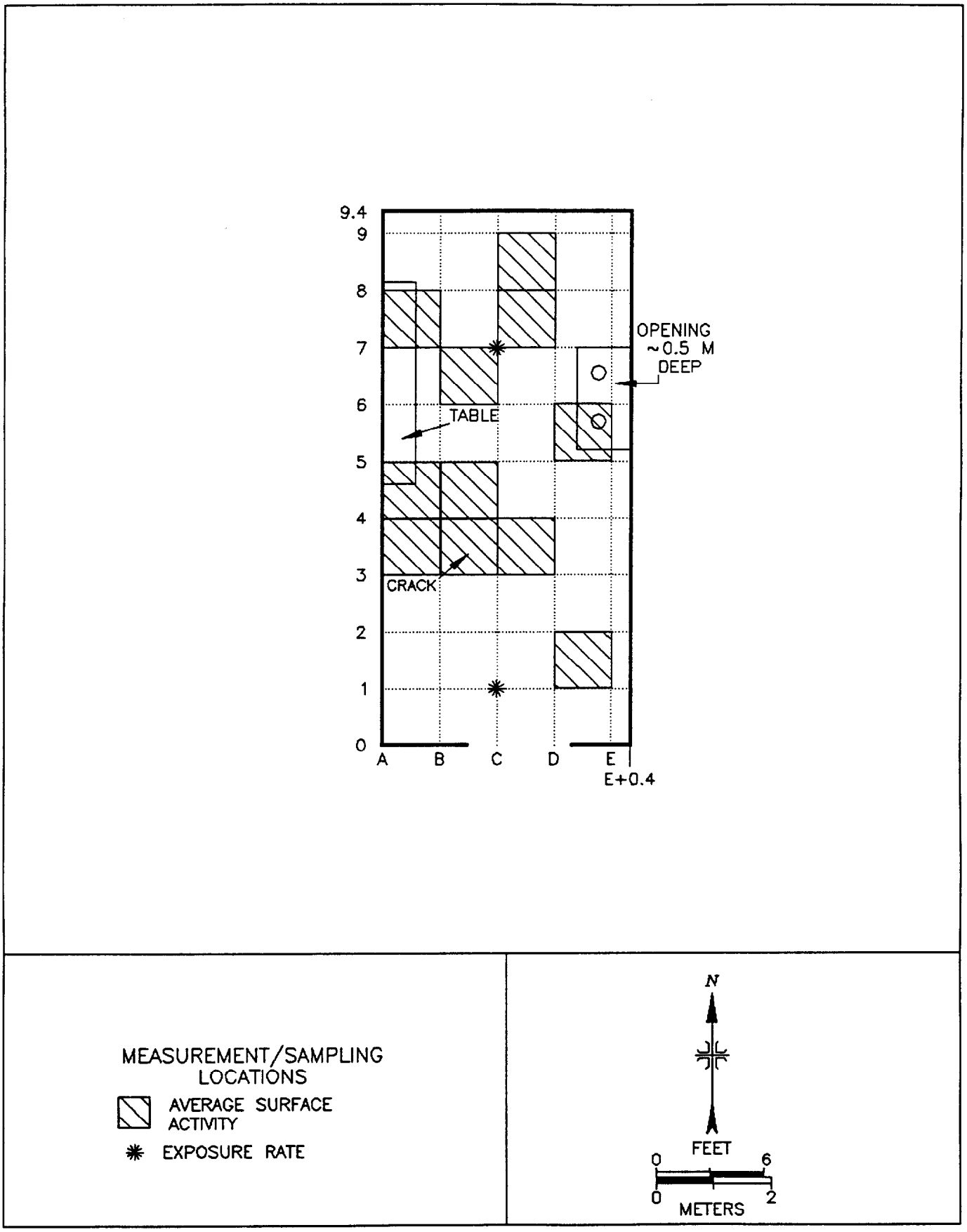


FIGURE 53: Building 8, Tool Room Floor – Measurement and Sampling Locations

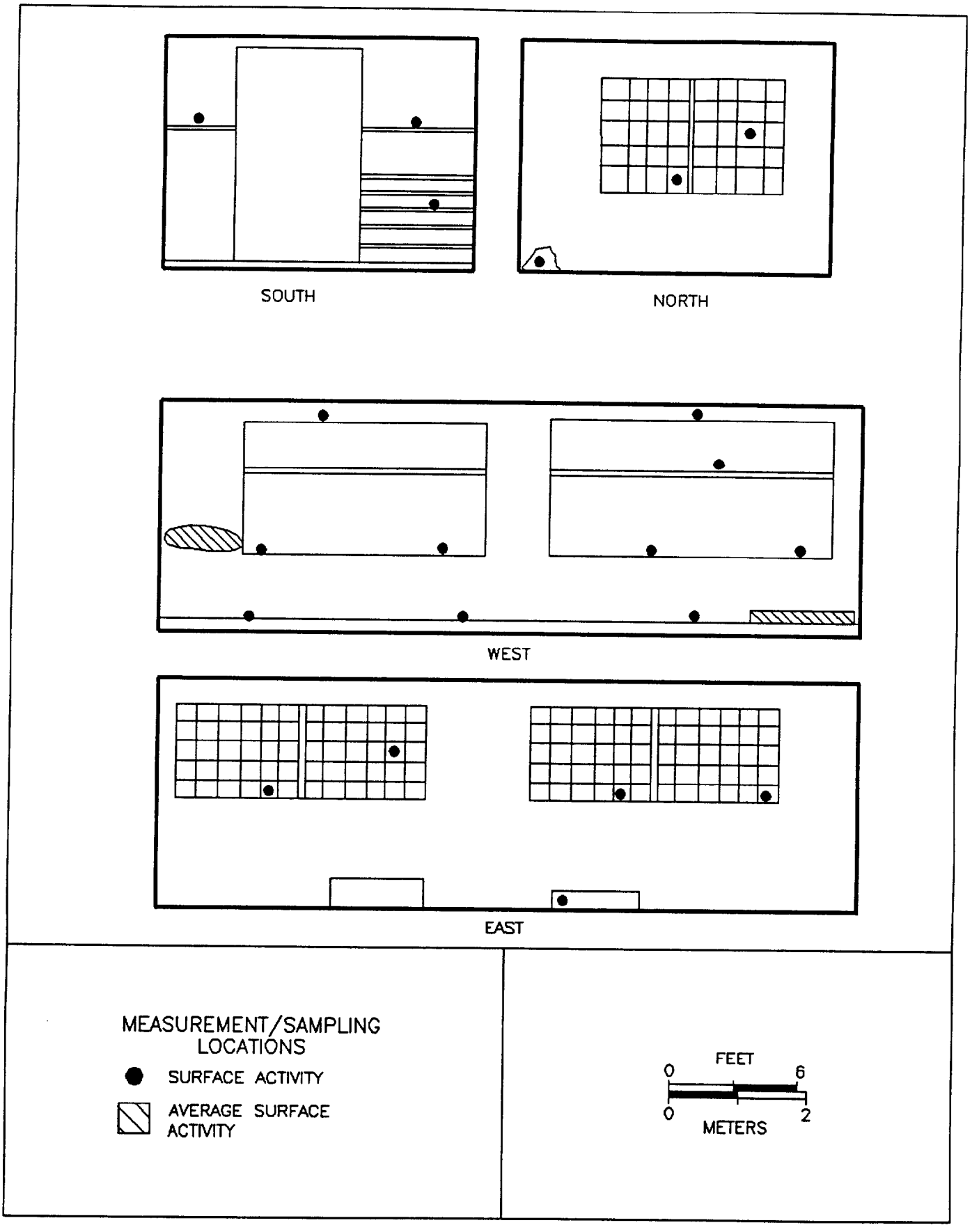
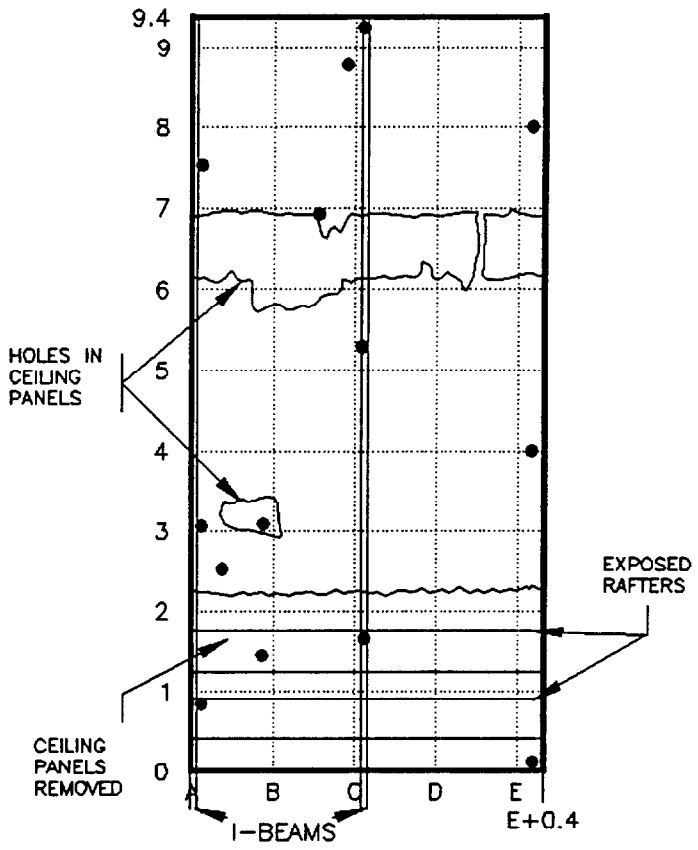


FIGURE 54: Building 8, Tool Room Walls – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

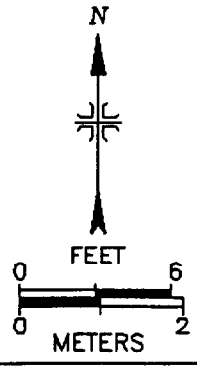


FIGURE 55: Building 8, Tool Room Ceiling – Measurement and Sampling Locations

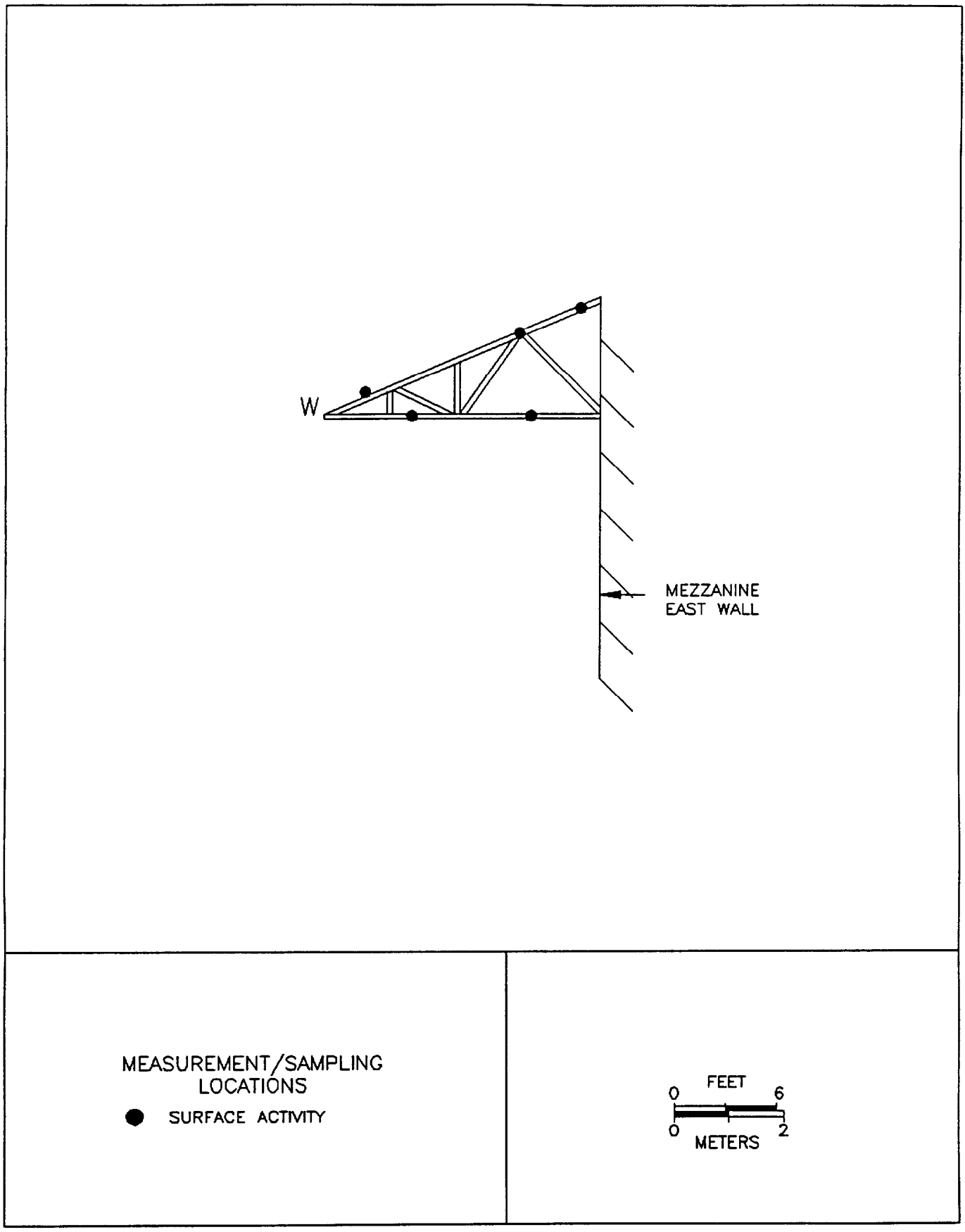


FIGURE 56: Building 8, Mezzanine, Truss 1 – Measurement and Sampling Locations

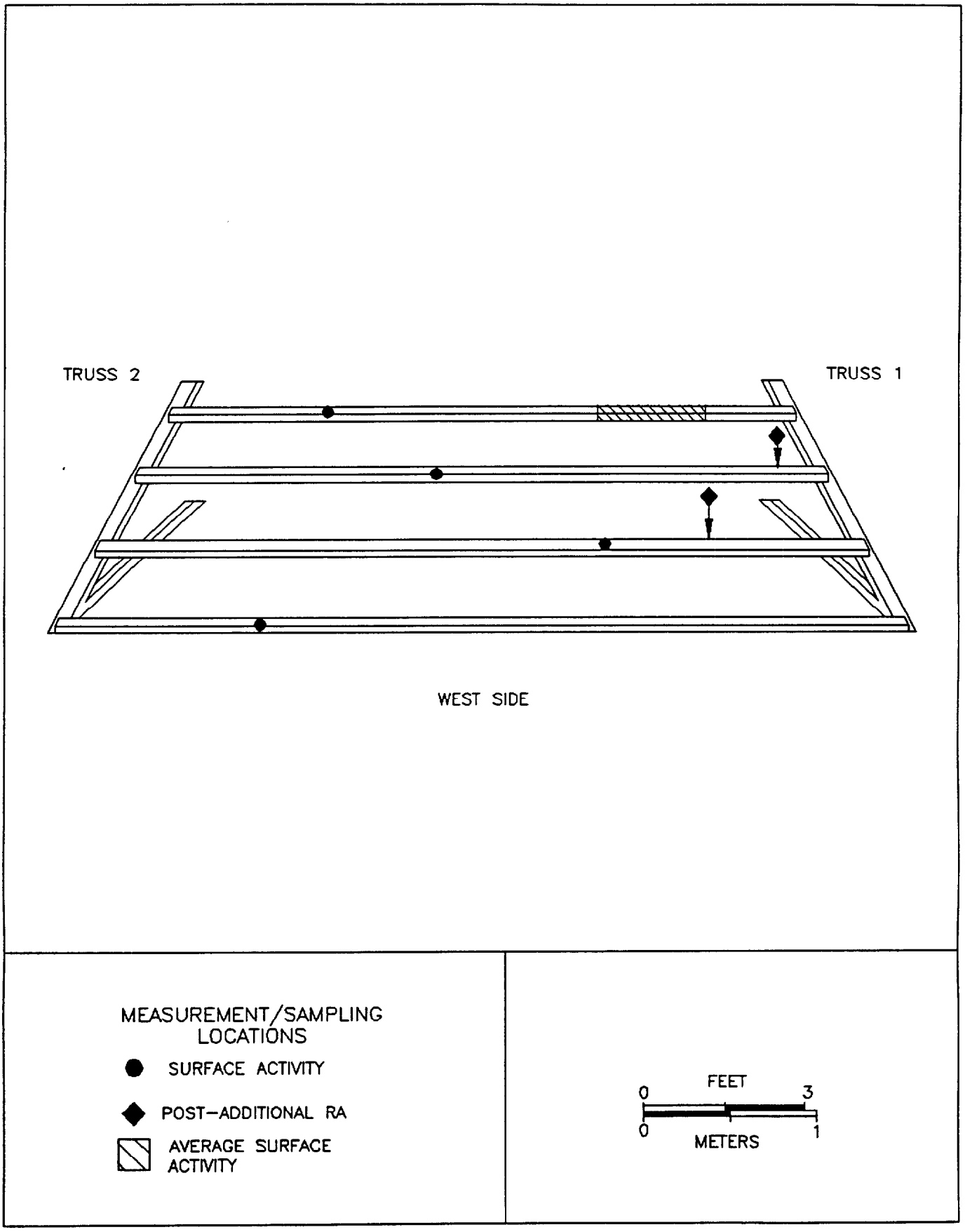
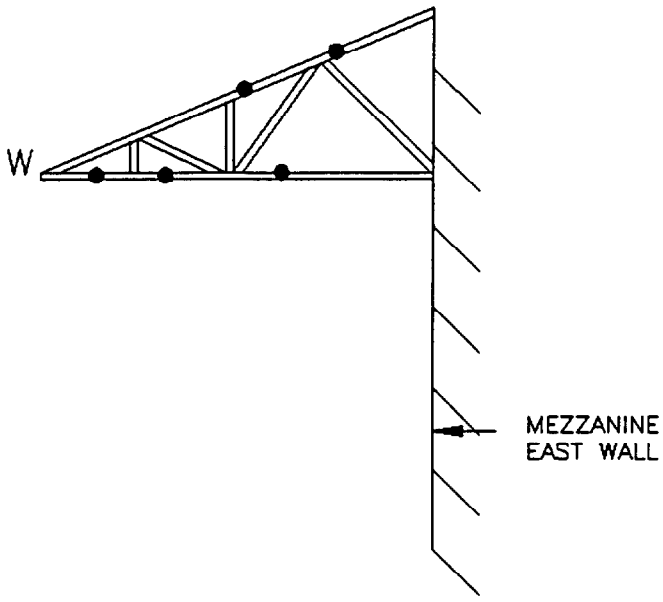


FIGURE 57: Building 8, Mezzanine, Bay 1 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

FEET
0 6
0 2
METERS

FIGURE 58: Building 8, Mezzanine, Truss 2 – Measurement and Sampling Locations

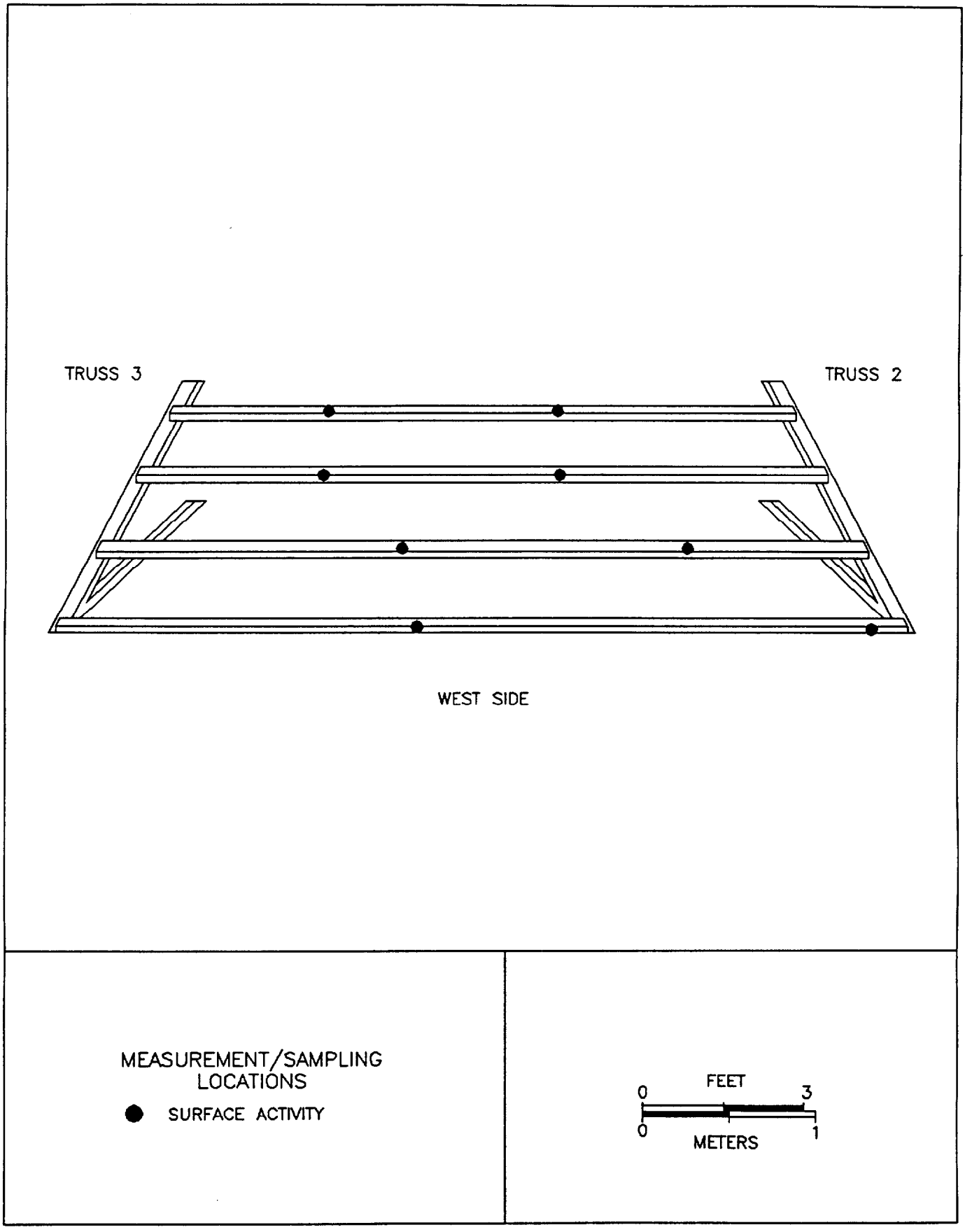


FIGURE 59: Building 8, Mezzanine, Bay 2 – Measurement and Sampling Locations

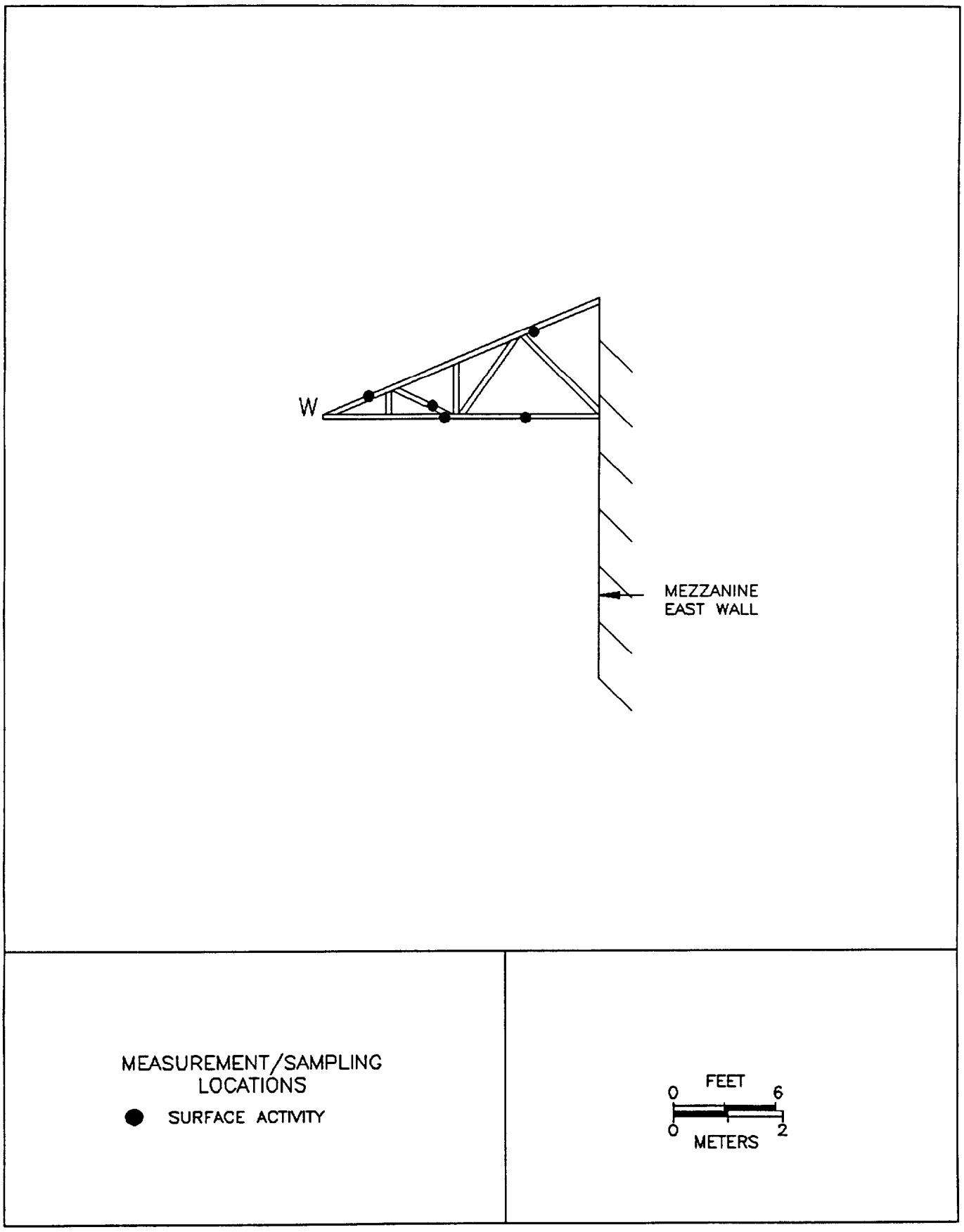


FIGURE 60: Building 8, Mezzanine, Truss 3 – Measurement and Sampling Locations

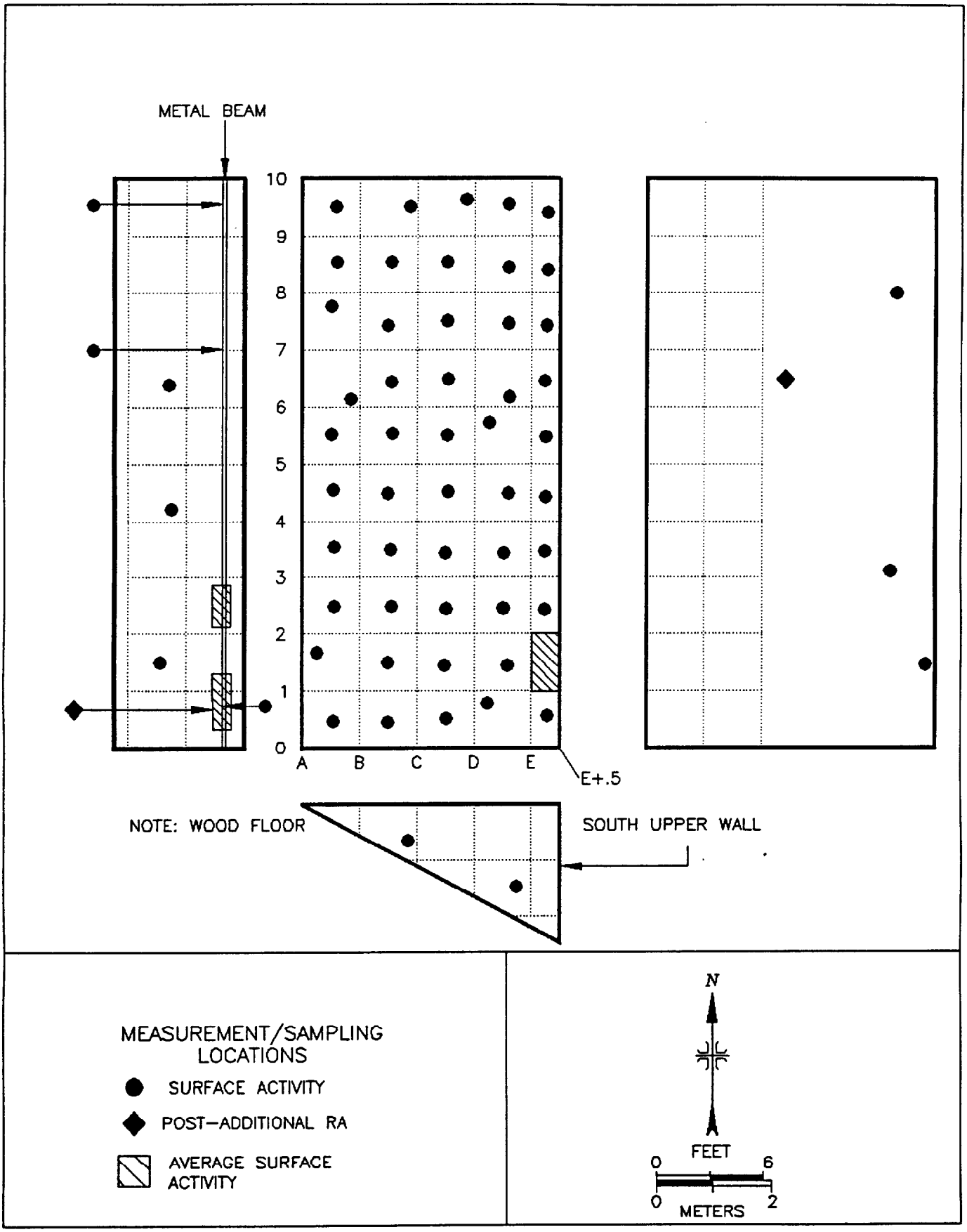


FIGURE 61: Building 8, Mezzanine Floor and Walls – Measurement and Sampling Locations

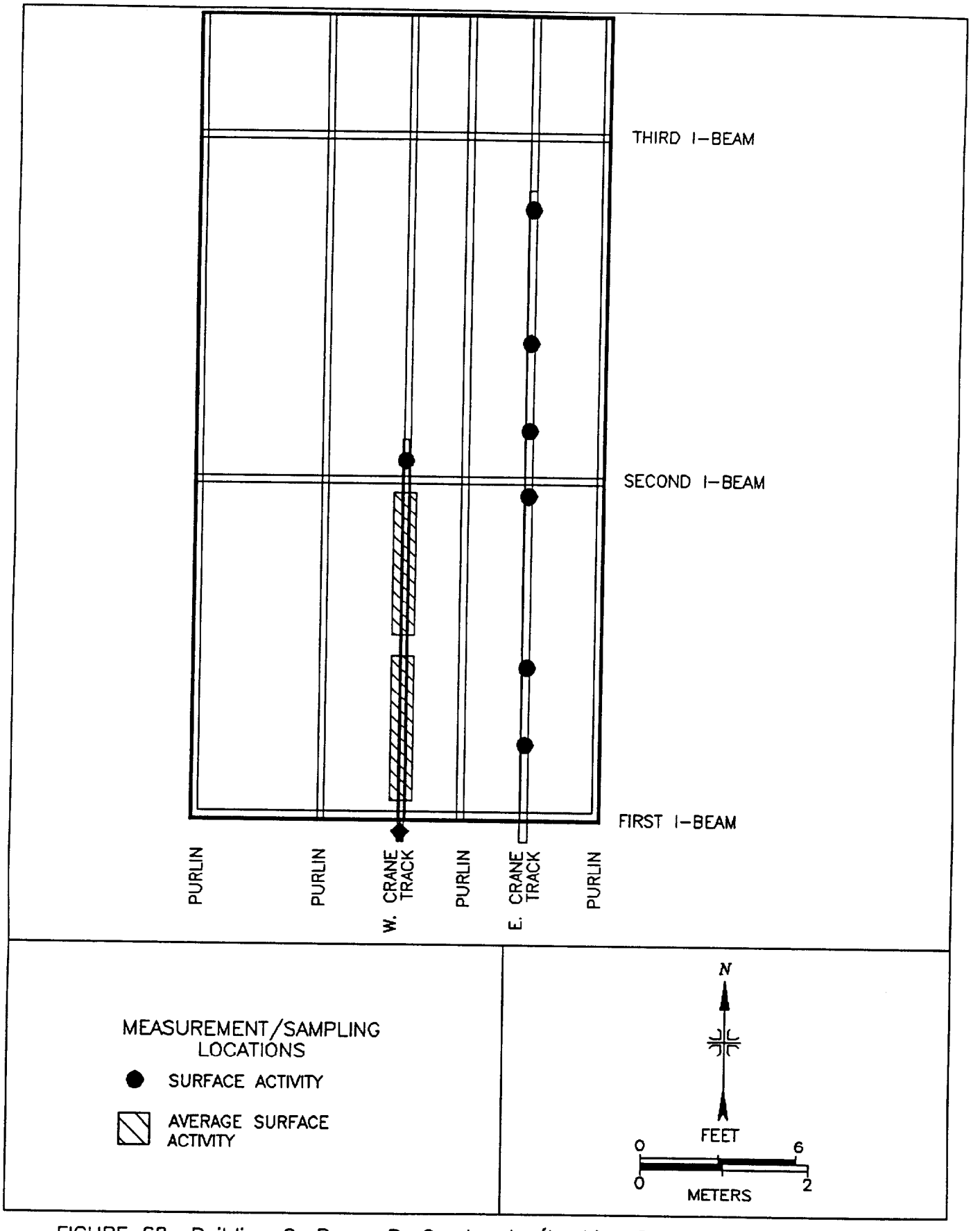
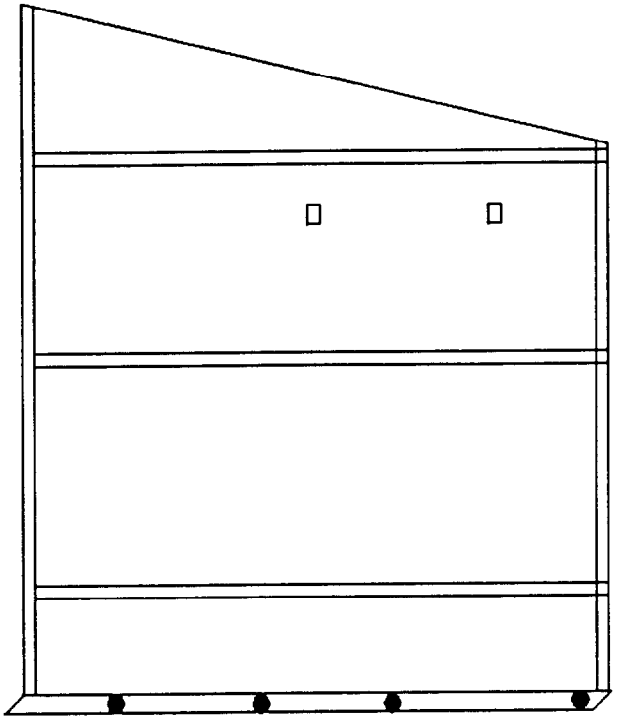


FIGURE 62: Building 8, Room B, Overheads (Looking Down From Above) – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

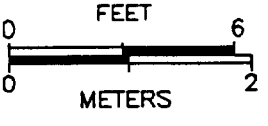
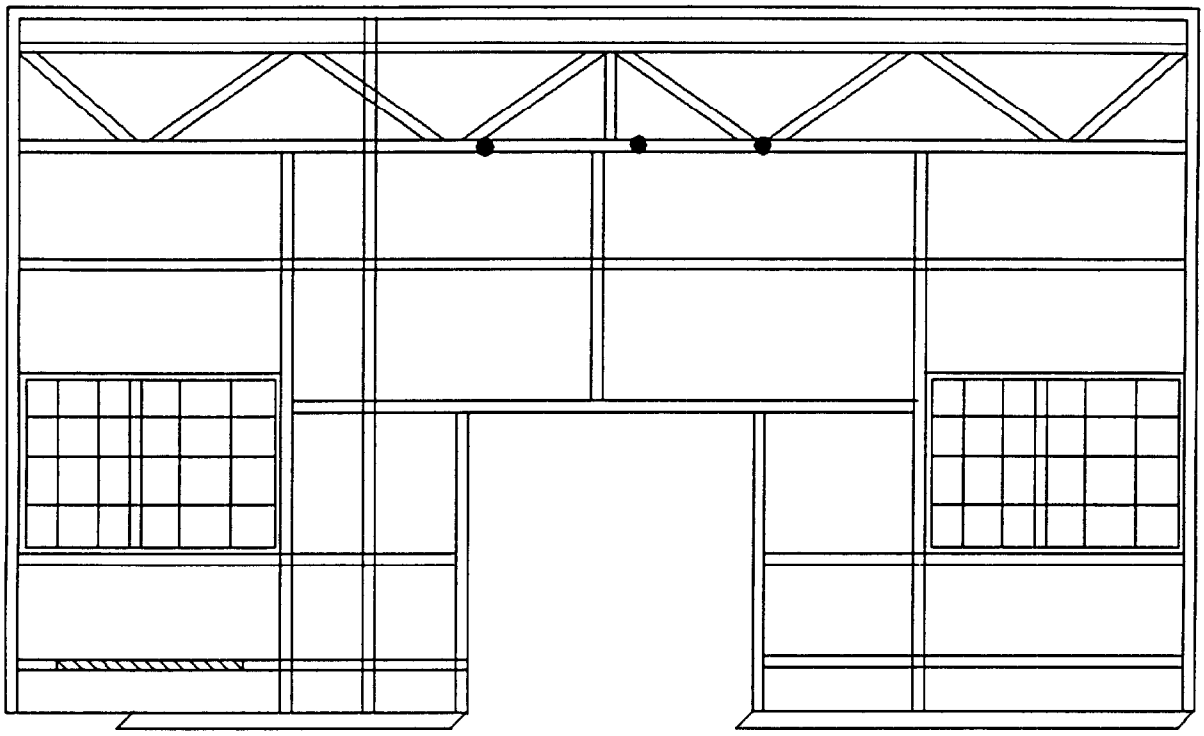


FIGURE 63: Building 8, Room B, North Wall – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY

▨ AVERAGE SURFACE ACTIVITY

N

FEET

0 6

0 2

METERS

FIGURE 64: Building 8, Room B, West Wall – Measurement and Sampling Locations

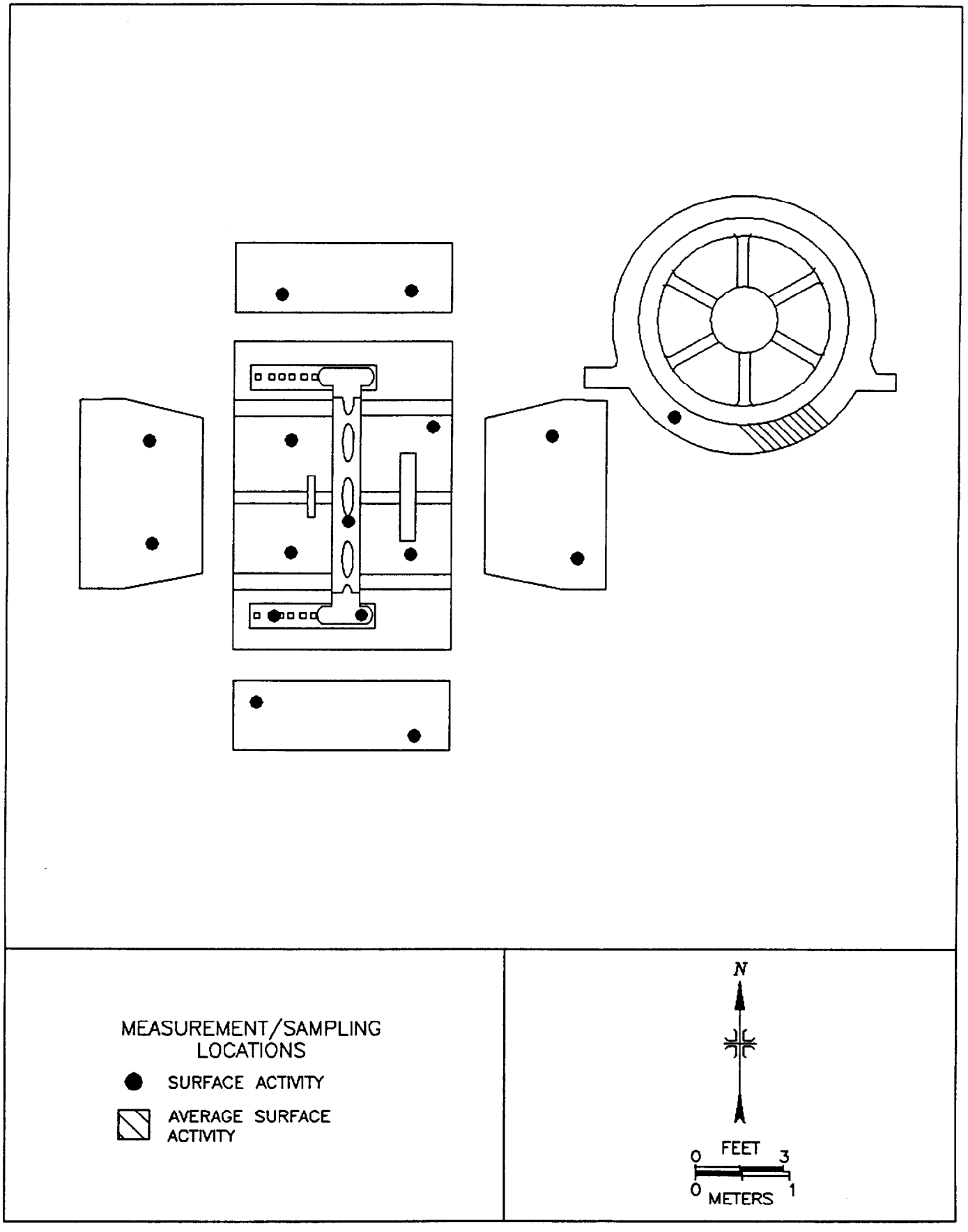


FIGURE 65: Building 8, East Compressor Pit – Measurement and Sampling Locations

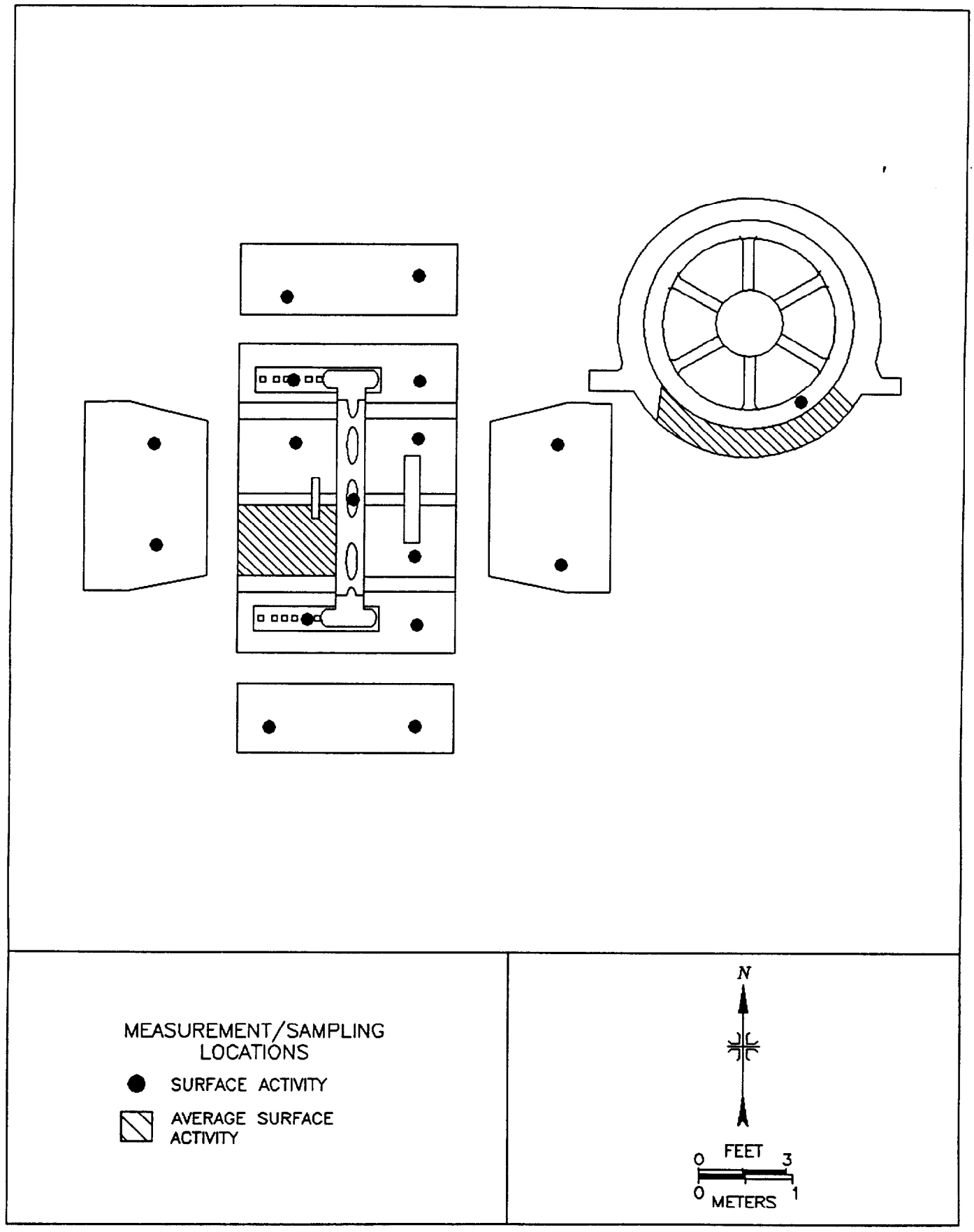


FIGURE 66: Building 8, West Compressor Pit – Measurement and Sampling Locations

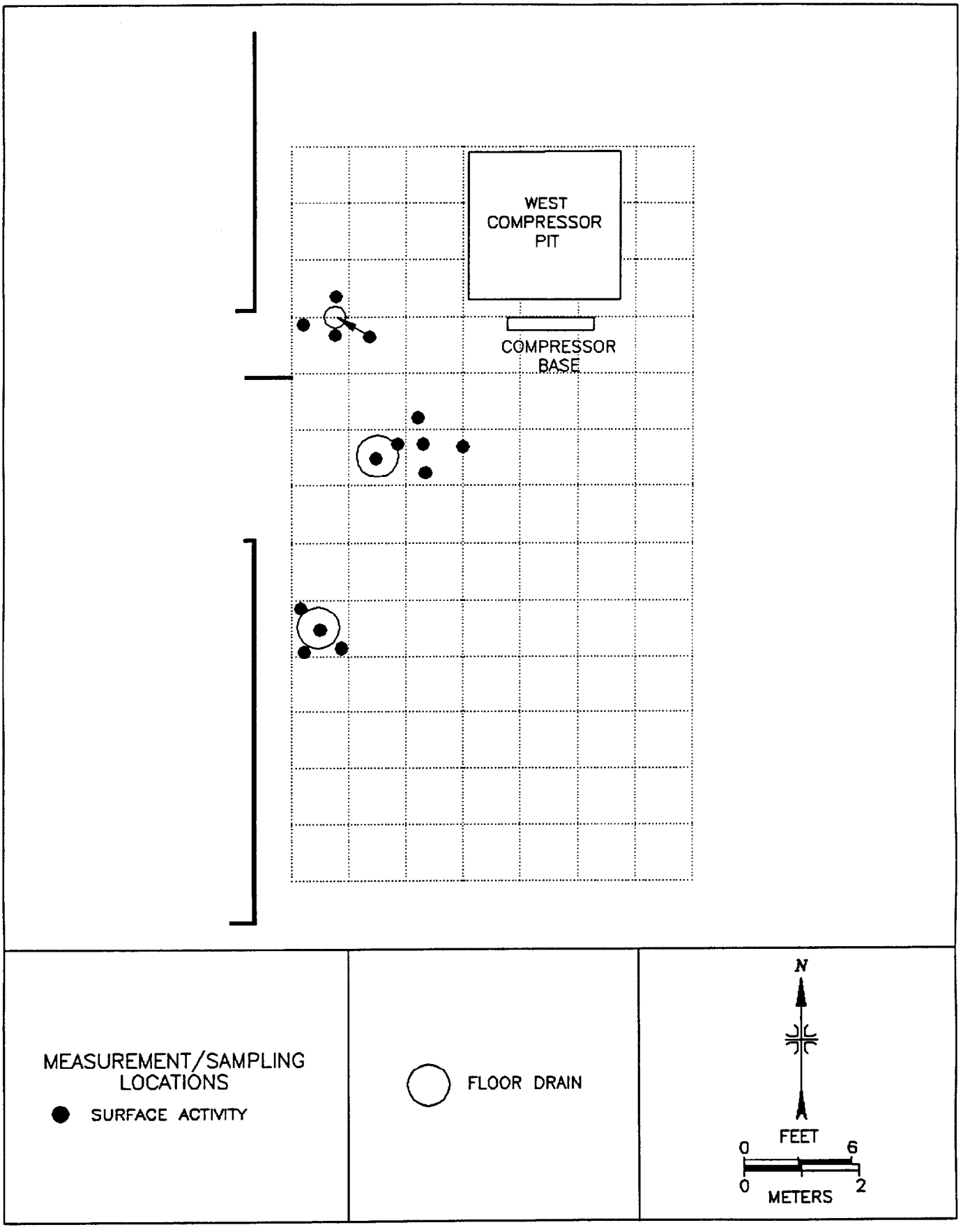
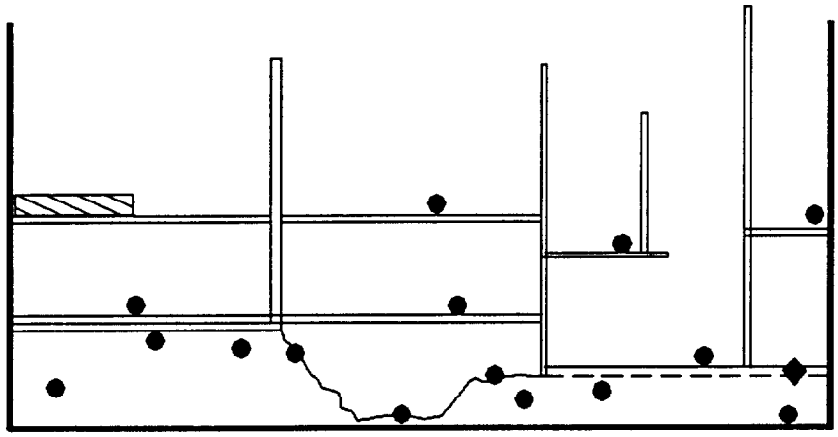


FIGURE 67: Building 8, Compressor Room – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY
- POST-ADDITIONAL RA
- AVERAGE SURFACE ACTIVITY

FEET 0 6

METERS 0 2

FIGURE 68: Building 8, Compressor Room, South Wall – Measurement and Sampling Locations

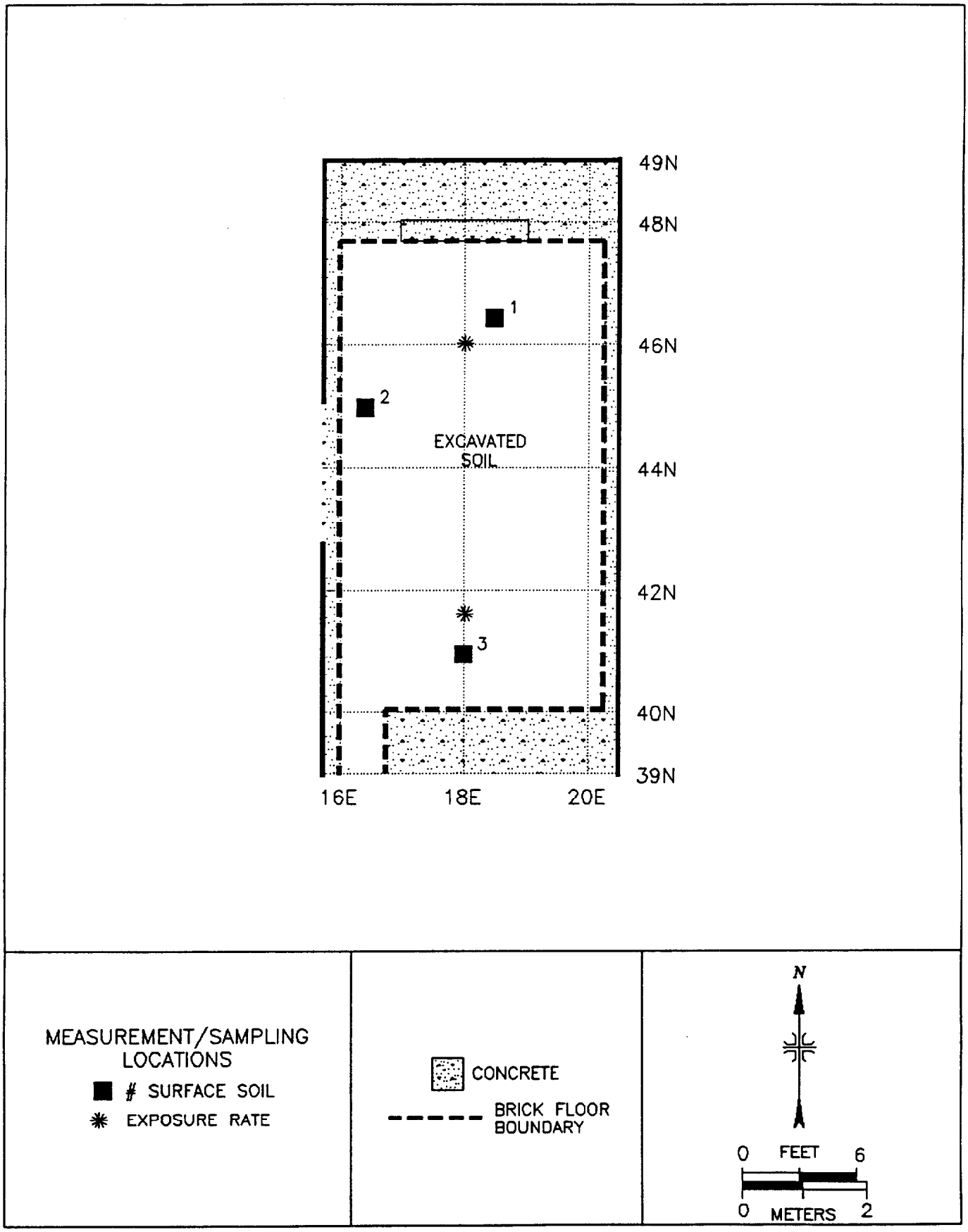


FIGURE 69: Building 8, Room B – Measurement and Sampling Locations

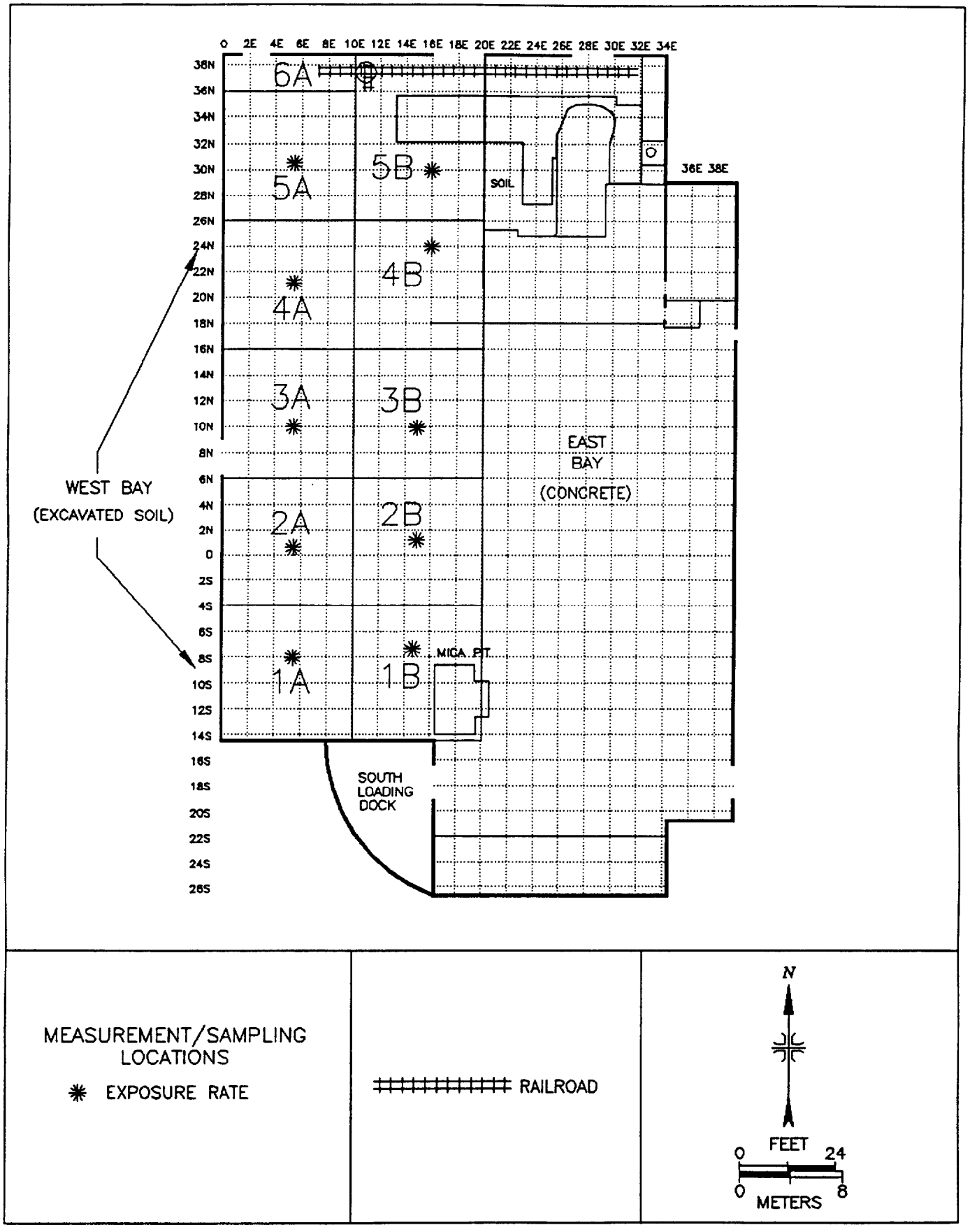


FIGURE 70: Building 3, West Bay – Exposure Rate Measurement Locations

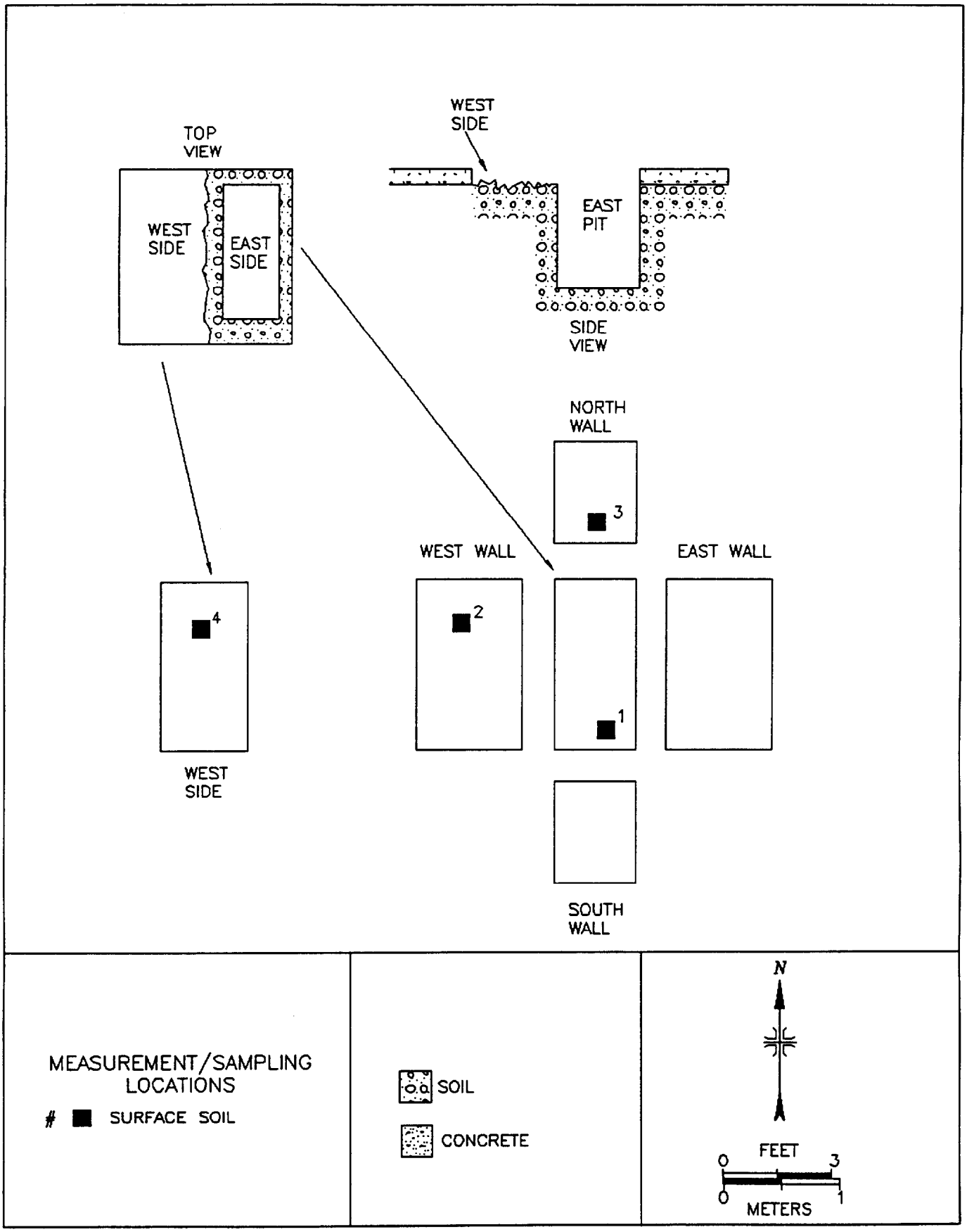


FIGURE 71: Building 3, Mica Pit – Measurement and Sampling Locations

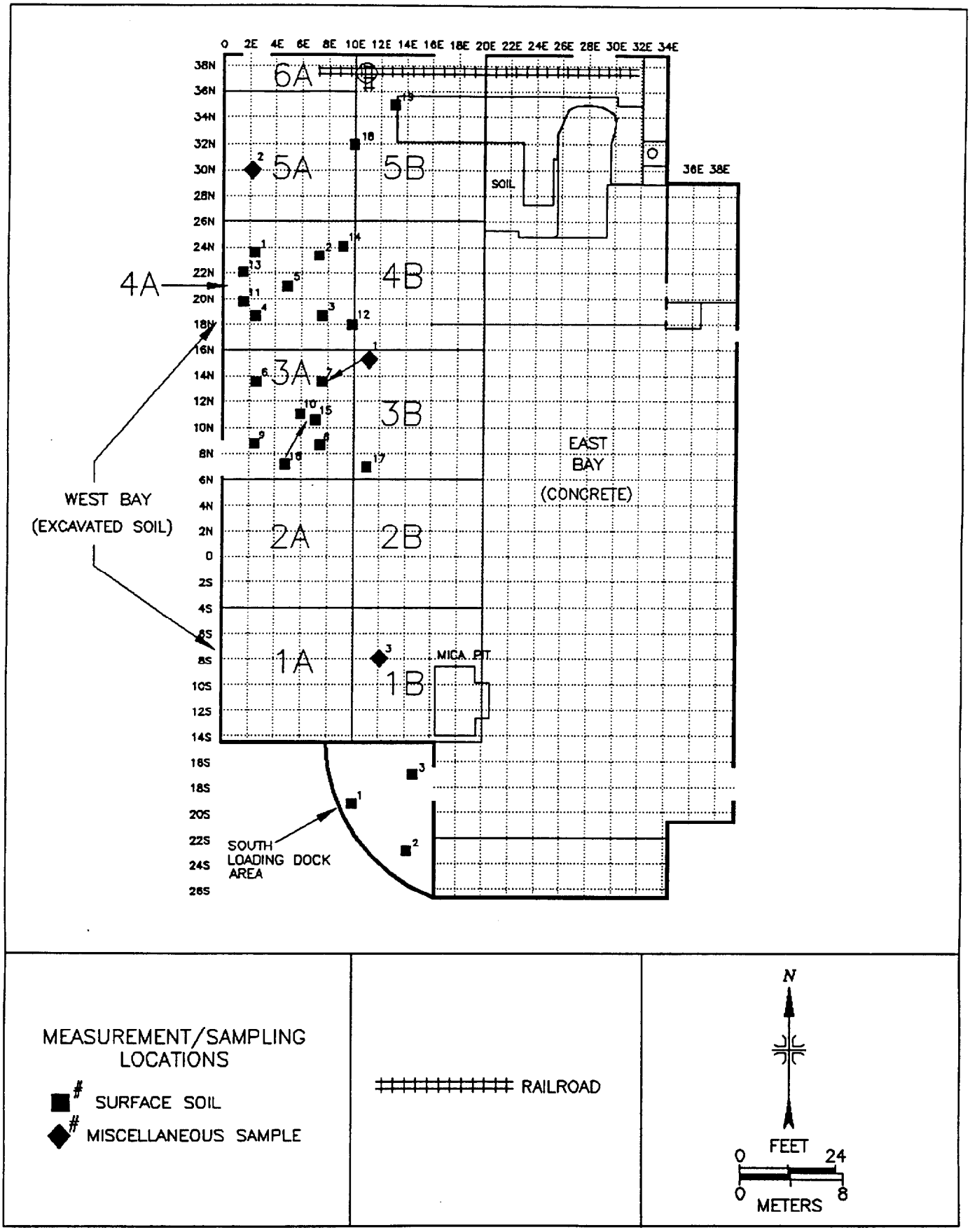
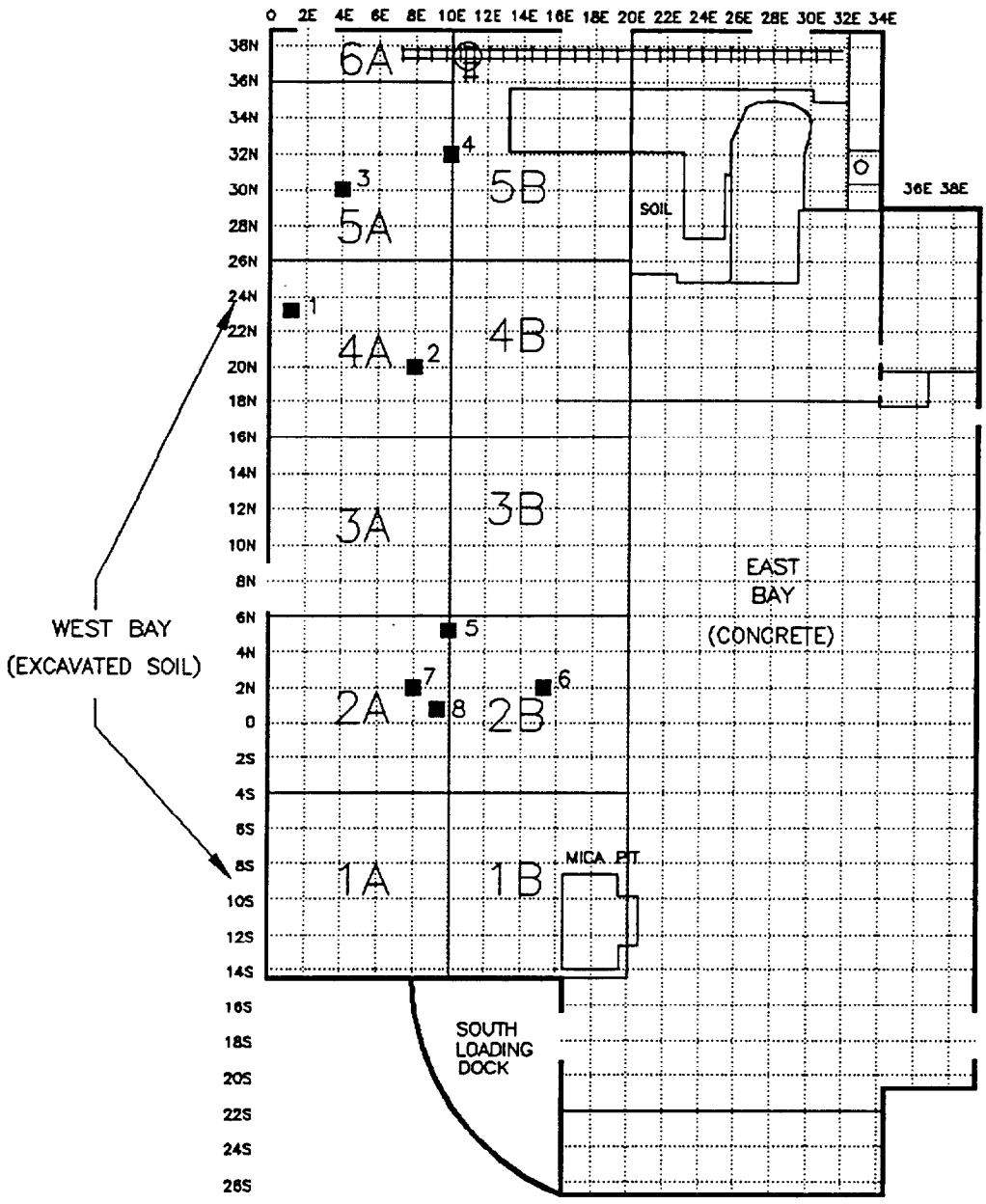


FIGURE 72: Building 3, West Bay and South Loading Dock – Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

■ # SURFACE SOIL

RAILROAD

N

FEET 0 24

METERS 0 8

FIGURE 73: Building 3, West Bay – ESSAP and PMC Soil Sampling Locations

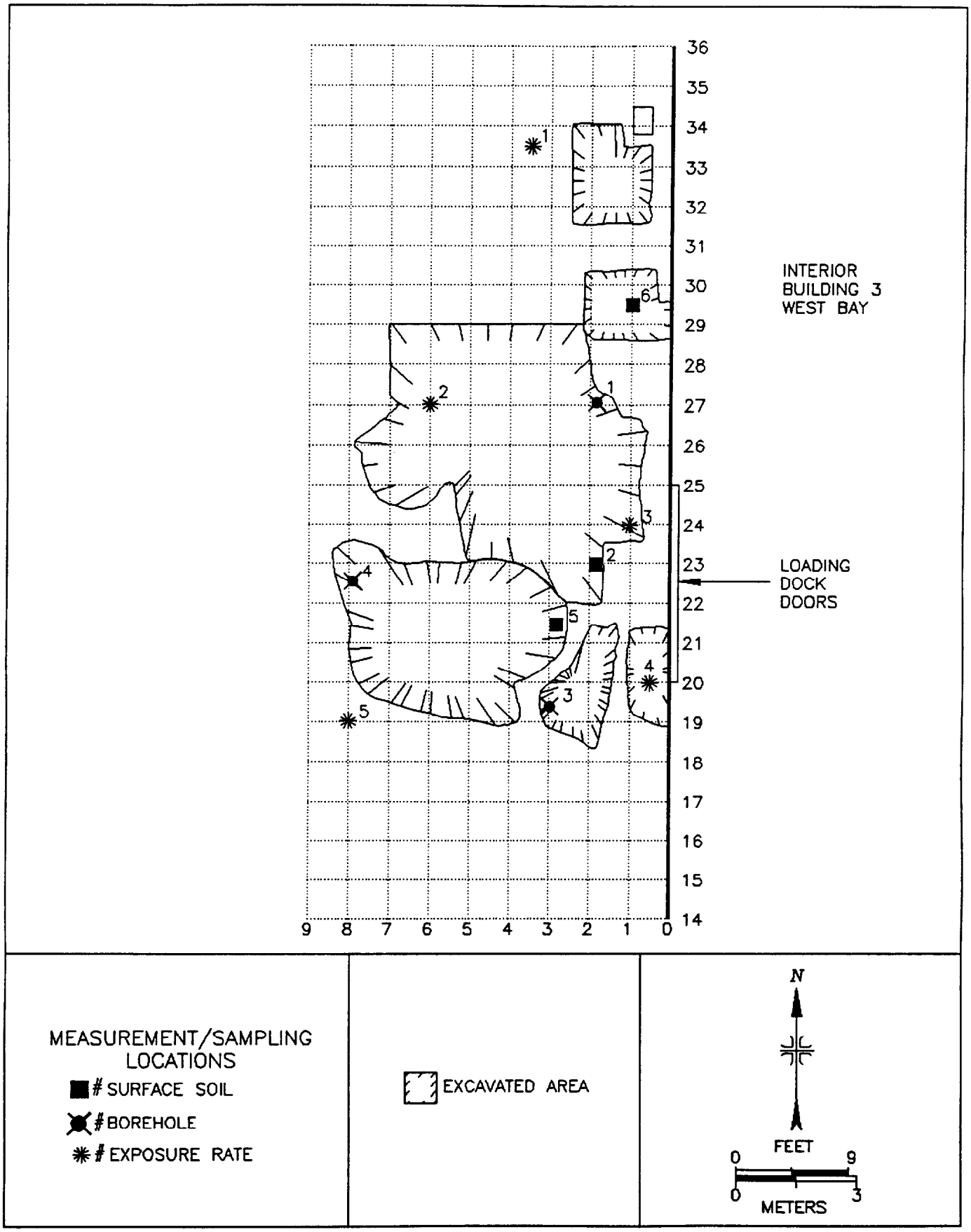


FIGURE 74: Building 3, West Side Soil Excavation – Measurement and Sampling Locations

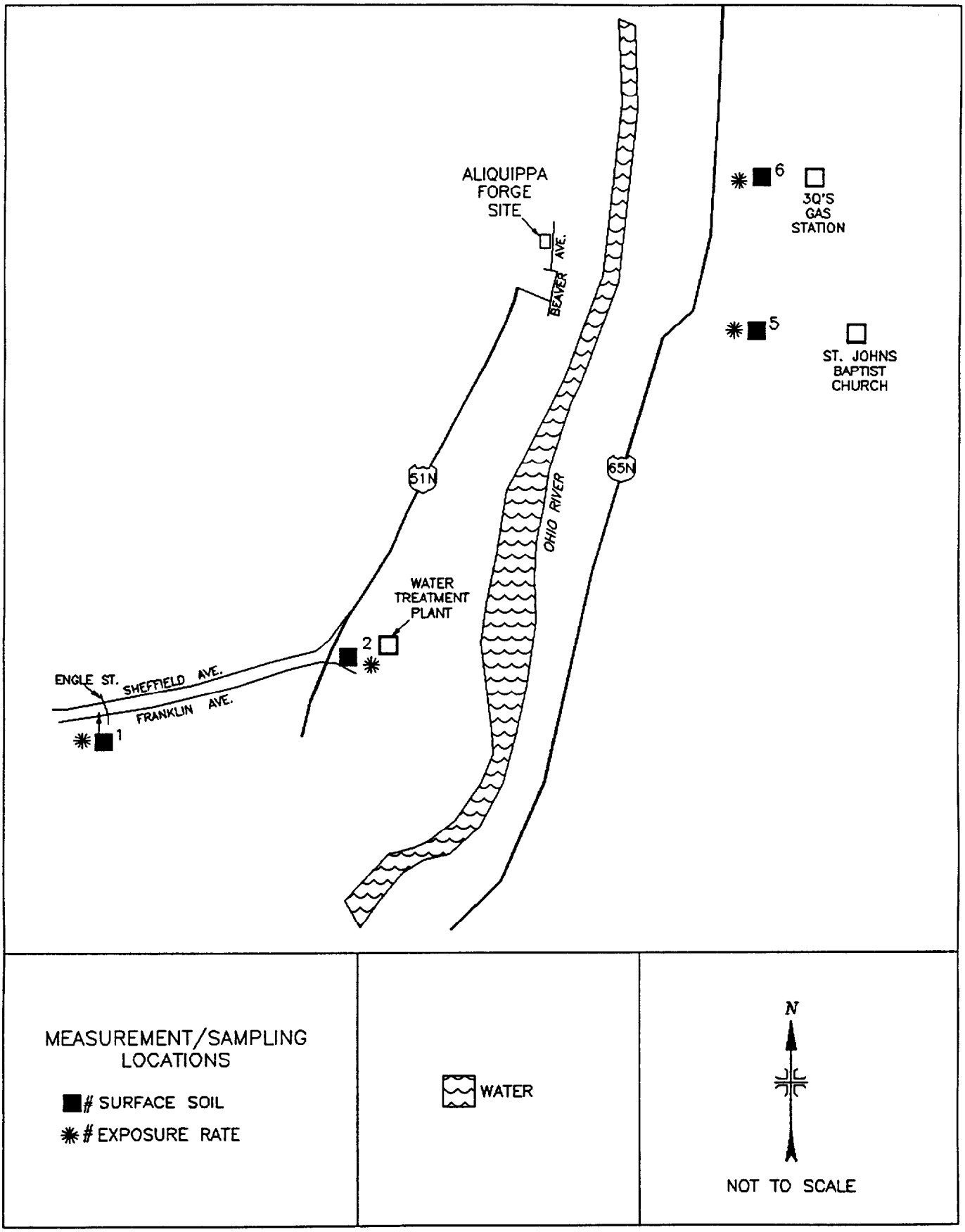


FIGURE 75: Background Exposure Rate Measurement and Soil Sampling Locations

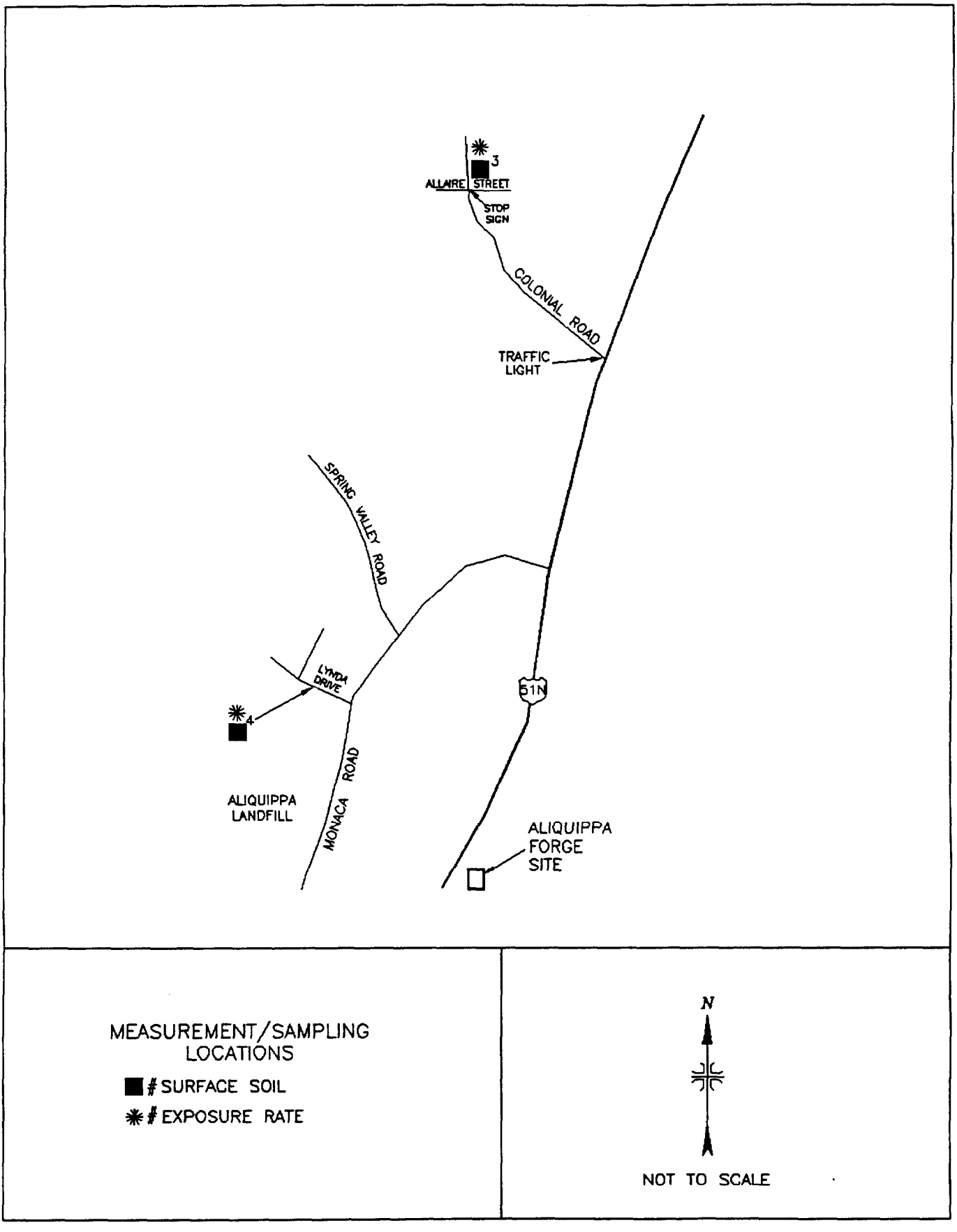


FIGURE 76: Background Exposure Rate Measurement and Soil Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BUILDINGS 3 AND 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure #	Number of Measurement Locations		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Average	Alpha	Beta
Building 3 Overheads							
Truss 1	6	12	N/A	<1,300	N/A	<12	<16
Bay 1, East	7	9	N/A	<1,300	N/A	<12	<16
Bay 1, West	8	11	1	<1,300-3,800	3,100	<12	<16
Truss 2	9	10	2	<1,300-3,100	6,100-6,200(2)[a]	<12	<16
Post - Additional RA[b]		2	N/A	<1,300-2,400	N/A	<12	<16
Bay 2, East	10	11	1	<1,300	1,900	<12	<16
Bay 2, West	11	4	6	<1,300-2,000	2,500-4,700	<12	<16
Truss 3	12	9	1	<1,300-2,700	2,200	<12	<16
Bay 3, East	13	13	2	<1,300-4,200	4,200	<12	<16
Bay 3, West	14	8	5	<1,300-4,300	3,300-7,500(2)	<12	<16
Post - Additional RA		2	N/A	<1,300	N/A	<12	<16
Truss 4	15	8	4	<1,300-3,800	2,400-6,600(2)	<12-15	<16-30
Post - Additional RA		N/A	2	N/A	4,100-6,300(1)	14-17	<16-18
Post - Additional RA		1	N/A	<1,300	N/A	<12	<16
Bay 4, East	16	9	5	<1,300-4,500	3,800-6,800(4)	<12-14	<16-20
Post - Additional RA		3	1	<1,300-2,100	5,000	<12	<16
Bay 4, West	17	6	6	<1,300-3,000	3,700-8,500(3)	<12	<16
Post - Additional RA		3	N/A	<1,300	N/A	<12	<16
Truss 5	18	6	4	<1,300-4,600	3,600-8,500(2)	<12- 19	<16
Post - Additional RA		1	1	3,400	4,400	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BUILDINGS 3 & 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure #	Number of Measurement Locations		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Average	Alpha	Beta
Building 3 Overheads (Continued)							
Bay 5, East	19	9	5	<1,300-2,700	1,800-6,900(3)	<12	<16
Post - Additional RA		2	1	<1,300	4,000	<12	<16
Bay 5, West	20	9	4	<1,300-22,000(1)	2,700-7,800(2)	<12	<16
Post - Additional RA		2	N/A	<1,300-2,500	N/A	<12	<16
Truss 6	21	11	3	<1,300-22,000(1)	2,600-4,300	<12	<16
Post - Additional RA		1	N/A	1,300	N/A	<12	<16
Bay 6, East	22	14	N/A	<1,300-4,500	N/A	<12-45	<16-17
Bay 6, West	23	13	N/A	1,300-4,300	N/A	<12	<16
Truss 7	24	8	2	<1,300-3,000	2,400-3,900	<12-17	<16
Bay 7, East	25	14	N/A	<1,300-4,200	N/A	<12	<16
Bay 7, West	26	12	N/A	1,300-15,000(1)	N/A	<12	<16
Post - Additional RA		1	N/A	16,000(1)	N/A	<12	<16
Post - Additional RA		1	N/A	2,200	N/A	<12	<16
Bay 7, Ceiling	26	4	N/A	<1,300-77,000	N/A	<12	<16
Truss 8	27	7	3	<1,300-16,000(1)	1,600-9,000(1)	≤12	<16-22
Post - Additional RA		2	N/A	1,700-2,800	N/A	<12	<16
Bay 8, East	28	15	N/A	<1,300-3,600	N/A	<12	<16
Bay 8, West	29	12	N/A	<1,300-4,000	N/A	<12	<16
Bay 8, Ceiling	29	9	N/A	<1,300-43,000	N/A	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BUILDINGS 3 & 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure #	Number of Measurement Locations		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Average	Alpha	Beta
Building 3 Overheads (Continued)							
Truss 9	30	12	2	<1,300-4,300	3,300-3,800	<12-14	<16
Bay 9, East	31	13	1	<1,300-4,900	1,600	<12	<16
Bay 9, West	32	11	1	<1,300-4,400	6,000(1)	<12-30	<16-22
Post - Additional RA		1	N/A	<1,300	N/A	<12	<16
Bay 9, Ceiling	32	5	N/A	<1,300-57,000	N/A	<12	<16
Truss 10	33	9	2	<1,300-24,000(2)	2,300-3,900	<12-27	<16-47
Post - Additional RA		2	N/A	1,400-2,800	N/A	<12	<16
Bay 10, East	34	13	1	<1,300-5,000	5,400(1)	<12	<16
Post - Additional RA		1	N/A	3,100	N/A	<12	<16
Bay 10, West	35	8	4	<1,300-4,700	3,200-5,400(1)	<12	<16
Post-Additional RA		N/A	1	N/A	2,400	<12	<16
Truss 11	36	8	2	<1,300-3,500	4,300-5,000(1)	<12	<16
Post - Additional RA		1	N/A	<1,300	N/A	<12	<16
Bay 11, East	37	12	3	<1,300-4,700	2,800-6,500(1)	<12	<16
Post - Additional RA		N/A	1	N/A	3,300	<12	<16
Bay 11, West	38	14	3	<1,300-3,800	2,500-3,100	<12	<16
North Wall	39	14	N/A	<1,300-4,600	N/A	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BUILDINGS 3 & 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure #	Number of Measurement Locations		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Average	Alpha	Beta
Building 8 Overheads							
Truss 1	40	7	1	<1,300-19,000(1)	5,900(1)	<12	<16
Post-Additional RA		2	N/A	<1,300	N/A	<12	<16
Bay 1, East	41	21	N/A	<1,300-1,500	N/A	<12	<16
Bay 1, West	42	6	N/A	<1,300	N/A	<12	<16
Truss 2	43	11	N/A	<1,300	N/A	<12	<16
Bay 2, East	44	21	N/A	<1,300	N/A	<12	<16
Bay 2, West	45	6	N/A	<1,300	N/A	<12	<16
Truss 3	46	7	N/A	<1,300-2,300	N/A	<12	<16
Building 3							
Cutter Components and Oven Doors	NA	10	2	<1,400-4,600	1,900-2,100	<12-23	<16
Superstructure	47	20	N/A	<1,300-53,000(4)	N/A	≤12	<16
Post-Additional RA		4	N/A	<1,300	N/A	<12	<16
Pipe Chase Manhole	48	3	N/A	2,700-3,600	N/A	<12	<16
Scale Apparatus Pit	49	11	N/A	<1,200	N/A	<12	<16
East Bay Floor	50	134	1	<1,600-19,000(2)	3,000	<12	<16
Post-Additional RA		2	N/A	1,700-4,900	N/A	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BUILDINGS 3 & 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure #	Number of Measurement Locations		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Average	Alpha	Beta
West Wall	51	1	21	18,000(1)	<1,500-9,000(1)	<12	<16
Post-Additional RA		N/A	2	N/A	<1,300-3,900	<12	<16
Building 8							
Basement	52	N/A	3	N/A	<1,500	<12	<16
Tool Room							
Floor	53	N/A	11	N/A	<1,400-3,500	<12	<16
Walls	54	21	2	<1,400-4,500	4,000-4,100	<12	<16-21
Ceiling	55	14	N/A	<1,400-1,900	N/A	<12	<16
Mezzanine							
Truss 1	56	5	N/A	<1,300-4,300	N/A	<12	<16
Bay 1, West	57	6	1	<1,300-15,000(2)	4,200	<12	<16
Post-Additional RA		1	1	<1,300	2,600	<12	<16
Truss 2	58	5	N/A	<1,300	N/A	<12	<16
Bay 2, West	59	8	N/A	<1,300-3,500	N/A	<12	<16
Truss 3	60	5	N/A	<1,300	N/A	<12	<16
Floor	61	49	1	<1,300-2,100	<1,300	<12	<16
Walls	61	12	2	<1,300-9,200(1)	4,000-7,100(1)	<12	<16
Post-Additional RA		2	N/A	1,600-2,000	N/A	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BUILDINGS 3 & 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure #	Number of Measurement Locations		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Average	Alpha	Beta
Room B							
Overheads	62	8	2	<1,300-25,000(1)	2,700-4,600	<12	<16
Post-Additional RA		1	N/A	<1,300	N/A	<12	<16
Walls	63-64	7	1	<1,300-1,900	3,700	<12	<16
East Compressor Pit							
Floor	65	7	N/A	<1,300-2,800	N/A	<12	<16
Walls	65	8	N/A	<1,300-4,000	N/A	<12	<16
Stator Wheel	65	1	1	<1,300	4,100	<12	<16
West Compressor Pit							
Floor	66	8	1	<1,300-1,800	3,700	<12	<16
Walls	66	8	N/A	<1,300-4,000	N/A	<12	<16
Stator Wheel	66	1	1	<1,300	2,600	<12	<16
Compressor Room							
Floor	67	11	N/A	<1,400-2,200	N/A	<12	<16
Drain	67	3	N/A	<1,400	N/A	<12	<16
South Wall	68	16	1	<1,400-27,000(1)	4,500	<12	<16
Post-Additional RA		1	N/A	1,400	N/A	<12	<16

[a]Number in parenthesis indicates the number of individual measurements exceeding 15,000 dpm/100 cm² or average measurements exceeding 5,000 dpm/100 cm².
[b]Post - Additional RA indicates that additional verification survey measurements were performed at locations requiring further remediation by the PMC.

TABLE 2

INTERIOR EXPOSURE RATE MEASUREMENTS
BUILDINGS 3 AND 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure No.	Number of Measurements	Exposure Rate Range (μR/h)
Building 3			
West Bay	70	10	9-11
Building 8			
Basement	52	2	10-12
Tool Room	53	2	8
Room B	69	2	11-12

TABLE 3

URANIUM CONCENTRATIONS IN SOIL SAMPLES COLLECTED INSIDE BUILDINGS 3 AND 8 ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Location	Depth of Sample (cm)	Uranium Concentrations (pCi/g)		
		U-235	U-238	Total Uranium[a]
Building 3, Mica Pit[b]				
1	0-15	0.1 ± 0.1[c]	2.2 ± 1.0	4.5
2	0-15	0.1 ± 0.1	1.0 ± 0.7	2.1
3	0-15	0.2 ± 0.1	1.4 ± 0.6	3.0
4	0-15	0.3 ± 0.1	5.1 ± 1.0	11
Building 3, West Bay[d]				
Systematic Samples, Grid Block 4A				
1	0-15	0.1 ± 0.1	1.3 ± 0.7	2.7
2	0-15	1.6 ± 0.1	22.5 ± 1.8	47
3	0-15	0.9 ± 0.1	8.8 ± 1.2	19
4	0-15	1.1 ± 0.1	20.8 ± 2.5	43
5	0-15	1.0 ± 0.1	16.6 ± 2.2	34
Systematic Samples, Grid Block 3A				
6	0-15	0.5 ± 0.1	9.7 ± 2.2	20
7	0-15	0.2 ± 0.1	2.3 ± 1.1	4.8
8	0-4	1.1 ± 0.1	17.1 ± 2.5	35
9	0-15	1.0 ± 0.1	15.6 ± 2.1	32
10	0-15	1.1 ± 0.1	17.8 ± 1.7	37
Biased Samples, Grid Block 4A				
11	0-15	4.8 ± 0.3	72.8 ± 3.7	150
12	0-15	2.5 ± 0.2	36.7 ± 2.5	76
13	0-15	10.8 ± 0.4	138.5 ± 4.9	290
14	0-15	2.7 ± 0.2	44.5 ± 4.0	92

TABLE 3 (Continued)

URANIUM CONCENTRATIONS IN SOIL SAMPLES
COLLECTED INSIDE BUILDINGS 3 AND 8
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Depth of Sample (cm)	Uranium Concentrations (pCi/g)		
		U-235	U-238	Total Uranium[a]
Building 3, West Bay[d] (Continued)				
Biased Samples, Grid Block 3A				
15	0-15	19.3 ± 0.4	353.1 ± 6.9	730
16	0-15	4.9 ± 0.2	74.0 ± 4.3	150
Biased Sample, Grid Block 3B				
17	0-15	2.8 ± 0.2	42.2 ± 3.6	87
Biased Samples, Grid Block 5B				
18	0-15	4.7 ± 0.1	70.3 ± 2.6	150
19	0-15	5.5 ± 0.3	79.7 ± 3.6	160
Building 8, Room B[e]				
1	0-15	1.1 ± 0.1	14.5 ± 2.0	30
2	0-15	0.3 ± 0.1	2.5 ± 1.4	5.3
3	0-15	0.1 ± 0.1	0.8 ± 0.5	1.7

[a]Total uranium concentrations are calculated based on natural isotopic abundances.
[b]Refer to Figure 71.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d]Refer to Figure 72.
[e]Refer to Figure 69.

TABLE 4

URANIUM CONCENTRATIONS IN SOIL SAMPLES (ANALYZED BY BOTH ESSAP AND THE PMC) BUILDING 3, WEST BAY EXCAVATION ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Location[a]	Uranium Concentrations (pCi/g)	
	ESSAP U-238	PMC U-238
#1; 23N, 1E	38.5 ± 2.3[b]	33.10 ± 1.80
#2; 20.5N, 8.5E	13.9 ± 2.2	4.30 ± 0.68
#3; 29.5N, 3.3E	8.1 ± 1.6	10.80 ± 4.60
#4; 32.5N, 10E	15.2 ± 2.4	20.00 ± 2.70
#5; 5.2N, 10.5E	2.2 ± 1.4	2.4 ± 0.72
#6; 2N, 15E	8.8 ± 1.7	6.90 ± 1.30
#7; 2N, 8E	26.4 ± 1.8	38.5 ± 1.40
#8; 1N, 8.7E	25.5 ± 2.4	25.6 ± 1.80

[a]Refer to Figure 73. Location coordinates are based on ESSAP grid system.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

TABLE 5

URANIUM CONCENTRATIONS IN CRUSHED BRICK AND CONCRETE SAMPLES ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Location	Uranium Concentrations (pCi/g)		
	U-235	U-238	Total Uranium[a]
Crushed Brick Piles			
East Furnace	0.3 ± 0.1[b]	6.4 ± 1.3	13
West Furnace	1.7 ± 0.3	32.2 ± 2.5	66
Room B Bricks	1.6 ± 0.2	28.6 ± 1.8	59
West Bay, Building 3 Crushed Concrete[c]			
#1; 14.1N, 8E	0.6 ± 0.5	10.1 ± 2.7	21
#2; 30N, 2E	0.5 ± 0.1	9.3 ± 1.9	19
#3; 8S, 12E	0.2 ± 0.1	4.0 ± 2.0	8.2

[a]Total uranium concentrations are calculated based on natural isotopic abundances.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]Refer to Figure 72.

TABLE 6

BACKGROUND EXPOSURE RATE MEASUREMENTS AND URANIUM CONCENTRATIONS IN SOIL ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Location[a]	Exposure Rate (μR/h) @ 1 m Above Surface	Total Uranium Concentration (pCi/g)[b]
Engle Street	9	4.3
Water Treatment Plant	8	4.7
Allaire Street	7	3.2
Lynda Drive	9	3.8
St. John's Church	7	2.3
3Q's Gas Station	7	2.8

[a]Refer to Figures 75 and 76.
[b]Total uranium concentrations are calculated based on natural isotopic abundances.

TABLE 7

EXTERIOR EXPOSURE RATE MEASUREMENTS
BUILDING 3 WEST SIDE SOIL EXCAVATION
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location[a]	Exposure Rate (μR/h)
#1 33.5N, 3.5W	9
#2 27N, 6W	9
#3 24N, 1.2W	10
#4 20N, 0.5W	9
#5 19N, 8W	10

[a]Refer to Figure 74.

TABLE 8

URANIUM CONCENTRATIONS IN EXTERIOR SOIL SAMPLES ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Location	Depth of Sample (cm)	Uranium Concentrations (pCi/g)		
		U-235	U-238	Total Uranium[a]
South Loading Dock Area[b]				
1	0-15	0.6 ± 0.1[c]	10.6 ± 2.0	22
2	0-15	0.5 ± 0.1	7.2 ± 1.6	15
3	0-15	0.3 ± 0.1	3.1 ± 1.6	6.5
Building 3 West Side Soil Excavation[d]				
#1; 27N, 1.7W	0-15	6.0 ± 0.3	100.2 ± 3.8	210[e]
27N, 1.7W	15-30	1.6 ± 0.2	24.9 ± 1.8	51[f]
#2; 22.9N, 1.8W	0-15	1.2 ± 0.1	17.1 ± 1.3	35
#3; 19.3N, 3.2W	0-15	6.3 ± 0.3	97.4 ± 2.9	200[e]
19.3N, 3.2W	15-30	0.9 ± 0.2	15.0 ± 1.4	31[f]
#4; 22.5N, 8W	0-15	8.8 ± 0.3	149.4 ± 3.5	310[e]
22.5N, 8W	15-30	1.4 ± 0.2	24.5 ± 2.1	50[f]
#5; 21.5N, 3W	0-15	2.7 ± 0.2	42.2 ± 2.2	87
#6; 29.5N, 1W	0-15	1.1 ± 0.1	17.9 ± 1.4	37

[a]Total uranium concentrations are calculated based on natural isotopic abundances.
[b]Refer to Figure 72.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d]Refer to Figure 74.
[e]These areas of contaminated soil were collected from locations of elevated direct radiation and were localized to an area less than 900 cm^2. The contaminated soil was removed by the PMC and the area surveyed to determine the success of remediation.
[f]These samples verify the success of the PMC's hot spot remediation.

REFERENCES

1. "Radiological Survey of Universal Cyclops, Inc., Titusville Plant (Formerly Vulcan Crucible Steel Company), Aliquippa, Pennsylvania," Argonne National Laboratory, May 1982.

2. "Site Plan for Universal Cyclops, Aliquippa, Pennsylvania," DOE/OR/20722-122, Bechtel National, Inc., August 1988.

3. "Radiological Survey of the Aliquippa Forge Site, West Aliquippa, Pennsylvania," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, December 1992.

4. "Characterization Survey of Portions of the Aliquippa Forge Site, West Aliquippa, Pennsylvania," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, December 1992.

5. "Additional Characterization Survey of Buildings 3 and 8, Aliquippa Forge Site, West Aliquippa, Pennsylvania," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, February 1994.

6. "Hazard Assessment for Radioactive Contamination at the Aliquippa Forge Site, Aliquippa, Pennsylvania," Bechtel National, Inc., June 1995.

7. "Post-Remedial Action Report for the Aliquippa Forge Site, Aliquippa, Pennsylvania," Bechtel National, Inc., Predecisional Draft, April 1994.

8. "Proposed Verification Survey Plan for the Aliquippa Forge Site," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, August 19, 1993.

9. DOE Memorandum from J. Wagoner to W. Seay, "Uranium Guidelines for the Aliquippa, Pennsylvania, Site," April 2, 1993.

10. Oak Ridge Institute for Science and Education, letter from E.W. Abelquist to J. Kopotic, FSRD, "Document Review - Predecisional Draft of the Hazard Assessment, Aliquippa Forge Site, Aliquippa, Pennsylvania," May 25, 1994.

11. Oak Ridge Institute for Science and Education, letter from E.W. Abelquist to J. Kopotic, FSRD,"Document Review - Predecisional Draft of the Post-Remedial Action Report for the Aliquippa Forge Site, Aliquippa, Pennsylvania," June 13, 1994.

12. Oak Ridge Institute for Science and Education, letter from E.W. Abelquist to M. Kucera, BNI, "Results of Confirmatory Analyses of Post-Remedial Action Soil Samples at the Aliquippa Forge Site," February 14, 1994.

13. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," Washington, D.C., February 8, 1990.

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 author 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, 15.5 cm^2
(Eberline, Santa Fe, NM)

Reuter-Stokes Pressurized Ion 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

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-5110-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. Surfaces were scanned using small area (15.5 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:

Beta	—	GM detector with ratemeter-scaler
Gamma	—	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements for total beta activity levels were performed using GM detectors with 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 beta activity background count rates for the GM detectors averaged approximately 45 cpm. Beta efficiency factors ranged from 0.15-0.18 for the GM detectors. The effective probe area for GM detectors is 15.5 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). The instrument was adjusted to one meter above the surface and allowed to stabilize. The measurement was read directly in μR/h.

Miscellaneous Sampling

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.

Crushed Brick and Concrete Sampling

Approximately 200 grams of crushed brick and concrete was collected at each sample location. Collected samples were placed in a plastic container, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Removable Activity

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

Miscellaneous Samples

Samples of soil and crushed brick and concrete were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 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. Energy peaks used for determination of radionuclides of concern were:

U-235 0.186 MeV
U-238 0.063 MeV or 0.093 MeV from Th-234*
*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 activity (MDA), were based on 2.71 plus 4.66 times the standard deviation of the background count [$2.71 + (4.66\sqrt{BKG})$]. When the activity was determined to be less than the MDA of the measurement procedure, the result was

reported as less than MDA. Because of variations in background levels, measurement efficiencies, the detection limits differ from 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 7 (September 1993) and Revision 8 (December 1993)
- Laboratory Procedures Manual, Revision 8 (August 1993)
- Quality Assurance Manual, Revision 6 (July 1993)

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

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES[1]

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 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	100 pCi/g[3]

[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.[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

1. "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.

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

3. DOE Memorandum from J. Wagoner to W. Seay, "Uranium Guidelines for the Aliquippa, Pennsylvania, Site," April 2, 1993.

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