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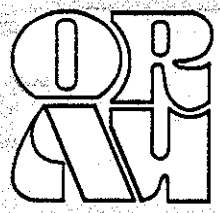

Prepared by
Oak Ridge Associated
Universities

Prepared for the
Decontamination and
Decommissioning
Division

U.S. Department
of Energy

RADIOLOGICAL SURVEY OF THE BAKER AND WILLIAMS WAREHOUSES NEW YORK, NEW YORK

P. R. COTTEN

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

FINAL REPORT
JUNE 1990

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Oak Ridge, TN 37831-0117

Project Staff

J. D. Berger	F. A. Payne
S. F. Barnett	J. L. Payne
M. J. Laudeman	A. Wallo*
E. A. Powell	C. F. Weaver

Prepared by

U.S. Department of Energy
as part of the
Formerly Utilized Sites - Remedial Action Program

FINAL REPORT

JUNE 1990

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

*With the U.S. Department of Energy

RADIOLOGICAL SURVEY
OF THE
BAKER AND WILLIAMS WAREHOUSES
NEW YORK, NEW YORK

Prepared by: Phyllis R. Cotten Date: 6/13/90
P. R. Cotten, Health Physicist, Project Leader
Environmental Survey and Site Assessment Program

Reviewed by: For Shawn S. Cunningham Date: 6/13/90
C. F. Weaver, Laboratory Manager
Environmental Survey and Site Assessment Program

Reviewed by: James D. Berger Date: 6/13/90
J. D. Berger, Program Director
Environmental Survey and Site Assessment Program

Approved by: Mark E. Baker for Date: 6/13/90
Roger J. Cloutier, Assistant Chairman
Energy/Environment Systems Division

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NEW YORK, NEW YORK

INTRODUCTION

During the early 1940s, the Baker and Williams warehouses on West 20th Street, in New York, New York, were used by the Manhattan Engineering District (MED) and the Atomic Energy Commission (AEC)-predecessors of the Department of Energy (DOE), for short term storage of uranium concentrates produced in Port Hope, Canada from African ores.[1] According to historical information, approximately 99,430 kg (219,000 lbs) of orange and yellow sodium uranate was delivered to the Baker and Williams (BW) warehouses for storage and later distribution to U.S. Government Reservations.

Baker and Williams owned three adjacent warehouse buildings at 513-519, 521-527, and 529-535 West 20th Street. The warehouses have been leased by several businesses since the 1940's. Ralph Ferrara, Inc., a LCM-FSW Partnership, currently owns and operates the buildings as a functioning warehouse facility and has leased Building 513-519 to Globe Moving and Storage Company. Historical shipping documentation indicate that MED/AEC shipments of uranium concentrates were delivered to the shipping and receiving office located in Building 529-535. However, shipments may have been received and unloaded at either of the adjacent warehouse buildings. Adjoining doorways between building 521-527 and 529-535 allows easy access between the two buildings, and is currently used in that manner. Because the MED/AEC materials shipped to the warehouses were stored for a short period of time before distribution, it is considered probable that only Buildings 521-527 and 529-535 would have been used for storage of radioactive material.

The DOE reviewed available historical documentation which describes the previous MED/AEC activities conducted at this facility. Based upon the review, the Department determined that the potential for radioactive material to be present as a result of the past MED/AEC activities was significantly low. However, there was not adequate documentation to verify the radiological condition of the site when MED/AEC activities were terminated. Therefore, DOE

determined that a preliminary survey should be performed to determine if additional investigations were required under the Formerly Utilized Sites Remedial Action Program (FUSRAP), or if the site could be eliminated from the program. DOE obtained consent to enter the property at 529-535 West 20th Street from the property owners. The Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Associated Universities (ORAU) was requested by DOE's Decontamination and Decommissioning Division to conduct a preliminary survey of the property at 529-535 West 20th Street. During the preliminary site visit conducted by ORAU, it was decided that Building 521-527 should be included based upon visual appearance and ease of accessibility into Building 529-535.

FACILITY DESCRIPTION

The BW warehouses are located on the west side of central New York City in the borough of Manhattan (Figure 1). Each building has approximately 855 m^2 (9200 ft^2) per floor of storage area. The general layout of Buildings 521-527 and 529-535 is illustrated in Figure 2. The main office space for each building is located on the first floor. Building 521-527 consists of 9 floors and a basement, and Building 529-535 has 11 floors and a basement. Each building is constructed of fire proof materials such as steel, concrete, terra-cotta, and brick. The floors in Building 521-527, excluding the basement, appeared to have been coated with a tar-like sealant and painted. The north and south walls of Building 521-527 had been re-surfaced with plaster and painted. In Building 529-535, the wall surfaces were covered with a variety of materials including paint, stucco, plaster, and a black foam material. Most of the wall surfaces on the upper seven floors have not been resurfaced, leaving the terra-cotta and masonry brick walls exposed.

PROCEDURES

During the period between August 24 - 30, 1989, ORAU performed a preliminary survey at 521-527 and 529-535 West 20th Street, New York, New York. The objective of the survey was to obtain sufficient radiological data, upon which to base a decision for exclusion or inclusion of the facility into FUSRAP.

Procedures

1. ORAU reviewed the available historical information as part of ORAU's survey procedures.

2. Surface scans were performed in accessible areas on the floors and lower walls (up to 2m), to identify areas of elevated gamma or beta-gamma direct radiation. NaI(Tl) gamma scintillation detectors and thin window GM detectors coupled to countrate meters with audible indicators were used for these measurements.

3. Direct measurements for total and removable alpha and beta-gamma activity were performed at randomly selected locations. Measurement locations were referenced to prominent building features.

4. Exposure rates were performed at 1 meter (3.3 ft) above the surface at 10 representative locations throughout Buildings 521-527 and 529-535.

5. Several samples of paint/sealant and construction materials were collected.

6. Samples and direct measurement data were returned to Oak Ridge, Tennessee, for analysis and interpretation. The construction materials and paint samples were analyzed by solid state gamma spectrometry. Smears were analyzed for gross alpha and beta activity.

Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Results were compared with DOE's Guidelines for Residual Radioactivity at Formerly Utilized Sites, Remedial Action Program and Remote Surplus Facilities Management Program Sites, provided in Appendix C.

FINDINGS AND RESULTS

Building 521-527

Gamma and beta-gamma scans in Building 521-527, identified elevated levels of activity in the east bay of the basement and on the first floor of the west bay (Figure 3 and 5). Measurements for total and removable activity were performed at 212 locations on accessible floor and lower wall locations in Building 521-527; the results of which have been summarized in Table 1. Total activity levels ranged from <27 - 400 dpm/100 cm^2 for alpha and ranged from <350 - 100,000 dpm/100 cm^2 for beta-gamma. Residual contamination was detected on the floor, on the west wall at a location approximately 2 m above the floor, and on the top surface of several foundation supports in the basement of Building 521-527. The maximum total beta-gamma level of 100,000 dpm/100 cm^2 was detected at location 54D on the basement floor (Figure 3).

Significant levels of elevated activity were identified over approximately 85% of the floor area on the first floor in the west bay of Building 521-527. The maximum beta-gamma level measured was 46,000 dpm/100 cm^2. Removable activity levels for alpha and beta-gamma ranged from <3 - 34 dpm/100 cm^2 and <6 - 99 dpm/100 cm^2, respectively. For comparison, the DOE surface contamination guideline levels for Uranium are:

5000 dpm/100 cm^2, averaged over a 1 m^2 area
15000 dpm/100 cm^2, maximum in a 100 cm^2 area
1000 dpm/100 cm, removable

Areas identified in the basement and first floor in Building 521-527 exceed the guidelines for total residual activity.

Samples of material containing paint and a tar-like sealant were collected in areas of elevated gamma activity identified on the floor in the west bay of the first floor (Figure 4). Analysis of these samples indicate uranium as the primary contaminant. Results have been summarized in Table 3. Radionuclide concentrations for U-235 ranged from 115 pCi/g to 130 pCi/g; U-238 concentrations in both samples were 3000 pCi/g.

Building 529-535

Surface scans of Building 529-535 did not identify any residual contamination. A total of 239 measurements for total and removable activity were collected from accessible areas on floor and lower wall surfaces. A total of 31 measurements were collected from the center stairwell between the two warehouse buildings. The results have been tabulated in Table 1. Total activity measurements ranged from <27 - 57 dpm/100cm^2 for alpha and ranged from <350 - 1400 dpm/100cm^2 for beta-gamma. Removable activity for alpha and beta-gamma ranged from <3 - 12 dpm/100cm^2 and <6 - 15 dpm/100cm^2, respectively. All measurements were within the guideline levels.

Exposure rates measured in 10 locations throughout Buildings 521-527 and 529-535 ranged from 7.6 μR/h - 15 μR/h (Table 2). These levels were below the DOE external gamma radiation guideline of 20 μR/h above background.

SUMMARY

In August of 1989, ORAU performed a preliminary survey of the facilities located at 521-527 and 529-535 West 20th Street, New York, New York. Survey activities included gamma and beta-gamma scans and measurements of exposure rates, total and removable surface activity levels, and radionuclide concentrations in building materials. With only a few exceptions, all floors are currently used for storage; surveys were performed in all accessible areas.

In Building 521-527 residual contamination in excess of guideline levels was detected on the floors and lower walls of the east bay of the basement. The floor surface of the west bay of the first floor contains residual contamination in excess of the DOE guideline levels. Although, less than half of the floor surface in the west bay of the first floor was accessible for the survey, the entire accessible surface was contaminated above guideline levels; on the basis of these results it is considered likely that the remaining

unaccessible floor surface is also contaminated. No additional areas in excess of DOE guidelines were identified in other portions of Building 521-527 or in the adjacent Building 529-535. All surface contamination was determined to be fixed; removable contamination levels and external radiation levels (gamma exposure rates) are well within the DOE guideline values. It is therefore ORAU's opinion that their is currently no significant risk to workers or members of the public from the residual contamination in this facility; however, the facility should be considered for inclusion into the DOE Formerly Utilized Sites Remedial Action Program.

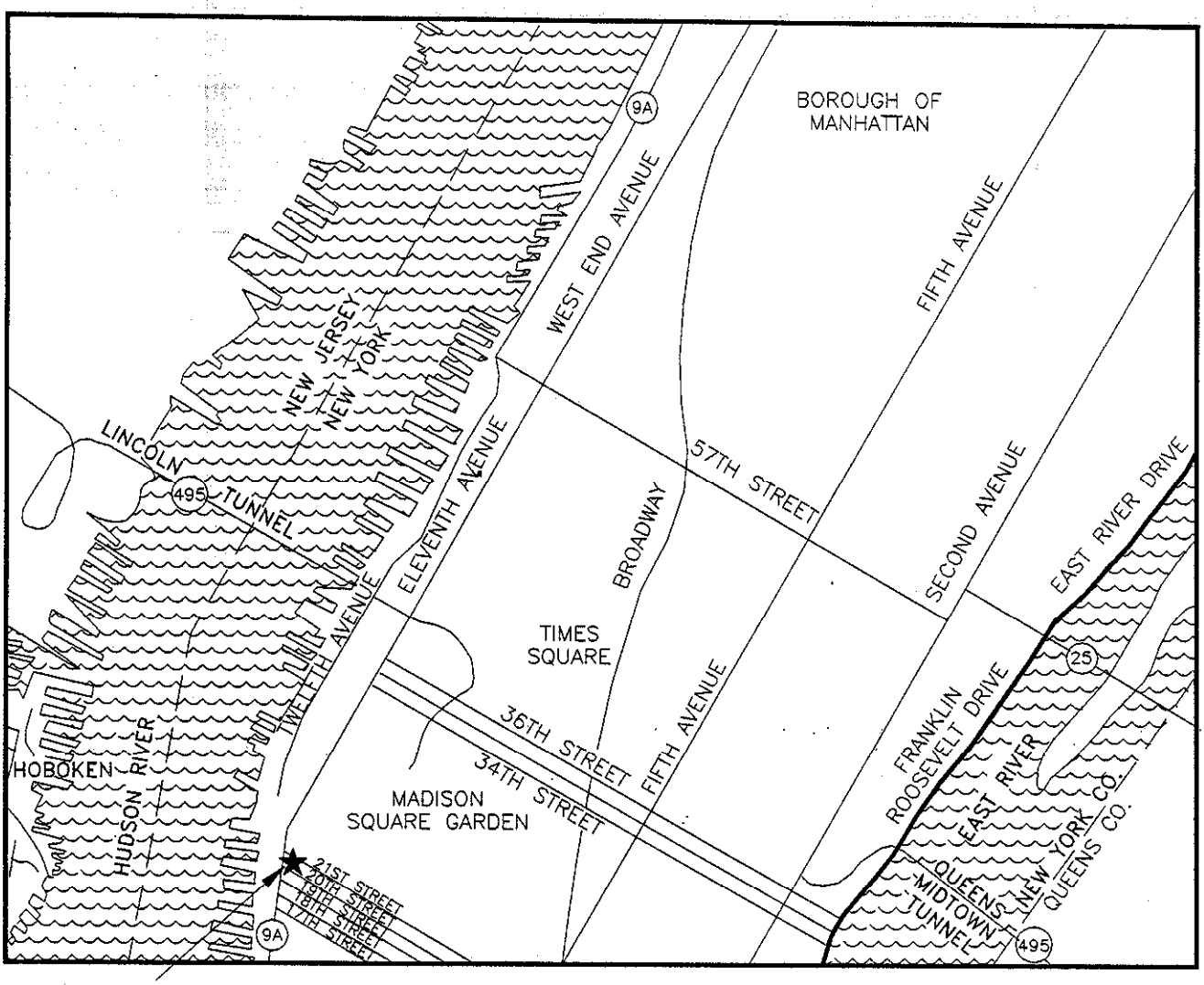
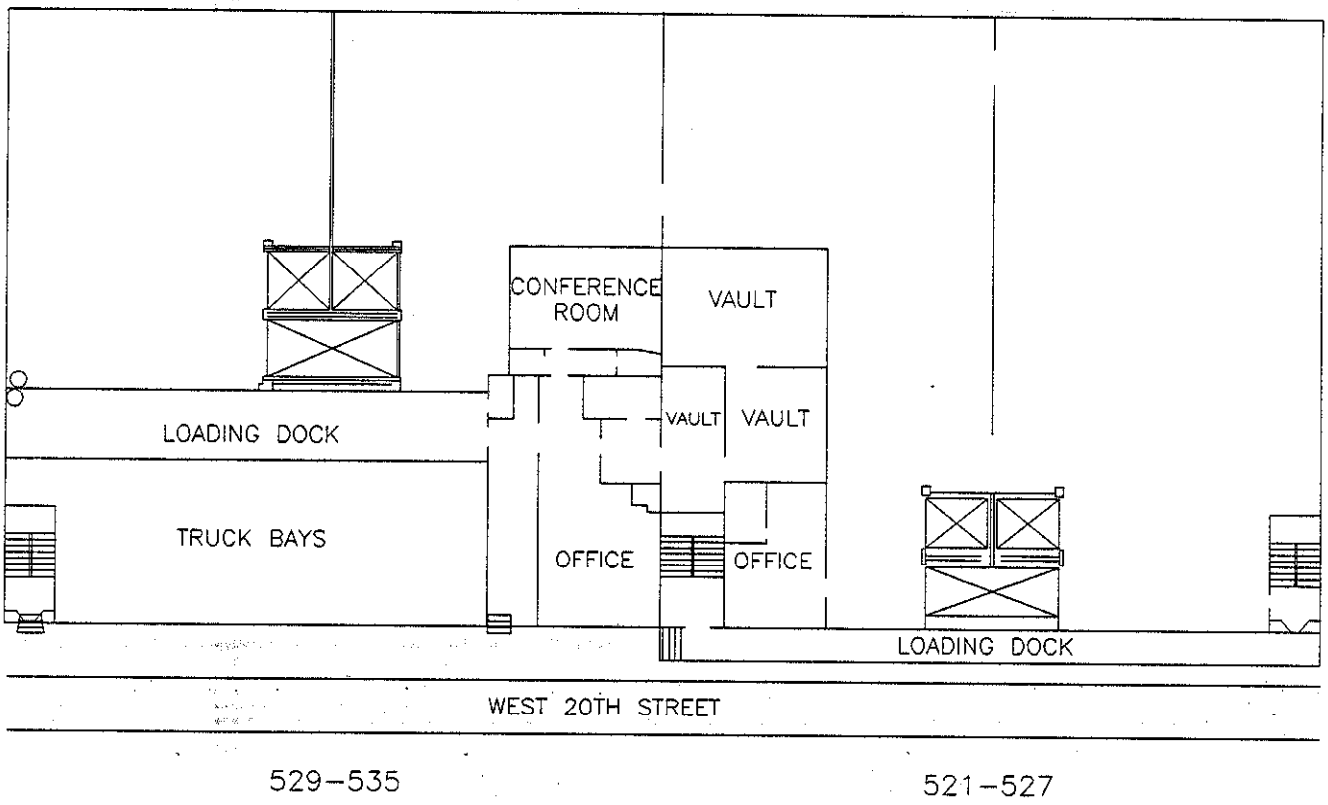
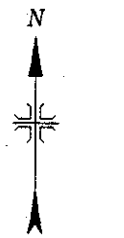


FIGURE 1: Map of Central New York, New York Indicating the Location of the Baker and Williams Warehouses





NOT TO SCALE

FIGURE 2: Plot Plan of the Baker and Williams Warehouses at 521–527 and 529–535 West Twentieth Street

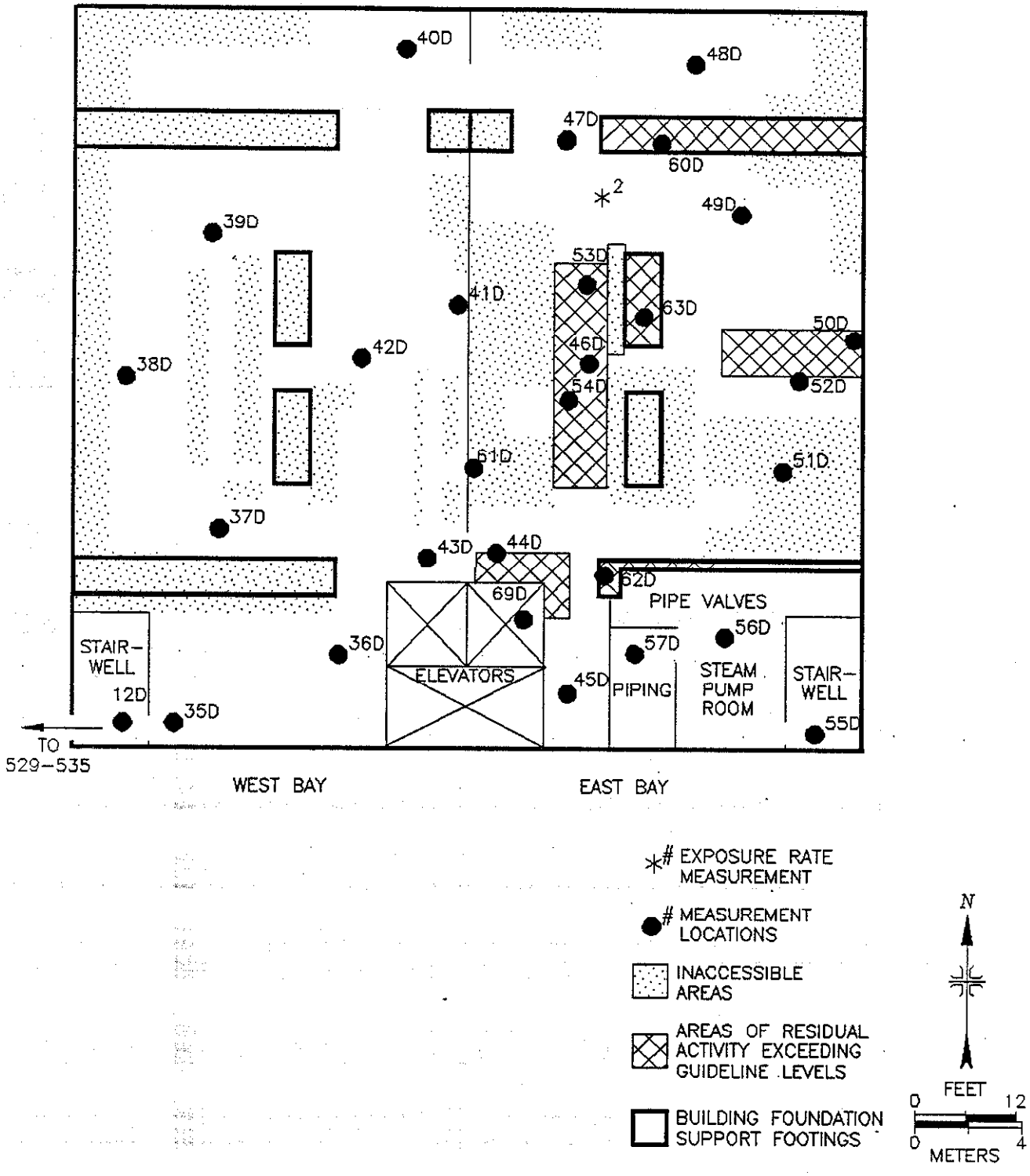


FIGURE 3: Floor Plan of Basement Floor, Building 521-527, Indicating Measurement Locations

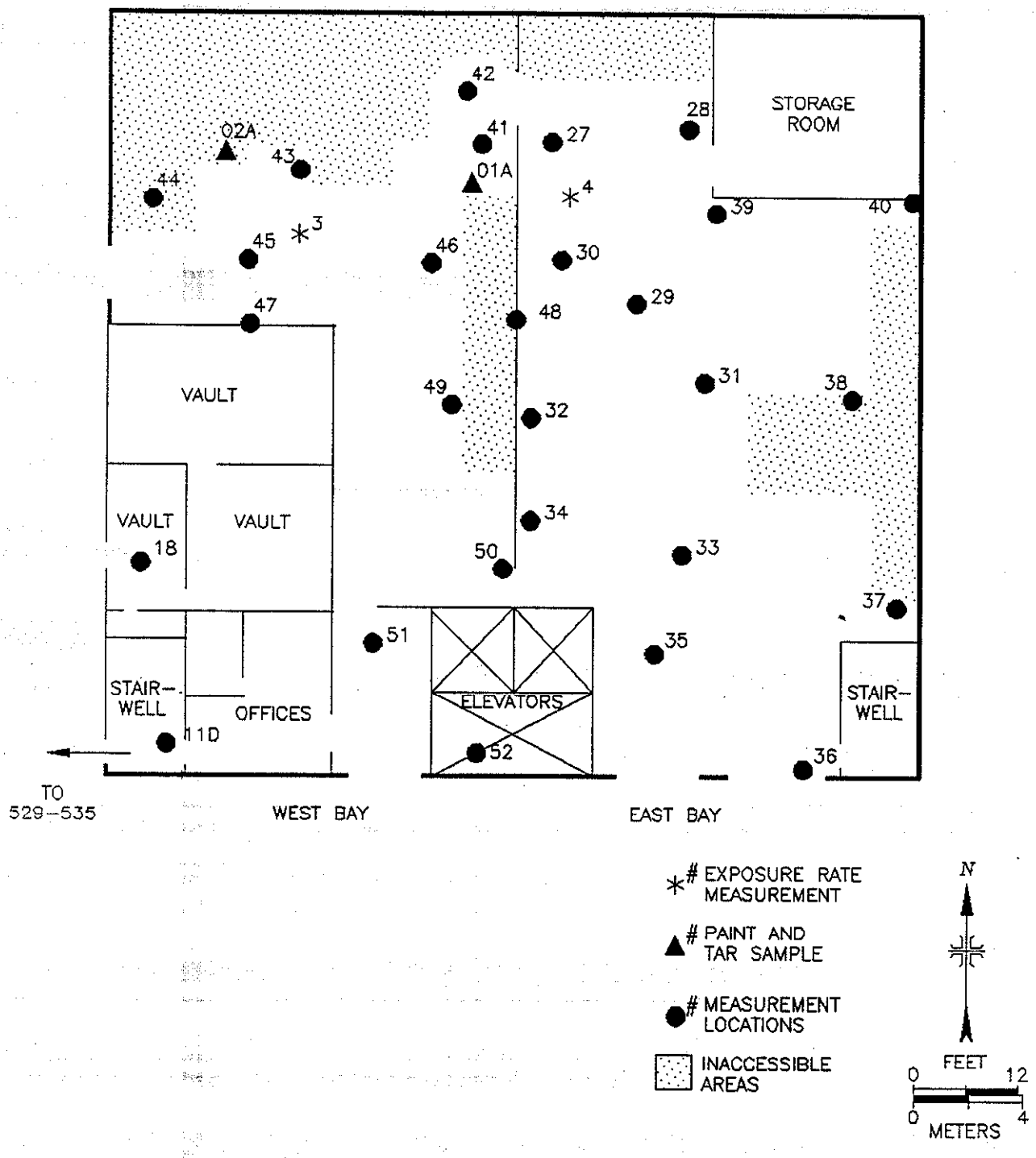


FIGURE 4: Floor Plan of First Floor, Building 521-527, Indicating Measurement Locations

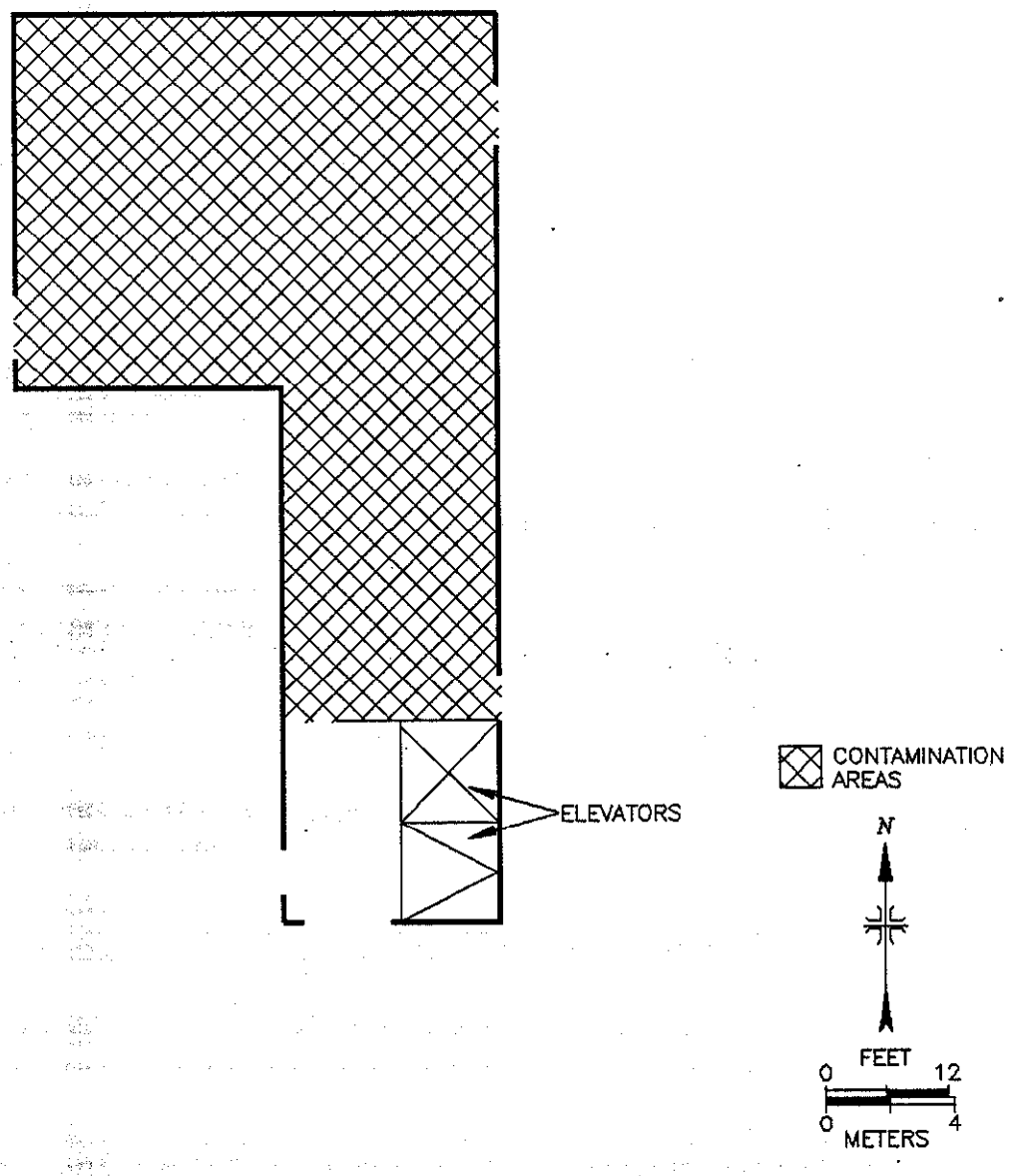


FIGURE 5: Floor Plan of West Bay, First Floor, Building 521–527, Indicating Contamination Areas

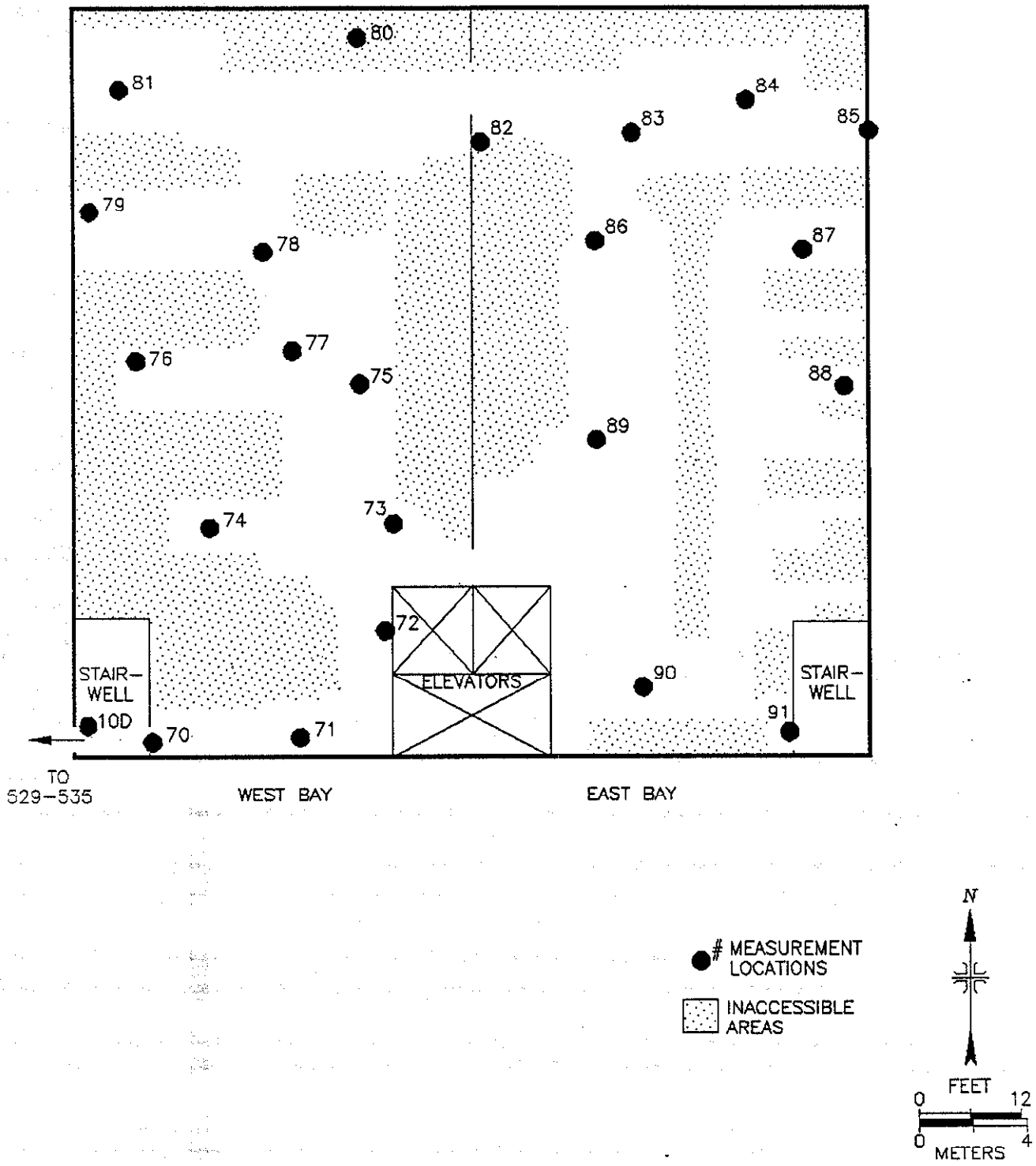


FIGURE 6: Floor Plan of Second Floor, Building 521-527, Indicating Measurement Locations

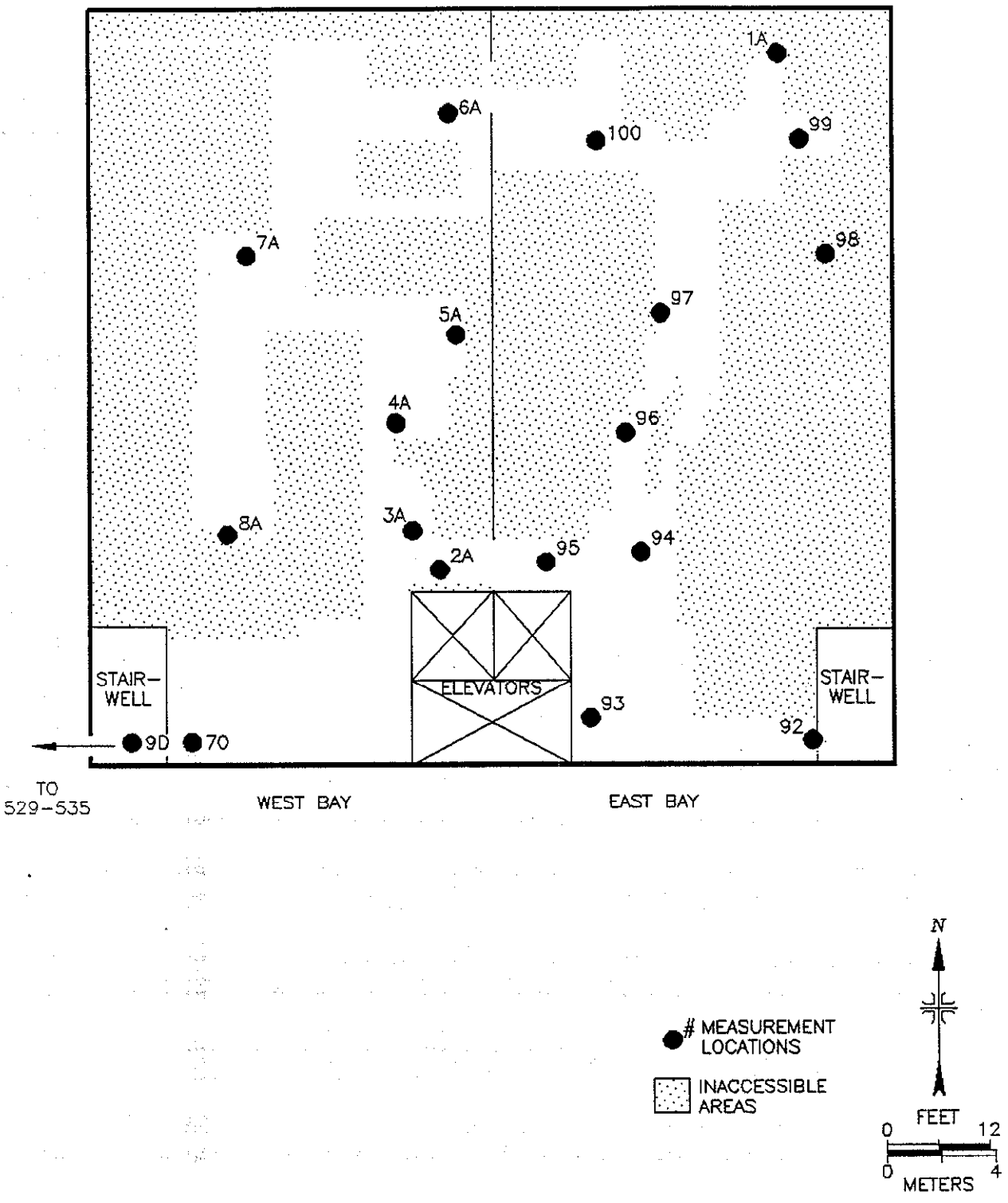


FIGURE 7: Floor Plan of Third Floor, Building 521–527, Indicating Measurement Locations

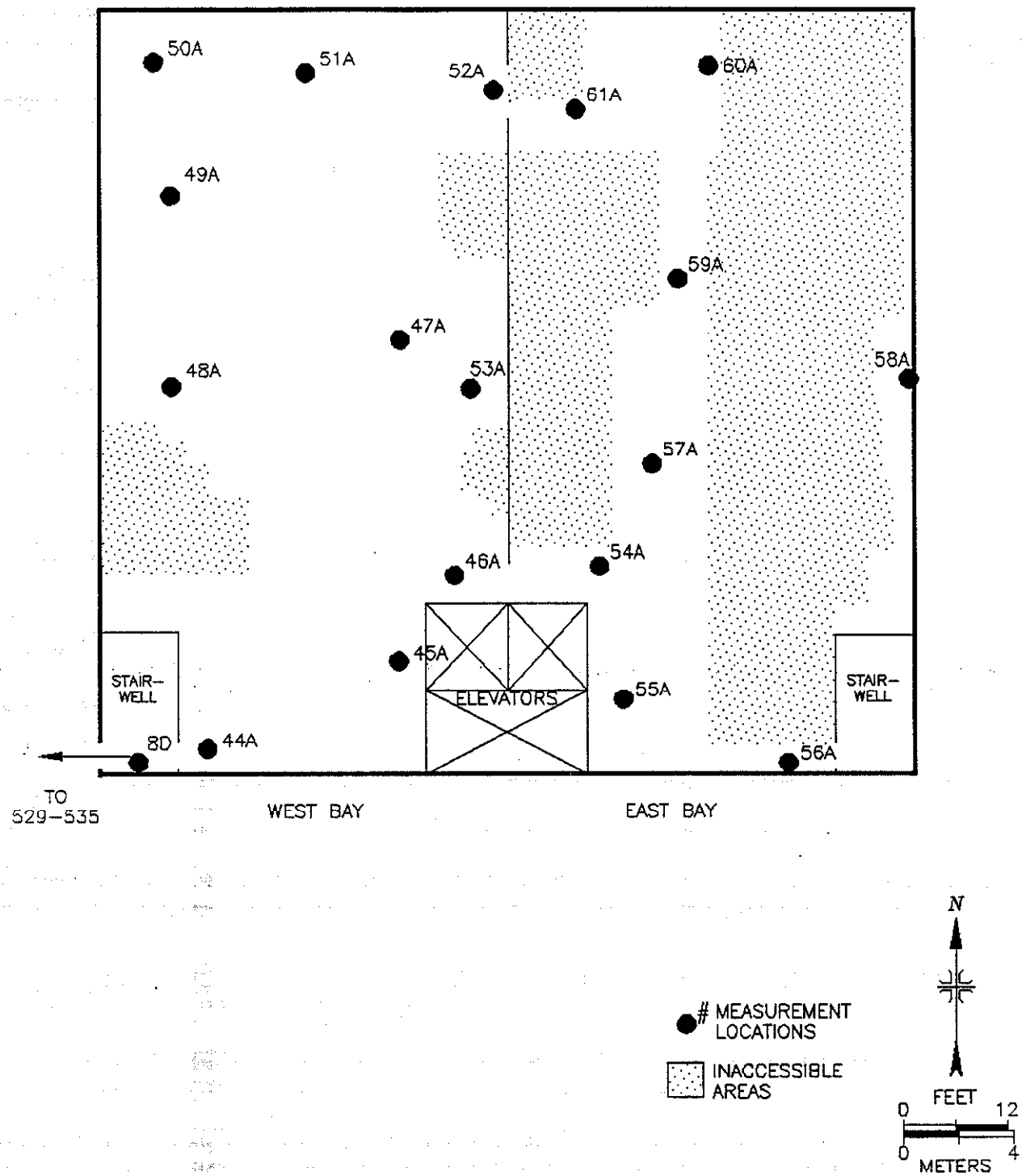


FIGURE 8: Floor Plan of Fourth Floor, Building 521-527, Indicating Measurement Locations

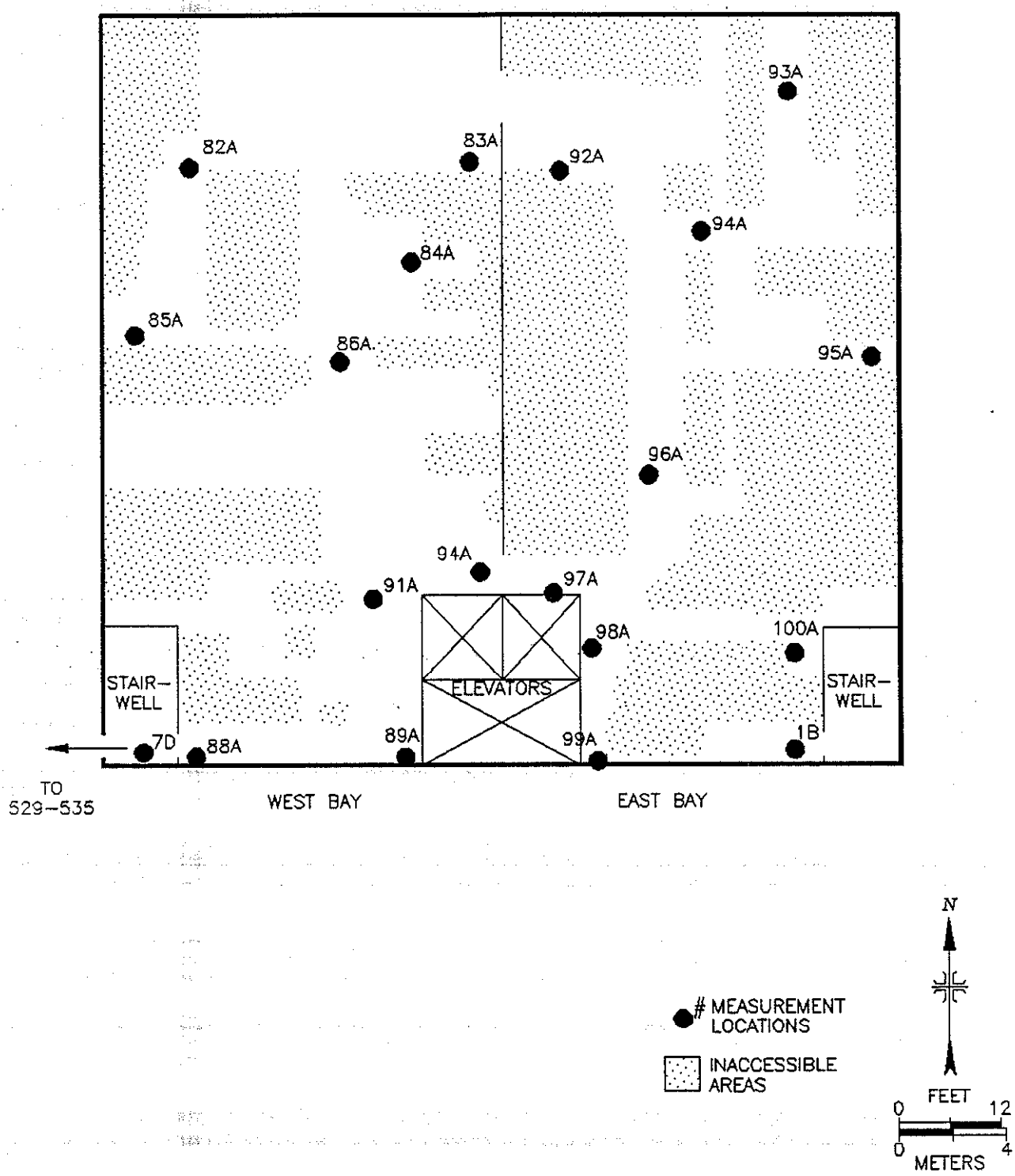


FIGURE 9: Floor Plan of Fifth Floor, Buidling 521-527, Indicating Measurement Locations

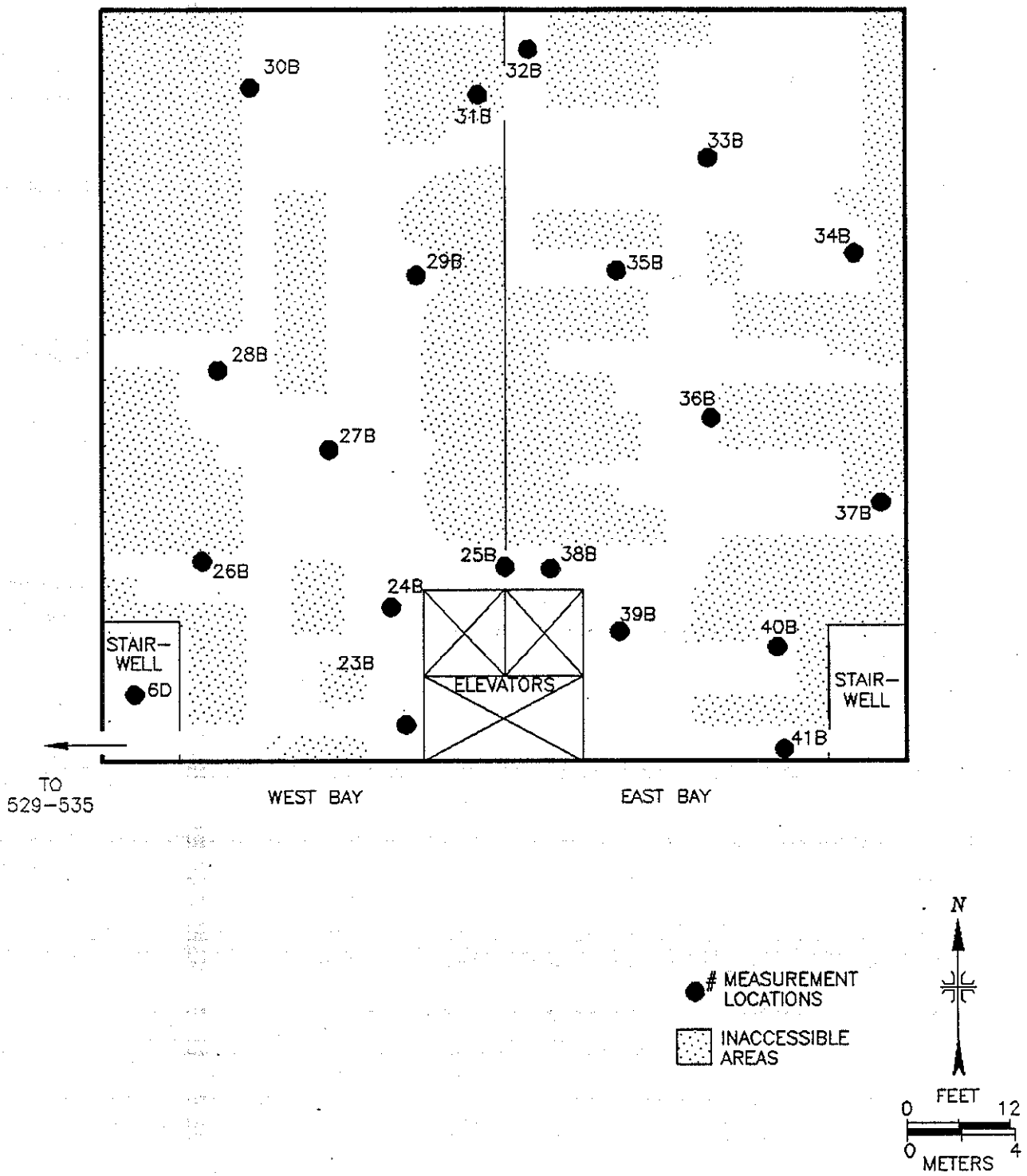


FIGURE 10: Floor Plan of Sixth Floor, Building 521-527, Indicating Measurement Locations

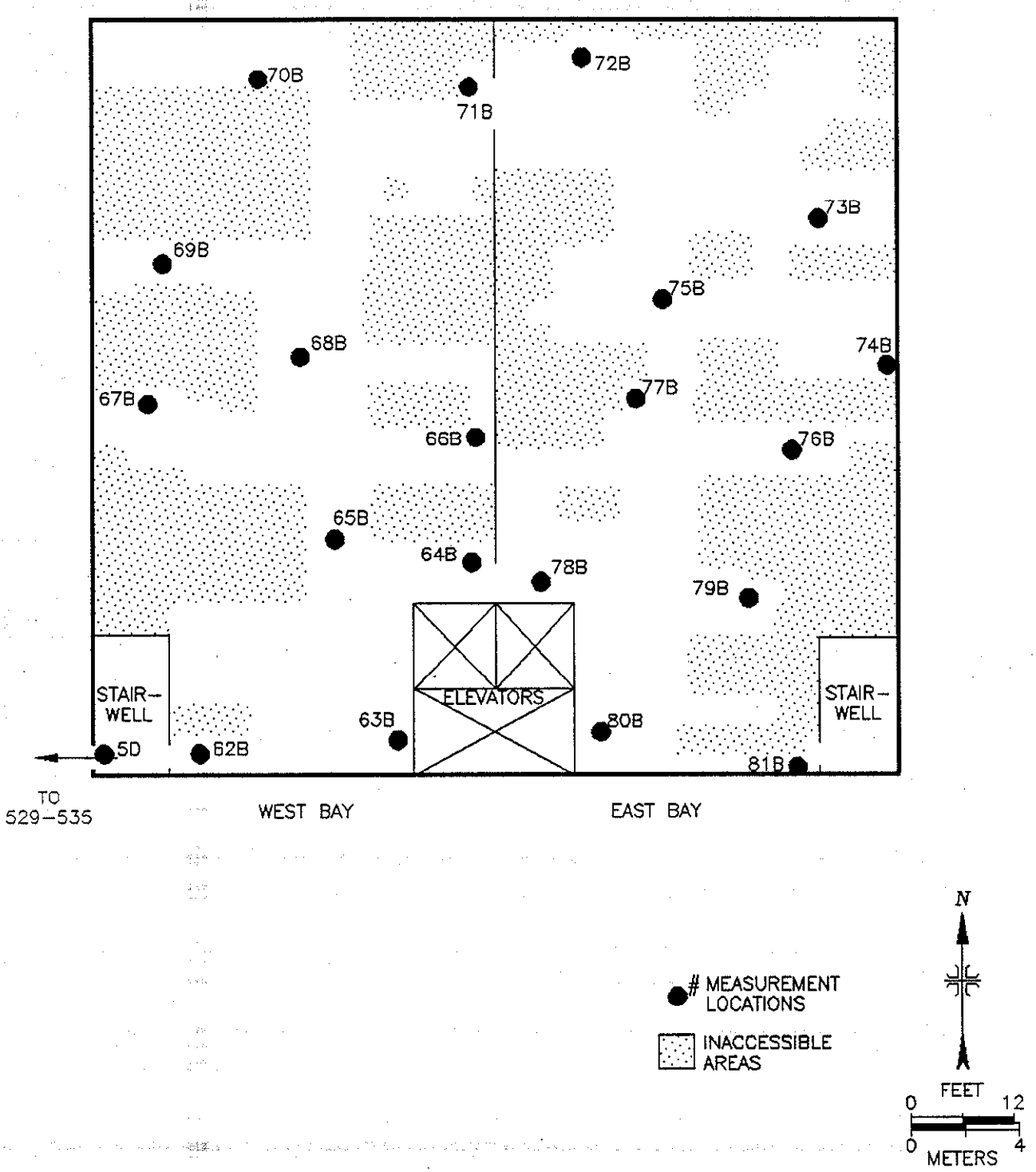


FIGURE 11: Floor Plan of Seventh Floor, Building 521-527, Indicating Measurement Locations

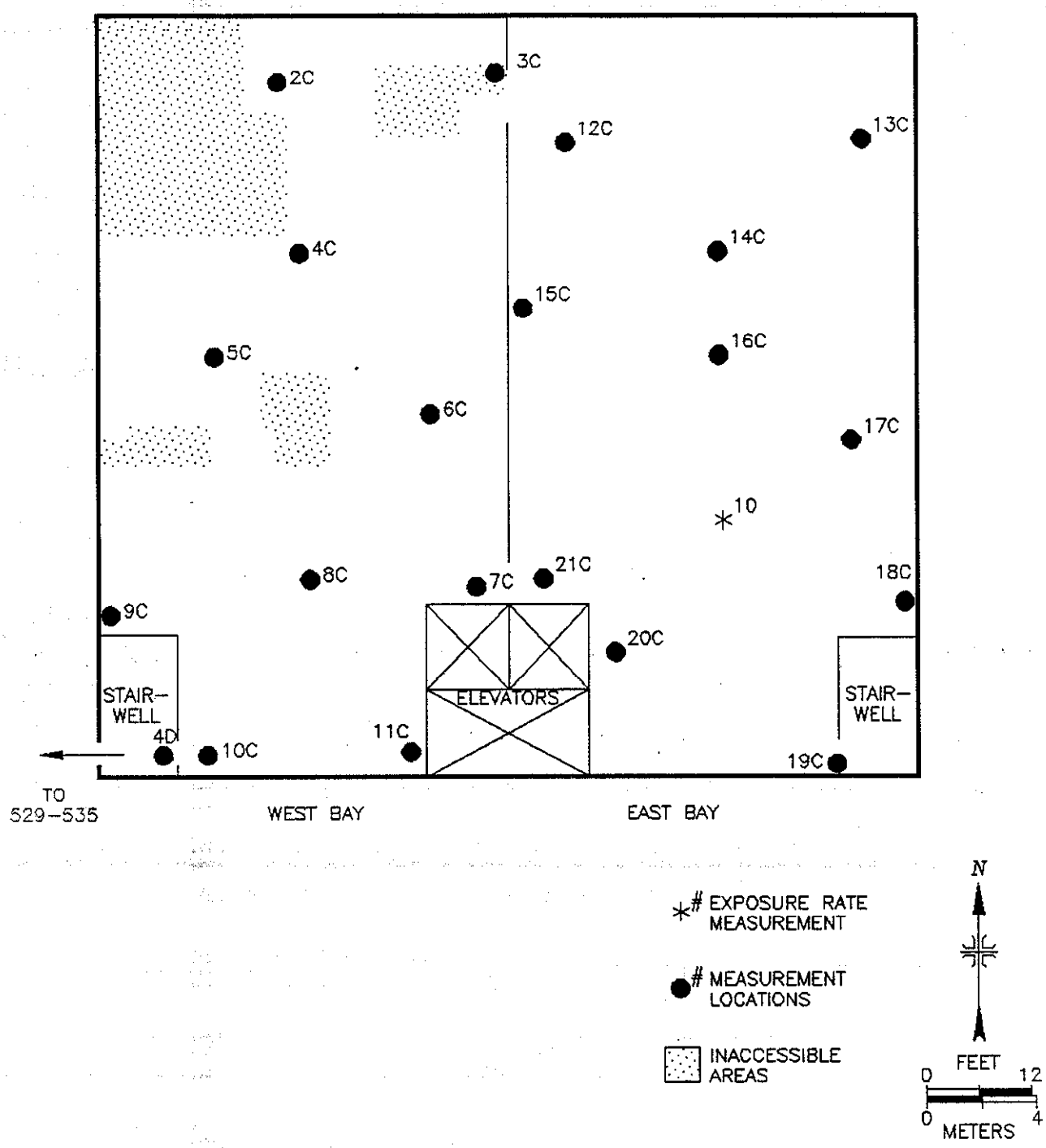


FIGURE 12: Floor Plan of Eighth Floor, Building 521-527, Indicating Measurement Locations

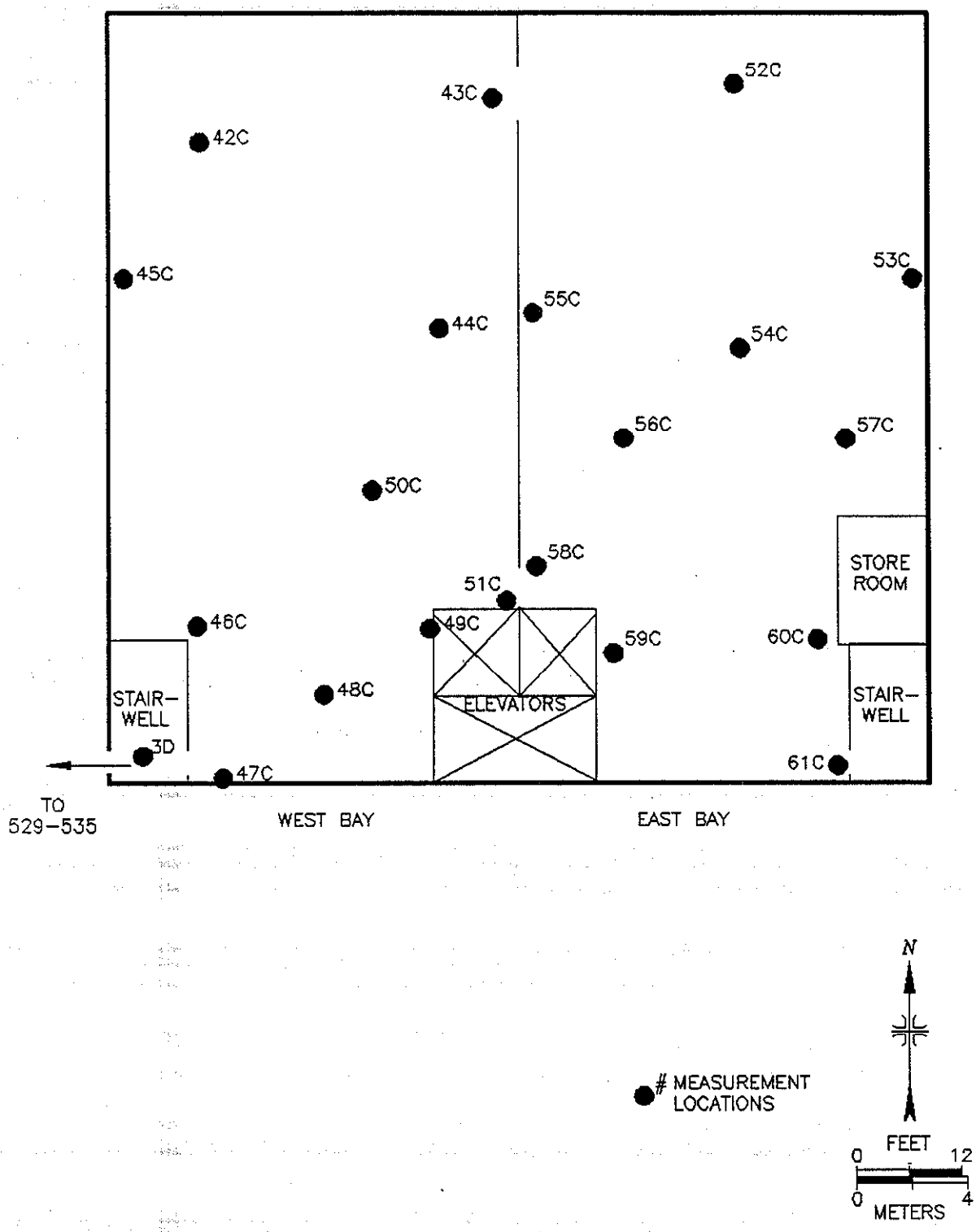


FIGURE 13: Floor Plan of Ninth Floor, Building 521-527, Indicating Measurement Locations

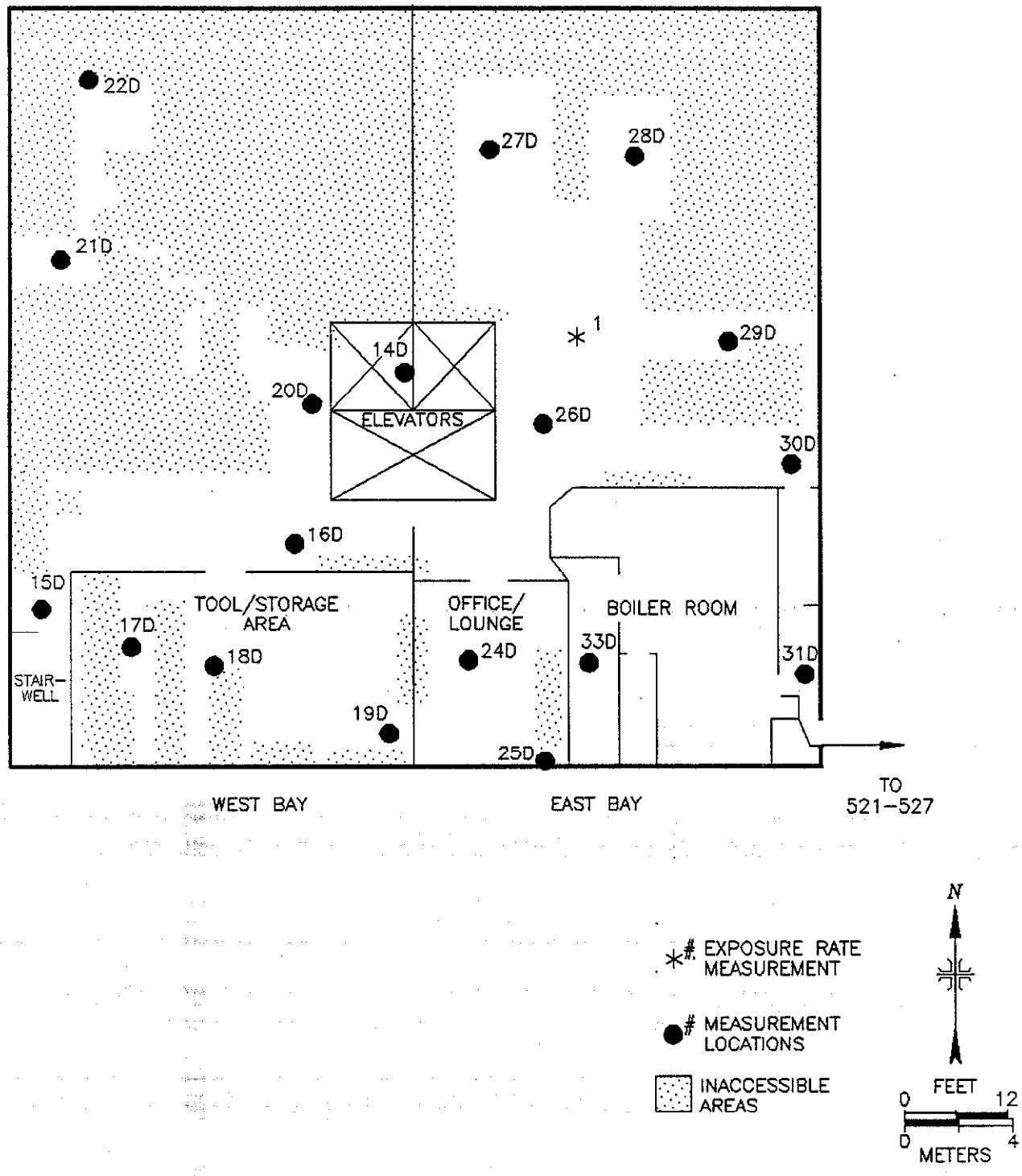


FIGURE 14: Floor Plan of Basement Floor, Building 529–535, Indicating Measurement Locations

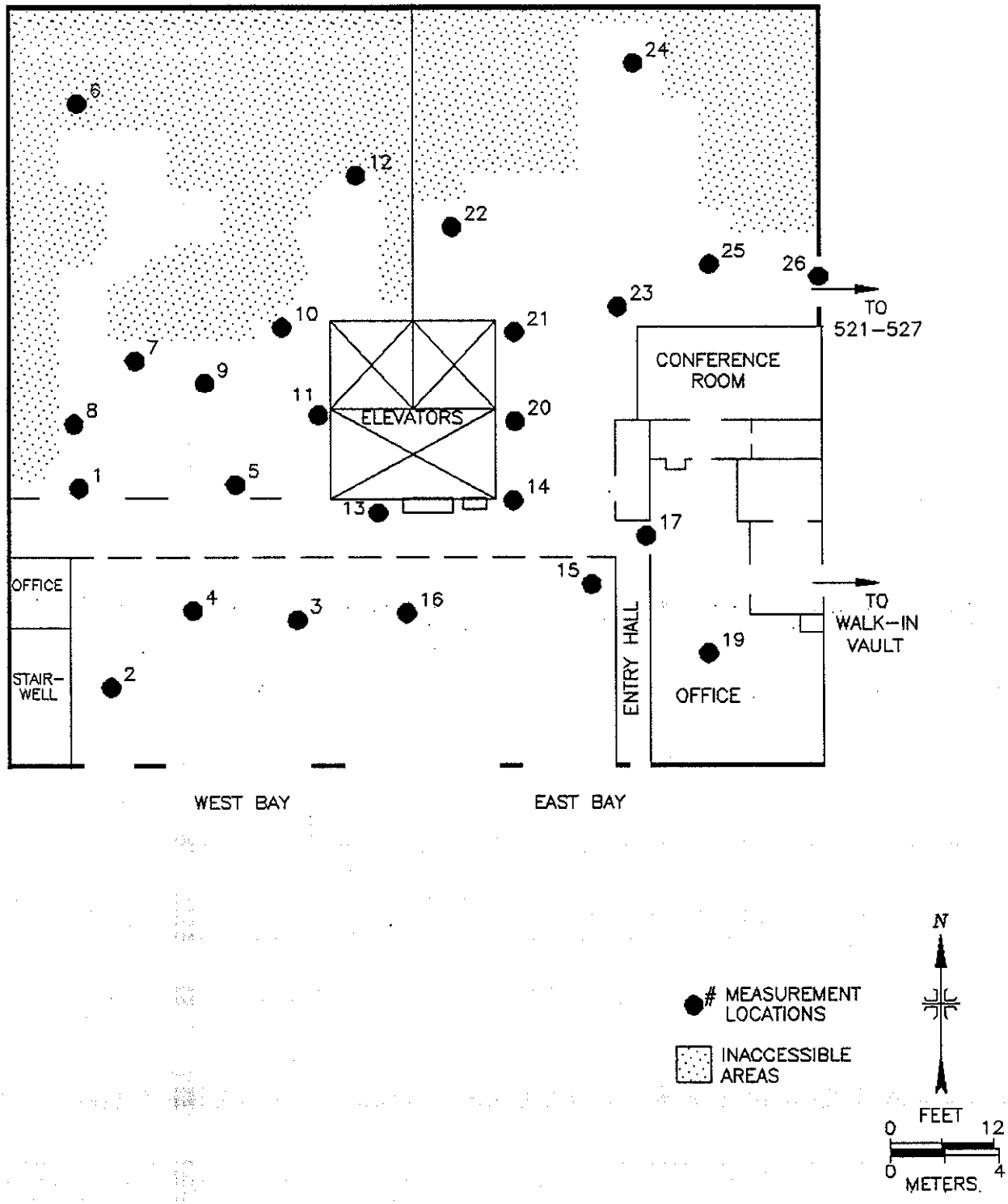


FIGURE 15: Floor Plan of First Floor, Building 529–535, Indicating Measurement Locations

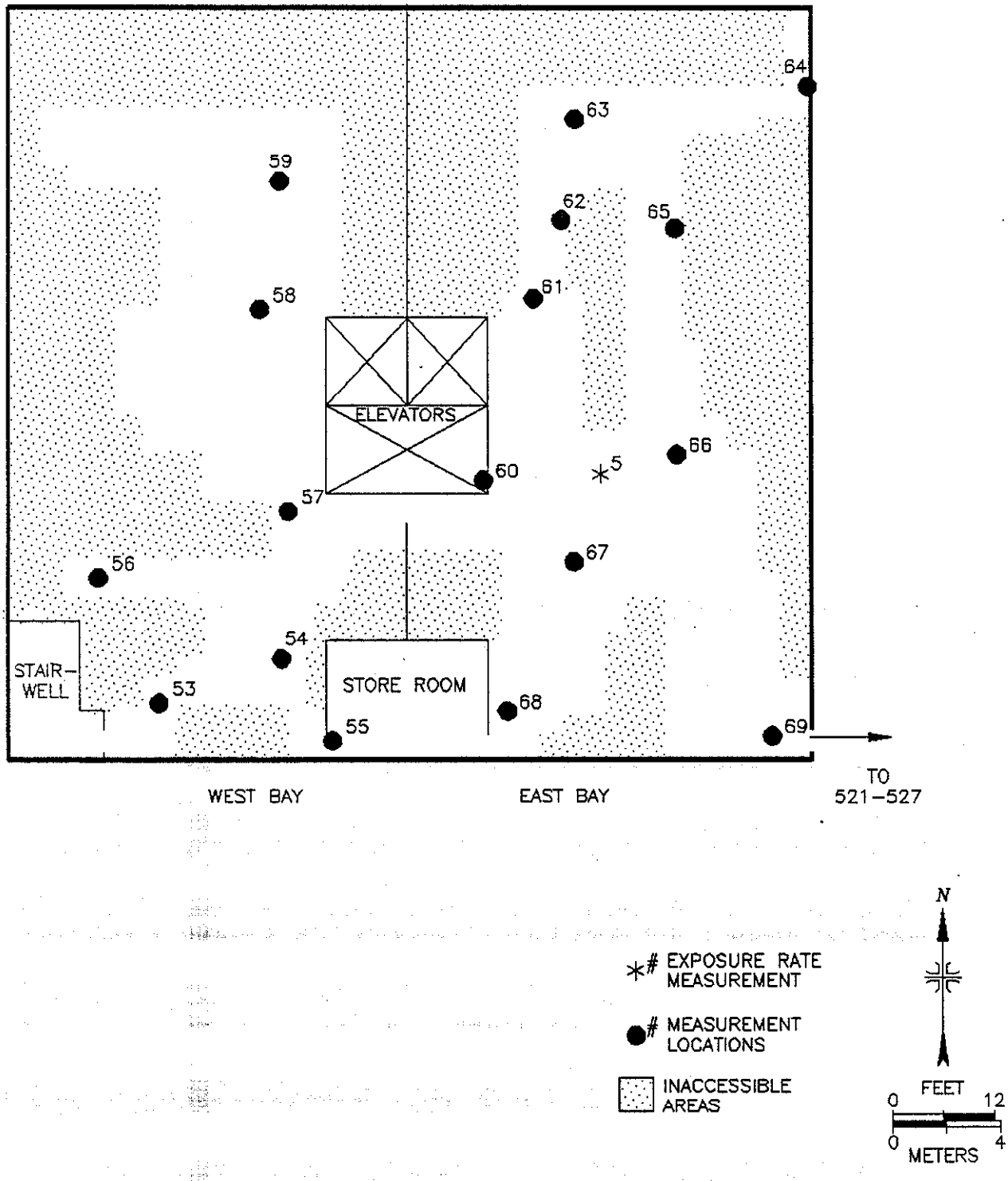


FIGURE 16: Floor Plan of Second Floor, Building 529-535, Indicating Measurement Locations

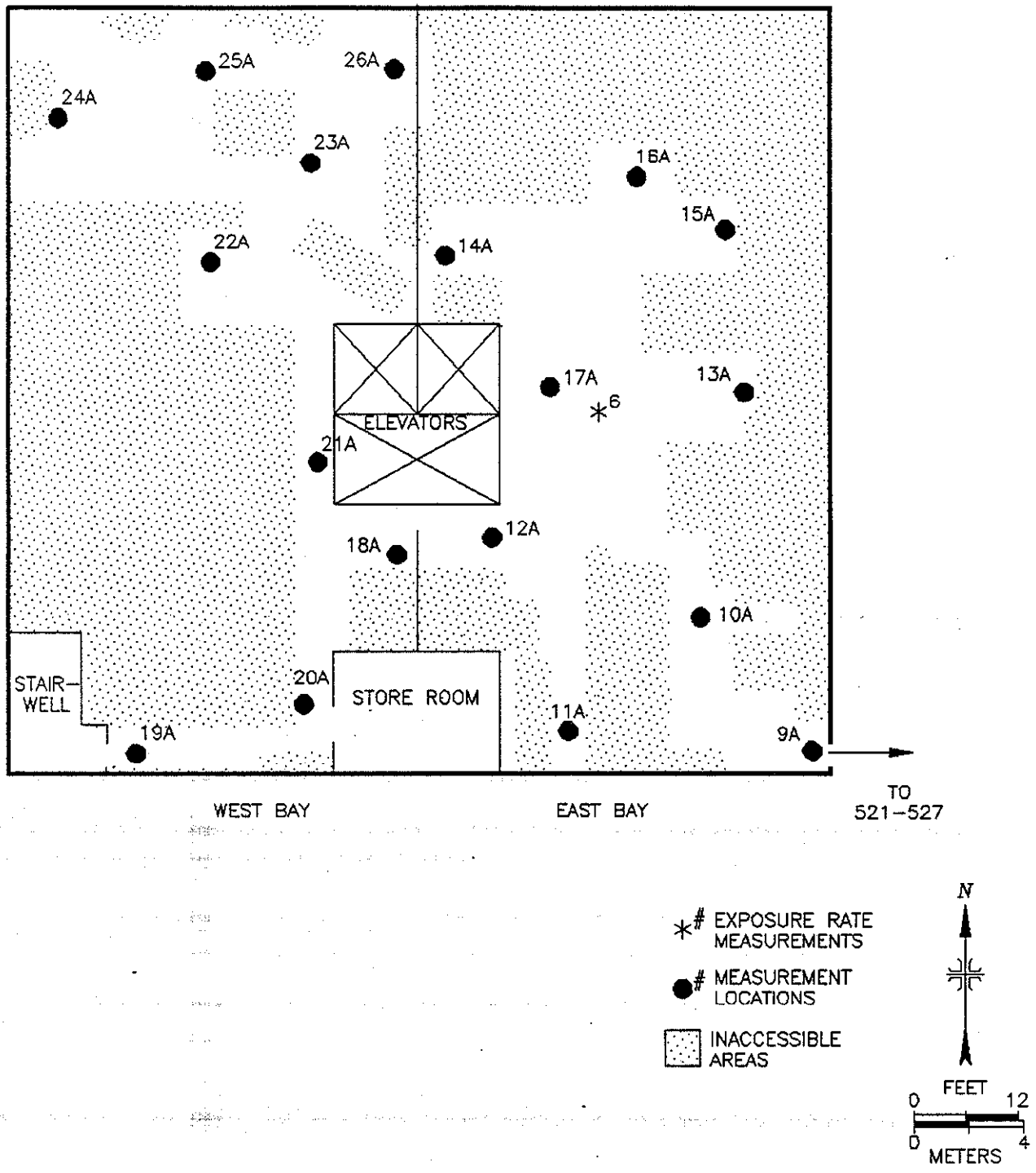


FIGURE 17: Floor Plan of Third Floor, Building 529–535, Indicating Measurement Locations

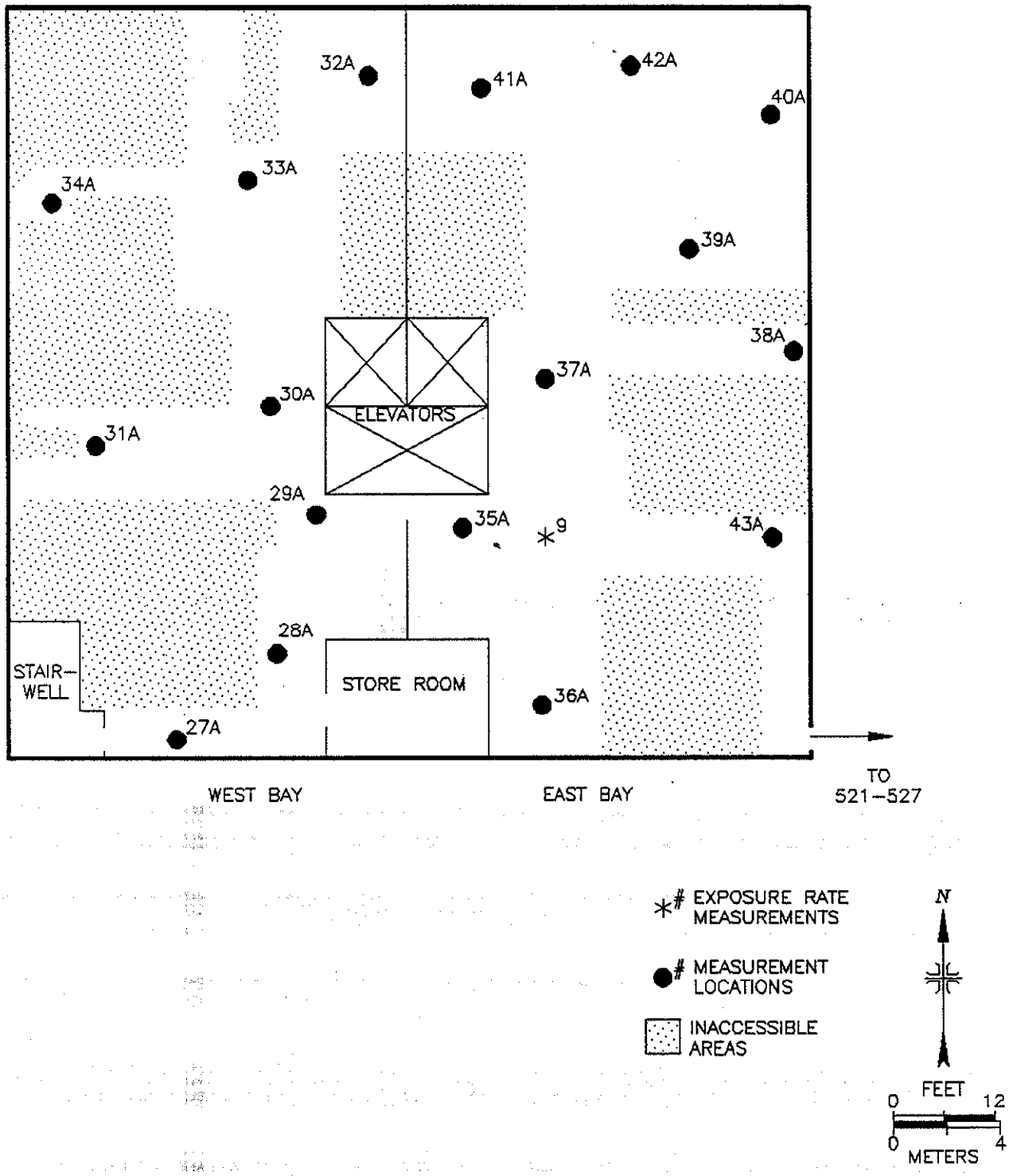


FIGURE 18: Floor Plan of Fourth Floor, Building 529–535, Indicating Measurement Locations

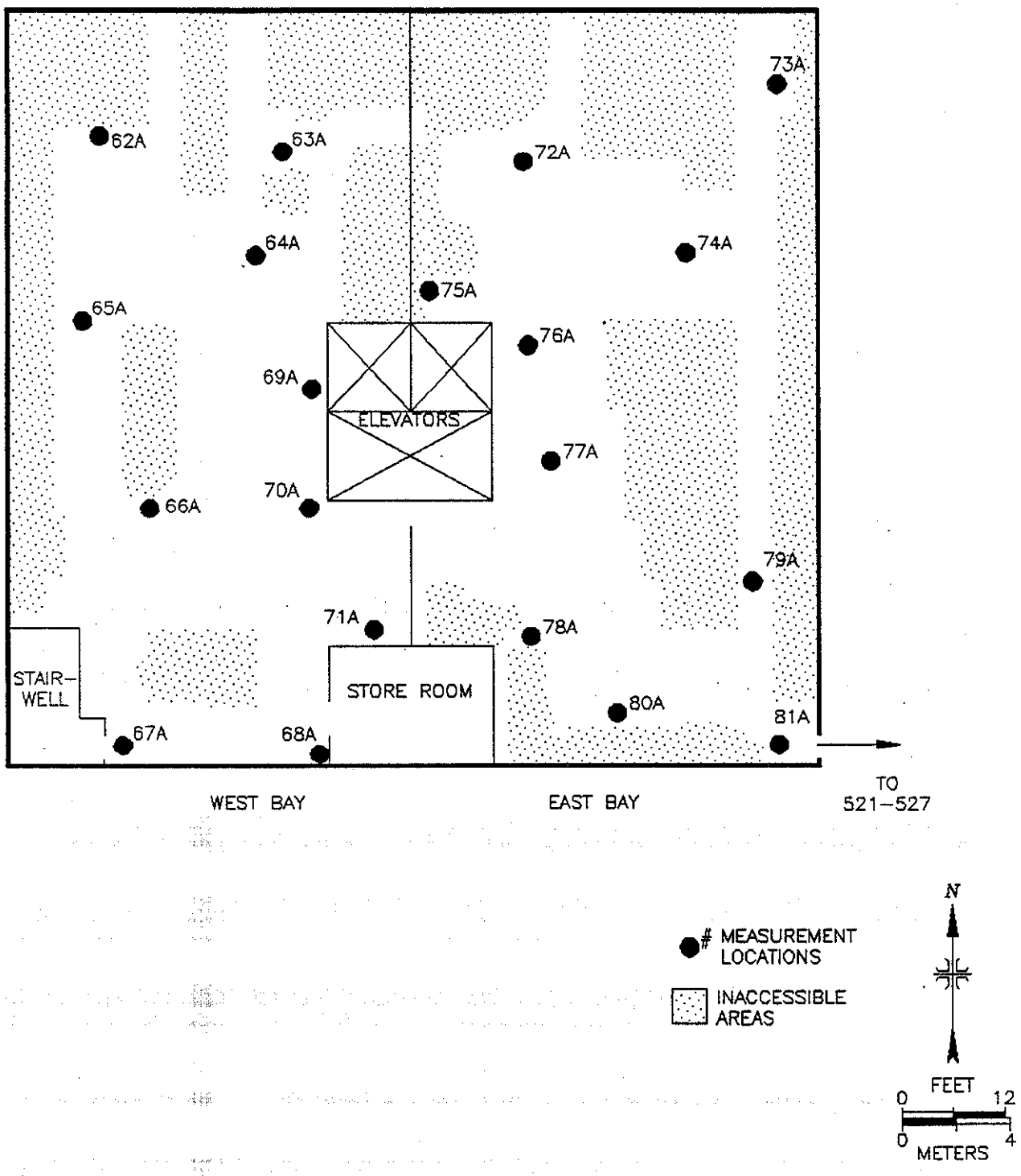


FIGURE 19: Floor Plan of Fifth Floor, Building 529-535, Indicating Measurement Locations

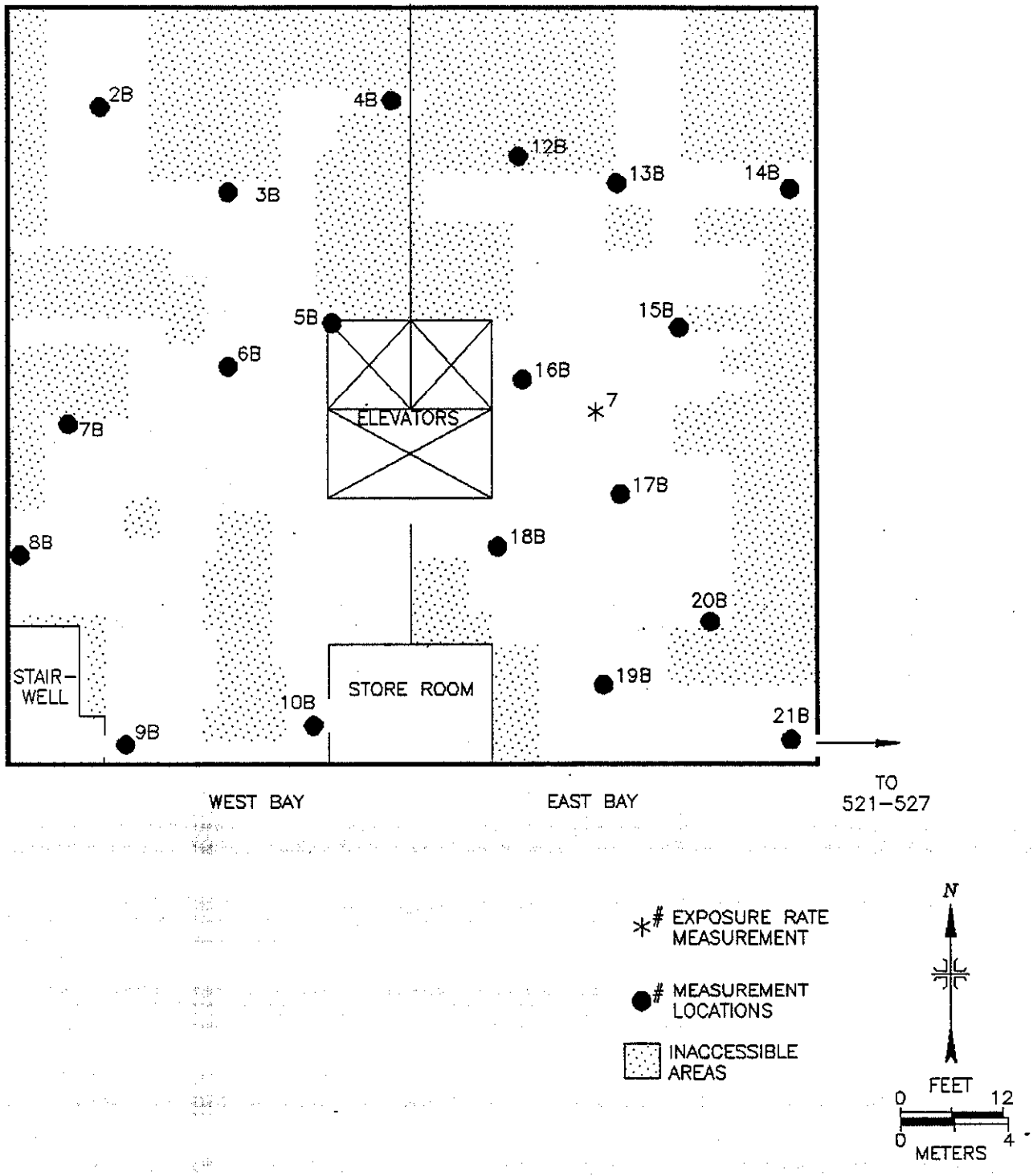


FIGURE 20: Floor Plan of Sixth Floor, Building 529–535, Indicating Measurement Locations

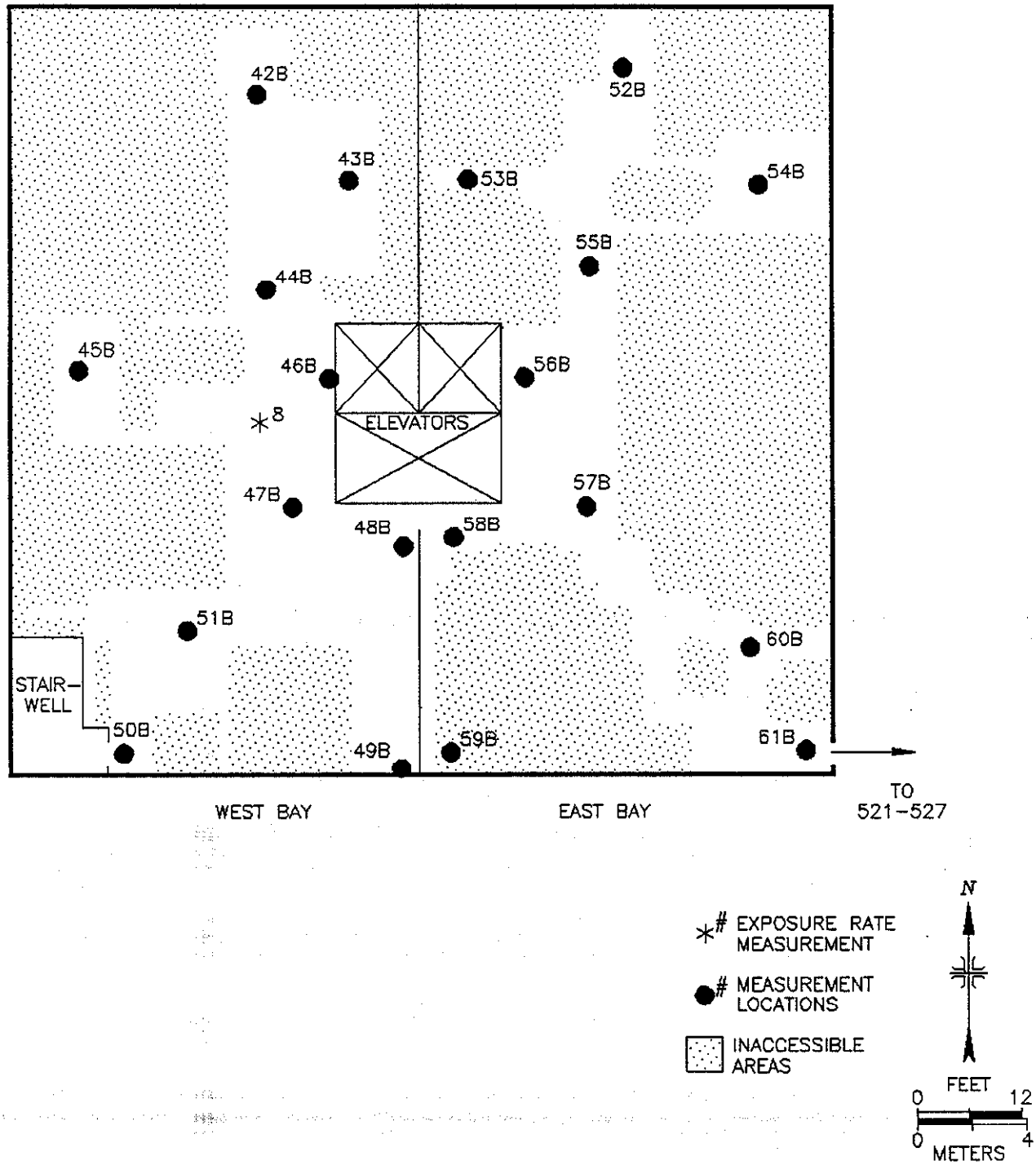


FIGURE 21: Floor Plan of Seventh Floor, Building 529–535, Indicating Measurement Locations

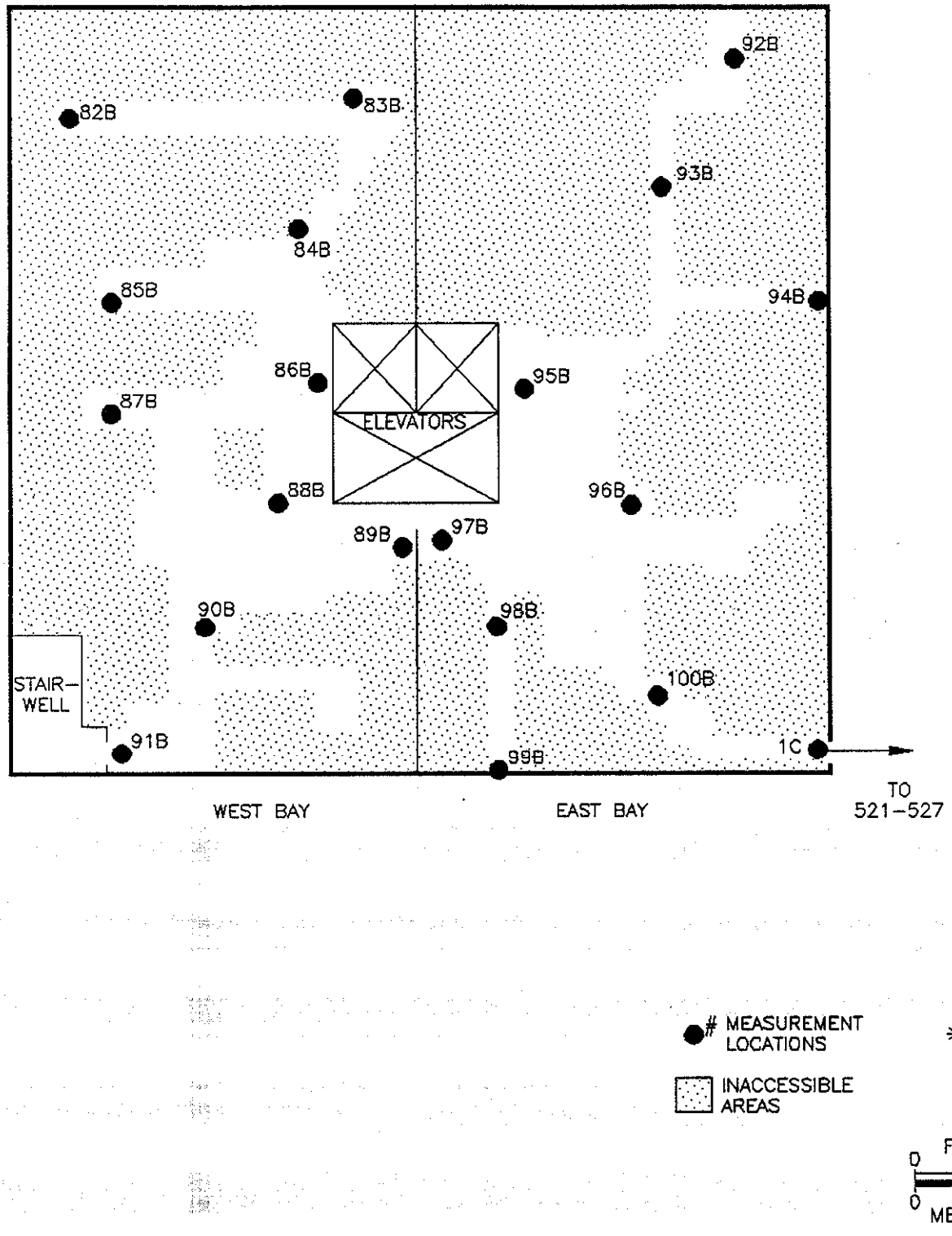


FIGURE 22: Floor Plan of Eighth Floor, Building 529-535, Indicating Measurement Locations

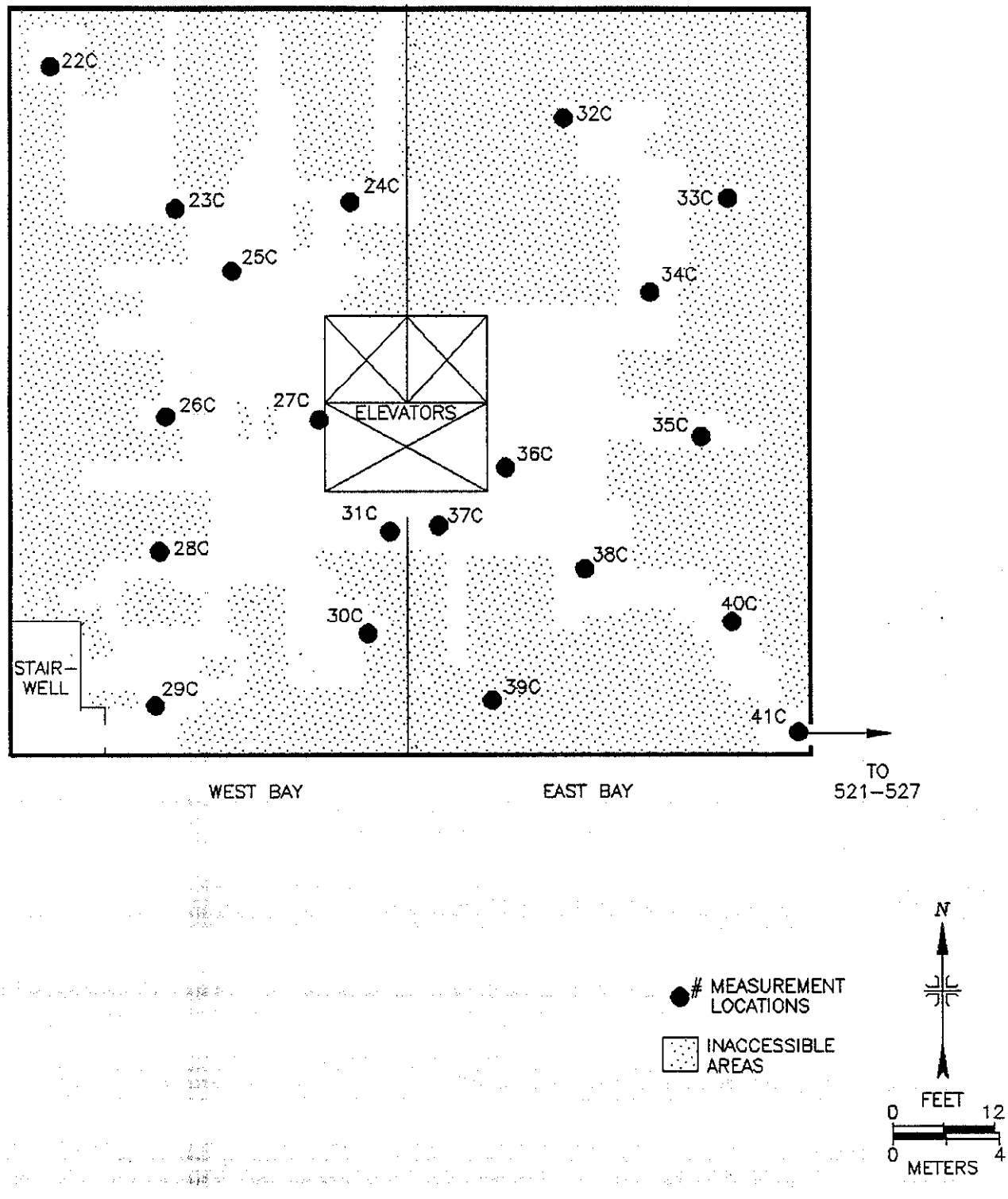


FIGURE 23: Floor Plan of Ninth Floor, Building 529–535, Indicating Measurement Locations

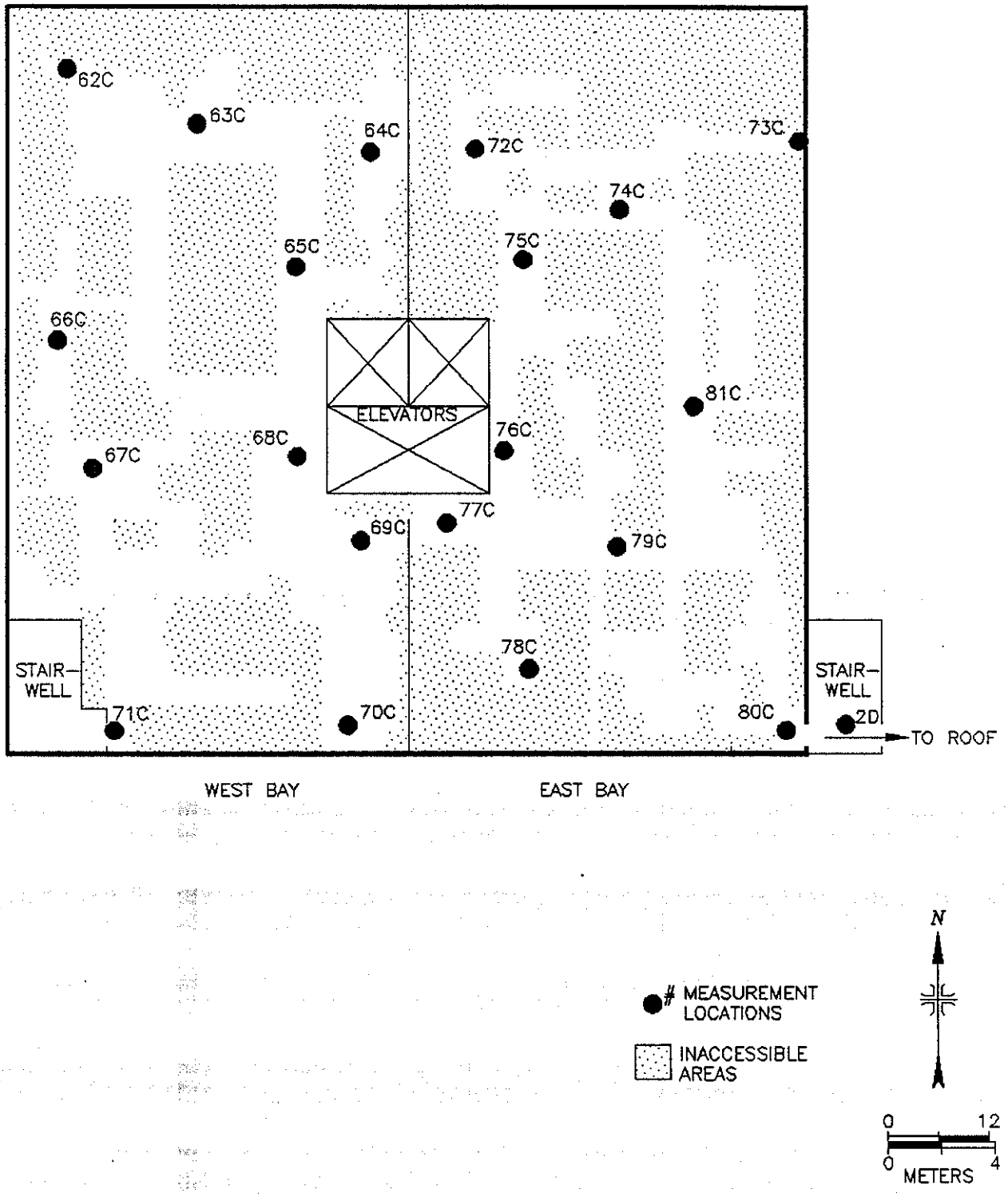


FIGURE 24: Floor Plan of Tenth Floor, Building 529–535, Indicating Measurement Locations

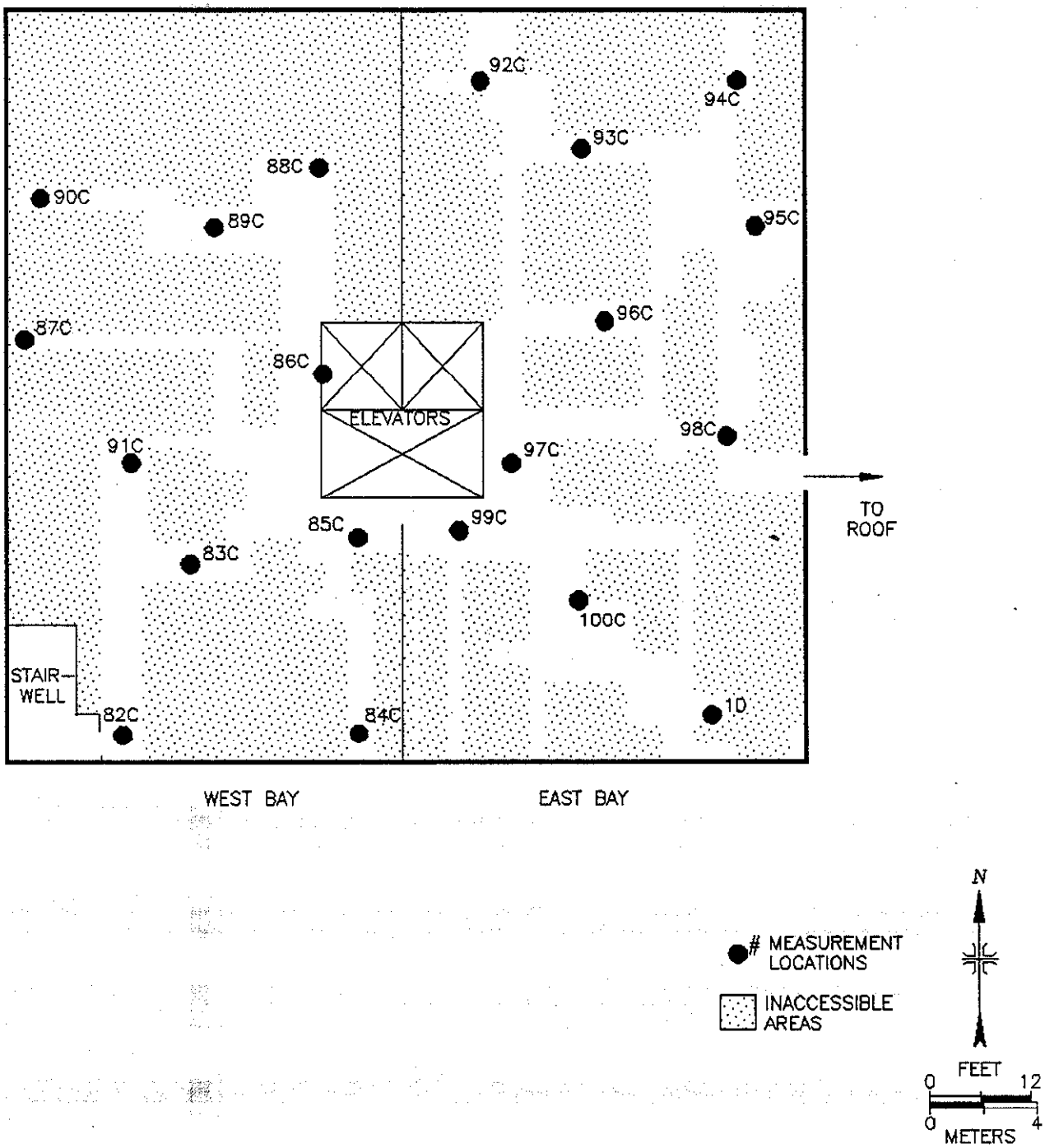


FIGURE 25: Floor Plan of Eleventh Floor, Building 529–535, Indicating Measurement Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BAKER AND WILLIAMS WAREHOUSE
NEW YORK, NEW YORK

Area[a]	Location	# of Measurements	TOTAL ACTIVITY (dpm/100 cm^2) Alpha Range	TOTAL ACTIVITY (dpm/100 cm^2) Beta-Gamma Range	REMOVABLE ACTIVITY (dpm/100 cm^2) Alpha Range	REMOVABLE ACTIVITY (dpm/100 cm^2) Beta-Gamma Range
Buildings 521-527 East and West Bays						
Basement	Floor	23	<27 - 400	<350 - 100000	<3 - 34	<6 - 99
East & West	Lower wall	1	100	11000	<3	7
Bay	Foundation Support	4	220	2300 - 91000	<3	<6
1ST Floor	Floor	25	<27 - 75	<350 - 46000	<3 - 9	<6 - 12
	Lower walls	2	<27	<350 - 1100	<3 - 5	<6
2ND Floor	Floor	22	<27 - 66	<350 - 1100	<3 - 3	<6 - 7
3RD Floor	Floor	17	<27 - 28	<350 - 990	<3 - 5	<6 - 13
4TH Floor	Floor	18	<27 - 56	<350 - 910	<3 - 5	<6 - 9
5TH Floor	Floor	20	<27 - 85	<350 - 1100	<3 - 3	<6 - 15
6TH Floor	Floor	20	<27 - 56	<350 - 1100	<3 - 3	<6 - 9
7TH Floor	Floor	20	<27 - 56	<350 - 960	<3 - 9	<6 - 13
8TH Floor	Floor	20	<27 - 66	<350 - 960	<3 - 3	<6 - 12
9TH Floor	Floor	20	<27 - 56	<350 - 1100	<3 - 3	<6 - 8
Stairwell[b] Center Landings	Landings Floor	11	<27 - 28	<350 - 610	<3 - 3	<6 - 8

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BAKER AND WILLIAMS WAREHOUSE
NEW YORK, NEW YORK

Area[a]	Location	# of Measurements	TOTAL ACTIVITY (dpm/100 cm^2) Alpha Range	TOTAL ACTIVITY (dpm/100 cm^2) Beta-Gamma Range	REMOVABLE ACTIVITY (dpm/100 cm^2) Alpha Range	REMOVABLE ACTIVITY (dpm/100 cm^2) Beta-Gamma Range
Buildings 529-535 East and West Bays						
Basement East & West Bay	Floor	20	<27	<350 - 430	<3 - 3	<6 - 7
	Lower wall	1	<27	<350	3	6
1ST Floor	Floor	25	<27 - 38	<350 - 910	<3 - 5	<6 - 7
2ND Floor	Floor	17	<27 - 57	<350 - 1400	<3 - 3	<6 - 8
3RD Floor	Floor	18	<27 - 38	<350 - 1200	<3 - 3	<6 - 9
4TH Floor	Floor	17	<27 - 38	400 - 1200	<3 - 7	<6 - 8
5TH Floor	Floor	20	<27 - 47	<350 - 1000	<3 - 7	<6 - 15
6TH Floor	Floor	20	<27 - 56	<350 - 1100	<3	<6 - 8
7TH Floor	Floor	20	<27 - 47	400 - 1300	<3 - 12	<6 - 8
8TH Floor	Floor	20	<27 - 28	<350 - 1000	<3 - 5	<6 - 7
9TH Floor	Floor	20	<27 - 56	<350 - 990	<3 - 5	<6

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
BAKER AND WILLIAMS WAREHOUSE
NEW YORK, NEW YORK

Area[a]	Location	# of Measurements	TOTAL ACTIVITY (dpm/100 cm^2) Alpha Range	TOTAL ACTIVITY (dpm/100 cm^2) Beta-Gamma Range	REMOVABLE ACTIVITY (dpm/100 cm^2) Alpha Range	REMOVABLE ACTIVITY (dpm/100 cm^2) Beta-Gamma Range
Buildings 529-535 East and West Bays						
10TH Floor	Floor	20	<27 - 47	430 - 1200	<3 - 5	<6 - 12
11TH Floor	Floor	20	<27 - 38	<350 - 1100	<3 - 5	<6 - 8

[a]Refer to Figures 1 thru 23.
[b]Meaurements were collected at each floor level between buliding 521-527 and 529-535.

TABLE 2

EXPOSURE RATE MEASUREMENTS
BAKER AND WILLIAMS WAREHOUSE
NEW YORK, NEW YORK

Location[a]	Exposure Rate (μR/h)
1	9.4
2	7.6
3	12
4	10
5	15
6	14
7	14
8	15
9	14
10	12

[a]Refer to Figures 1,2,10,12,14,15,16,18 & 19.

TABLE 3

RADIONUCLIDE CONCENTRATIONS IN BUILDING MATERIALS
BAKER AND WILLIAMS WAREHOUSE
NEW YORK, NEW YORK

Sample #	Sample Type	Radionculide Concentrations (pCi/g) U-235	U-238
01	Paint	115 ± 49	3000 ± 200
02	Tar and Paint[b]	130 ± 9	3000 ± 12

[a]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory analysis of ± 6 to 10% have not been propagated into these data.
[b]Refer to Figure 2.

REFERENCES

1. Letter from James J. Fiore, (DOE-NE) to Dr. L.R. Solon Bureau of Radiation Control, New York City Dept. of Health, Washington, D.C., October 5,1987.

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

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

A. Direct Radiation Measurements

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

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

Eberline Alpha Scintillation Detector
Model AC-3-7
(Eberline, Santa Fe, NM)

Eberline Beta-Gamma "Pancake" Detector
Model HP-260
(Eberline, Santa Fe, NM)

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

Victoreen NaI Scintillation Detector
Model 489-55
(Victoreen, Cleveland, OH)

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

Ludlum Ratemeter-Scaler
Model 2220
(Ludlum, Sweetwater, TX)

B. Laboratory Analyses

Low Background Alpha-Beta Counter
Model LB-5110
(Tennelec, Oak Ridge, TN)

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

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

Multichannel Analyzer
ND-66/MicroVaxII
(Digital Equipment Corp., Maynard, MA)

APPENDIX B

MEASUREMENT AND ANALYTICAL PROCEDURES

APPENDIX B

MEASUREMENT AND ANALYTICAL 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. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Scans of large surface areas on the floor of the facility were accomplished by use of a gas proportional floor monitor, with a 550 cm^2 sensitive area. The detector was slowly moved in a systematic pattern to cover 100% of the accessible floor area. Other surfaces were scanned using smaller, hand-held detectors. Combinations of detectors and instrument for the scans were:

Beta-Gamma - Pancake GM probe with PRM-6 ratemeter.
Beta-Gamma - Pancake GM probe with PRS-1 scaler/ratemeter.
Gamma - NaI scintillation detector (3.2 cm x 3.8 cm crystal) with PRM-6 ratemeter.
Alpha-Beta - Gas Proportional Floor Monitor with Ludlum Model 2220 Scaler/ratemeter

Alpha and Beta-Gamma Surface Measurements

Measurements of total alpha activity levels were performed using Eberline Model PRS-1 portable scaler/ratemeters with Model AC-3-7 alpha scintillation probes. Measurements of total beta-gamma activity levels were performed using Eberline Model PRS-1 portable scaler/ratemeters with Model HP-260 thin-window "pancake" G-M probes. Count rates (cpm) were converted to disintegration rates (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. Effective window areas were 59 cm^2 for the

ZnS detectors and 15 cm^2 for the GM detectors. The background count rate for ZnS alpha probes averaged approximately 2 cpm; the average background count rate was approximately 40 cpm for the G-M detectors.

Removable Measurements

Smears for determination of removable activity were performed using numbered filter paper disks, 47 mm in diameter; smears were sealed in labeled envelopes with the locations and other pertinent information recorded. The smears were returned to laboratories in Oak Ridge and counted on a low-background gas-proportional counter for gross alpha and gross beta activity.

Gamma Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a Reuter-Stokes pressurized ionization chamber. The chamber was placed 1 meter above the surface at several locations throughout the facility.

Gamma Spectrometry

Samples were placed in an appropriate container chosen to reproduce the calibrated counting geometry. Net weights were determined and the samples counted using a high purity germanium detector coupled to a Nuclear Data Model ND-66/MicroVaxII 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-238	0.093 MeV from Th-234*
U-235	0.143 Mev

Spectra were reviewed for other identifiable photopeaks.

*Secular equilibrium assumed.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report, represent the 95% confidence levels for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limits of the measurement procedure. Because of variations in background levels, sample volumes or weights, measurement efficiencies, and Compton contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties of $\pm$ 6 to 10%, associated with sampling and laboratory procedures, have not been propagated into the data presented in this report.

Calibration and Quality Assurance

The Environmental Survey and Site Assessment Program conducted the survey and analytical activities in accordance with field survey and laboratory procedures which are documented in manuals developed specifically for the Oak Ridge Associated Universities' ESSAP to meet the requirements of ANSI/ASME Nuclear Quality Assurance-1 (NQA-1). The specific manuals and procedures applicable to this survey were the "Quality Assurance Manual," December 1988, Revision 2: "Survey Procedures Manual," August 1988, Revision 4; and the "Laboratory Procedures Manual," August 1988, Revision 4.

With the exception of the measurements conducted with portable gamma scintillation survey meters, instruments were calibrated with NIST-traceable standards. The calibration procedures for the portable gamma instruments are performed by comparison with an NIST calibrated pressurized ionization chamber.

Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA and EML Quality Assurance Programs.

In accordance with the requirements of DOE Order 1324.2, Attachment V-1, which specifies retention times for DOE contractor records related to environmental contamination measurements, all samples and records are to be retained five years beyond the completion date of the project or upon publication of the certification docket. At the end of the five-year retention period, ORAU will request permission from DOE, for permission to make final disposition of the non-permanent records. Permanent records will be retained by ORAU unless otherwise directed by DOE.

APPENDIX C

U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(REVISION 2, MARCH 1987)

U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(Revision 2, March 1987)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive materials and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).* The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987) referred to herein as the "supplement".

*A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

"Residual radioactive material" is used in these guidelines to describe radioactive materials derived from operations or sites over which the Department of Energy has authority. Guidelines or guidance to limit the levels of radioactive material to protect the public and environment are provided for: (1) residual concentrations of radionuclides in soil material, (2) concentrations of airborne radon decay products, (3) external gamma radiation level, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil material. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards or guidelines (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are only used when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactivity or of the radioactive material that is acceptable if the use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards, and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the

supplement. The basis for the guidelines is generally a presumed worst case plausible scenario for a site.

An "Authorized Limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use. The Authorized Limit for a site will include limits for each radionuclide or group of radionuclides, as appropriate, associated with the residual radioactive material in the soil or in surface contamination of structures and equipment, and in the air or water, and, where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, Authorized Limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which Authorized Limits might differ from guideline values are specified in Sections D and F. A site may be released for unrestricted use only if the conditions do not exceed the Authorized Limits or approved supplemental limits as defined in Section F.1 at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if the site conditions exceed the approved limits, or if there is potential to exceed the dose limit if the site use was not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below Authorized Limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies, procedures and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic dose limit for the annual radiation dose received by an individual member of the general public is 100 mrem/year. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus dose from penetrating radiation sources external to the body shall be used for determining the dose. This dose shall be described as the "Effective Dose Equivalent". Every effort shall be made to ensure that actual doses to the public are as far below the dose limit as is reasonably achievable.

Under unusual circumstances it will be permissible to allow potential doses to exceed 100 mrem/year where such exposures are based upon scenarios which do not persist for long periods and where the annual life time exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/year. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbable, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 sq. meters. Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

If the average concentration in any surface or below surface area less than or equal to 25 sq. meters exceeds the Authorized Limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "Hot Spots" shall also be applicable. These Hot Spot Limits depend on the extent of the elevated local concentrations and are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate soil limit irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of the Ra-226, Ra-228, Th-230, and Th-232 are:

- 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

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, 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 appropriate guideline is applied as a limit to the radionuclide with 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 the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private

property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μR/h and shall comply with the basic dose limit when an appropriate use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit considering an appropriate use scenario for the area.

C.4 Surface Contamination

The generic guidelines provided in the Table 1, Surface Contamination Guidelines are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory

*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

TABLE 1

SURFACE CONTAMINATION GUIDELINES

Radionuclides[2]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[1] Average[3,4]	Maximum[4,5]	Removable[4,6]
Transuranic, 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	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β-γ	15,000 β-γ	1,000 β-γ

1 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.

2 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.

3 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.

4 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.

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

6 The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and 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.

Commission (1982)* and will be applied in a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but, should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

The Authorized Limits shall be established to: 1) ensure that, as a minimum, the Dose Limits specified in Section B will not be exceeded under the worst case plausible use scenario consistent with the procedures and guidance provided, or 2) where applicable generic guidelines are provided, be consistent with such guidelines. The Authorized Limits for each site and vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site specific data, including health, safety and socioeconomic considerations, that the guidelines are not appropriate for use at the specific site. Consideration should also be given to ensure that the limits comply with or

*These guidelines are functionally equivalent to Section 4 - Decontamination for Release for Unrestricted Use of NRC Regulatory Guide 1.86, but are applicable to Non-Reactor facilities.

provide an equivalent level of protection as other appropriate limits and guidelines (i.e., state, or other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because it covers an entire site.

Remedial actions shall not be considered complete unless the residual radioactive material levels comply with the Authorized Limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should only be considered if it is clearly demonstrated that it is not reasonable to decontaminate the area to the Authorized Limit or guideline value. The Authorized Limits are developed through the project offices in the field (Oak Ridge Technical Services Division for FUSRAP) and approved by the headquarters program office (the Division of Facility and Site Decommissioning Projects).

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and subsequent guidance or superceding orders require compliance with applicable Federal, and state environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to the interim storage, interim management, and long-term management.

a. 5440.1C, Implementation of the National Environmental Policy Act

b. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution

c. 5480.2, Hazardous and Radioactive Mixed Waste Management

d. 5480.4, Environmental Protection, Safety, and Health Protection Standards

e. 5482.1A, Environmental Safety, and Health Appraisal Program

f. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities

g. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

h. 5000.3, Unusual Occurrence Reporting System

i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.

b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed: (1) 100 pCi/L at any given point, (2) an annual average concentration of 30 pCi/L over the facility site, and (3) an annual concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-1).

c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive materials shall not exceed existing Federal, or state standards.

d. Access to a site shall be controlled and misuse of onsite material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers--active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, an effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

E.2 Interim Management

a. A site may be release under interim management when the residual radioactive material exceeds guideline values if residual radioactive material is in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.

b. The administrative controls, as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactivity or cause it to migrate.

c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.

b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere from the waste shall not: (1) exceed an annual average release rate of 20 $pCi/m^2/s$, and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.

c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded, and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).

d. Groundwater shall be protected in accordance with Appropriate Departmental orders in Federal and state standards, as applicable to FUSRAP and remote SFMP sites.

e. Access to a site should be controlled and misuse of onsite material contaminated by residual radioactive material should be prevented through appropriate administrative controls and physical barriers--active and passive controls as described by

the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

Other Radionuclides

f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site specific circumstances indicate that the guidelines or Authorized Limits established for a given site are not appropriate for a portion of that site or a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field must justify that the subject guidelines or Authorized Limits are not appropriate and that the alternative action will provide adequate protection giving due consideration to health and safety, environment, and costs. The field office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section and in the FUSRAP and SFMP protocols and subsequent guidance documents. The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to insure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F.1 Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of the site and/or vicinity property. Supplemental limits may be applied to a property or portion of a property or site if, on the basis of a site specific analysis, it is determined that certain aspects of the property or portion of the site were not considered in the development of the established Authorized Limits and associated guidelines for the site, and as a result of these unique characteristics, the established limits or guidelines either do not provide adequate protection or are unnecessarily restrictive and costly.

F.2 Exceptions

Exceptions to the Authorized Limits defined for unrestricted use of the site may be applied to a portion of a site or a vicinity property when it is established that the Authorized Limits cannot be achieved and restrictions on use of the site or vicinity property are necessary to provide adequate protection of the public and environment. The field office must clearly demonstrate that the exception is necessary, and the restrictions will provide the necessary degree of protection and that they comply with the requirements for control of residual radioactive material as set forth in Part E of these guidelines.

F.3 Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case by case basis using site specific data. Every effort should be made to minimize the use of the supplemental limits and exceptions. Examples of specific situations that warrant the use of supplemental standards and exceptions are:

a. Where remedial actions would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.

b. Where remedial actions--even after all reasonable mitigative measures have been taken--would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that can reasonably be anticipated.

c. Where it is clear that the scenarios or assumptions used to establish the Authorized Limits do not under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.

d. Where the cost of remedial actions for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive materials do not pose a clear present or future risk after taking necessary control measures. The likelihood that buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial actions will generally not be necessary where only minor quantities of residual radioactive materials are involved or where residual radioactive materials occur in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples are residual radioactive materials under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis

must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the residual radioactive material must be included in the appropriate state and local records.

e. Where there is no feasible remedial action.

G. SOURCES

Limit or Guideline	Source
Basic Dose Limits	
Dosimetry Model and Dose Limits	International Commission on Radiological Protection (1977,1978)
Generic Guidelines for Residual Radioactivity	
Residual Concentrations of Radium and Thorium in Soil Material	40 CFR 192
Airborne Radon Decay Products	40 CFR 192
External Gamma Radiation	40 CFR 192
Surface Contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
Control of Radioactive Wastes and Residues	
Interim Storage	DOE Order 5480.1A and subsequent guidance
Long-Term Management	DOE Order 5480.1A and subsequent guidance; 40 CFR 192; DOE order 5820.2

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