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RADIOLOGICAL SURVEY OF PORTIONS OF THE BLOOMFIELD LAMP PLANT WESTINGHOUSE ELECTRIC CORPORATION BLOOMFIELD, NEW JERSEY

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Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

FINAL REPORT
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RADIOLOGICAL SURVEY
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BLOOMFIELD, NEW JERSEY

INTRODUCTION

The Bloomfield Lamp Plant, owned and operated by Westinghouse Electric Corporation, was devoted primarily to the development and manufacture of electric lamps; however, radioactive materials were utilized in various processes during the plant operation. Westinghouse Electric Corporation (WEC) operated this facility until 1982 under Nuclear Regulatory Commission (NRC) License No. SMB-1527. Thorium was used in a variety of studies and manufacturing processes related to the production of metallic wire for filaments. Uranium was used in work related to the Manhattan Engineer District (MED) during World War II and in projects prior to and following that period.

The entire Bloomfield Lamp Plant (BLP) is in the process of being decontaminated and decommissioned for unrestricted use. WEC is responsible for overseeing the decontamination of the facility and has contracted several organizations to perform characterization surveys, remedial decontamination activities, and final radiological surveys. At present, Buildings 1 through 6, the garage, and property on the west side of Arlington Avenue, have been remediated and are awaiting final NRC approval for release without radiological restrictions. It is expected that all remedial actions will be completed by 1992.

In May, June, and July of 1986, Radiation Management Corporation (RMC) (currently Canberra Nuclear Services Division/RMC) performed a radiological characterization survey of the BLP facility to identify areas within the facility that contained radioactive materials or contamination. The survey identified areas throughout the facility that exceeded prescribed limits of contamination for unrestricted release.[1]

In July 1989, Scientific Ecology Group, Inc. (SEG), a subsidiary of WEC, initiated the remediation work in the contaminated areas identified by RMC. During the process of remediation, SEG identified additional locations of contamination and traced contaminated piping and ventilation systems into additional areas where remedial actions were performed. The remedial action included the removal of tile, scabbling concrete floor areas, excavation of soil to expose and remove contaminated piping, removing overhead pipes, ductwork, filters, blower units, fire brick from the incinerator, railroad ties and rails, and the removal of vessels that contained radioactive materials. Asbestos and mercury were also found to be a significant contaminant in some of these locations. Asbestos was identified primarily in floor tile and pipe insulation. Mercury was found along the railroad tracks, the reservoir, and in some building locations.

The final radiological survey report of Buildings 1 through 6, the garage, and property on the west side of Arlington Avenue, was prepared by Canberra Nuclear Services Division in May of 1990.[2] With one exception, the radiological survey report by the licensee's representative indicates that Buildings 1 through 6, Building 11, and the garage north of Building 1, and the property on the west side of Arlington Avenue satisfy NRC guidelines for unrestricted use. The final radiological survey report indicates that the sump on the southside of Building 3 contains drainage pipes from Building 3 that are contaminated above release criteria. The licensee is seeking an exemption from release guidelines from the NRC for this area; the removal of the contaminated pipe would require the destruction of a load-bearing wall of Building 3.

Decontamination and decommissioning (D&D) activities are presently being conducted on the remainder of the facility, with the majority of the D&D effort being focused in Building 7. A final radiological survey report for the remainder of the facility is expected in 1992.

At the request of the Nuclear Regulatory Commission's (NRC's) Region I Office, the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Associated Universities (ORAU) conducted a radiological survey of the decontaminated portions of the

facility in and around Buildings 1 through 6, Building 11, the garage north of Building 1, and the property on the west side of Arlington Avenue. The radiological survey included the following remediated areas: garage basement; Moly Ribbon and Blower Rooms on the second level of Building 2; Caustic Wash Area on the third level of Building 3; loading dock for Building 4; Fork Lift Ramp Area in Building 6; Sump on the southside of Building 3; Reservoir; and, railroad spurs near Buildings 4 and 6. Additional surface scans were to be conducted to assess the radiological condition of 10% of the remaining manufacturing and warehouse floor space of Buildings 1 through 6 and Building 11; portions of the rooftops of Buildings 1, 3, and 4; and, 10% of the ground and paved areas surrounding Buildings 1 through 6 and 11.

FACILITY DESCRIPTION

BLP is located approximately 12 kilometers (7.5 mi) north of the Newark International Airport just off the Garden State Parkway in Bloomfield, New Jersey (Figures 1&2). The facility is located on 5.7 hectares (14 acres) in a mixed industrial/residential area. BLP is comprised of eleven principal buildings with multiple floor levels and several smaller structures (Figure 3), which contain approximately 93,000 m^2 (1,000,000 ft^2) of usable floor space.

The building construction is primarily of concrete and steel foundations and frames, concrete floors, and brick and concrete block walls. Wooden flooring is present in several manufacturing and warehouse areas throughout the facility. Office areas consist of wood frame walls with tile or carpeted floors. Buildings 1 through 6, and Building 11 contain approximately 65,000 m^2 of floor space of which approximately 49,000 m^2 is manufacturing or warehouse space. The remaining 16,000 m^2 consists of offices, conference rooms, a hospital, a company store, a cafeteria, and restrooms.

PROCEDURES

OBJECTIVES

The objectives of the independent confirmatory survey were to provide sufficient data to the NRC to evaluate the radiological condition of the facility and confirm that D&D efforts (survey, sampling, and analyses) by SEG and Canberra were effective and to evaluate the accuracy and adequacy of the supporting documentation.

DOCUMENT REVIEW

As part of the confirmatory activities, ESSAP reviewed the final survey report and other supporting documentation prepared by Canberra. The survey report was reviewed to assess the adequacy of the decontamination activities.

INDEPENDENT SURVEY PROCEDURES

During the period of March 11 - 16, 1991, ESSAP conducted a radiological survey of those areas identified in the Statement of Work prepared by the NRC. The NRC designated priority areas included: the manufacturing and warehouse floor space and several interior remediated areas of Buildings 1 through 6 and Building 11 (Figure 4); and, several exterior remediated areas, all ground surface areas, the rooftops of Buildings 1, 3, and 4 (Figure 5), as well as several non-remediated areas. The measurement and sampling activities were performed in accordance with a plan developed by ESSAP and reviewed and approved by the NRC Region I Office.[3] The procedures and results are presented in this report.

Background Measurement/Baseline Sampling

Background exposure rate measurements were obtained from six locations within office areas of the buildings at the site, having similar construction but no history of radiological usage.

Outdoor baseline soil samples were collected and background exposure rates were measured at eight off-site locations within a 10 km radius around the BLP facility. A pressurized ionization chamber (PIC) was used to measure exposure rates one meter above the surface at each location.

Interior Survey

Gridding

With the exception of the Caustic Wash Area on the third level of Building 3, an alphanumeric 2 m x 2 m grid was established for survey reference in remediated areas designated as priority areas by the NRC. Grids were extended to a height of 2 m on each wall. An alphanumeric 1 m x 1 m grid was established in the Caustic Wash Area on the third level of Building 3. The grid was extended to a height of 2 m on the adjacent wall.

Surface Scans

Interior gamma radiation scans to identify locations of residual activity were performed on lower walls (up to 2 m) and floors in each interior remediated area and on approximately 50% of the remaining manufacturing and warehouse floor space of each surveyed building. Large area gas-flow proportional detectors were used to scan floors, lower walls, and equipment for alpha and alpha/beta activity. Floor surface scans consisted of walkover gamma and alpha/beta scans of 10% - 50% of the available floor space in the non-priority, manufacturing and warehouse areas and 100% scans of the floors and lower walls in the remediated areas of the buildings which were being decommissioned. Surface scans were also performed on lower walls and floors of areas not accessible with the gas proportional detectors using alpha scintillator and "pancake" GM beta-gamma detectors. All detectors were coupled to ratemeters/scalers equipped with audible indicators. Locations of elevated contact radiation levels identified by surface scans were marked for further investigation.

Measurement and Surface Activity Levels

Measurements to determine surface activity levels were performed on randomly selected grid blocks (10%) located on the floors and lower walls of the priority remediated areas. Measurements for total alpha and alpha/beta activity levels in these grid blocks were performed at the center and at four points equidistant from the center and grid block corners (five-point measurements). Direct alpha and alpha/beta measurements were performed using thin window 100 cm^2 gas-flow proportional detectors with ratemeters/scalers. Single-point measurements for total activity levels were also taken within randomly selected grid blocks in remediated areas and at selected locations of elevated contact radiation levels identified by surface scans.

A smear sample for determining removable activity was obtained for each set of five-point measurements at the location corresponding to the maximum direct measurement, from each single-point measurement location, and from areas where miscellaneous samples were taken. If the surface to be smeared was too rough to maintain the integrity of the smear, a sample of the surface material was collected. Measurement locations were marked on maps provided by WEC or on drawings prepared by ESSAP.

Miscellaneous Samples

Miscellaneous (concrete, floor tile, etc.) samples were collected from several areas that exhibited elevated direct contact radiation levels to identify the contaminant.

Soil Sampling

Soil samples were collected from sub-floor excavations within the Fork Lift Ramp area of Building 6 and from the water service pit in the Garage Basement.

Exposure Rate Measurements

Gamma radiation exposure rate measurements were performed in work areas at one meter (3.3 ft) above interior building floor surfaces with a pressurized ionization chamber (PIC) on the first level in each building. Exposure rate measurements were also made on every surveyed level within each surveyed building with NaI(Tl) gamma scintillation detectors, cross-calibrated with the PIC.

Exterior Survey

Gridding

In outdoor areas, an alphanumeric 10 m x 10 m grid was established for survey reference in remediated priority areas. Coordinates of other grid points are referenced to the 0,0 point using the alpha-numeric identifiers. The numeric identifier indicates the distance (meters) and the alphabetic identifier indicates the direction from the reference point (N-north, E-east, W-west, and S-south). In areas where reference grids were not established, measurement and sampling locations were referenced to prominent building features and documented on facility drawings.

Surface Scans

Exterior gamma radiation scans were performed in each remediated area and on approximately 10% of the remaining non-remediated ground surface areas. Rooftop gamma scans were performed on 50% of the available surface areas (to include exhaust vents, mechanical equipment, and ledges) on Buildings 1, 3, and 4. Gamma scans were performed using NaI(Tl) gamma scintillation detectors coupled to countrate meters with audible indicators. Beta-gamma surface scans were performed on rooftop surfaces with "pancake" GM detectors. Elevated contact radiation levels detected in these areas were marked for further investigation. GM detectors were coupled to ratemeters/scalers equipped with audible indicators.

Measurement and Surface Activity Levels

Single-point direct measurements were taken with "pancake" GM detectors at three locations on each surveyed rooftop. Smear samples for determining removable activity levels were obtained from each single-point measurement location.

Miscellaneous Samples

A concrete sample was collected from the concrete pad at the end of the railroad spur near Building 3 since the pad exhibited elevated direct contact radiation levels.

Soil Sampling

Surface soil samples (depth 0-15 cm) were collected from the grid block intersections within the Reservoir and at randomly selected locations along the remediated areas of the railroad tracks.

Exposure Rate Measurements

Five outdoor exposure rate measurements were performed at one meter above ground and/or paved surfaces with a PIC. Exposure rate measurements were taken at each soil sample location with NaI(Tl) gamma scintillation detectors coupled to ratemeters.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples were returned under chain-of-custody to ORAU's ESSAP Laboratory for analyses and interpretation. Smears were analyzed for gross alpha and gross beta activity. Soil and miscellaneous samples were analyzed by solid state gamma spectroscopy and were reviewed for radionuclides in the uranium and thorium series. Spectra were also reviewed for other

identifiable photopeaks. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B.

FINDINGS AND RESULTS

DOCUMENT REVIEW

In general, the documentation provided by Canberra was considered by ESSAP to be inadequately developed in areas regarding survey procedures and survey instrumentation. There are data within the report which do not support several remediated areas as being releasable under the guidelines for processed thorium or natural uranium. These areas include the sump on the southside of Building 3 and in the room underneath the Moly Ribbon Room on the first level of Building 2, where removable contamination > 200 dpm/100 cm^2 exists.

BACKGROUND MEASUREMENT/BASELINE SAMPLING (FIGURES 6 AND 7)

Background exposure rates within office areas of the buildings that have similar construction, but no history of radiological usage, are presented in Table 1. Background exposure rates ranged from 7 μR/h to 9 μR/h.

Exterior background exposure rates and baseline soil concentrations within the vicinity of BLP are presented in Table 2. Background exposure rates ranged from 8 μR/h to 11 μR/h. Soil samples were also taken from the these locations and the radionuclide concentrations ranged from 1.6 - 2.9 pCi/g for U-238; 0.5 - 1.2 pCi/g for Th-232; and 0.7 - 1.1 pCi/g for Ra-226.

Radionuclide concentrations in baseline soil samples are typical of concentrations normally occurring in the environment.

INTERIOR SURVEY

Surface Scans, Surface Activity Levels, and Miscellaneous Samples

Surface scans of the NRC designated priority non-remediated and priority remediated areas identified several locations where activity levels were elevated. The priority non-remediated areas where elevated contact radiation level were detected include the following: the first level of Building 2; the first, third, and fourth levels of Building 3; the first and second levels of Building 4; and the fourth level of Building 5. Elevated contact radiation levels were identified in the following priority remediated areas: the Blower Room and the Moly Ribbon Room in Building 2; the loading dock of Buildings 3 and 4; the Fork Lift Ramp in Building 6; the Sump on the southside of Building 3; and the concrete pad at the end of the railroad spur near Building 3. Elevated contact radiation levels were also found in remediated, but non-priority areas, of Building 6. The first level room underneath the Moly Ribbon Room was not surveyed due to the asbestos remediation work that was being performed.

The results of total and removable surface activity measurements are summarized in Table 3 and the results of sample analyses of interior soil and miscellaneous samples are in Tables 4 and 5, respectively. Measurement locations are provided in Figures 9 - 21.

Garage Basement (Figures 8 and 9): Remediated Areas

Floor and lower wall alpha, beta, and gamma surface scans did not identify any areas of elevated contact radiation levels. Six single-point direct measurements and smears, and one soil sample were collected from this area. Alpha direct measurements ranged from <66 to 71 dpm/100 cm^2 and beta direct measurements were <1020 dpm/100 cm^2. Removable activity levels were <6 dpm/100 cm^2 and <13 dpm/100 cm^2 for alpha and beta emitters, respectively. The soil sample radionuclide concentration from the water service pit was 16.8 pCi/g for U-238 and 1.0 pCi/g for Th-232. The contaminant of concern in this area was uranium.

Building 1 (Figure 10): Manufacturing and Warehouse Floor

The second, third, and fourth levels of Building 1 were not surveyed since they were mainly office and administrative areas. Gamma and alpha/beta floor scans did not identify any areas of elevated contact radiation levels on the first and fifth levels. Since no elevated contact radiation levels were detected, direct measurements and smears were not performed.

Building 2 (Figure 11): Manufacturing and Warehouse Floor

Approximately 25% of the floor space on the first level was covered with plastic and equipment and therefore floor scans in that area were not performed. Alpha/beta floor scans of the first level identified five locations of elevated contact radiation levels. The results of direct measurement from these locations ranged from 35 - 5,000 dpm/100 cm^2 for alpha activity and 3,600 - 49,000 dpm/100 cm^2 for alpha/beta activity. Removable activity measurements ranged from <6 - 140 dpm/100 cm^2 and <13 - 86 dpm/100 cm^2 for alpha and beta activity, respectively. Gamma and alpha/beta floor scans of the second and third levels and gamma scans of the first level did not identify any area of elevated contact radiation levels.

Building 2 (Figures 12): Blower Room

Gamma surface scans did not identify any areas of elevated contact radiation levels. Alpha and alpha/beta surface scans identified one area of elevated activity on the south wall in grid block C,0,0. Alpha and alpha/beta total activity measurements for this location were 2,400 dpm/100 cm^2 and 7,200 dpm/100 cm^2, respectively. Six five-point grid block measurements were performed. Surface activity levels ranged from <32 - 87 dpm/100 cm^2 for alpha and <240 - 660 dpm/100 cm^2 for alpha/beta. Removable activity was <6 dpm/100 cm^2 for alpha and <13 dpm/100 cm^2 for beta. Thorium was identified as the contaminant in the Blower Room, in grid block C,0,0.

Building 2 (Figure 13): Moly Ribbon Room

Gamma scans did not identify any areas of elevated contact radiation levels. Alpha and alpha/beta surface scans identified numerous locations of elevated contact radiation levels. Six single-point direct measurements and smears were taken in elevated areas to document the activity levels. Total activity levels of these measurements ranged from 810 - 1,900 dpm/100 cm^2 for alpha and 1,500 - 5,900 dpm/100 cm^2 for alpha/beta. Removable activity levels in this locations ranged from <6 - 17 dpm/100 cm^2 for alpha and <13 - 18 dpm/100 cm^2 for beta.

Building 3 (Figure 14): Manufacturing and Warehouse Floor

Gamma floor scans of the four levels identified only one area as being slightly elevated; this area was an office area on the third level. The area was identified for further investigation. Alpha/beta floor scans identified an elevated location on the fourth level and in the office area on the third level as mentioned previously. Total alpha activity measurements for the second, third, and fourth levels ranged from <32 - 87 dpm/100 cm^2 and the alpha/beta total activity ranged from 5,100 - 59,000 dpm/100 cm^2. Removable activity levels were <6 dpm/100 cm^2 for alpha and <13 dpm/100 cm^2 for beta.

Gamma and alpha/beta surface scans on the first level located a large area with elevated contact radiation levels that was between the second and third support columns from the southern wall and in front of the paint and storage rooms. Further investigation by WEC determined that the area had been used to experiment with uranium based paints. Two locations were chosen from which to take direct measurements for the purpose of documenting contamination levels. The alpha activity levels were 140 dpm/100 cm^2 and 2,000 dpm/100 cm^2 and the alpha/beta activity levels were 14,000 dpm/100 cm^2 and 170,000 dpm/100 cm^2. No removable activity was detected.

Building 3 (Figure 15): Caustic Wash Area

Gamma surface scans did not identify any areas of elevated contact radiation levels. Alpha and alpha/beta surface scans identified one area of elevated contact radiation levels. Alpha and alpha/beta total activity measurements for this location were 74 dpm/100 cm^2 and 1,100 dpm/100 cm^2, respectively. Further investigation determined that the average value was less than 1,000 dpm/100 cm^2 over the contiguous 1 m^2 area. Three five-point grid block measurements and three single-point measurements were performed. The grid block measurements ranged from <32 - 83 dpm/100 cm^2 for alpha and <240 - 1,100 dpm/100 cm^2 for alpha/beta. Surface activity levels for the single point measurements ranged from <32 dpm/100 cm^2 for alpha and <240 - 370 dpm/100 cm^2 for alpha/beta. Removable activity measurements were <6 dpm/100 cm^2 for alpha and <13 dpm/100 cm^2 for beta.

Building 4 (Figure 16): Manufacturing and Warehouse Floor

With the exception of the scabbled storage area at the northeast end of the third level which was slightly elevated, gamma scans of each level and alpha/beta floor scans of the third and fourth levels did not identify any area of elevated contact radiation levels. Alpha/beta floor scans of the first and second levels identified three locations of elevated contact radiation levels. Direct measurement results of the elevated location on the first level were 230 dpm/100 cm^2 for alpha activity and 22,000 dpm/100 cm^2 for alpha/beta activity. The results of direct measurements of the two elevated areas on the second level were <32 and 120 dpm/100 cm^2 for alpha activity and 1,500 and 3,300 dpm/100 cm^2 for alpha/beta activity. Removable activity levels were <6 dpm/100 cm^2 and <13 dpm/100 cm^2 for alpha and beta activity, respectively.

Building 4 (Figure 17): Loading Dock

Gamma surface scans did not identify any areas of elevated contact radiation levels. Alpha/beta surface scans identified six areas of elevated contact radiation levels. Alpha and alpha/beta total activity measurements for these locations ranged from <32 - 200 dpm/100 cm^2 and 2,500 -

3,900 dpm/100 cm^2, respectively. Only one measurement was below 3,000 dpm/100 cm^2. Further investigation of that location determined that the average activity across the contiguous 1 m^2 area was < 1,000 dpm/100 cm^2. Six five-point grid block measurements were performed in randomly selected grid blocks. The grid block measurements ranged from < 32 - 65 dpm/100 cm^2 for alpha and < 190 - 920 dpm/100 cm^2 for alpha/beta. No removable activity was detected. Two concrete samples taken from this area indicated that the contamination within the concrete was uranium (Table 4).

Building 5 (Figure 18): Manufacturing and Warehouse Floor

Gamma and alpha/beta floor scans of the first, second, and third levels and gamma scans of the fourth level did not identify any area of elevated contact radiation levels. Alpha/beta floor scans of the fourth level identified four locations of elevated contact radiation levels. The results of direct measurement from these locations were < 32 dpm/100 cm^2 for alpha activity and < 240 - 1,700 dpm/100 cm^2 for alpha/beta activity. Removable activity was < 6 dpm/100 cm^2 and < 13 dpm/100 cm^2 for alpha and beta activity, respectively. Further investigation of the location which was > 1000 dpm/100 cm^2 determined that the average activity across the contiguous 1 m^2 area was < 1,000 dpm/100 cm^2. The analysis of a concrete sample taken from this area was below the detection sensitivity of the analysis procedure which was < 21 dpm/100 cm^2 for U-238, < 8.4 dpm/100 cm^2 for Th-232, and < 6.7 dpm/100 cm^2 for Ra-226.

Building 6 (Figures 19): Manufacturing Floor

Gamma scans identified one area of elevated contact radiation levels which was marked for further investigation. Alpha/beta floor scans identified fourteen elevated locations in areas not including the Fork Lift Ramp area. The results of direct measurement from these locations ranged from < 90 - 7,600 dpm/100 cm^2 for alpha activity and < 290 - 20,000 dpm/100 cm^2 for alpha/beta activity. Removable activity levels were < 6 - 17 dpm/100 cm^2 and < 13 dpm/100 cm^2 for alpha and beta activity, respectively. The radiological contaminant of concern in this area, as identified by Canberra, was thorium.

Building 6 (Figure 20): Fork Lift Ramp Area

Gamma scans identified one area of elevated contact radiation levels at the south end of the excavated trench in the Fork Lift Ramp area. Alpha and alpha/beta surface scans of the area identified elevated contact radiation levels along the lower portion of the wall at the north end of the Fork Lift Ramp. Results of a direct measurement from this location were 250 dpm/100 cm^2 for alpha activity and 19,000 dpm/100 cm^2 for alpha/beta activity. Three five-point grid block and three single-point measurements were taken in this area. Five-point grid block measurements ranged from <32 dpm/100 cm^2 for alpha activity and <270 - 1,000 dpm/100 cm^2 for alpha/beta activity. Single-point measurement activity levels ranged from <32 - 57 dpm/100 cm^2 for alpha and 540 - 820 dpm/100 cm^2 for alpha/beta. No removable activity was detected. Thorium was the radiological contaminant identified in this area.

Five soil samples were collected from the open trench. The results of gamma spectroscopy analysis of these samples are listed in Table 4. The highest concentrations for U-238, Th-232, and Ra-226 were 4.4 pci/g, 7.0 pCi/g, and 1.0 pCi/g, respectively. Contact exposure rate measurements taken from these locations ranged from 11 - 29 μR/h, with the highest reading occurring at the north end of the trench from the elevated gamma location. Exposure rate measurements at one meter from each location were 11 μR/h.

Building 11 (Figure 21): Power and Heat Building Floor

Gamma and alpha/beta floor scans did not identify any areas of residual contamination on the floor. Since no elevated contact radiation levels was detected on the floor, direct measurements and smears were not collected. However, gamma scans of the circuit breakers within the transformers did exhibit elevated contact radiation levels. Contact exposure rates from the circuit breakers were 33 μR/h. The NRC and the remedial action contractor were informed immediately of the findings.

Exposure Rate Measurements (Figures 10 - 21)

Interior exposure rates were measured on every surveyed level within the surveyed buildings. These measurements are presented in Table 6. With the exception of the Fork Lift Ramp Area in Building 6, the exposure rates in Buildings 1-6, Building 11, and the Garage Basement, ranged from 7 to 16 μR/h.

EXTERIOR SURVEY

Surface Scans, Exposure Rates, Surface Activity Levels, and Soil Samples

Surface scans of the NRC designated priority non-remediated and remediated areas (Figure 5) identified several locations that are elevated. The priority remediated areas where elevated contact radiation levels was determined included the Sump on the southside of Building 3 and the concrete pad at the end of the railroad spur near Building 3. Exposure rate measurements were performed at all soil sample locations.

The results of total and removable surface activity measurements are summarized in Table 3 and the results of sample analyses of exterior miscellaneous samples are in Table 5.

Exterior Ground Surfaces (Figure 5): Non-Remediated Areas

Gamma scans between and around the buildings did not identify any elevated contact radiation levels. Exposure rates ranged from 9 to 13 μR/h in these areas.

Sump - Southside of Building 3 (Figure 22): Remediated Area

According to the results in the final report[2], contamination still exists in the drain pipes. Two direct measurements from the interior surface of the drain pipes and one water sample were collected from this area. Results of the direct measurements were <32 dpm/100 cm^2 and 210

dpm/100 cm^2 for alpha activity and 1,200 dpm/100 cm^2 and 1,300 dpm/100 cm^2 for alpha/beta activity. Results for the water sample indicated a gross alpha activity level less than the detection sensitivity of the counting equipment which was 1.7 pCi/L and the gross beta activity level was 3.1 pCi/L.

Reservoir (Figure 23): Remediated Area

The soil in this 20 m x 20 m reservoir area had been excavated and backfilled with clean dirt. Gamma exposure rates from the scans ranged from 8 - 13 μR/h. Ten soil samples were taken - nine from the grid block intersections and one at grid coordinate 15N,5E. The results of the exposure rate measurements and sample analyses are presented in Table 7. The exposure rates taken at contact and one meter above the surface at each soil sample location ranged from 8 - 13 μR/h and are within typical background values as listed in Table 1. Radionuclide concentrations within the soil samples ranged from 0.5 -7.5 pCi/g for U-238; 0.3 - 3.0 pCi/g for Th-232; and 0.3 - 3.5 pCi/g for Ra-226.

Railroad Spur Adjacent to Building 4 (Figure 24): Remediated Area

Gamma scans along the railroad tracks at the north end of Building 4 were higher when compared to the majority of the site. Exposure rates ranged from 8 - 16 μR/h. Eight soil samples were collected at randomly selected locations. Results of the exposure rate measurements and the sample analyses for the samples are listed in Table 7. Exposure rates taken at one meter above the surface at each soil sample location ranged from 10 - 12 μR/h and are within expected values. Radionuclide concentrations within the soil samples ranged from 4.7 - 24.9 pCi/g for U-238; 1.1 - 1.6 pCi/g for Th-232; and 0.8 - 2.1 pCi/g for Ra-226. The concrete pad at the north end of the railroad spur had been scabbled. Gamma scans indicated that the radiation levels of the pad were slightly higher. A single-point direct measurement was taken and the alpha activity was <32 dpm/100 cm^2 and the alpha/beta activity was 1,100 dpm/100 cm^2. The analysis of the concrete sample indicated 12.9 pCi/g of U-238 (Table 5).

Railroad Spur Adjacent to Building 6 (Figure 25): Remediated Area

Gamma scans along the railroad tracks along the north end of Building 6 did not identify any areas of elevated contact radiation levels. Exposure rates along the concrete paved areas were approximately 9 μR/h and along the tracks in the soil area the range was 13 - 16 μR/h. Eight soil samples were collected at randomly selected locations. Results of the exposure rate measurements and the radionuclide concentrations within the soil samples are listed in Table 7. The exposure rates taken at one meter (3.3 ft) above the surface at each soil sample location ranged from 8 - 13 μR/h and are within background values. The radionuclide concentrations within the soil samples ranged from 1.8 - 9.5 pCi/g for U-238; 0.9 - 11.0 pCi/g for Th-232; and 0.9 - 2.2 pCi/g for Ra-226 and are higher than the baseline measurements.

Rooftop Surveys of Buildings 1, 3, and 4 (Figure 26): Non-Remediated Areas

Gamma scans of the rooftops of Buildings 1, 3, and 4 ranged from 4 μR/h to 10 μR/h. Three direct measurements and smears were taken at randomly selected locations on each rooftop and the results are presented in Table 3. Total activities from the direct measurements ranged from $<$32 - 65 dpm/100 cm^2 for alpha and $<$240 - 480 dpm/100 cm^2 for beta-gamma. Removable activity was $<$6 dpm/100 cm^2 and $<$13 dpm/100 cm^2 for alpha and beta, respectively.

Exposure Rate Measurements (Figure 27)

Exterior exposure rate measurements are presented in Table 8. Five on-site exposure rate measurements, taken with a PIC, ranged from 8 - 11 μR/h at 1 m (3.3 ft) above surfaces and are comparable to the off-site background baseline measurements which range from 8 - 11 μR/h.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity guidelines established for the release of formerly licensed facility for unrestricted use and the guidelines for residual concentrations of thorium and uranium wastes in soil are presented in Appendix C. The primary contaminants of concern for this site were uranium and thorium.

The uranium contaminant at this site is processed uranium (i.e. uranium separated from its long lived daughter products); the isotopic abundances or ratios of U-234, U-235, and U-238 are those present in nature, i.e. activity ratios of approximately 1:0.045:1.

The thorium contaminant is thorium-232 plus all daughter products in equilibrium as confirmed by comparisons of Th-232 to Th-228 concentrations.

The acceptable surface contamination levels are:

For Thorium:

1000 dpm/100 cm^2, total, averaged over 1 m^2
3000 dpm/100 cm^2, total, maximum in 100 cm^2
200 dpm/100 cm^2, removable

The most restrictive guideline for total and removable activity was applied. Numerous alpha and alpha/beta total activity measurements exceeded 3,000 dpm/100 cm^2 for thorium and several alpha/beta total activity measurements exceeded 15,000 dpm/100 cm^2 for uranium (Table 3). The locations of the direct measurements that exceeded these values are indicated in Figures 9 - 26. With one exception, all removable activity measurements were below 200 dpm/100 cm^2 (the limit for thorium). On the first level in Building 3, the measurement was 260 dpm/100 cm^2 for gross alpha activity and 330 dpm/100 cm^2 for gross beta activity; the radiological contaminant was identified by Canberra as uranium which has a removable release limit of 1,000 dpm/100 cm^2. Soil concentrations for residual uranium and thorium wastes are presented in the

NRC's Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations" (Appendix C). The NRC has made a preliminary interpretation of the Branch Technical Position that the guideline for depleted uranium, which is 35 pCi/g of total uranium, is applicable to processed uranium in its naturally occurring isotopic abundances. These applicable soil concentration guidelines are:

Processed Uranium (natural abundances) Total of all uranium isotopes above Natural background	35 pCi/g
Natural Thorium Total of all thorium isotopes above Natural background	10 pCi/g

U-238 and Th-232 background concentrations were determined by averaging the radionuclide concentrations from the baseline samples that were collected within the vicinity of the facility. The average backgrounds for U-238 and Th-232 were 2.1 pCi/g and 0.9 pCi/g, respectively. For purposes of comparison with gamma spectrometry results, U-238 and Th-232 levels, representative of the guideline values, were calculated. Based on natural abundances of uranium isotopes, the level of U-238 representative of a total concentration of 35 pCi/g is approximately 17.5 pCi/g. The level of Th-232 representative of a total thorium concentration of 10 pCi/g is 5 pCi/g since Th-232 and Th-228 are considered to be in secular equilibrium. The NRC guidelines for these contaminants are expressed in terms of concentrations above normal background levels. As determined by this survey, the average background levels for U-238 and Th-232 are 2.1 pCi/g and 0.9 pCi/g, respectively. The sample analysis results indicating that the NRC guidelines have been exceeded are thus:

19.6 pCi/g for U-238, and

5.9 pCi/g for Th-232

Several soil samples exceeded these values. Of the interior areas, a soil sample from the Fork Lift Ramp Area in Building 6 exhibited a Th-232 concentration of 7.0 pCi/g. Two soil samples from the railroad spur at the northeast ends of Buildings 3 and 4 had U-238 concentrations greater than 19.6 pCi/g. Two soil samples from the railroad spur at the northeast end of Building 6 exhibited Th-232 concentrations above 5.9 pCi/g.

SUMMARY

At the request of the Nuclear Regulatory Commission, Region I, the Environmental Survey and Site Assessment Program of Oak Ridge Associated Universities conducted an independent radiological survey of the Westinghouse Electric Corporation Bloomfield Lamp Plant from March 11 through March 16, 1991. The survey included alpha/beta floor scans, alpha, alpha/beta and beta-gamma lower wall scans, gamma scans; measurement of direct and removable activity levels; exposure rate measurements; and the determination of radionuclide concentrations in soil, concrete, tile, and other miscellaneous samples.

The results of the survey demonstrate that radiological contamination in excess of guideline values still exists in several of the remediated areas of the facility such as the Moly Ribbon Room and the Blower Room of Building 2, the Loading Dock in Building 4, the Fork Lift Ramp area of Building 6, and along the railroad spurs near Buildings 3, 4, and 6. Elevated contact radiation levels were also found in the manufacturing and warehouse floor space of the first level of Building 2; the first, third, and fourth levels of Building 3; the third and fourth levels of Building 4; and, in Building 6. The findings did not support the final survey provided by the licensee.

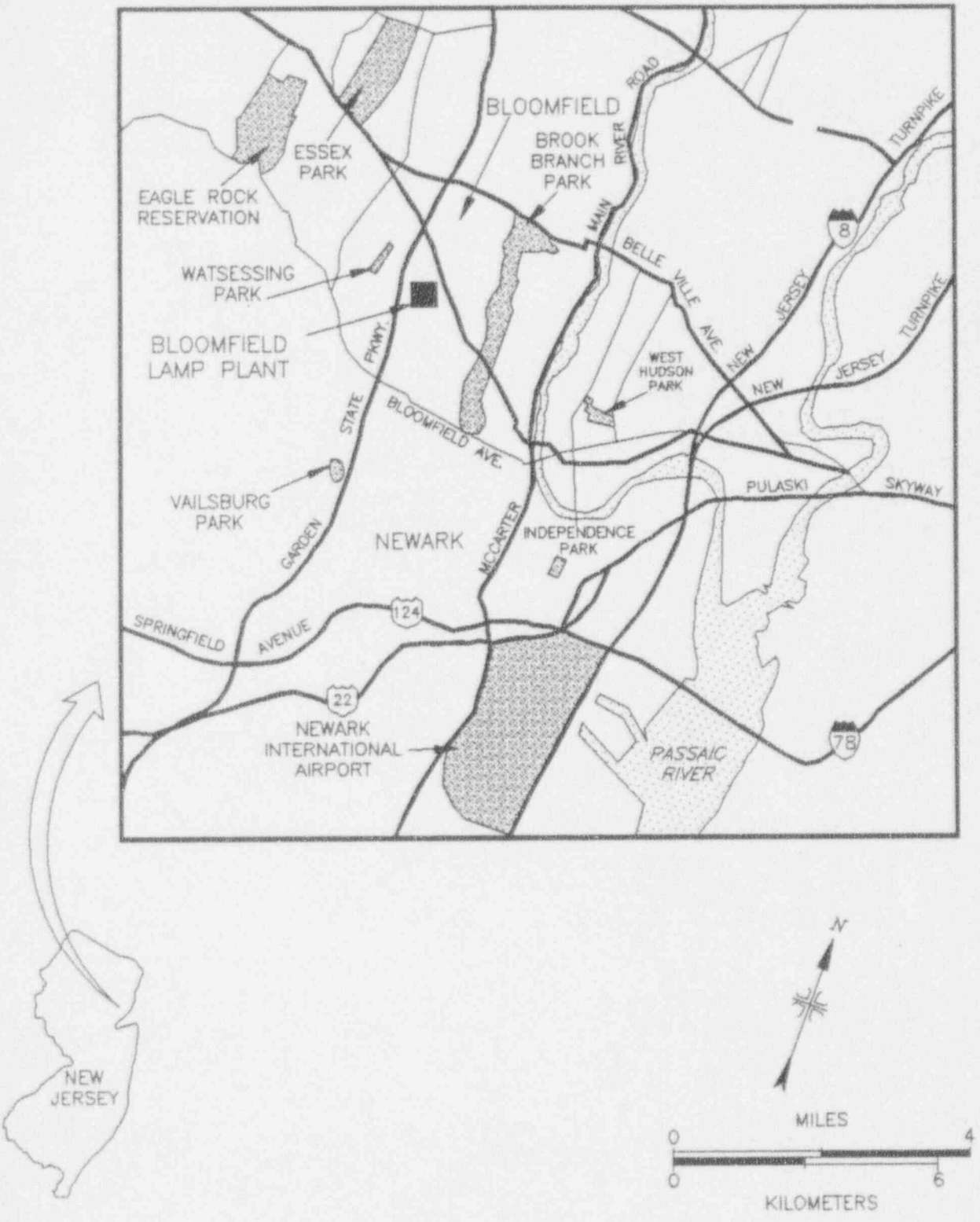

FIGURE 1: Location of Westinghouse Electric Corporation's Bloomfield Lamp Plant, Bloomfield, New Jersey

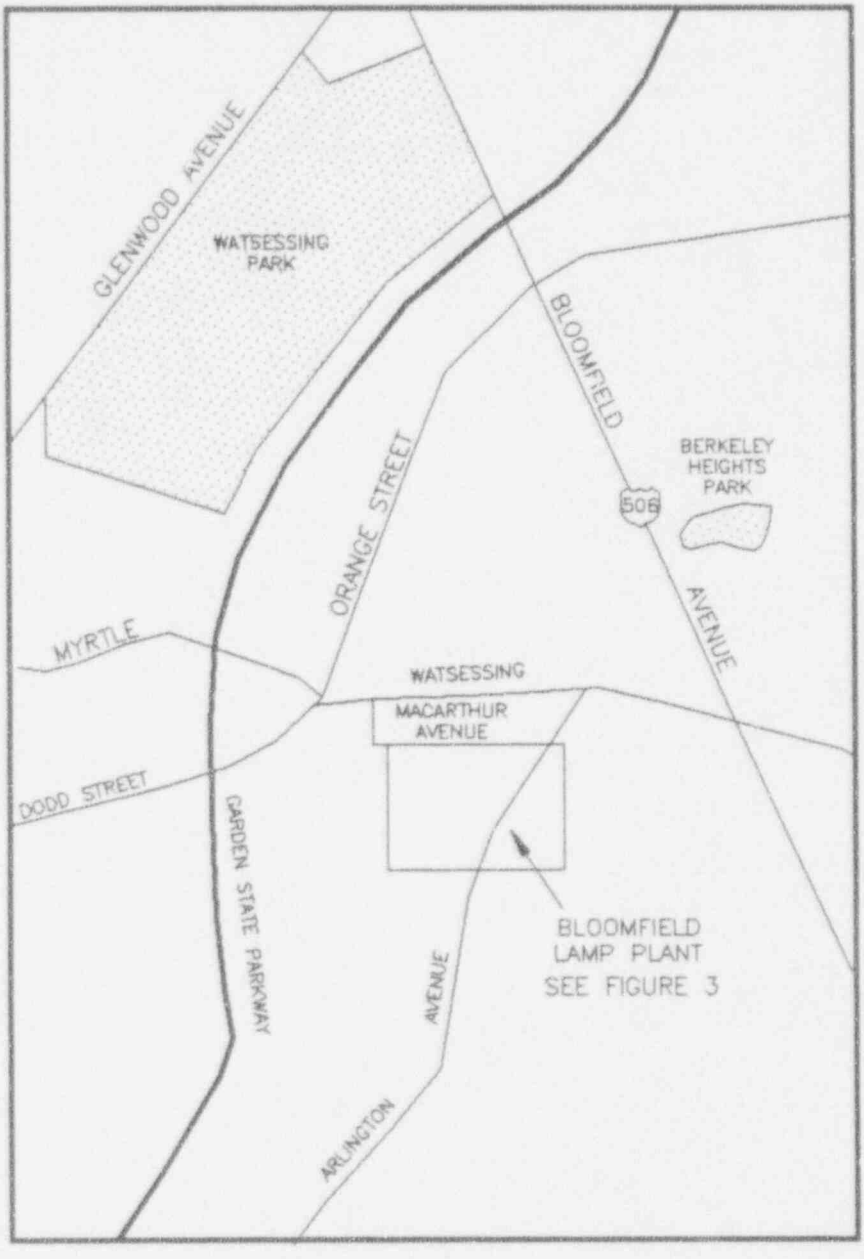

FIGURE 2: Bloomfield, New Jersey Area: Location of Westinghouse Electric Corporation's Bloomfield Lamp Plant

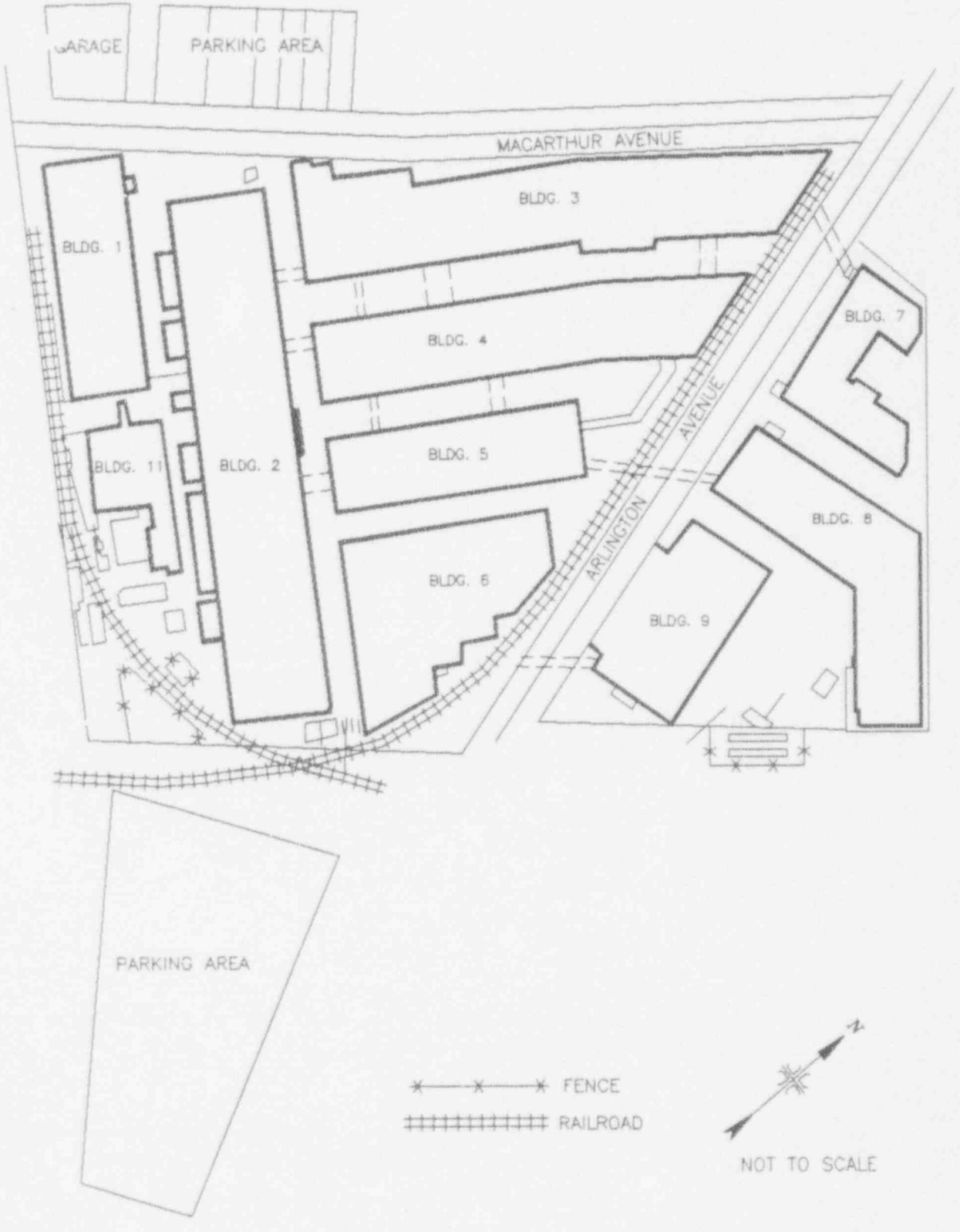

FIGURE 3: Plot Plan of the Bloomfield Lamp Plant
Bloomfield, New Jersey

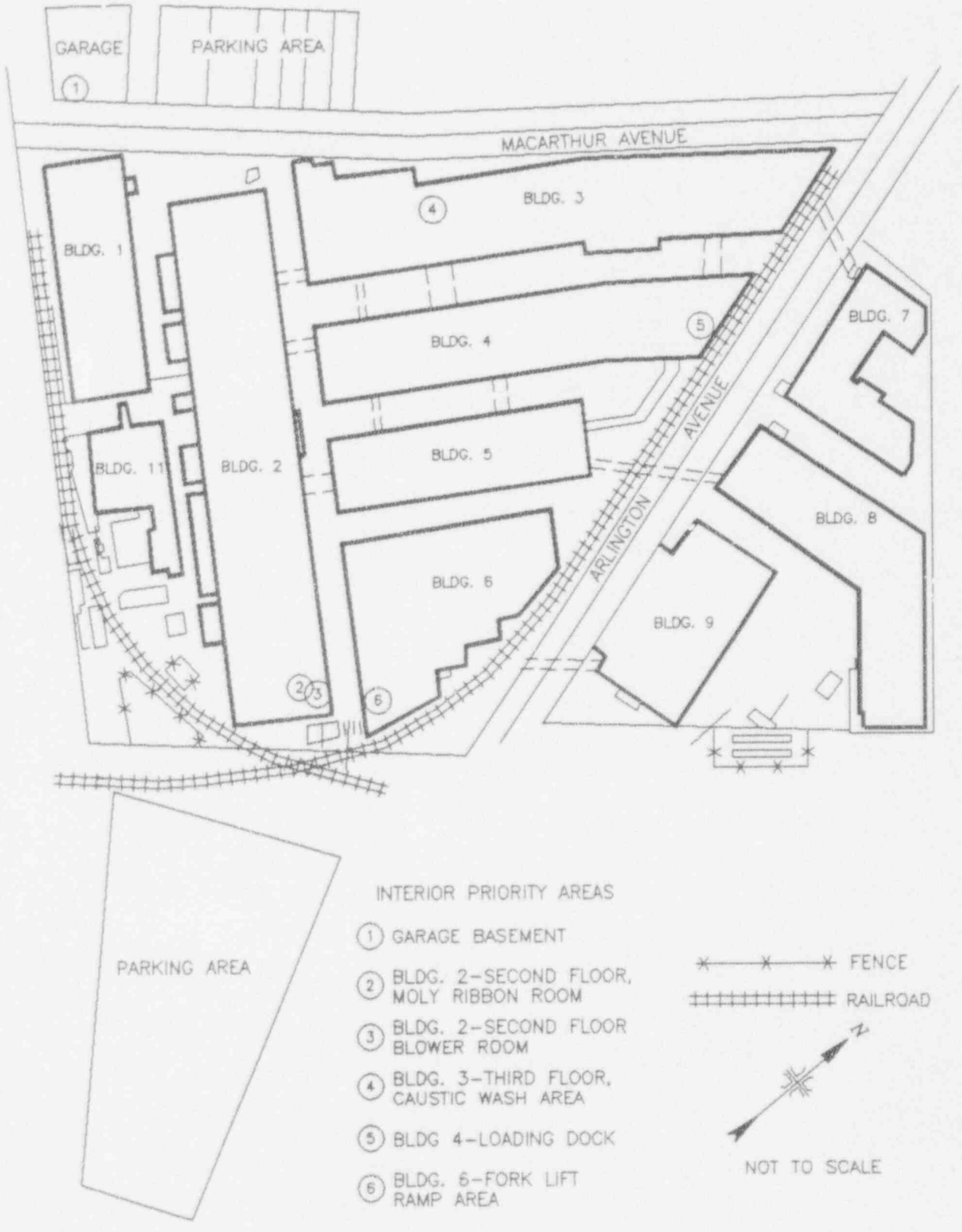

FIGURE 4: Interior Priority Areas

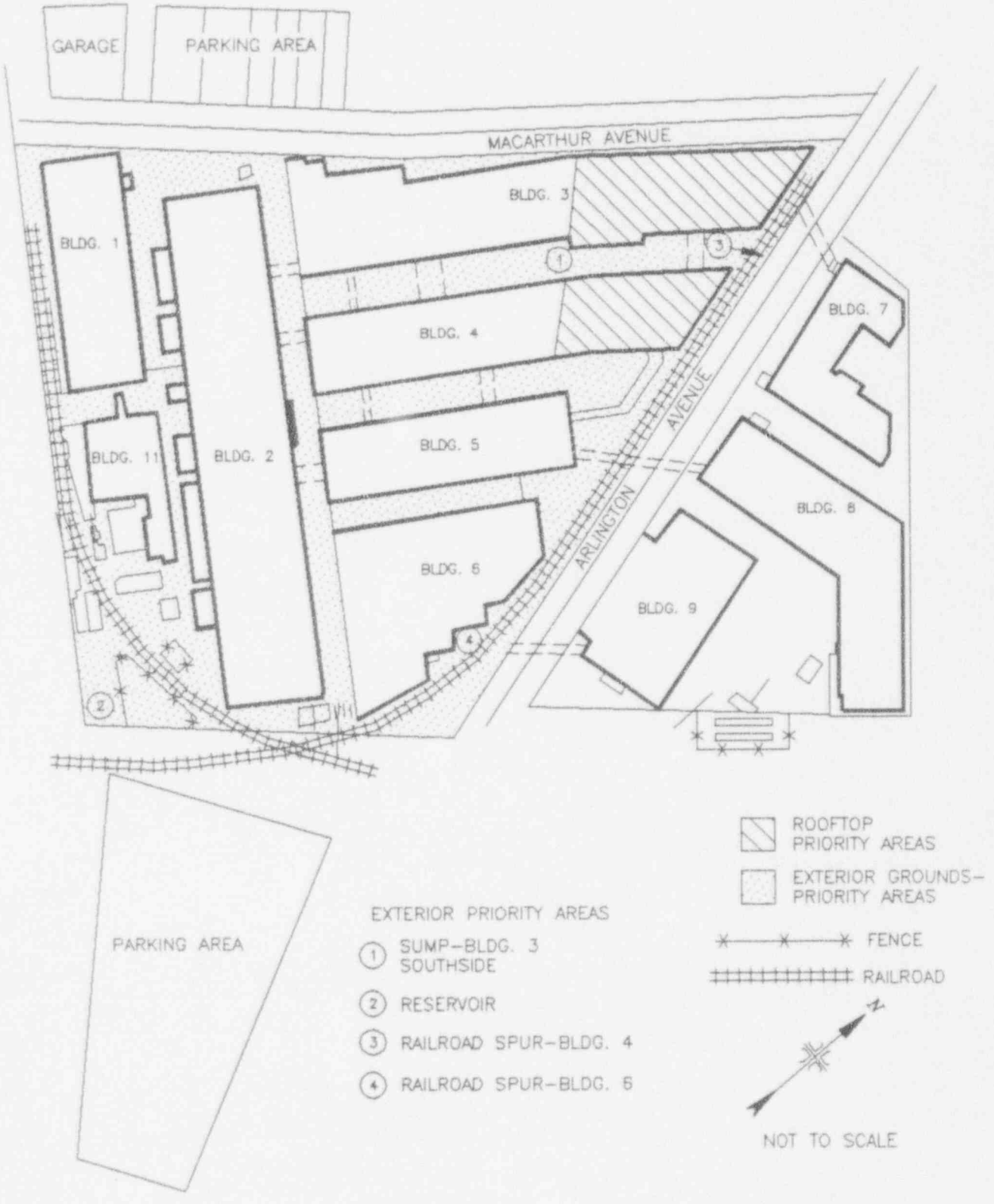

FIGURE 5: Exterior and Rooftop Priority Areas

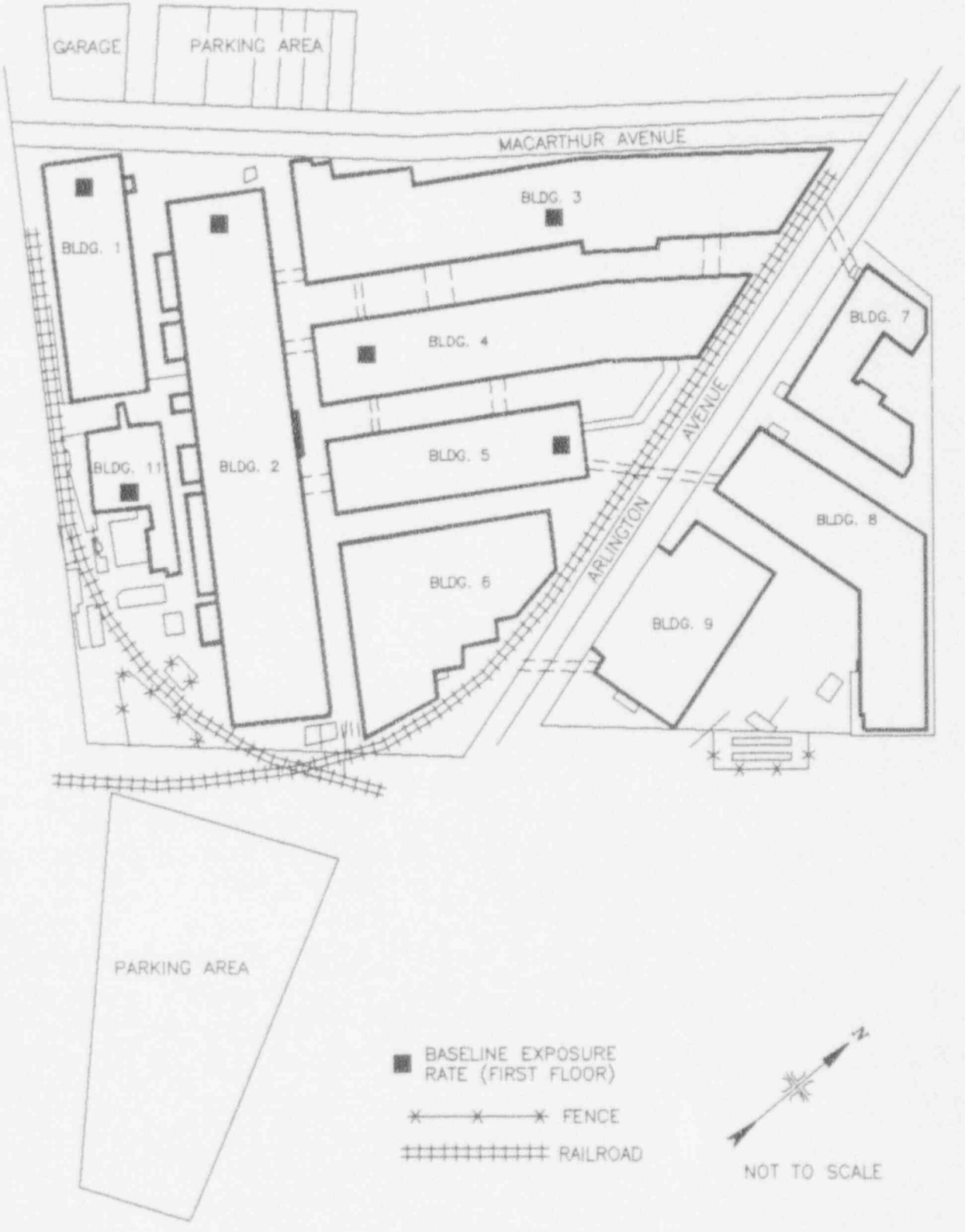

FIGURE 6: Baseline Interior: Exposure Rate Measurement Locations

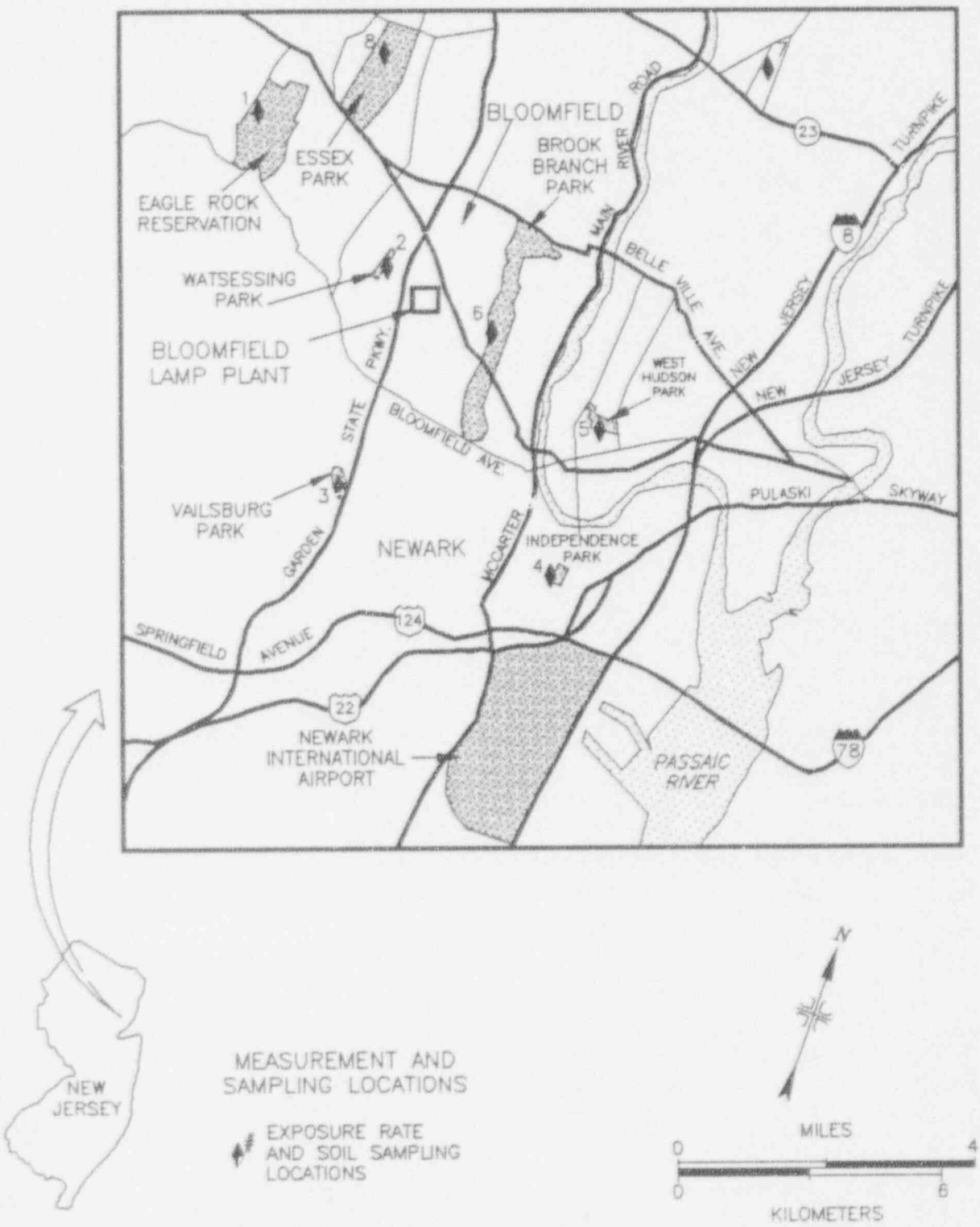

FIGURE 7: Newark and Bloomfield, New Jersey Area: Background Measurement and Sampling Locations

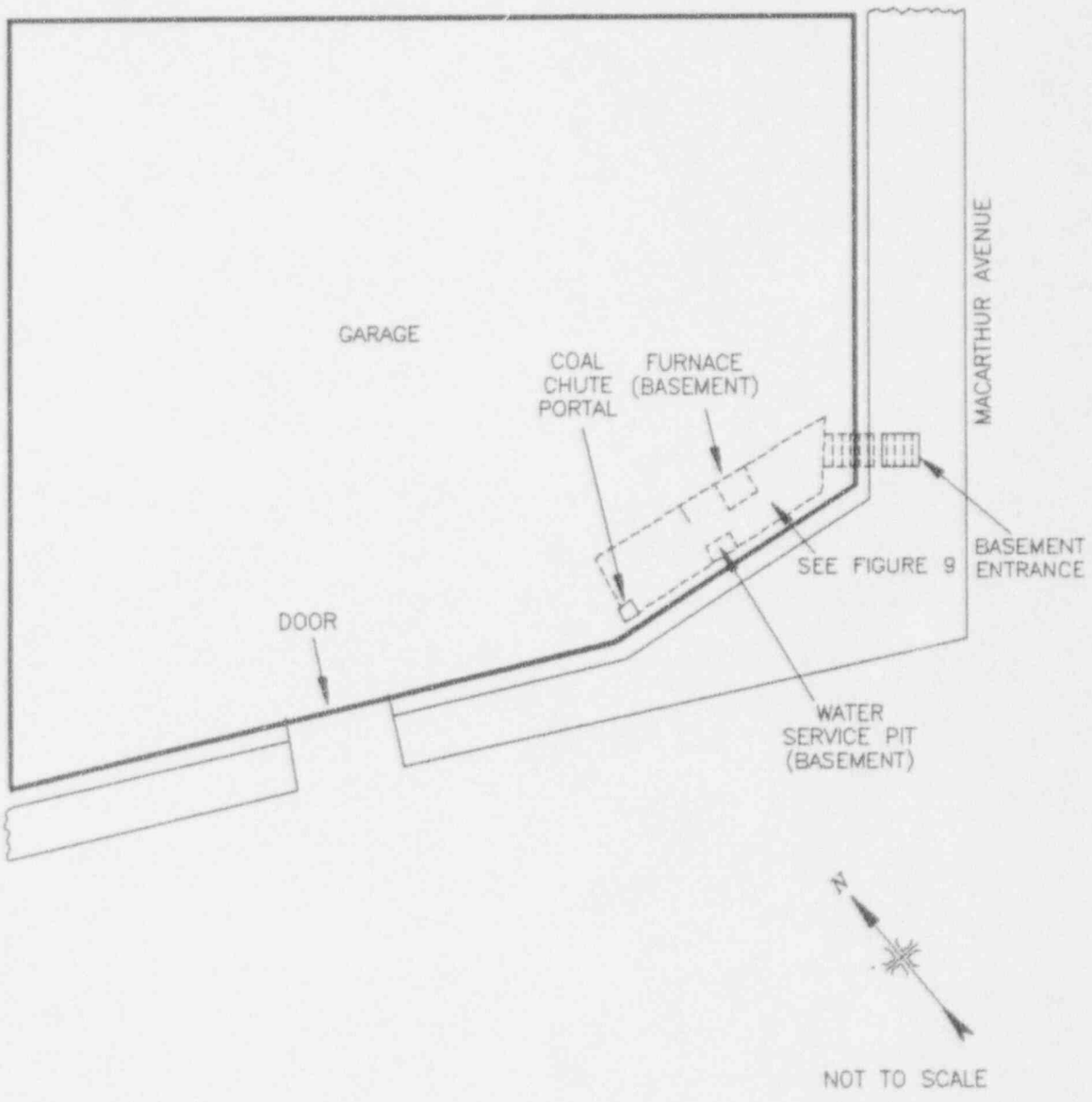

FIGURE 8: Garage: Basement Location

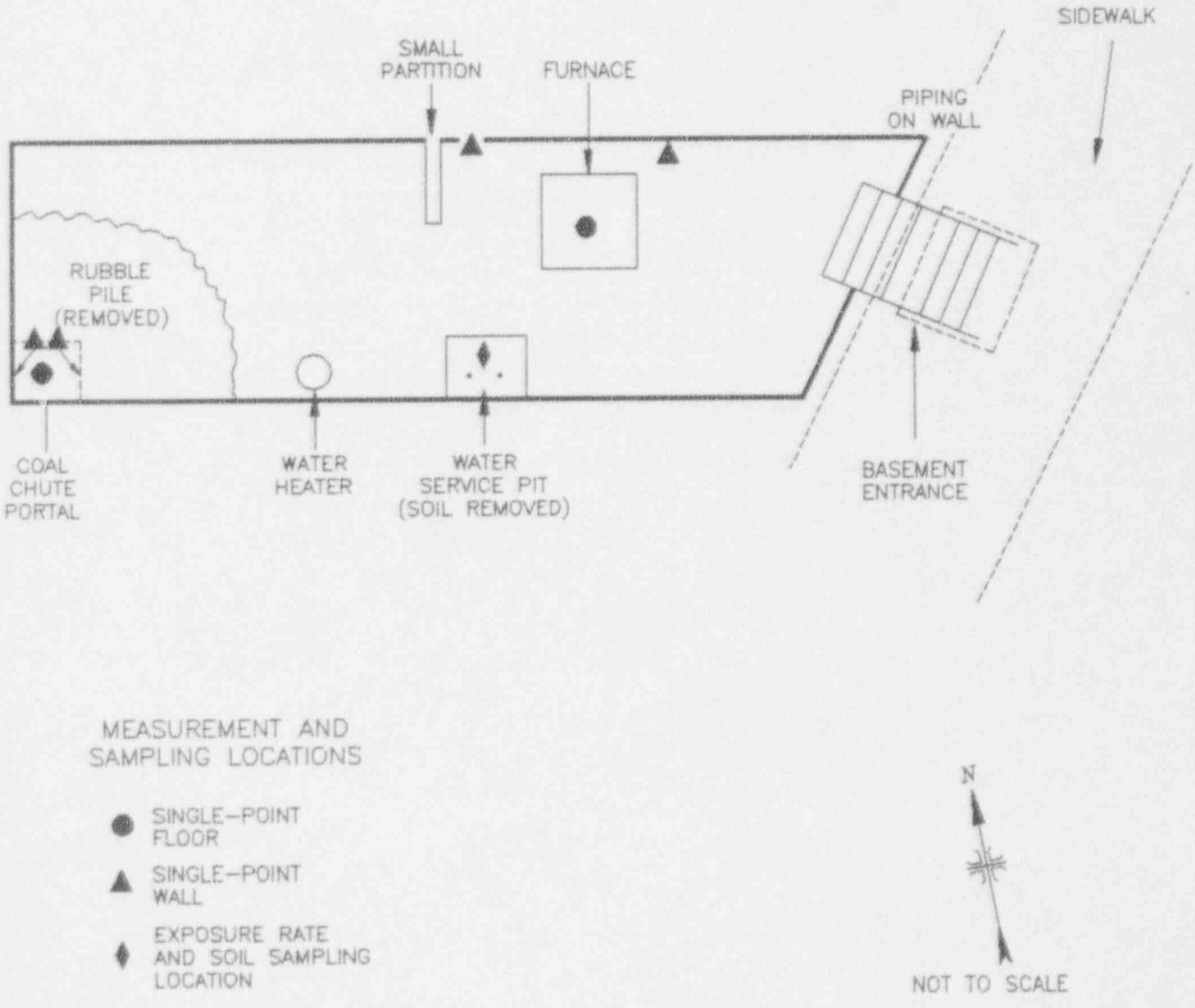

FIGURE 9: Garage Basement: Measurement and Sampling Locations

WEB2

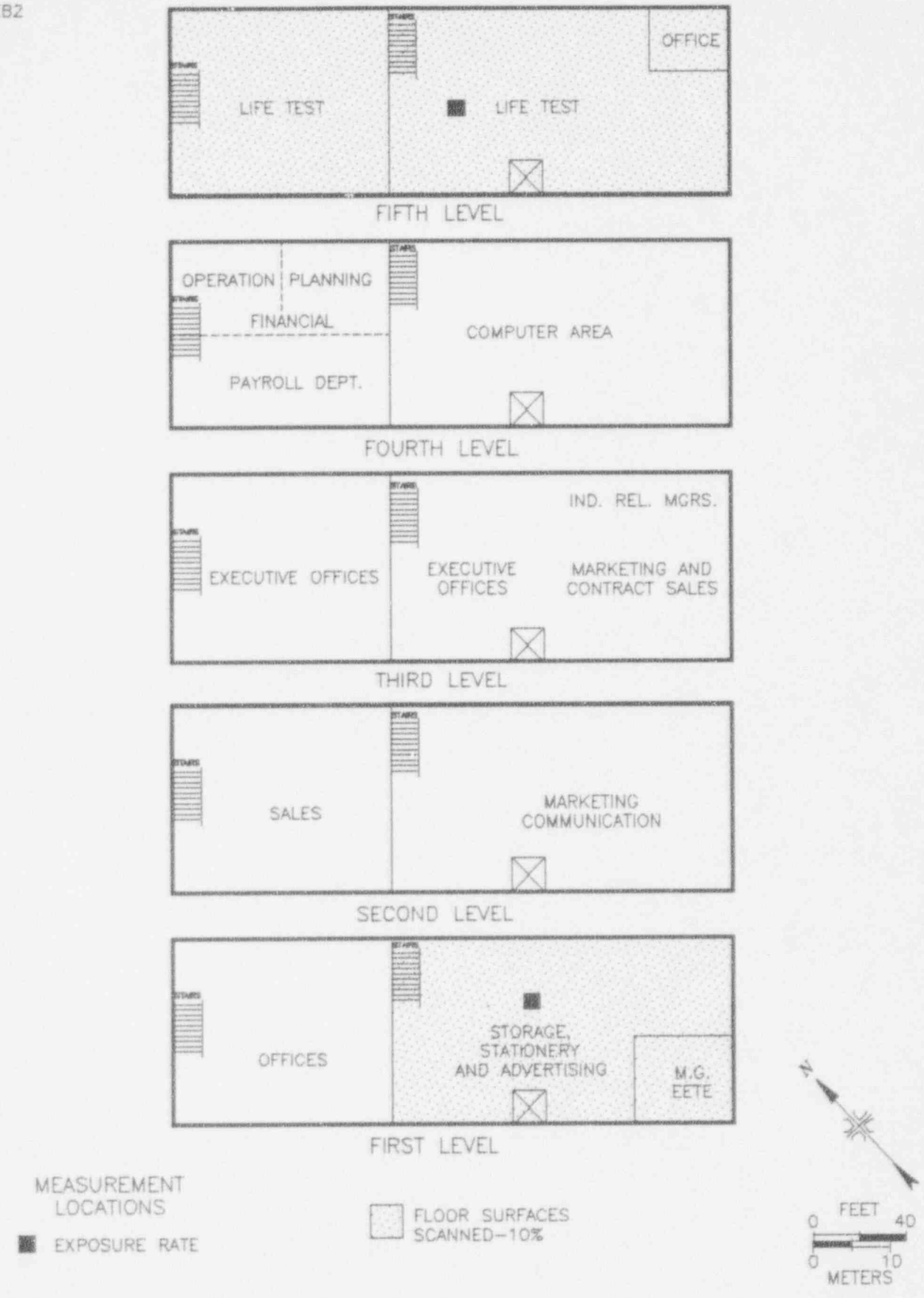

FIGURE 10: Building 1: Measurement Locations

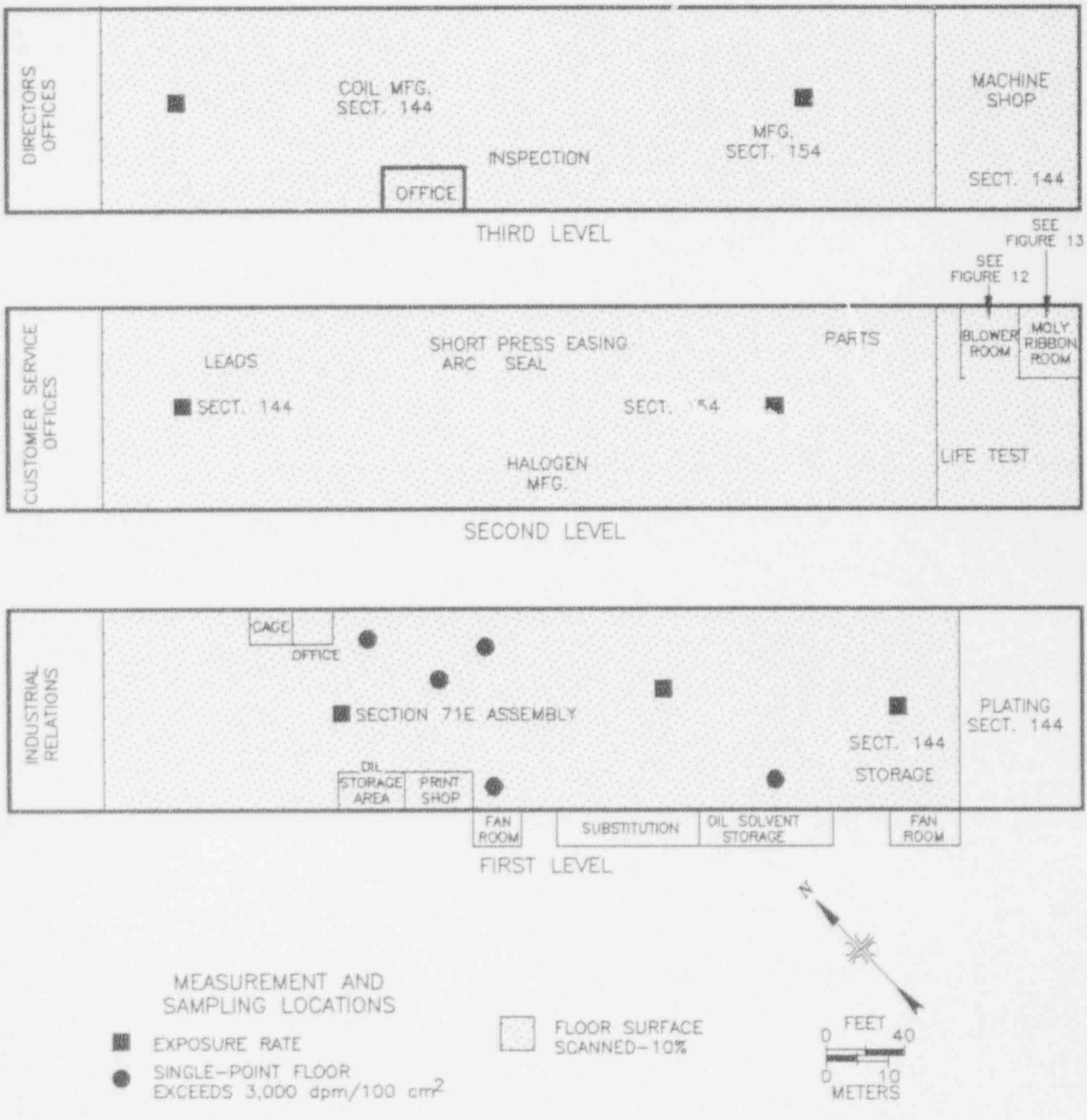

FIGURE 11: Building 2: Measurement and Sampling Locations

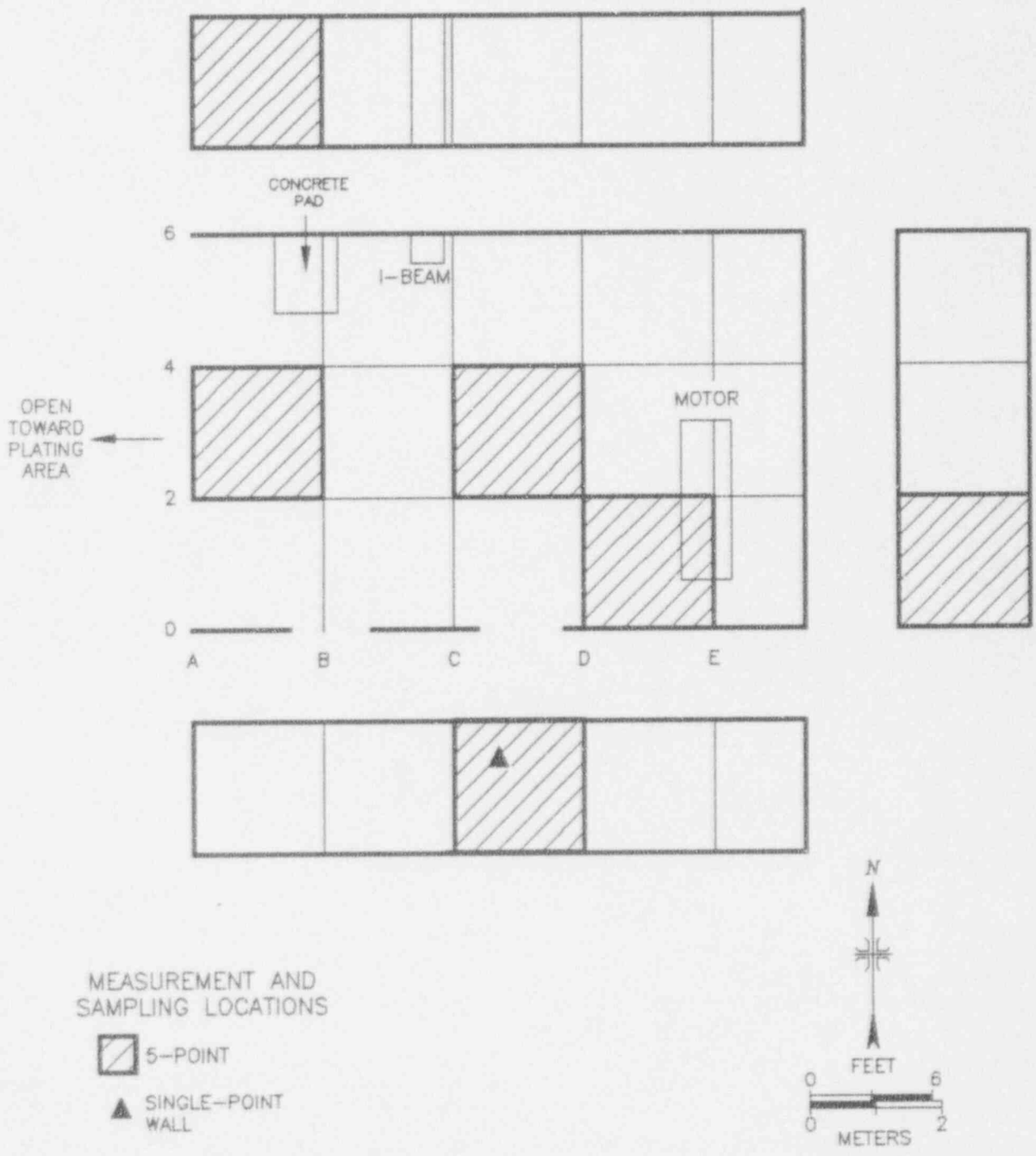

FIGURE 12: Building 2-Blower Room: Measurement and Sampling Locations

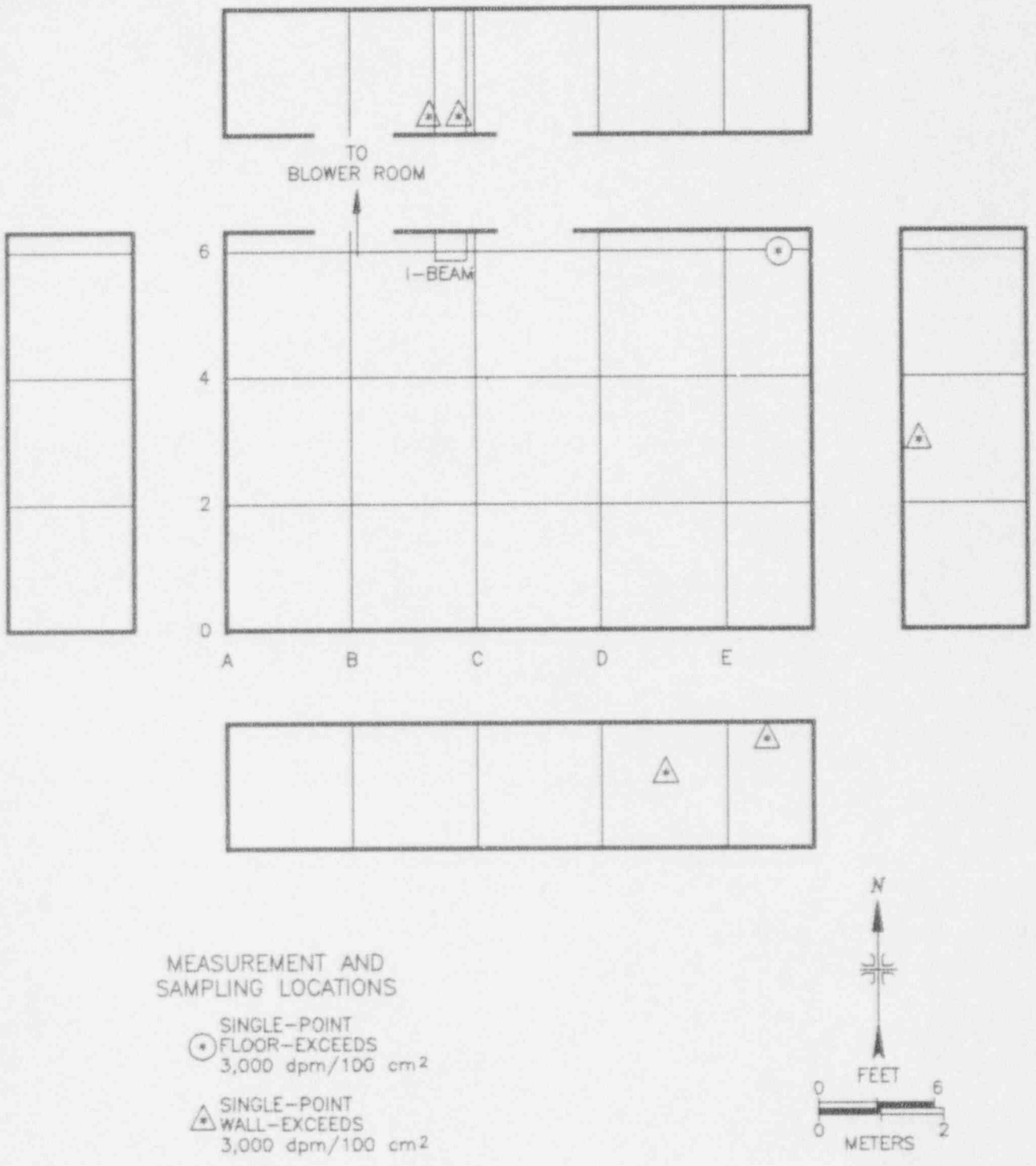

FIGURE 13: Building 2-Moly Ribbon Room: Measurement and Sampling Locations

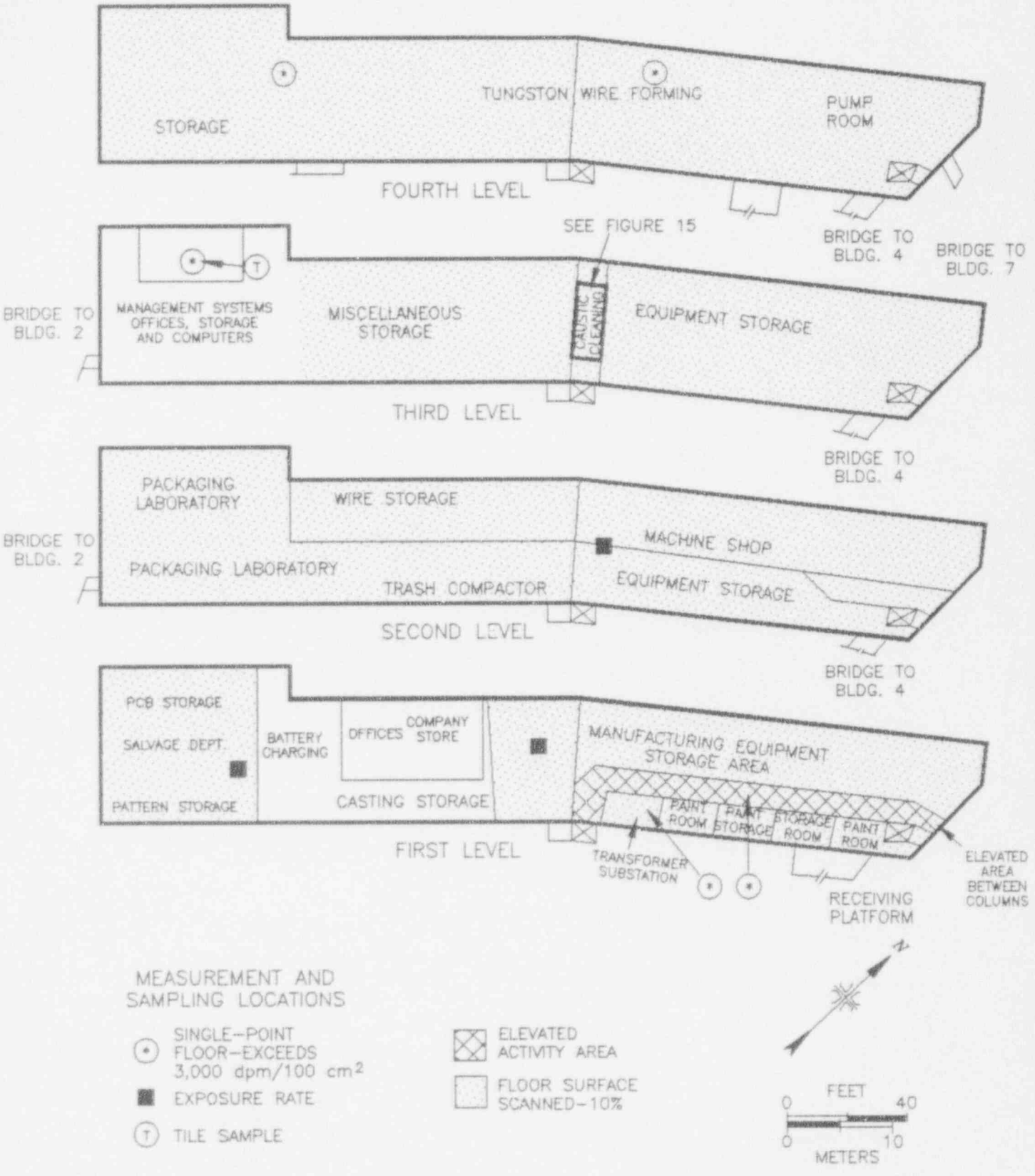

FIGURE 14: Building 3: Measurement and Sampling Locations

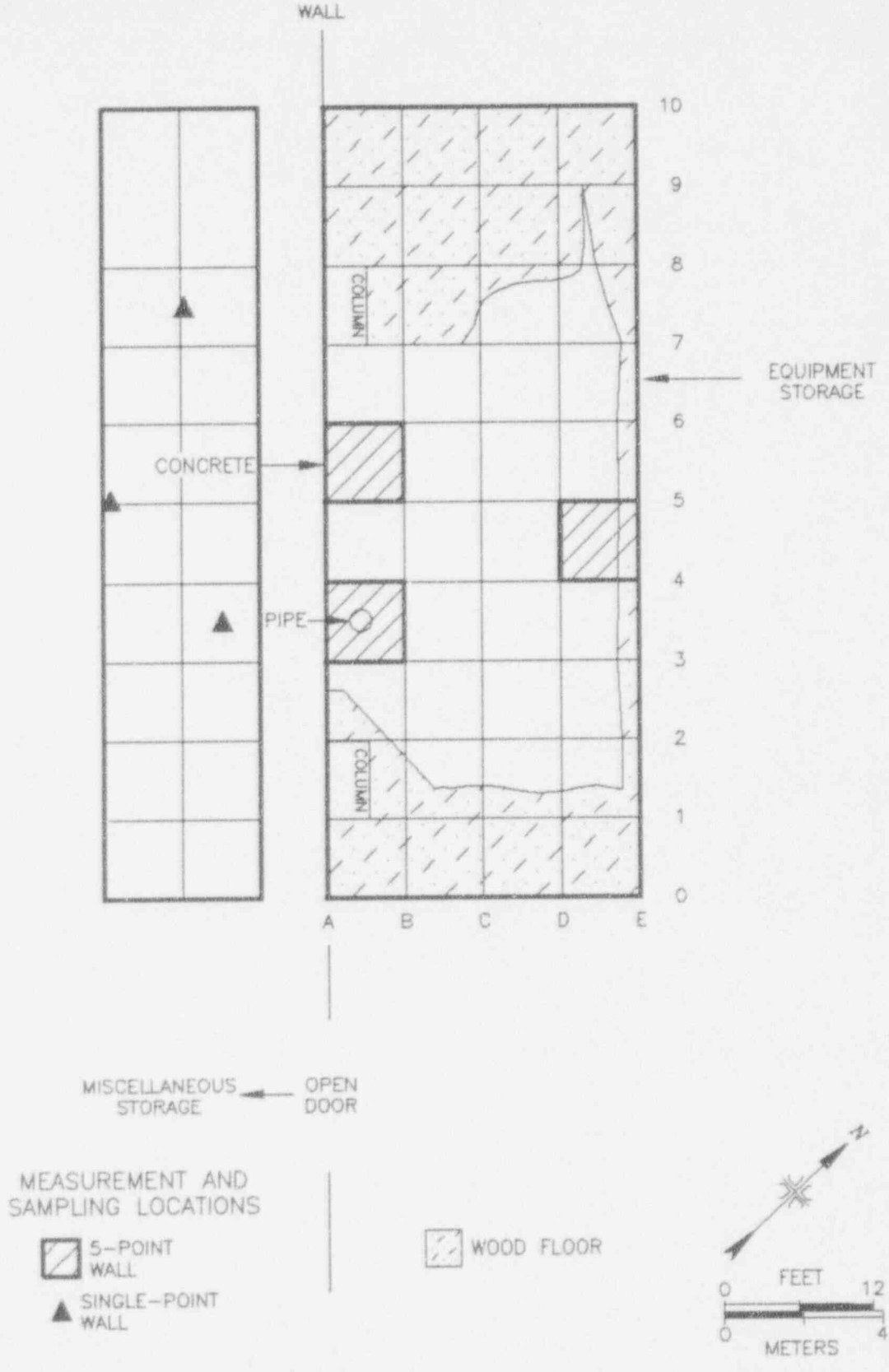

FIGURE 15: Building 3—Third Level Caustic Wash Area: Measurement and Sampling Locations

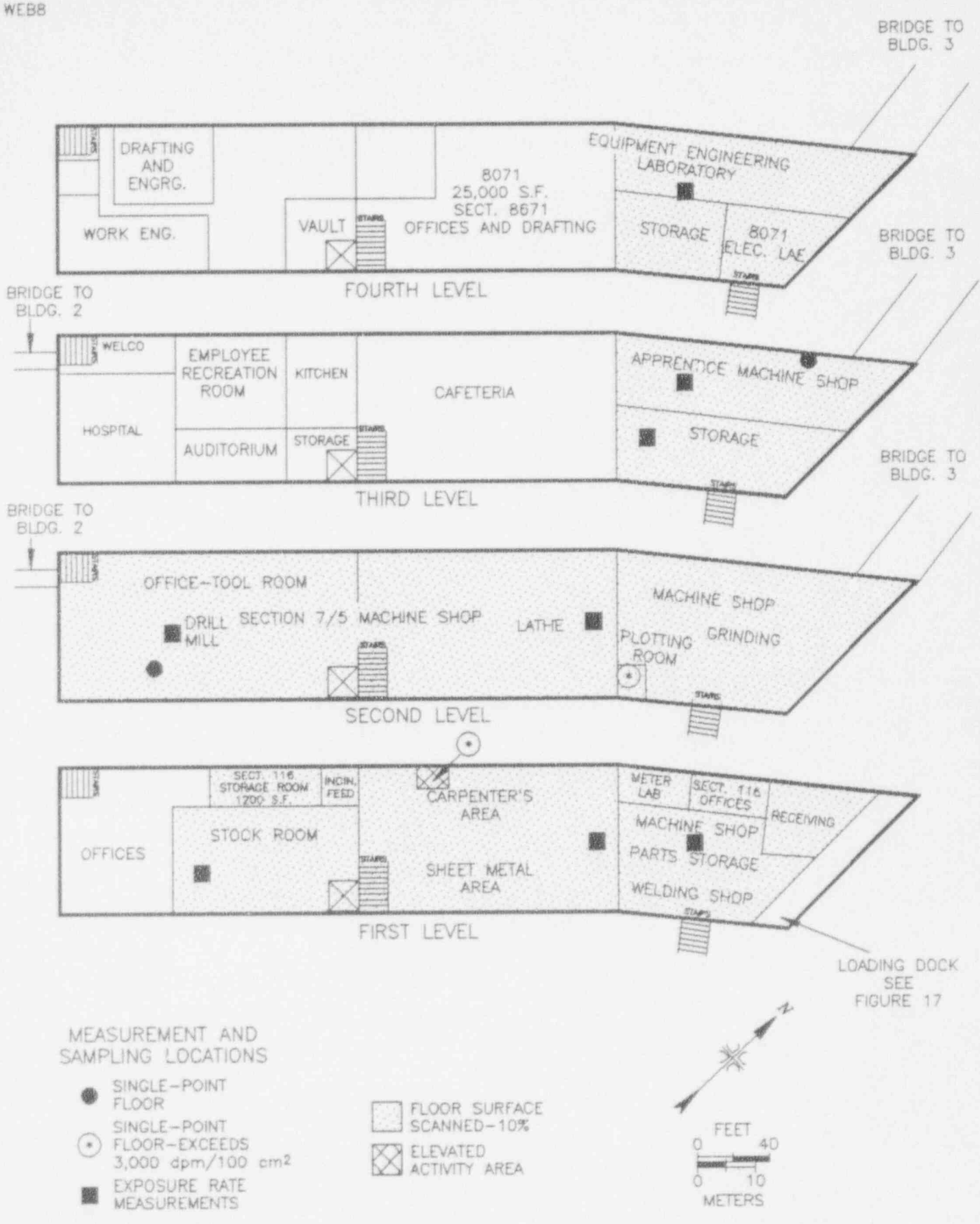

FIGURE 16: Building 4: Measurement and Sampling Locations

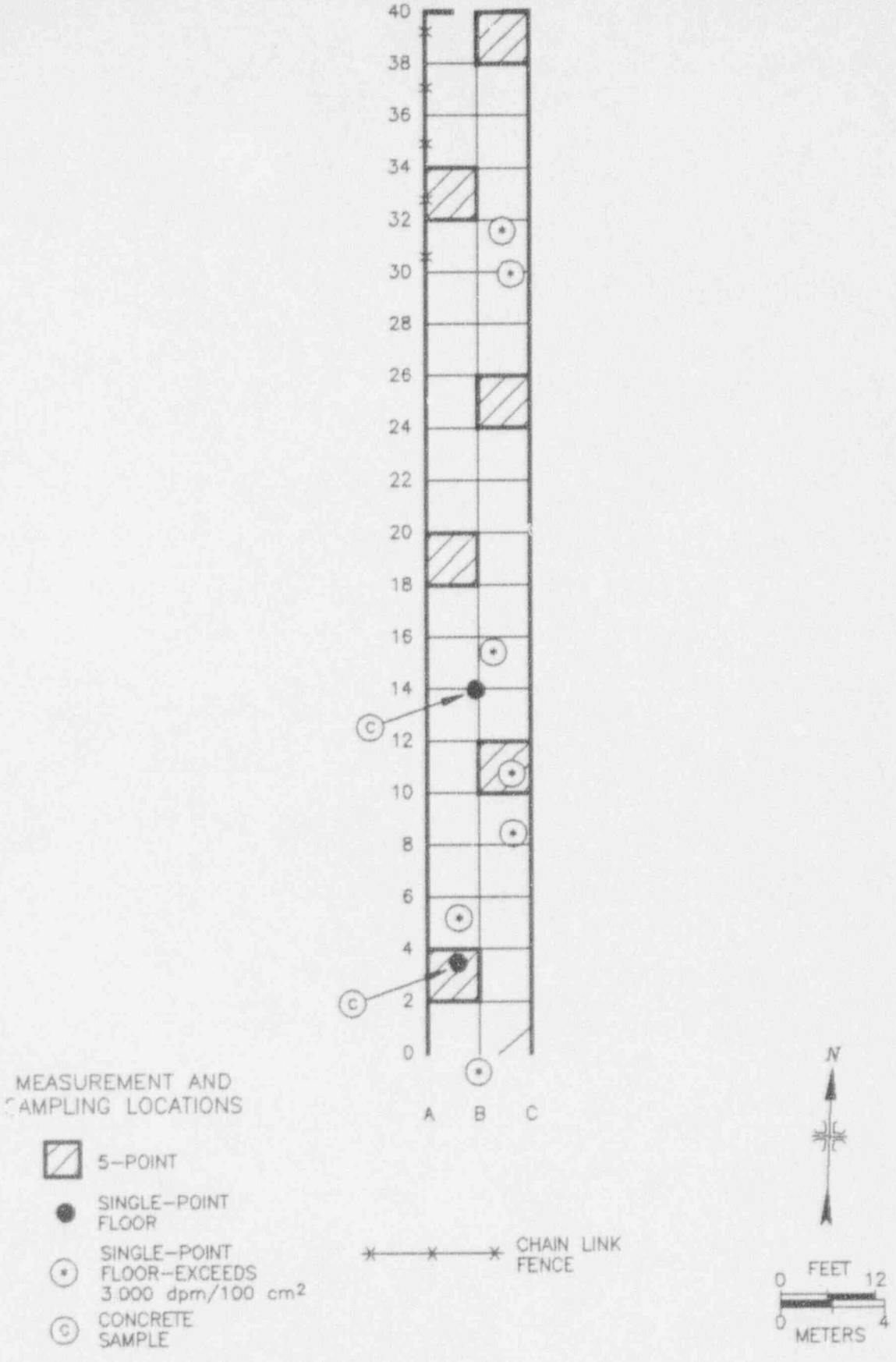

FIGURE 17: Building 4–Loading Dock: Measurement and Sampling Locations

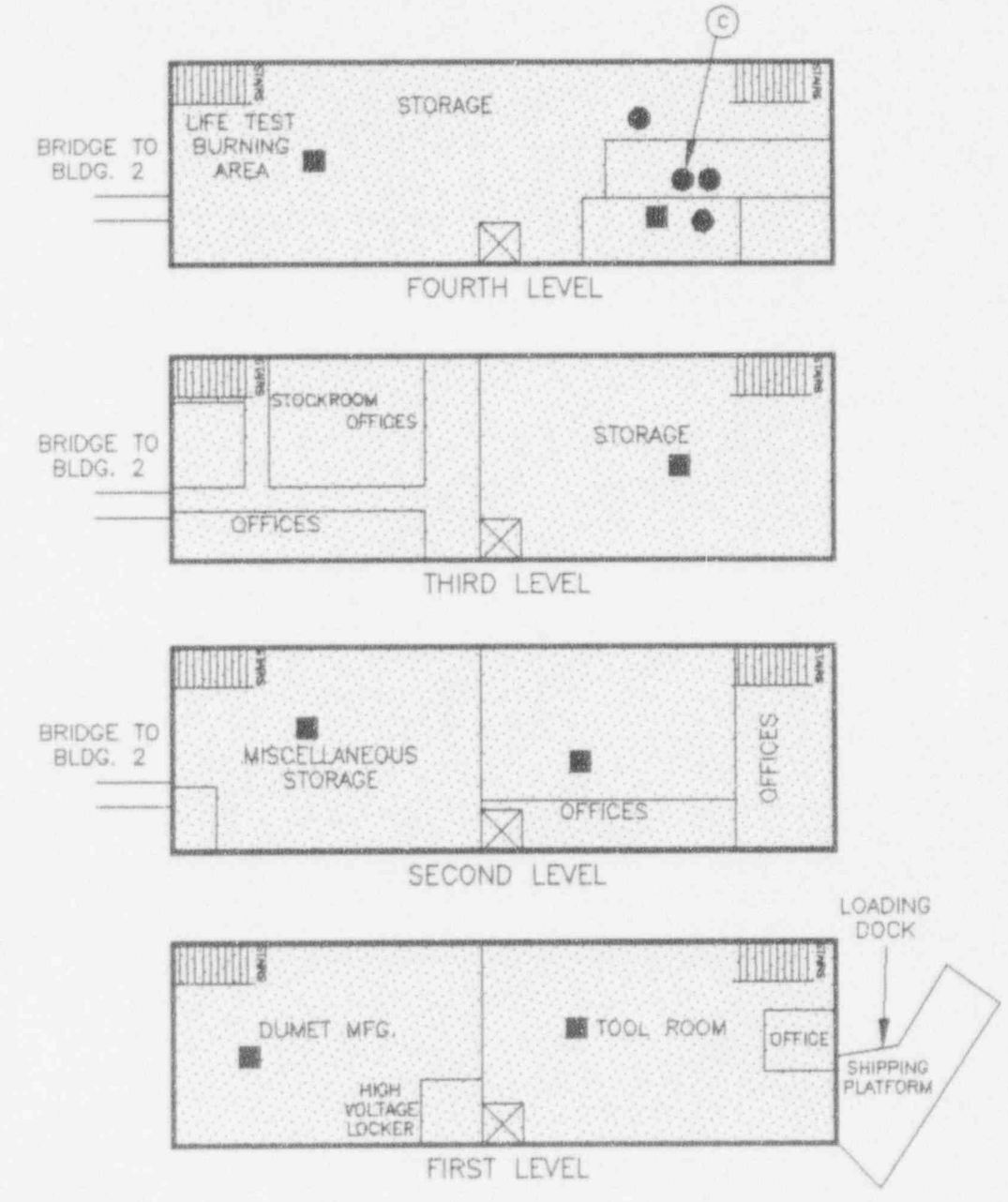

FIGURE 18: Building 5: Measurement and Sampling Locations

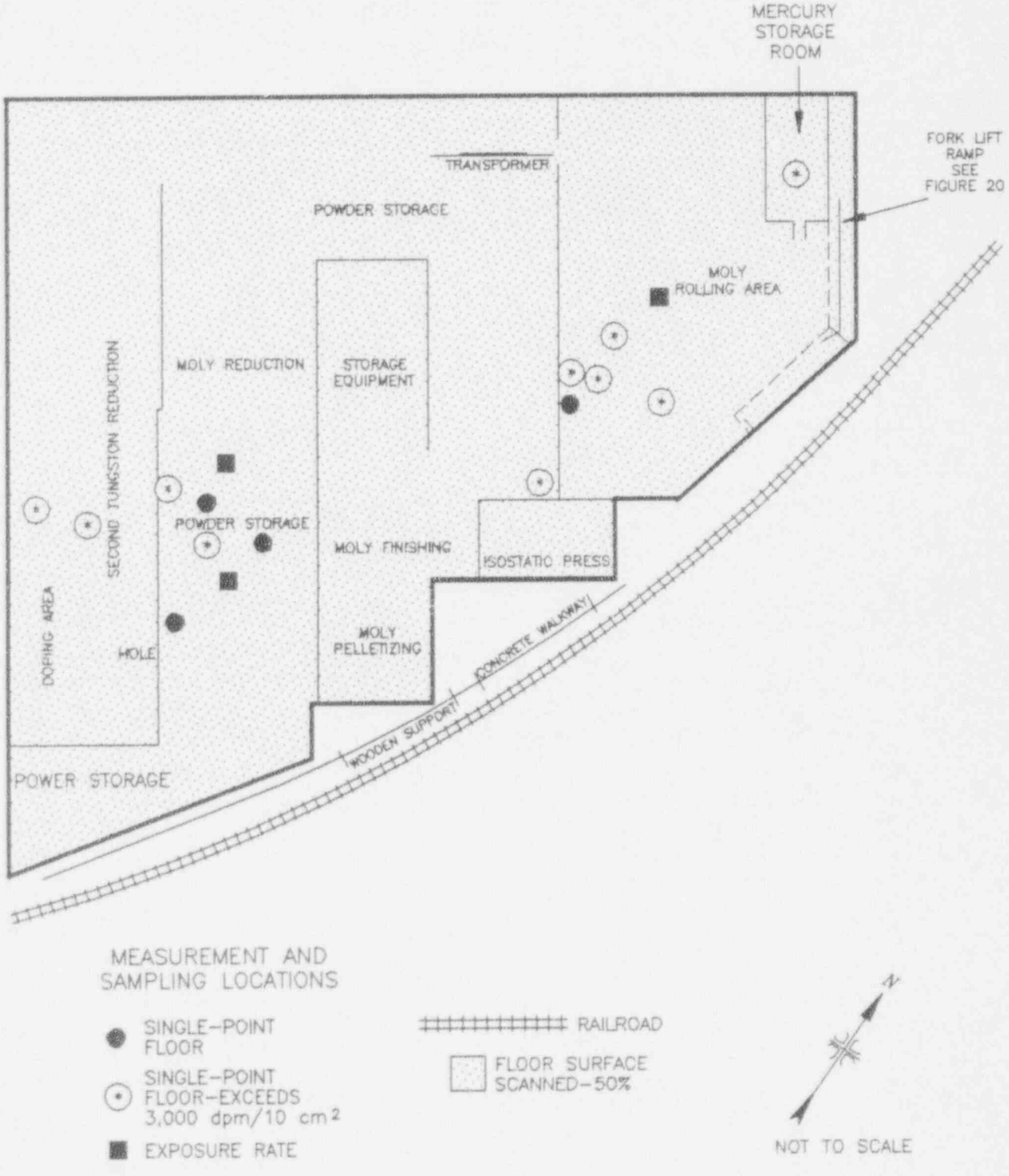

FIGURE 19: Building 6: Measurement and Sampling Locations

WEB11

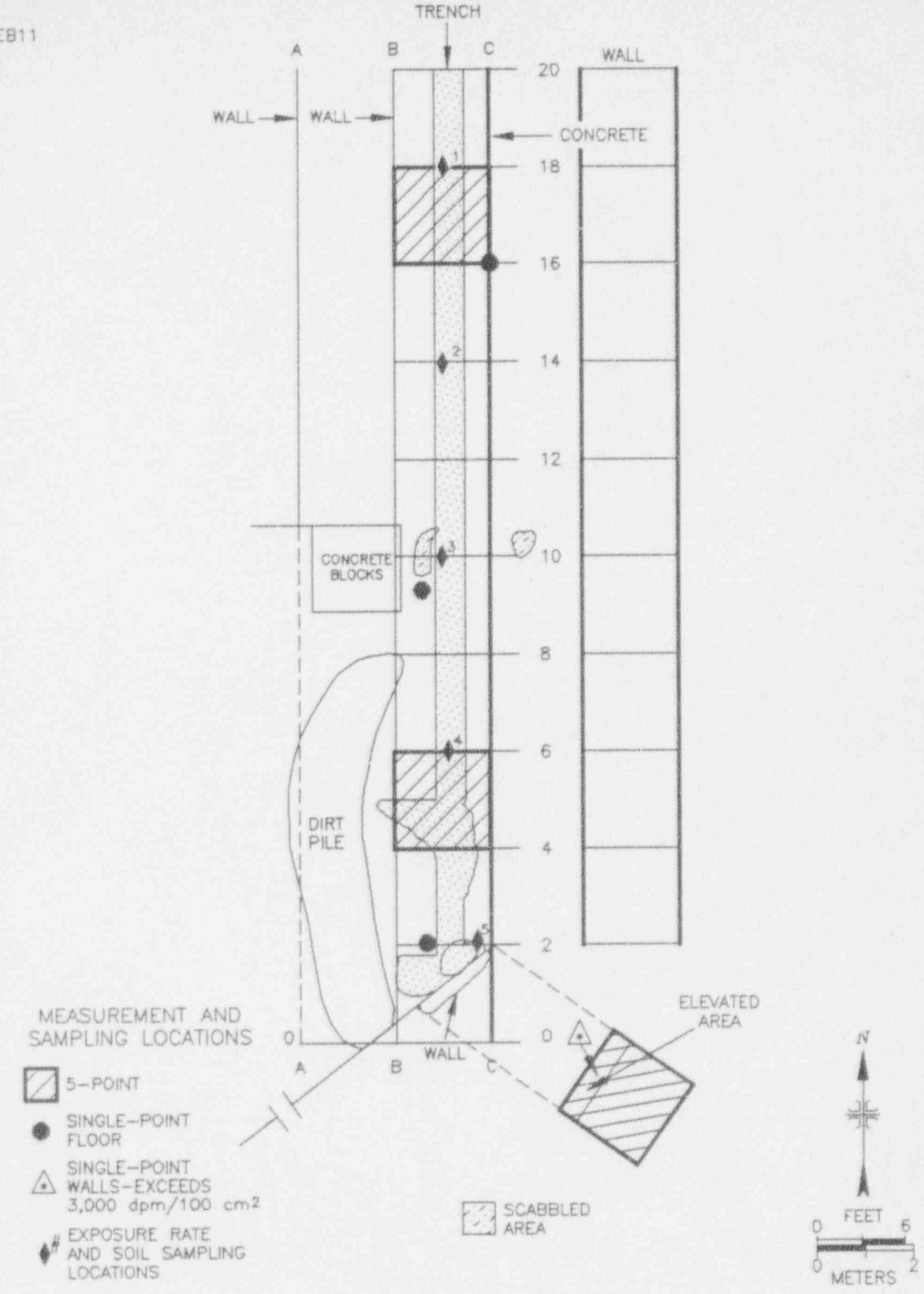

FIGURE 20: Building 6-Fork Lift Ramp Area: Measurement and Sampling Locations

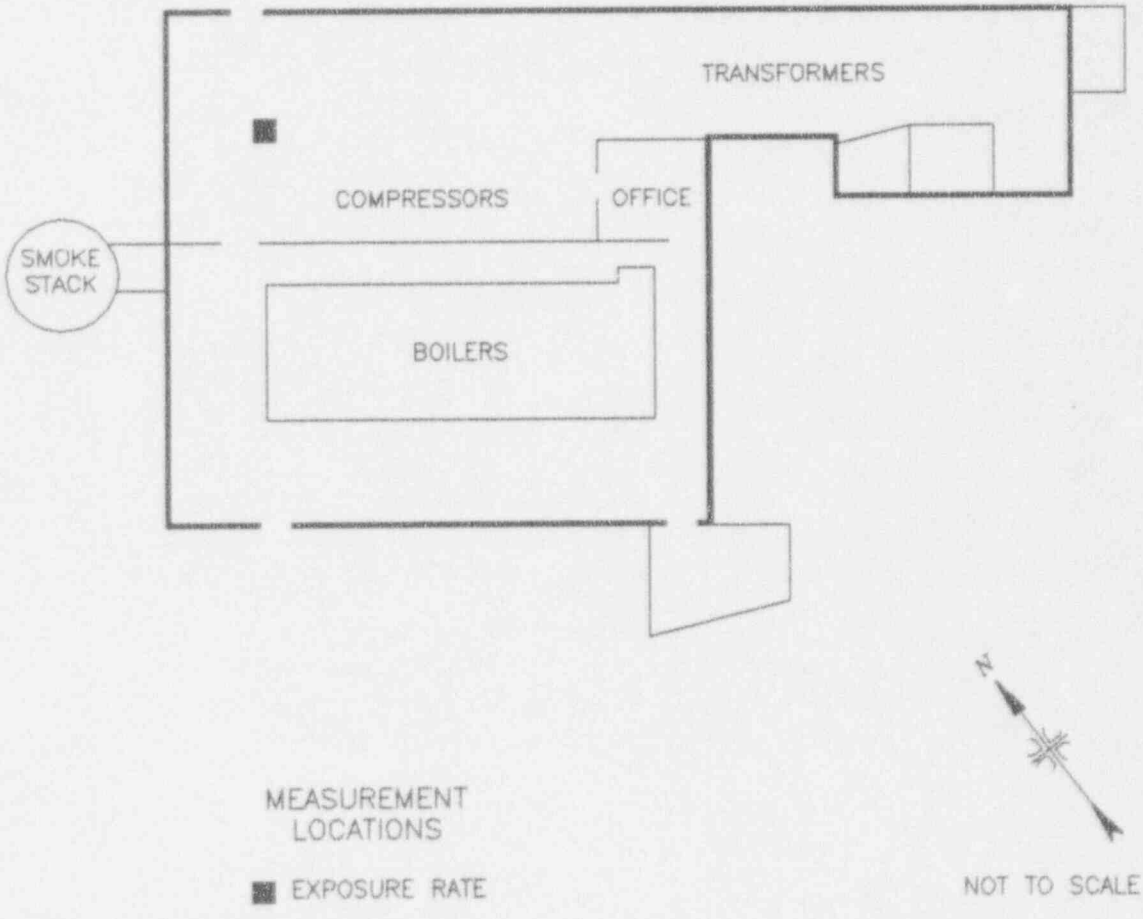

FIGURE 21: Building 11—Heat and Power: Measurement Location

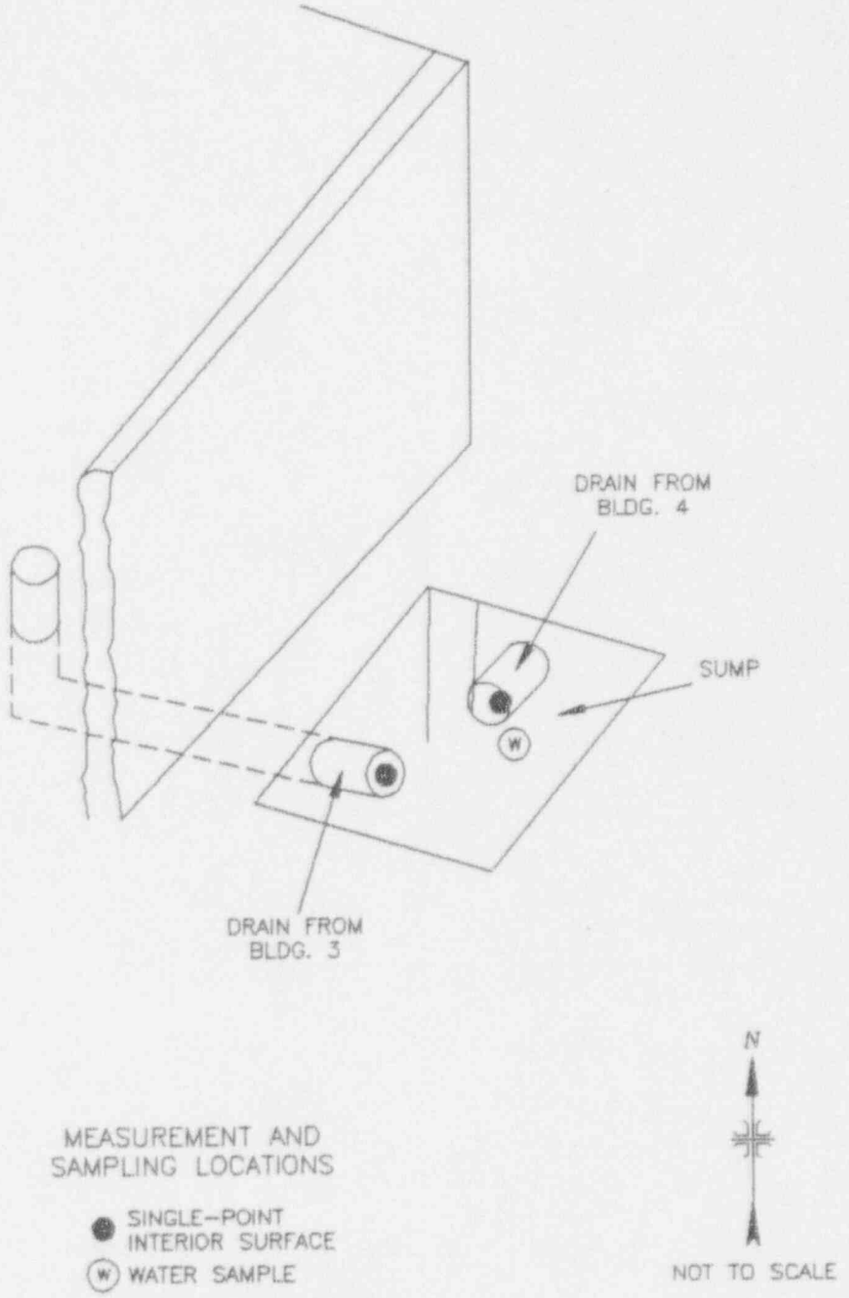

FIGURE 22: Sump–Southside of Building 3:
Measurement and Sampling Locations

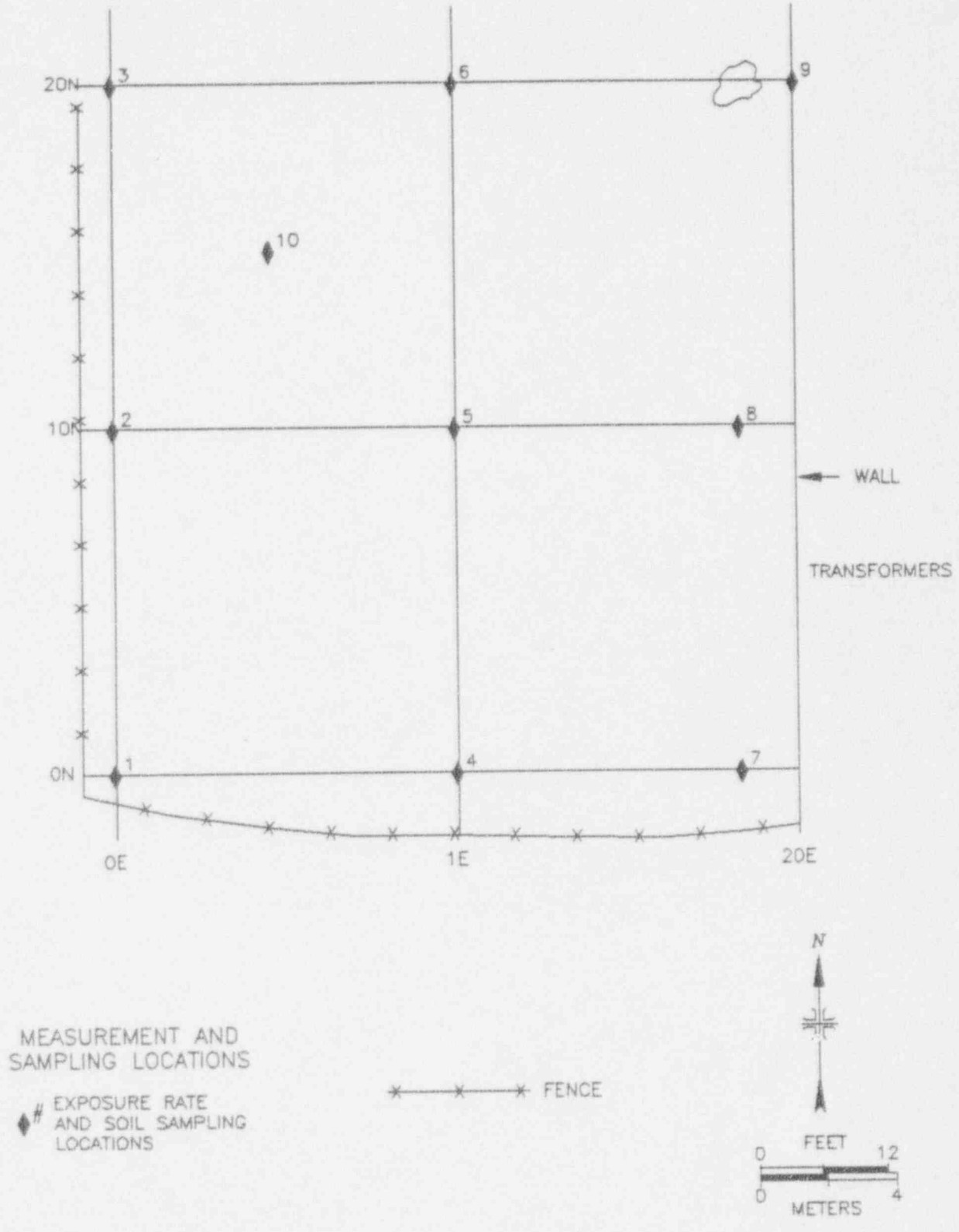

FIGURE 23: Reservoir: Measurement and Sampling Locations

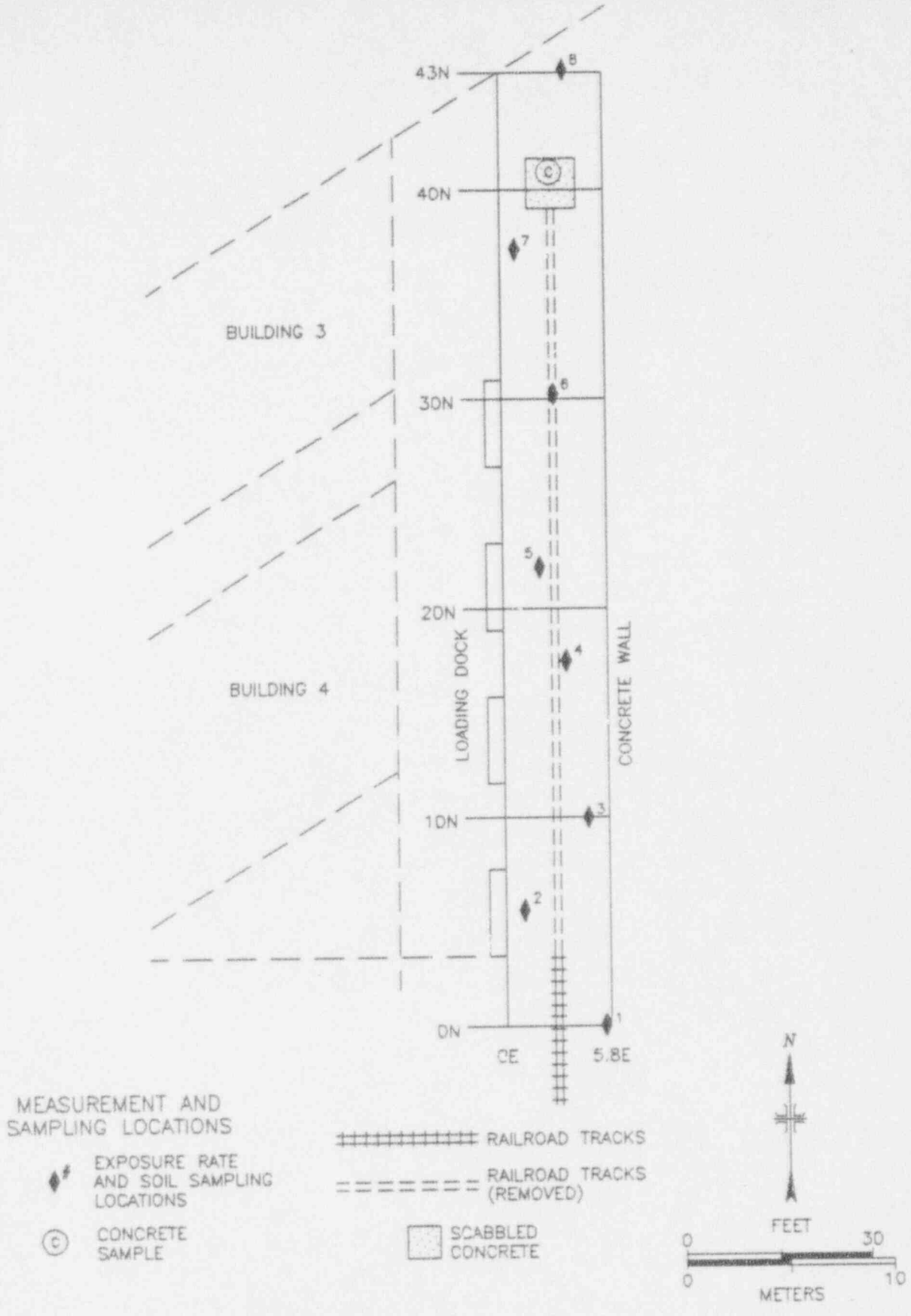

FIGURE 24: Rail Spur Adjacent to Buildings 3 and 4: Measurement and Sampling Locations

WEB15

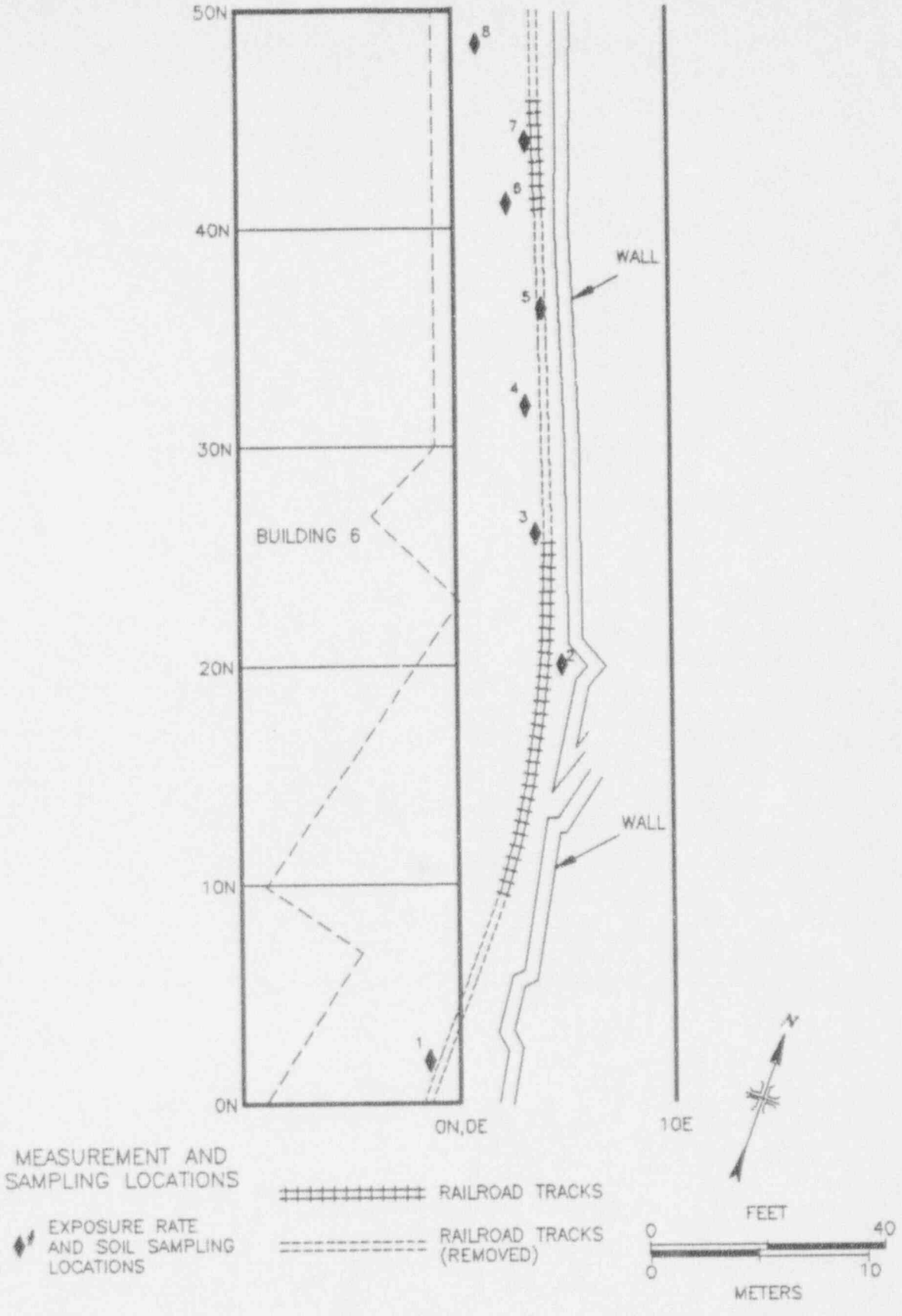

FIGURE 25: Railroad Spur Adjacent to Building 6: Measurement and Sampling Locations

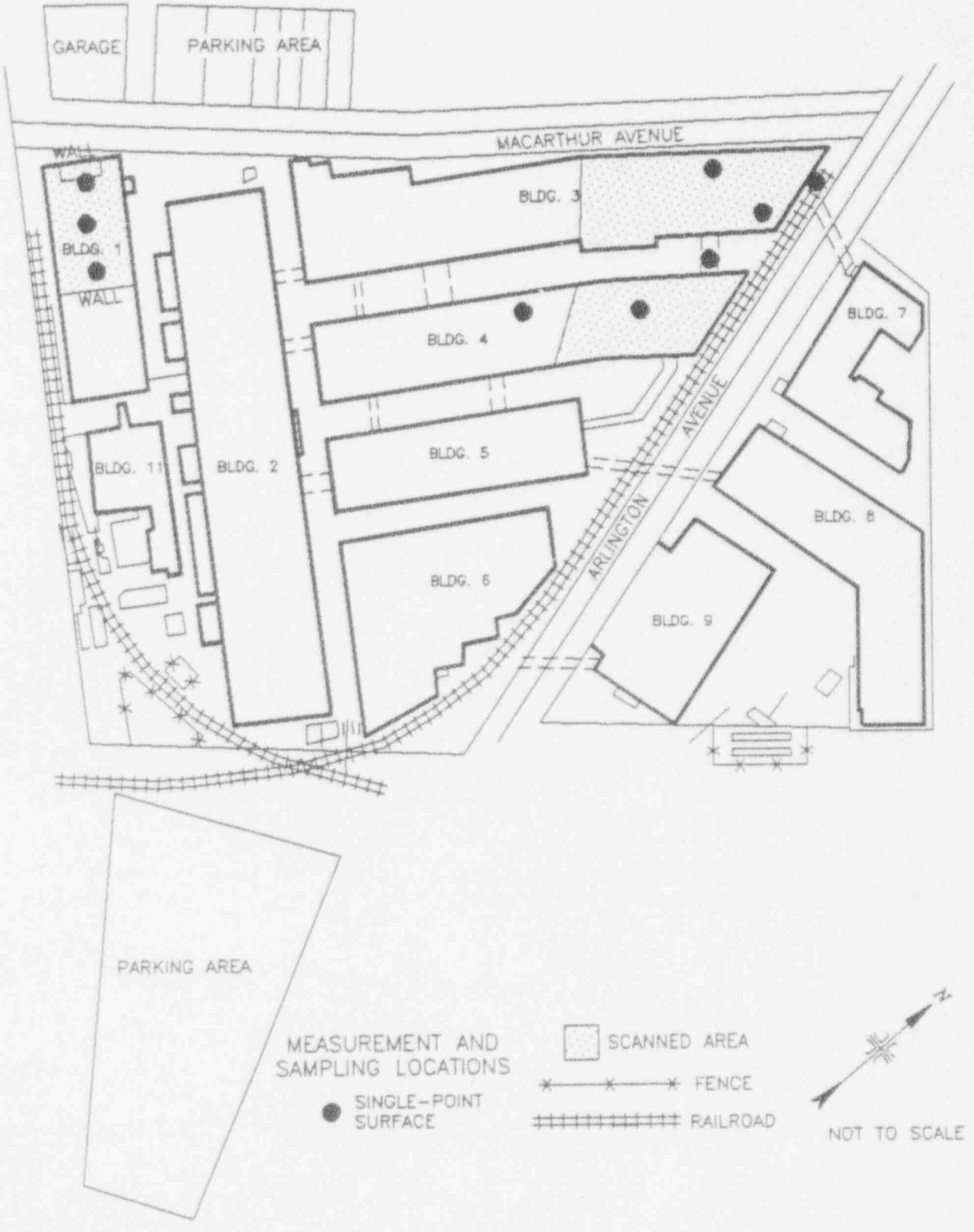

FIGURE 26: Rooftops: Measurement and Sampling Locations

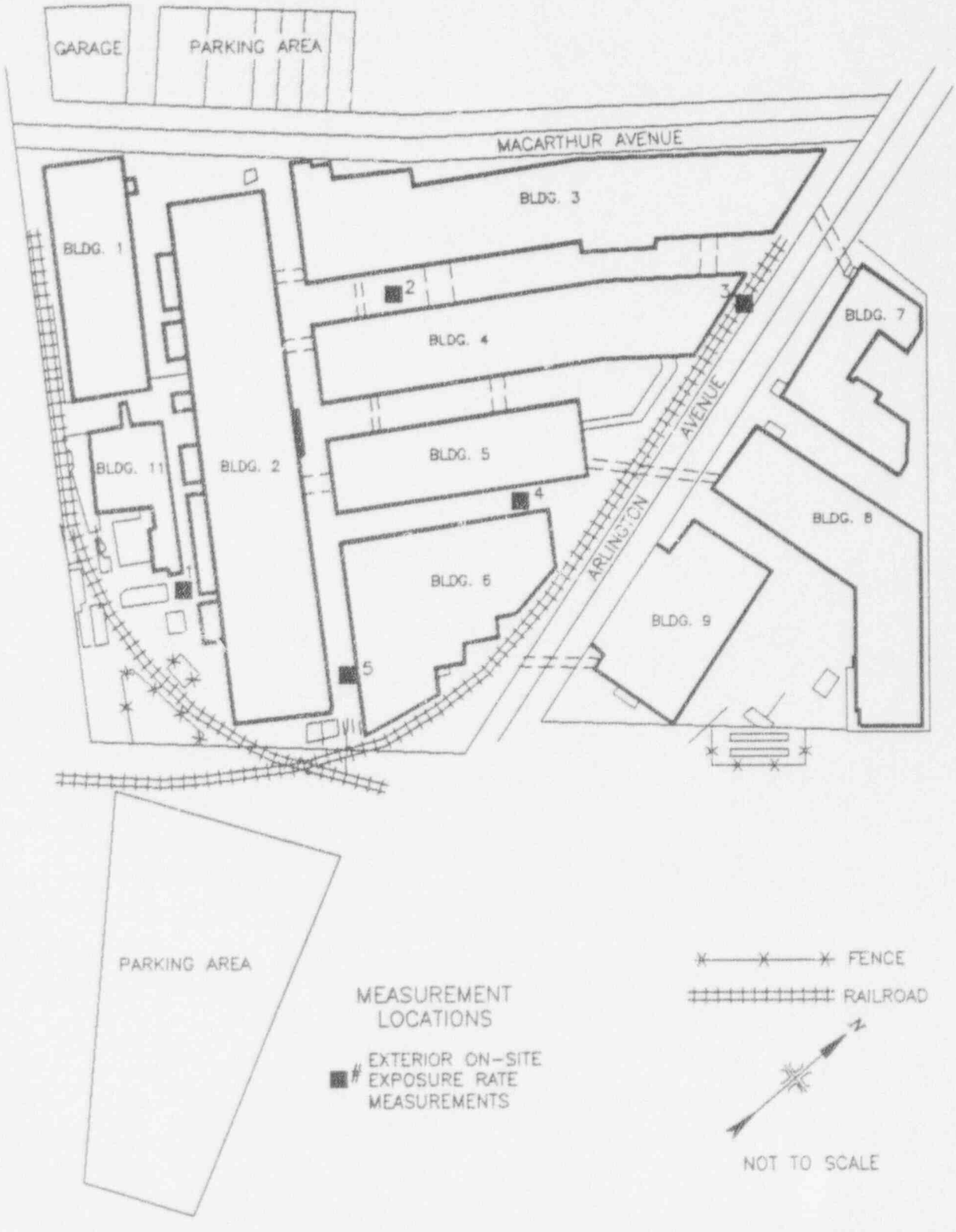

FIGURE 27: Exterior On-Site: Exposure Rate Measurement Locations

TABLE 1

ON-SITE INTERIOR BASELINE
EXPOSURE RATE MEASUREMENTS

Measurement Location[a]	Exposure Rate at 1 Meter Above Surface (μR/h)
1 - Building 1	9
2 - Building 2	8
3 - Building 3	7
4 - Building 4	9
5 - Building 5	8
6 - Building 11	9

[a]See Figure 6.

TABLE 2

OFF-SITE BASELINE EXPOSURE RATE MEASUREMENTS AND SOIL SAMPLES

Measurement Location[a]	Exposure Rate (μR/h) at 1 m Above Surface	Radionuclide Concentration (pCi/g)		
		U-238	Th-232	Ra-226
1 - Eagle Rock Reservation	8	2.3 ± 1.6[b]	0.9 ± 0.4	1.1 ± 0.3
2 - Watsessing Park	8	1.9 ± 1.7	0.7 ± 0.4	1.0 ± 0.3
3 - Vailsburg Park	10	1.6 ± 1.2	1.2 ± 0.4	0.7 ± 0.2
4 - Independence Park	11	1.9 ± 1.5	0.5 ± 0.3	0.9 ± 0.1
5 - West Hudson Park	8	2.9 ± 2.2	1.2 ± 0.3	1.1 ± 0.3
6 - Branch Brook Park	9	1.6 ± 1.3	0.9 ± 0.3	1.1 ± 0.2
7 - Ridge Ave - Polito Ave	8	2.1 ± 1.3	0.9 ± 0.4	0.7 ± 0.2
8 - Essex Park	9	<2.2	0.9 ± 0.4	0.8 ± 0.2

[a]See Figure 7.

[b]Uncertainties represent the 95% confidence level, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 3

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS

Building/ Figure	Location	# of Meas./or 5-Point Grid Blocks	Total Activity (dpm/100 cm^2)		Removable Activity		Radiological Contaminant
			Alpha Range	Beta Range	Alpha Range	Beta Range	
Garage/9	Basement	6[a]	<66-71	<1,020[b]	<6	<13	U-238
Building 1/ 10	First Floor	NDM[c]	---[d]	----	---	---	----
	Fifth Floor	NDM	----	----	---	---	----
Building 2/ 11	First Floor	5[a]	35-5,000	3,600-49,000	<6-140	<13-86	Unknown
	Second Floor	NDM	----	----	---	---	----
	Third Floor	NDM	----	----	---	---	----
Building 2/12	Second Floor - Blower Room	6[e]	<32-87	<240-660	<6	<13	Th-232
		1[a]	2,400	7,200	37	21	Th-232
Building 2/ 13	Second Floor - Moly Ribbon Room	6[a]	810-1,900	1,500-5,900	<6-17	<13-18	Th-232

TABLE 3 (Cont'd)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS

Building/ Figure	Location	# of Meas./or 5-Point Grid Blocks	Total Activity (dpm/100 cm^2)		Removable Activity		Radiological Contaminant
			Alpha Range	Beta Range	Alpha Range	Beta Range	
Building 3/ 14	First Floor	2[a]	140-2,000	14,000-170,000	<6-260	<13-330	U-238
	Second Floor	NDM	---	----	---	---	----
	Third Floor	1[a]	<32	59,000	<6	<13	U-238
	Fourth Floor	2[a]	78-87	5,100-7,300	<6	<13	----
Building 3/ 15	Third Floor Caustic Wash Area	3[c]	<32-83	<240-1,100[f]	<6	<13	Th-232
		3[a]	<32	<240-370	<6	<13	Th-232
Building 4/ 16	First Floor	1[a]	230	22,000	<6	<13	U-238 & Th-232
	Second Floor	2[a]	<32-120	1,500-3,300	<6	<13	U-238 & Th-232
	Third Floor	NDM	---	---	---	---	----
	Fourth Floor	NDM	---	---	---	---	----

TABLE 3 (Cont'd)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS

Building/ Figure	Location	# of Meas./or 5-Point Grid Blocks	Total Activity (dpm/100 cm^2)		Removable Activity		Radiological Contaminant
			Alpha Range	Beta Range	Alpha Range	Beta Range	
Building 4/ 17	Loading Dock	6[c]	<32-65	<190-920	<6	<13	U-238 & Th-232
		1[a]	100	3,600	<6	<13	U-238 & Th-232
		6[a]	<32-200	2,500-3,900	<6	<13	U-238 & Th-232
Building 5/ 18	First Floor	NDM	---	----	---	---	----
	Second Floor	NDM	---	----	---	---	----
	Third Floor	NDM	---	----	---	---	----
	Fourth Floor	4[a]	<32	<240-1,700	<6	<13	U-238 & Th-232
Building 6/ 19	Floor	14[a]	<90-7,600	<290-20,000	<6-17	<13	Th-232
Building 6/ 20	Fork Lift Ramp	3[c]	<32	<270-1,000	<6	<13	Th-232
		1[a]	250	19,000	<6	<13	Th-232
		3[a]	<32-57	540-820	<6	<13	Th-232

TABLE 3 (Cont'd)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS

Building/ Figure	Location	# of Meas./or 5-Point Grid Blocks	Total Activity (dpm/100 cm^2)		Removable Activity		Radiological Contaminant
			Alpha Range	Beta Range	Alpha Range	Beta Range	
Building 11/ 21	Floor	NDM	---	----	---	---	----
Building 3/ 22	Sump - Southside of Building 3	2[a]	<32-210	1,200-1,300	---	---	----
Building 3/ 24	Concrete Pad End of Railroad Spur Building 3	1[a]	<32	1,100	---	---	----
Building 1/ 26	Rooftop	3[a]	<32	<240-430	<6	<13	----
Building 3/ 26	Rooftop	3[a]	<32-65	<240-480	<6	<13	----
Building 4/ 26	Rooftop	3[a]	<32-35	<240-430	<6	<13	----

[a]Single-point direct measurement.
[b]Beta-gamma measurements obtained with "pancake" GM detector due to physical restrictions for using gas proportional detectors in this area.
[c]NDM - No elevated activity was determined from surface scans, therefore no direct measurements were taken.
[d]Dash indicates that measurements were not taken or radiological contaminant in the area is unknown.
[e]Five-point measurements.

TABLE 4
EXPOSURE RATES AND RADIONUCLIDE CONCENTRATIONS
FROM INTERIOR SOIL SAMPLES

Location/ Figure	Exposure Rate (μR/h)		Radionuclide Concentration (pCi/g)		
	1 meter	contact	U-238	Th-232	Ra-226
Garage Basement/9					
Water Service Pit	---[a]	---	16.8 ± 2.0[b]	1.0 ± 0.4	0.8 ± 0.2
Building 6 - Forklift Ramp/20					
1	11	20	4.4 ± 1.9	4.9 ± 0.7	0.9 ± 0.3
2	11	16	0.9 ± 0.9	0.8 ± 0.3	0.8 ± 0.2
3	11	11	<1.0	0.4 ± 0.2	0.4 ± 0.2
4	11	11	1.4 ± 1.3	1.2 ± 0.3	0.8 ± 0.2
5	11	29	4.4 ± 1.6	7.0 ± 0.7[c]	1.0 ± 0.3

[a]Dash indicates measurements not performed.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into the data.
[c]Exceeds 5 pCi/g above background.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN CONCRETE SAMPLES

Location/Figure	Radionuclide Concentrations (pCi/g)		
	U-238	Th-232	Ra-226
Building 4 - Loading Dock/17			
1	33[a] ± 13[b]	<6.4	2.2 ± 2.1
2	43.9[a] ± 7.7	<3.2	0.5 ± 0.8
Building 5 - Fourth Floor/18	<21	<8.4	<6.7
Railroad Spur - Building 3 & 4/24	12.9 ± 6.4	<4.4	1.0 ± 1.3

[a]Exceeds 17.5 pCi/g above background.

[b]Uncertainties represent the 95% confidence level, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into the data.

TABLE 6

ON-SITE INTERIOR EXPOSURE
RATE MEASUREMENTS

Measurement Location - Figure	Exposure Rate (μR/h) at One Meter Above Surface
Work Area Measurements[a]	
Garage - Figure 9	16
Building 1 - Figure 10	
First Floor	9
Fifth Floor	7
Building 2 - Figure 11	
First Floor	7
Second Floor	8
Third Floor	8
Building 3 - Figure 14	
First Floor	9
Second Floor	9
Third Floor	9
Fourth Floor	7
Building 4 - Figure 16	
First Floor	9
Second Floor	8
Third Floor	10
Fourth Floor	9
Building 5 - Figure 18	
First Floor	8
Second Floor	10
Third Floor	9
Fourth Floor	9
Building 6 - Figure 19	8
Fork Lift Ramp	
North End - Figure 20	29
Building 11 - Figure 21	8

[a]A work area is defined as an area where the radioactive material was used for manufacturing or for research and development. Office areas and break areas do not constitute work areas.

TABLE 7

EXPOSURE RATES AND RADIONUCLIDE CONCENTRATIONS
FROM EXTERIOR ON-SITE SOIL SAMPLES

Location/ Figure	Exposure Rate (μR/h)		Radionuclide Concentration (pCi/g)		
	1 meter	contact	U-238	Th-232	Ra-226
Reservoir/23					
1	9	9	5.0 ± 2.0*	3.0 ± 0.6	2.4 ± 0.5
2	11	13	7.5 ± 1.6	1.9 ± 0.8	3.5 ± 0.5
3	11	13	7.0 ± 1.9	1.9 ± 0.5	3.1 ± 0.4
4	9	9	2.0 ± 1.5	1.1 ± 0.4	0.7 ± 0.2
5	8	8	0.5 ± 0.6	0.3 ± 0.2	0.3 ± 0.1
6	8	8	1.9 ± 1.6	0.4 ± 0.3	0.5 ± 0.2
7	13	13	2.7 ± 1.0	1.2 ± 0.2	0.9 ± 0.2
8	11	11	1.1 ± 1.3	0.3 ± 0.2	0.4 ± 0.1
9	9	9	0.6 ± 0.7	0.7 ± 0.4	0.7 ± 0.2
10	9	9	<2.8	0.5 ± 0.3	0.6 ± 0.2

TABLE 7 (Cont'd)

EXPOSURE RATES AND RADIONUCLIDE CONCENTRATIONS
FROM EXTERIOR ON-SITE SOIL SAMPLES

Location/ Figure	Exposure Rate (μR/h)		Radionuclide Concentration (pCi/g)		
	1 meter	contact	U-238	Th-232	Ra-226
Railroad Spur - Bldg. 3 & 4/24					
1	11	10	9.0 ± 1.1	1.3 ± 0.4	1.4 ± 0.3
2	10	11	4.7 ± 2.3	1.6 ± 0.5	2.0 ± 0.4
3	11	13	8.3 ± 1.1	1.1 ± 0.4	1.7 ± 0.3
4	11	11	9.2 ± 2.8	1.5 ± 0.7	1.8 ± 0.4
5	12	13	7.1 ± 1.6	1.5 ± 0.5	1.9 ± 0.3
6	12	16	15.0 ± 3.6	1.5 ± 0.5	1.8 ± 0.3
7	10	16	24.9 ± 2.8[b]	1.6 ± 0.5	2.1 ± 0.4
8	10	12	19.6 ± 2.1[b]	1.2 ± 0.3	0.8 ± 0.2

TABLE 7 (Cont'd)

EXPOSURE RATES AND RADIONUCLIDE CONCENTRATIONS
FROM EXTERIOR ON-SITE SOIL SAMPLES

Location/ Figure	Exposure Rate (μR/h)		Radionuclide Concentration (pCi/g)		
	1 meter	contact	U-238	Th-232	Ra-226
Railroad Spur - Bldg. 6/25					
1	12	13	4.9 ± 2.5	11.0 ± 1.0[b]	1.3 ± 0.2
2	8	8	2.1 ± 2.5	0.9 ± 0.5	1.4 ± 0.4
3	12	12	5.6 ± 1.9	2.8 ± 0.7	1.4 ± 0.2
4	13	20	6.9 ± 2.5	3.7 ± 0.8	2.0 ± 0.3
5	10	12	6.3 ± 1.1	2.3 ± 0.5	2.1 ± 0.3
6	11	11	9.5 ± 3.6	5.1 ± 0.8	2.2 ± 0.4
7	9	10	1.8 ± 1.8	1.6 ± 0.5	1.8 ± 0.3
8	10	12	6.0 ± 4.4	1.7 ± 0.5	0.9 ± 0.3

[a]Uncertainties represent the 95% confidence level, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into the data.
[b]Exceeds 5 pCi/g above background.

TABLE 8

EXTERIOR ON-SITE EXPOSURE
RATE MEASUREMENTS

Measurement Location*	Exposure Rate (μR/h) at One Meter Above Surface
1	10
2	8
3	11
4	10
5	9

*See Figure 27.

REFERENCES

1. "Radiological Survey of the Westinghouse Electric Corporation/North American Phillips Corporation Facility at Bloomfield, NJ", Radiation Management Corporation, August 27, 1986.

2. "Decontamination Surveys for the Bloomfield Lamp Plant, Westinghouse Electric Corporation", Canberra Nuclear Services Division, May 1990.

3. "Proposed Confirmatory Radiological Survey Plan for Portions of the Westinghouse Electric Corporation Bloomfield Lamp Plant, Bloomfield, New Jersey", Environmental Survey and Site Assessment Program, Oak Ridge Associated Universities, March 6, 1991.

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

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

DIRECT RADIATION MEASUREMENT

Instruments

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

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

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

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

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

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

Ludlum Alpha-Beta Gas Proportional Detector
Model 43-37
(Ludlum, Sweetwater, TX)

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum, Sweetwater, TX)

Ludlum Alpha-Beta Gas Proportional Detector
Model 43-68
(Ludlum, Sweetwater, TX)

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

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

LABORATORY ANALYTICAL EQUIPMENT

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

High-Purity Germanium Coaxial Well Detector
Model GWL-110210-PWS-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield Model G-16
(Applied Physical Technology, Atlanta, GA)

Multichannel Analyzer
ND66/MicroVax
(Nuclear Data, Schaumburg, IL/Digital
Equipment, Maynard, MA)

APPENDIX B

MEASUREMENT AND ANALYTICAL PROCEDURES

APPENDIX B

MEASUREMENT 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. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. A large surface area, gas proportional floor monitor, with a 550 cm^2 sensitive area detector, was used to scan the floors of the surveyed areas. The detector was slowly moved in a systematic pattern to cover 10% of the accessible areas. Other surfaces were scanned using smaller, hand-held detectors. Combinations of detectors and instruments for the scans were:

Alpha/Beta	-	Gas Proportional Floor Monitor (550 cm^2) with Ludlum Model 2221 or Model 2220 ratemeters/scalers.
	-	Gas Proportional (100 cm^2) probes with Ludlum Model 2221 ratemeter/scaler.
Alpha	-	Gas Proportional (100 cm^2) probes with Ludlum Model 2221 ratemeter/scaler.
	-	Alpha scintillation detector (59 cm^2) with Ludlum Model 2221 ratemeter/scaler.
Beta-Gamma	-	Pancake GM probe (15 cm^2) with PRS-1 scaler/ratemeter.
Gamma	-	NaI scintillation detector (3.2 cm x 3.8 cm crystal) with PRM-6 ratemeter.

Alpha, Alpha/Beta, and Beta-Gamma Surface Activity Measurements

Measurements of total alpha activity levels were performed using Ludlum Model 2221 portable scaler/ratemeters with either Model 43-68 hand held gas proportional detectors (100 cm^2 face area) or Eberline Model AC-3-7 alpha scintillation detectors (59 cm^2 face area). Count rates (cpm) were converted to disintegration rates per 100 cm^2 by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. The background count rates for the gas proportional detectors and the alpha scintillation detectors averaged approximately 1 cpm.

Measurements of total beta-gamma activity levels were performed using Eberline Model HP-260 pancake GM detectors (15 cm^2 face area) with Eberline Model PRS-1 portable scaler/ratemeters. Measurements of total alpha plus beta surface activity were performed using Model 43-68 hand held gas proportional detectors (100 cm^2 face areas). 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. The background count rates for the proportional detectors and the pancake detectors averaged approximately 180 and 40 cpm, respectively.

As demonstrated by the results at this facility and consistent with past ESSAP experience, the alpha activity and gamma activity contributions to the total activity for an alpha plus beta calibrated gas proportional detector is only a small percentage of the total activity measured. Therefore, all activity measured with the alpha plus beta gas proportional detectors was predominantly due to the beta activity.

Removable Activity Measurement

Smears for determination of removable activity levels were performed using numbered filter paper disks, 47 mm in diameter; smears were placed in labeled envelopes with the location and other pertinent information recorded. The smears were 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 (PIC), Model RSS-111 or Eberline PRM-6 portable ratemeters with Victoreen Model 489-55 gamma scintillation probes. Count rates from the portable meters were converted to exposure rates (μR/h) by cross-calibrating with the PIC.

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 **
Th-232	0.911 MeV from Ac-228*
Th-228	0.583 MeV from Tl-208
Ra-226	0.609 MeV from Bi-214*

* Secular equilibrium assumed.

** Reviewed to confirm natural isotopic abundances.

Spectra were reviewed for other identifiable photopeaks at concentrations above those normally encountered in environmental media.

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 samples 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 procedures 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," February 1990, Revision 3; "Survey Procedures Manual," February 1991, Revision 6; the "Laboratory Procedures Manual," February, 1990, Revision 5; and, the "Laboratory Procedures Manual," April, 1991.

With the exception of the measurements conducted with the 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 a 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.

APPENDIX C

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BY-PRODUCT, SOURCE OR SPECIAL NUCLEAR MATERIAL

AND

GUIDELINES FOR RESIDUAL CONCENTRATIONS OF THORIUM AND URANIUM WASTES IN SOIL

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U.S. Nuclear Regulatory Commission
Division of Fuel Cycle & Material Safety
Washington, D.C. 20555

May 1987

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces or premises, equipment, or scrap which are likely to be contaminated, but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to special circumstances such as razing of buildings, transfer from premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

    a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

    b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle, Medical, Academic, and Commercial Use Safety, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instruction.

   Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclides[a]	Average[b,c,f]	Maximum[b,d,f]	Removable[b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

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

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

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

[e] 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 assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal Register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document establishes guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options			
	1[a]	2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	---	500
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200
Depleted Uranium:				
Soluble	35	100	---	1,000
Insoluble	35	300	---	3,000
Enriched Uranium:				
Soluble	30	100	---	1,000
Insoluble	30	250	---	2,500

[a] Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.

[b] Based on limiting individual dose to 170 mrem/yr.

[c] Based on limiting equivalent exposure to 0.02 working level or less.

[d] Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.