

**ORISE**  
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

November 30, 2005

Mr. Ron Bostic  
Rocky Flats Project Office  
U.S. Department of Energy  
10808 Hwy 93, Unit A  
Golden, CO 80403

**SUBJECT: CONTRACT NO. DE-AC05-00OR22750  
FINAL REPORT—VERIFICATION SURVEY OF THE FORMER  
BUILDING 374 CLOSURE PROJECT, ROCKY FLATS  
ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN, COLORADO**

Dear Mr. Bostic:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has prepared the final report for the former Building 374 Closure Project, Rocky Flats Environmental Technology Site in Golden, Colorado. Comments provided on the draft report have been incorporated into the final report.

Please contact me at (865) 576-5321 or Scott Kirk at (865) 574-0685 should you need additional information.

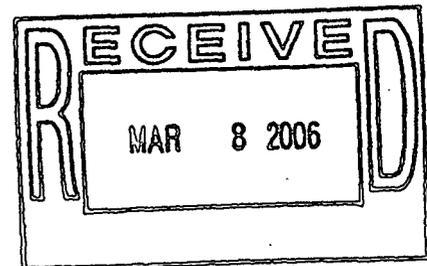
Sincerely,



Phyllis C. Weaver  
Health Physics/Project Leader  
Environmental Survey and  
Site Assessment Program

PW:db

cc: B. Wallin, K-H/RFETS  
E. Abelquist, ORISE/ESSAP  
S. Kirk, ORISE/ESSAP  
File/407



P. O. BOX 117, OAK RIDGE, TENNESSEE 37831-0117

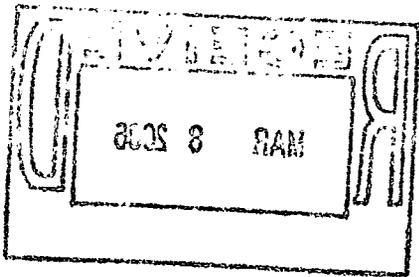
Operated by Oak Ridge Associated Universities for the U.S. Department of Energy



ADMIN RECORD

B371-A-000318

1  
65



The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities. Established in 1946, ORAU is a consortium of 91 colleges and universities.

#### NOTICES

The opinions expressed herein do not necessarily reflect the opinions of the sponsoring institutions of Oak Ridge Associated Universities.

This report was prepared as an account of work sponsored by the United States Government. Neither the United States Government nor the U.S. Department of Energy, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe on privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement or recommendation, or favor by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

**VERIFICATION SURVEY  
OF THE  
FORMER BUILDING 374 CLOSURE PROJECT  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

Prepared by

P. C. Weaver

Environmental Survey and Site Assessment Program  
Radiological Safety, Assessments and Training  
Oak Ridge Institute for Science and Education  
Oak Ridge, Tennessee 37831-0117

Prepared for the

Department of Energy

**FINAL REPORT**

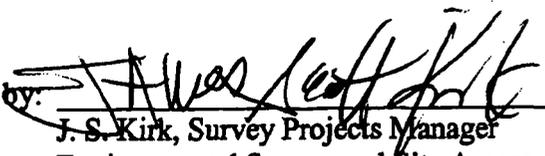
**NOVEMBER 2005**

This report is based on work performed under contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

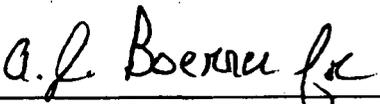
**VERIFICATION SURVEY  
OF THE  
FORMER BUILDING 374  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN COLORADO**

Prepared by:   
P. C. Weaver, Project Leader  
Environmental Survey and Site Assessment Program

Date: 11/22/05

Reviewed by:   
J. S. Kirk, Survey Projects Manager  
Environmental Survey and Site Assessment Program

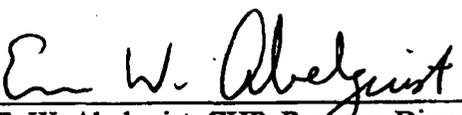
Date: 11/22/05

Reviewed by:   
A. T. Payne, Quality Manager  
Environmental Survey and Site Assessment Program

Date: 11/30/05

Reviewed by:   
R. D. Condra, Laboratory Manager  
Environmental Survey and Site Assessment Program

Date: 11/29/05

Reviewed by:   
E. W. Abelquist, CHP, Program Director  
Environmental Survey and Site Assessment Program

Date: 11/30/05

## **ACKNOWLEDGMENTS**

The author would like to acknowledge the significant contributions of the following staff members:

### **FIELD STAFF**

T. L. Brown  
T. D. Herrera  
A. L. Mashburn

### **LABORATORY STAFF**

R. D. Condra  
W. P. Ivey  
J. S. Cox

### **CLERICAL STAFF**

D. K. Boody  
K. L. Pond  
A. Ramsey

### **ILLUSTRATOR**

T. D. Herrera

## TABLE OF CONTENTS

	<u>PAGE</u>
List of Figures .....	ii
List of Tables .....	iii
Abbreviations and Acronyms .....	iv
Introduction.....	1
Site Description and Site History.....	2
Independent Verification Objectives .....	2
Document Review.....	3
Radiological Survey Procedures .....	3
Sample Analysis and Data Interpretation .....	5
Findings and Results .....	6
Comparison of Results With Guidelines.....	8
Follow-Up Actions and Conclusions .....	10
Figures.....	11
Tables.....	21
References.....	43
<b>Appendices:</b>	
Appendix A: Major Instrumentation	
Appendix B: Survey and Analytical Procedures	
Appendix C: Summary of Department of Energy Residual Radioactive Material Guidelines	

## LIST OF FIGURES

	<u>PAGE</u>
FIGURE 1: Location of the Rocky Flats Closure Site .....	12
FIGURE 2: Location of the 374 Building .....	13
FIGURE 3: Plot Plan of Building 374.....	14
FIGURE 4: DOP Area—Upper Walls and Ceiling—Measurement and Sampling Locations.....	15
FIGURE 5: Room 2804—Upper Walls and Ceiling—Measurement and Sampling Locations.....	16
FIGURE 6: Ground Floor Level—Lower Walls and Floor—Measurement and Sampling Locations.....	17
FIGURE 7: Ground Floor Level—Upper Walls and Ceiling—Measurement and Sampling Locations.....	18
FIGURE 8: Mezzanine—Lower Walls and Floor—Measurement and Sampling Locations.....	19
FIGURE 9: Basement Level—Measurement Locations .....	20

## LIST OF TABLES

	<u>PAGE</u>
TABLE 1: Surface Activity Levels—Room 2804 South Wall—Survey Unit 374017.....	22
TABLE 2: Surface Activity Levels—Room 2804 North, East, and West Walls—Survey Unit 374001 .....	23
TABLE 3: Surface Activity Levels—Room 2804 Upper South Wall—Survey Unit 374010.....	25
TABLE 4: Surface Activity Levels—Survey Unit DOP001.....	26
TABLE 5: Surface Activity Levels—Room 2801—Survey Unit DOP002.....	27
TABLE 6: Surface Activity Levels—Survey Unit 374002.....	28
TABLE 7: Surface Activity Levels—Survey Unit 374003.....	29
TABLE 8: Surface Activity Levels—Survey Unit 374004.....	30
TABLE 9: Surface Activity Levels—Survey Unit 374005.....	31
TABLE 10: Surface Activity Levels—Room 4802 Mezzanine—Survey Unit 374005 .....	32
TABLE 11: Surface Activity Levels—Survey Unit 374006.....	33
TABLE 12: Surface Activity Levels—Survey Unit 374008.....	34
TABLE 13: Surface Activity Levels—Survey Unit 374011.....	35
TABLE 14: Surface Activity Levels—In Excess of Guidelines .....	36
TABLE 15: Gamma Surface Activity Levels and Volumetric Concentrations—Survey Unit DOP001 .....	40
TABLE 16: Gamma Surface Activity Levels and Volumetric Concentrations — Survey Unit DOP002.....	41
TABLE 17: Gamma Surface Activity Levels and Volumetric Concentrations — Survey Unit DOP003.....	42

## ABBREVIATIONS AND ACRONYMS

cm	centimeter
cm <sup>2</sup>	square centimeter
cpm	counts per minute
DCGL	derived concentration guideline level
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOP	decommissioning operations plan
dpm/100 cm <sup>2</sup>	disintegrations per minute per 100 square centimeters
DQO	data quality objectives
ESSAP	Environmental Survey and Site Assessment Program
FIDLER	field instrument for the detection of low-energy radiation
ITP	Intercomparison Testing Program
IV	independent verification
IVPP	independent verification project plan
IVT	independent verification team
JHA	job hazard analysis
KeV	Kilo electron Volt
K-H	Kaiser-Hill Company
m	meter
m <sup>2</sup>	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
mm	millimeter
MeV	million electron volts
mrem/yr	millirem per year
nCi/g	nanocuries per gram
NIST	National Institute of Science and Technology
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PSP	project specific plan
PDS	pre-demolition survey
PDSR	pre-demolition survey report
RA	remedial action
RFETS	Rocky Flats Environmental Technology Site
RFPO	Rocky Flats Project Office
PRA	Post-remedial action
TSA	total surface activity
ZnS	zinc sulfide

**VERIFICATION SURVEY  
OF THE  
FORMER BUILDING 374 CLOSURE PROJECT  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

**INTRODUCTION**

The Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), selected the Rocky Flats site in 1951 to serve as a nuclear weapons component production facility. Production began in 1952 on both nuclear and non-nuclear components with the plutonium pits being the key component. Uranium and beryllium were also utilized in the production of various components and processes. Operations continued until 1989 when environmental and safety concerns temporarily halted operations. There were over 700 structures, such as process and support buildings that were involved in the site's mission. In 1993, the production mission was permanently ended and a new mission to cleanup the site by 2006 was initiated. The site has since been renamed as the Rocky Flats Environmental Technology Site (RFETS).

Kaiser-Hill Company, L.L.C. (K-H), is the DOE contractor responsible for closure of the RFETS by the year 2006. To meet the closure goal, K-H characterized, remediated, performed pre-demolition surveys (PDS), and demolished each building at the site. This process has been completed for the Building 374 and the associated 3813 Dock Area.

The DOE's Rocky Flats Project Office (RFPO) has the responsibility for oversight of closure at RFETS. The RFPO requested the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) to: (1) conduct independent verification (IV) assessments in the former Building 374 of those surfaces to which the criteria for free release was applicable and (2) evaluate surfaces that will remain after building demolition located at six feet below the final finish grade.

## SITE DESCRIPTION AND SITE HISTORY

The RFETS is located approximately 16 miles northwest of Denver, Colorado on State Highway 93 and Cactus Road. RFETS occupies approximately 385 acres within the 6,000-acre DOE reservation site (Figure 1). The site was divided into two major operable units: the Industrial Area and the Buffer Zone (Figure 2). All nuclear facilities at the site were within the boundaries of the Industrial Area.

Building 374 was designed and constructed in the 1970s in association with Building 371 to replace the plutonium pit assembly and pyrochemical operation in Building 776/777 and the residue and waste operations in Building 771/774. In 1981, the primary mission for these facilities was suspended with the exception of waste operations (K-H 2003). Building 374 was located adjacent to the east side of Building 371 and constructed of reinforced concrete. The building consisted of three levels: a main or first floor, mezzanine, and basement (Figure 3). Building 374 primarily housed tanks for receiving and storing liquid process wastes, a drum handling and storage area, and building support and mechanical equipment and utility area. The 3813 Dock was a later addition on the east end of 374 that was used for shipping and receiving miscellaneous waste and equipment from on-site processes (K-H 2004a). Building 374 was designated as a Type 3 facility.

## INDEPENDENT VERIFICATION OBJECTIVES

The primary objective for independent verification survey of Building 371 was to implement the data quality objectives (DQO) as defined in the independent verification program plan (IVPP) to evaluate the pre-demolition survey (PDS) efforts in Building 374 against the applicable guideline criteria (ORISE 2004a). Specifically, the IVT collected total surface activity measurements, smear samples for removable activity, and direct gamma measurements to determine the adequacy of the Decontamination and Decommissioning (D&D) contractor's compliance with the objectives stated in the approved project-specific pre-demolition survey plan (ORISE 2004b).

## DOCUMENT REVIEW

Document reviews of the contractor's PDS plans, sampling plans, and Pre-Demolition Survey Report (PDSR) supporting data were conducted by ESSAP. This documentation was used to develop the ESSAP project-specific survey plan, as well as assess and validate the overall results reported by K-H (ORISE 2004b).

A Type A review was implemented to evaluate the PDSR for the Building 374 3813 Dock. The review generated comments concerning inconsistencies in the presentation of the data as it related to subject documentation for survey methodology and survey results (ORISE 2004c). The overriding issue was a misapplication of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance protocol in the classification or the non-reclassification of survey units based on sampling results (e.g., reclassification of a Class 2 area to Class 1 when contamination in excess of the DCGLs identified in the area). However, K-H took exception to the MARSSIM guidance based on the requirements in the site-specific Pre-Demolition Survey Plan.

The PDSR of the Building 374 interior was reviewed prior to Building 374 demolition which indicated that the levels of contamination identified during the characterization were remediated successfully to meet the guidance for unrestricted release (K-H 2005a). Furthermore, the PDSR indicated that scans, as well as direct measurements (statistically determined per MARSSIM protocol), were less than the derived concentration guideline levels (DCGLs) for free release (K-H 2003).

## RADIOLOGICAL SURVEY PROCEDURES

Survey activities were conducted in accordance with a project-specific plan and supplemented by the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2004b d, and e). Site verification activities were performed during the period of January 17 through January 20, 2005. Verification surveys included low-energy gamma surface scans, alpha surface scans, and surface activity measurements. Instrumentation included a field instrument for the detection of low-energy radiation (FIDLER), gas proportional, dual phosphor and zinc sulfide

(ZnS) scintillator detectors coupled to ratemeter-scalers with audible output. Verification surveys were performed in each of the six Class 1 survey units and in seven Class 2 survey units.

#### **REFERENCE GRID**

The IVT used the survey unit reference system established by the D&D contractor to identify measurement locations. Measurement locations were documented on detailed survey maps and/or photographic records.

#### **SURFACE SCANS**

Alpha surface scan coverage for Class 1 survey units ranged from 75 to 100 percent in accessible areas and for Class 2 survey units, 25 to 75 percent of the accessible areas were surveyed. A lower percentage of scans (approximately 5 to 10 percent), were performed on overhead and upper surfaces. Scans were concentrated on areas such as ledges, support beams, and around penetrations or other openings through the ceiling. Gas proportional detectors or dual phosphor detectors coupled to ratemeter-scalers with audible indicators were used to perform alpha scans. Locations of elevated radiation were marked and identified for further investigation. Scans focused on areas such as ledges, support beams, and around penetrations or other openings through the ceiling

Gamma scans were performed over ninety percent of accessible floor areas in the DOP001, DOP002, and DOP003 survey units. All DOP units consisted of the concrete slab that remained after building demolition greater than six feet below final grade. Gamma scans were performed using a low-energy photon FIDLER detectors coupled to ratemeters with audible indicators. Any location identified during the scan was identified for further investigation.

#### **SURFACE ACTIVITY MEASUREMENTS**

Total surface activity (TSA) measurements for alpha activity were performed at 174 randomly selected and judgmental locations (Figures 4-8). At the request of DOE, two of the 174 measurements were obtained from the inlet and outlet of the filter plenum in DOP001 (Figure 4). When determined appropriate, a five-point measurement was made in the contiguous 1 m<sup>2</sup> area surrounding the location of elevated direct radiation to determine area average activity

levels. TSA measurements were performed using gas proportional detectors or dual phosphor detectors coupled to ratemeter-scalers. A smear sample was collected at random and judgmental TSA measurement locations to determine the presence of any removable surface activity were selected.

Gamma surface measurements were performed to determine if the remaining building floor slab (at greater than six feet below final grade) would meet the surficial radionuclide concentration criteria. Thirty-one gamma surface activity measurements were obtained on the floor in survey units DOP001 through DOP003 (Figure 9). Gamma surface activity measurements were performed with the FIDLER detector coupled to a ratemeter-scaler.

#### **MEDIA SAMPLES**

Based on the identification of an area of elevated activity by ESSAP, K-H collected one media sample, constituting a 100 cm<sup>2</sup> stamp of concrete, from the west wall in Room 2804 survey unit (SU) 374001 in an area where a spill had occurred during the D&D process. The sample was collected to determine whether or not the contaminant was entrained in the concrete matrix. K-H obtained a gamma spectrum of the sample and followed up by decontaminating the location.

#### **SAMPLE ANALYSIS AND DATA INTERPRETATION**

Smears were returned to the ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Analysis of smear samples was performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 2004f). Smear samples were analyzed for gross alpha activity using a low-background proportional counter. The results of field measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm<sup>2</sup>).

Direct alpha surface activity measurements were calculated based on an alpha efficiency as specified in ESSAP procedures (which are based on ISO-7503). ESSAP performs a  $2\pi$  calibration, and multiplies that value by the surface efficiency, that results in total efficiency that is a  $4\pi$  value.

Total gamma surface activity measurements were used to estimate the concentration of isotopic plutonium based on the Am-241 to Pu-239 ratio of 1:8. The radionuclide of concern for

Building 374 is 35 year old weapons grade plutonium (Pu-239/240). Gamma surface activity measurements were converted to units of nanocuries per gram (nCi/g) based on the calculation approach adapted from K-H (K-H 2005b). Additional information concerning major instrumentation, sampling equipment, calculation variables, and analytical procedures is provided in Appendices A and B.

Total and removable activity results presented in Tables 1 to 13 were compared to the following DOE Order 5400.5 surface activity guidelines (DOE 1993 and 1995):

Total Activity

100  $\alpha$  dpm/100 cm<sup>2</sup>; 1,000  $\beta$  dpm/100 cm<sup>2</sup>, averaged over a 1 m<sup>2</sup> area  
300  $\alpha$  dpm/100 cm<sup>2</sup>; 3,000  $\beta$  dpm/100 cm<sup>2</sup>, maximum in a 100 cm<sup>2</sup> area

Removable Activity

20  $\alpha$  dpm/100 cm<sup>2</sup>; 200  $\beta$  dpm/100 cm<sup>2</sup>

The concrete slab basement floor will remain in place at six feet below the final grade as indicated by survey results. Gamma surface activity measurements obtained by ESSAP were compared to the 100 nCi/g average surface (defined as 0 to 1 cm concrete depth) activity over 1 m<sup>2</sup> (K-H-2004b).

## FINDINGS AND RESULTS

### DOCUMENT REVIEW

ESSAP reviewed various documents pertaining to the closure of Building 374. ESSAP's review of the PDS Plan and Decommissioning Operations Plan (DOP), determined that the PDS was conducted in accordance with specified procedures (K-H 2005). Comments were provided for K-H to consider. A Type A letter report was prepared by ESSAP of the PDS Plan for Room 3813 Dock (ORISE 2004c). Conclusions reached by ESSAP from data cited in the PDS Plan for the 3813 Dock, indicated that the site release guidelines were met based on survey results and historical usage of the area.

## **SURFACE SCANS**

Alpha scans were conducted to evaluate the potential for fixed activity. Alpha surface scans conducted in areas within the 6 feet above final grade (unrestricted release limits) resulted in a range of activity from 0 to 1,100 cpm. The highest alpha activity of 1,100 cpm was identified on a piece of support metal along the north wall in Room 2804 (Survey Unit 374001). Scans in 374003 (Class 2 area) identified several locations above the maximum guidelines. Further investigation by the IV team noted that many of the horizontal surfaces had not been wiped down as required. In the DOP areas 001 and 002, scans identified one area along the upper south wall of DOP002 (Room 2801) with TSAs ranging from 460 to 1,100 dpm/100 cm<sup>2</sup>. Smears were collected to determine if removable activity would be significant and whether or not further investigation would be needed.

Gamma surface scan results for the DOP areas ranged from 2,400 cpm to 13,000 cpm with the highest levels detected in the two sumps located in DOP003 (Room 2804). Water had to be pumped from the sumps and the surface wiped down prior to obtaining actual measurements.

## **SURFACE ACTIVITY MEASUREMENTS**

TSA measurements are reported in Tables 1 to 13. After the removal of a piece of metal support, the activities ranged from -14 to 8,000 dpm/100 cm<sup>2</sup>. Of the 174 measurements, twenty-six measurements (15 percent) exceeded the 300 dpm/100 cm<sup>2</sup> maximum guideline. Areas with the highest total activity measurements were detected in Survey Units 374001 (Room 2804 along the north and west wall) and on the floor of Survey Units 374002 and 374006.

Five-point measurement evaluations were performed at fifteen locations to determine 1 m<sup>2</sup> average activity levels at locations that exceeded the average activity (Table 14). The average activity ranged from 40 to 330 dpm/100 cm<sup>2</sup>. Eleven of the fourteen locations (78 percent) exceeded the average of 100 dpm/100 cm<sup>2</sup>. Measurements for total alpha obtained in the DOP001 and DOP002 survey areas identified three locations having surface activity exceeding the hot spot criteria. Each location was smeared and re-measured to determine if contamination exceeded removable activity guideline levels. Removable alpha activity ranged from

0 to 80 dpm/100 cm<sup>2</sup>. The 80 dpm/100 cm<sup>2</sup> activity that exceeded the removable criteria was collected from the inlet side of the filter plenum in DOP001.

Surface activity measurements on the concrete slab in DOP areas 001 through 003 were compared to a field action level of 250,000 cpm that is roughly equivalent to the 100 nCi/g surface activity averaged over 1 m<sup>2</sup> of the first centimeter of concrete depth (K-H 2003). Measurements for surface gamma activity are presented in Tables 15-17. In Survey Units DOP001, DOP002, and DOP003, the activities ranged from 2,400 to 13,000 cpm (0.35 to 2.34 nCi/g), with the highest activity identified in the east and west sumps of DOP003 which measured 6,800 and 13,000 cpm, respectively (Table 17).

### **COMPARISON OF RESULTS WITH GUIDELINES**

Verification survey data results are compared with the DOE-approved site-specific release criteria. Measurements exceeding the guidelines were identified in several survey units throughout the building. Survey units that had measurements exceeding guidelines for the free release of materials are provided in Table 14. The area having the greatest number of locations above the average and maximum release criteria were identified on the ground level in Survey Units 374002 through 374006. Measurements ranged from 0 to 1,900 dpm/100 cm<sup>2</sup> in these survey units with the majority of contamination detected on the floor of survey unit 374002. Forty-two measurement locations in Survey Units 374002 through 374004 and 374006 exceeded the guidelines in which, twenty (40 percent) of these exceeded the maximum of 300 dpm/100 cm<sup>2</sup>. However, no removable activity above the guideline was identified. DOE and K-H were notified of the findings.

In two survey units located on the Mezzanine level (374005 and 374008) of Building 374, scans identified two locations for additional investigation. Static measurements were taken and both exceeded the maximum TSA guideline at 300 and 330 dpm/100 cm<sup>2</sup>, respectively. No measurable removable activity was identified. DOE and K-H were notified of the findings.

In the north truck bay area (Survey Unit 374011), the IVT identified one location that exceeded the maximum TSA guideline. A five-point measurement in the contiguous square meter area

resulted in an average activity of 300 dpm/100 cm<sup>2</sup> that still exceeded the average guideline. No removable activity above the guideline was identified. DOE and K-H were notified of the findings.

TSA measurements were obtained in Survey Units DOP001, DOP002, 374001, 374010, and 374017 (all in Room 2804) were primarily from upper wall and ceiling locations. All DOP TSA measurements were on surfaces that were above the final finish grade of the building which were subject to free release guideline criteria. One location in the DOP001 survey unit and three locations in the DOP002 survey unit exceeded the maximum TSA guideline. The one TSA measurement exceeding the guideline in DOP001 was obtained from a plenum housing. The removable activity (80 dpm/100 cm<sup>2</sup>) exceeded the guideline. The three locations identified in the DOP002 were found on a metal beam just below grating from the ground level floor. No removable activity above the guideline was found.

Fifty-eight measurements were collected in Survey Units 374001, 374010, and 374017. These units were subject to the free release guideline criteria for surfaces that were greater than six feet above the final grade. Of the fifty-eight measurements, two exceeded the maximum hot spot guideline criteria of 300 dpm/100 cm<sup>2</sup>. The higher of the two was 8,000 dpm/100 cm<sup>2</sup> identified on a metal bracing. This location was also one of only two that had removable activity greater than 20 dpm/100 cm<sup>2</sup>. Four TSA measurement locations in Survey Unit 374001 exceeded the average guideline criteria. Two of the measurement locations (11 and 12) were remediated by K-H and the IVT re-evaluated the locations. The post-remediation results included both locations within the same 1 m<sup>2</sup> area and were averaged. The final result met the average guideline criteria.

Gamma surface activity measurements were performed in the DOP survey units to determine if the remaining radionuclide concentration in the building slab would meet the surface criteria of 100 nCi/g. Measurements ranged from 2,400 cpm to 13,000 cpm with a calculated activity of 0.35 to 2.34 nCi/g, well below the concentration guidelines.

## FOLLOW-UP ACTIONS AND CONCLUSIONS

DOE and K-H were notified of all locations that exceeded TSA guideline criteria measurements. The survey effort identified numerous locations that did not meet the established guideline criteria for the free release of surfaces above six feet below final grade. The majority of measurement locations that exceeded the release guideline criteria was determined to be on the floor and lower walls in Survey Units 374002 and 374004. In Survey Unit 374001, the highest activity exceeding the release criteria was found on a ledge on the west wall and another hot spot along the north side of the wall. These two locations were immediately decontaminated to acceptable levels by K-H. Five locations were identified in Survey Unit 374003 along the I-beams and horizontal surfaces of the duct work, as well as four from the upper walls in Survey Unit 374001 (Room 2804).

All locations that exceeded either the average or maximum guideline release criteria were discussed and walked-down by DOE and K-H prior to ESSAP demobilizing from the site. Per the direction of DOE, all locations with levels of radioactivity above the release criteria were remediated by either removing the material and equipment or by wiping down the surface. Most of the decontamination of identified locations was conducted after ESSAP had demobilized. Therefore, the K-H post-remediation measurement results were provided to DOE for ESSAP's review (DOE 2005a and b). The results indicated that the total surface activity was reduced to levels less than release guidelines (DOE 2005a). DOE investigated the reported observations and subsequently confirmed that aggressive measures were used to remediate remaining radioactivity above the guideline criteria.

ESSAP reviewed the final results provided by DOE for Building 374 and determined that the remaining alpha activity levels were below the applicable free release guideline criteria. ESSAP determined that all sub-grade slab surfaces greater than six feet below the final grade were well below the 100 nCi/g guideline. Therefore, it is ESSAP's position that the Building 374 Closure Project meets the DOE allowable contamination guidelines.

## **FIGURES**

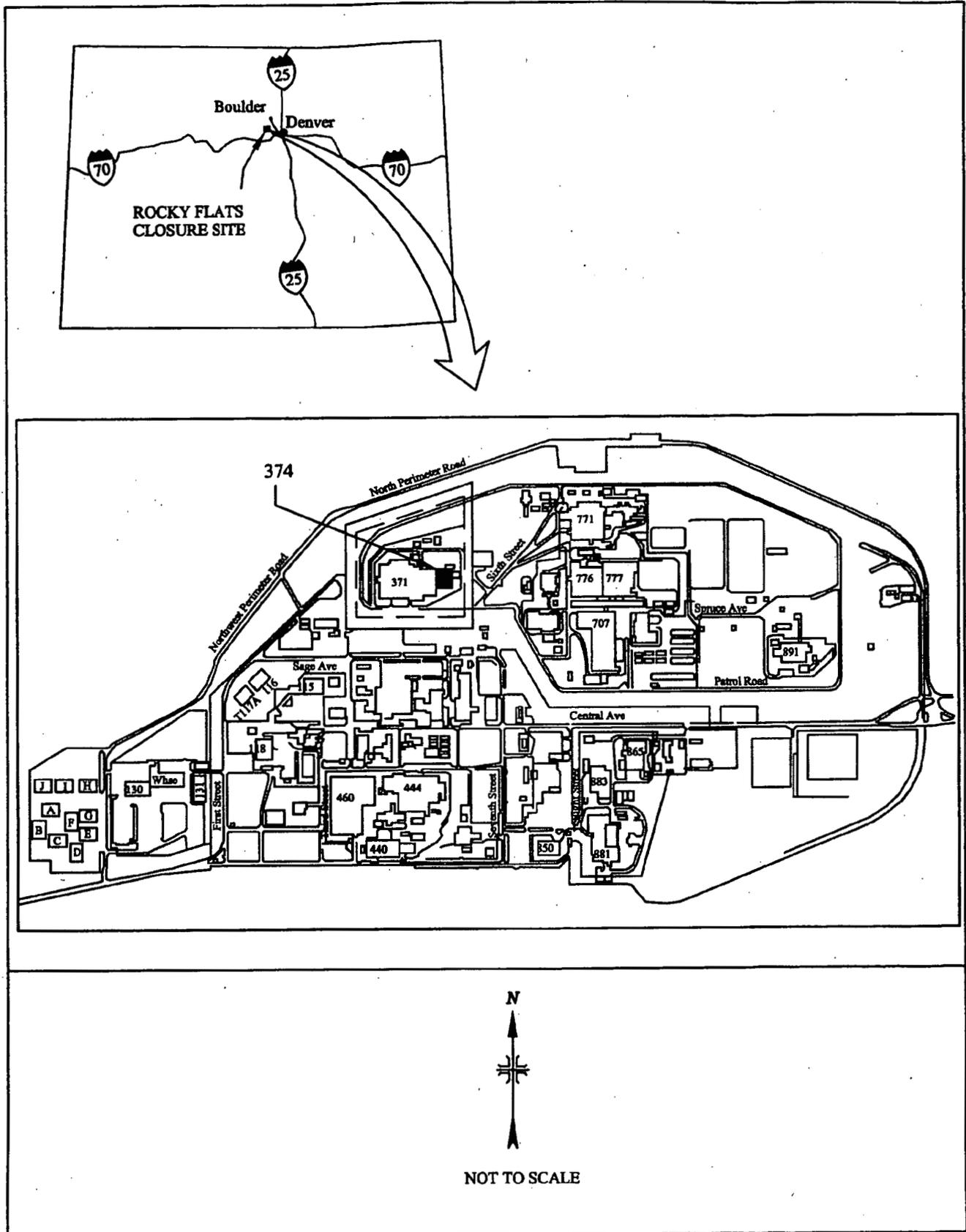


FIGURE 1: Location of the Rocky Flats Closure Site

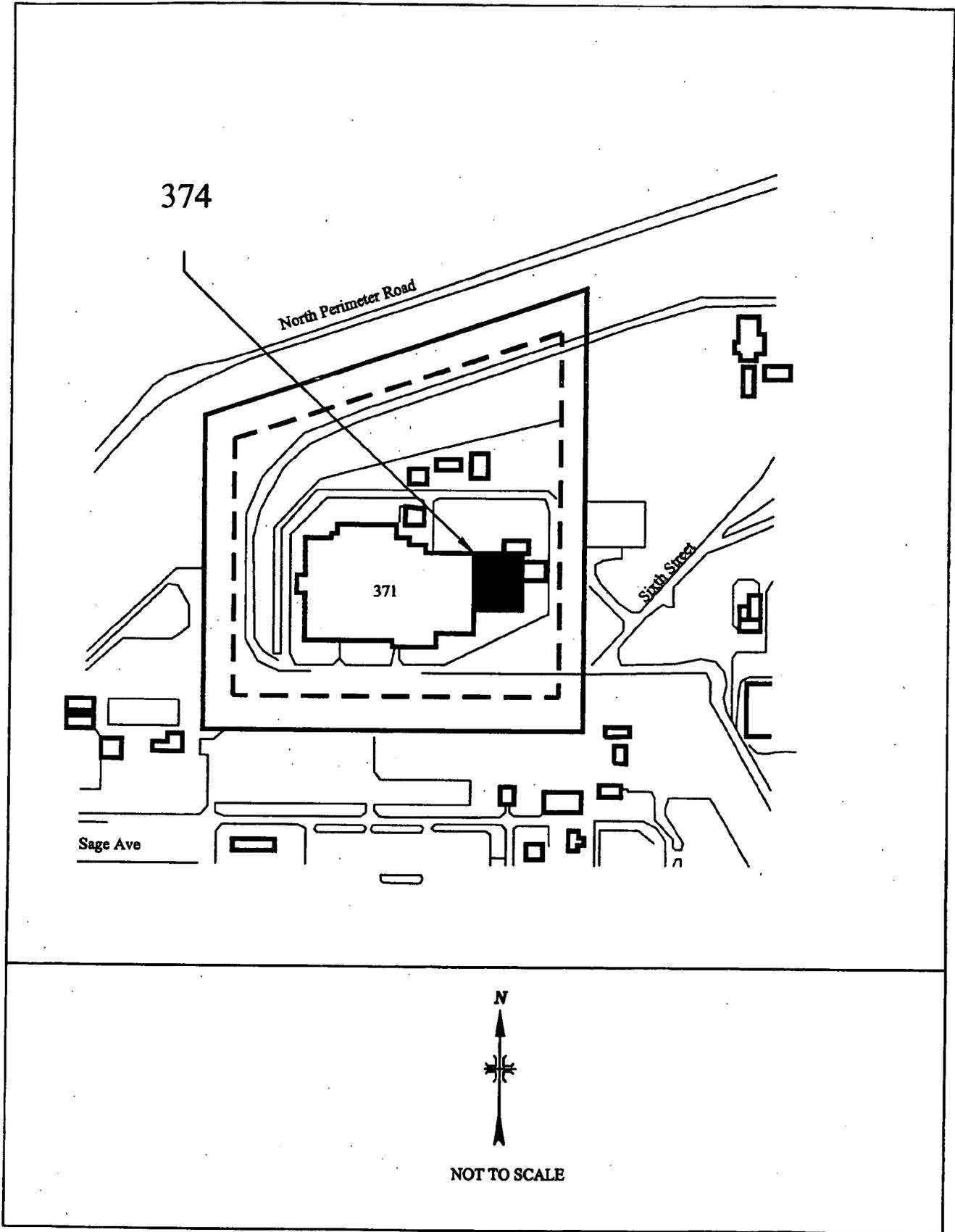


FIGURE 2: Location of the 374 Building

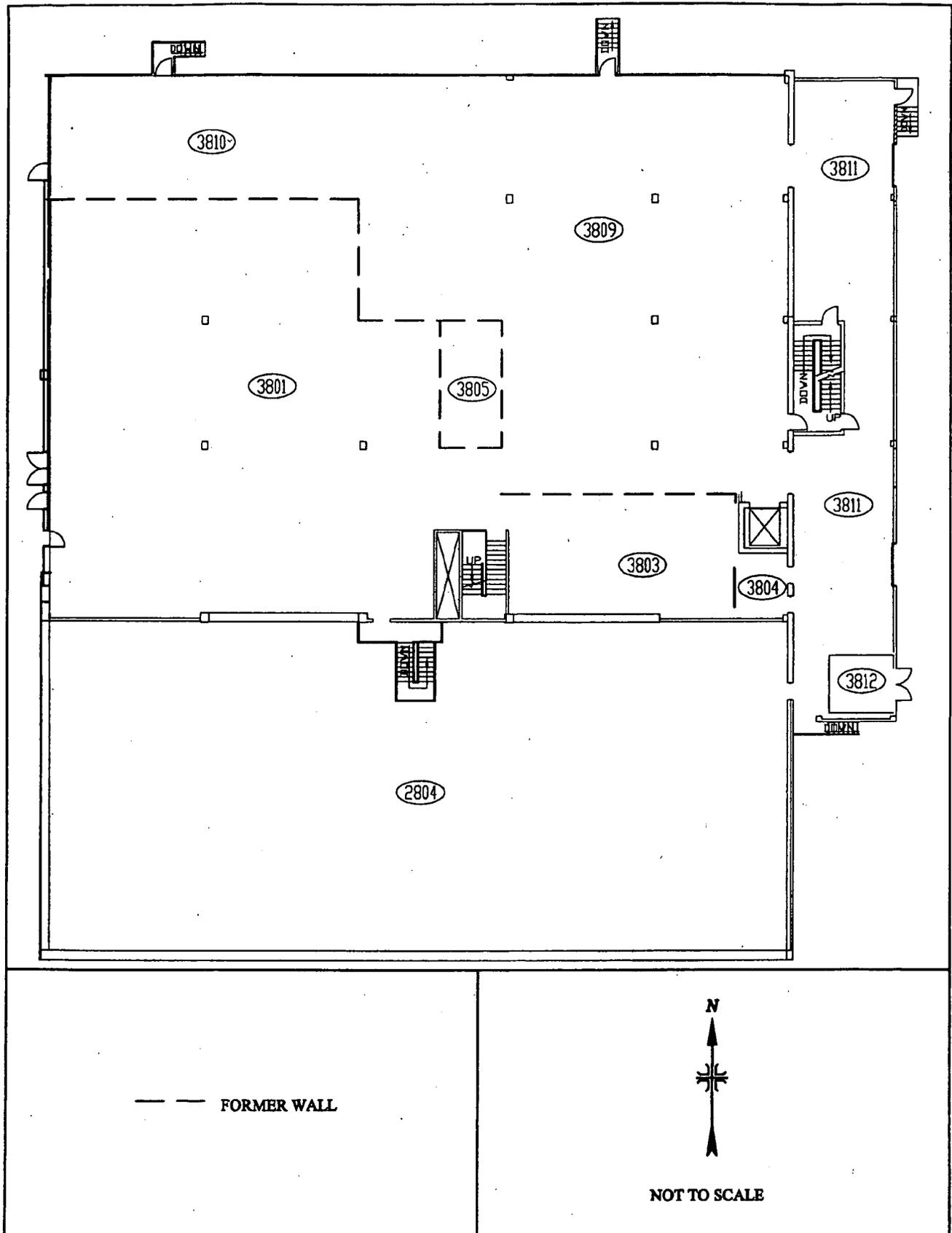


FIGURE 3: Plot Plan of Building 374

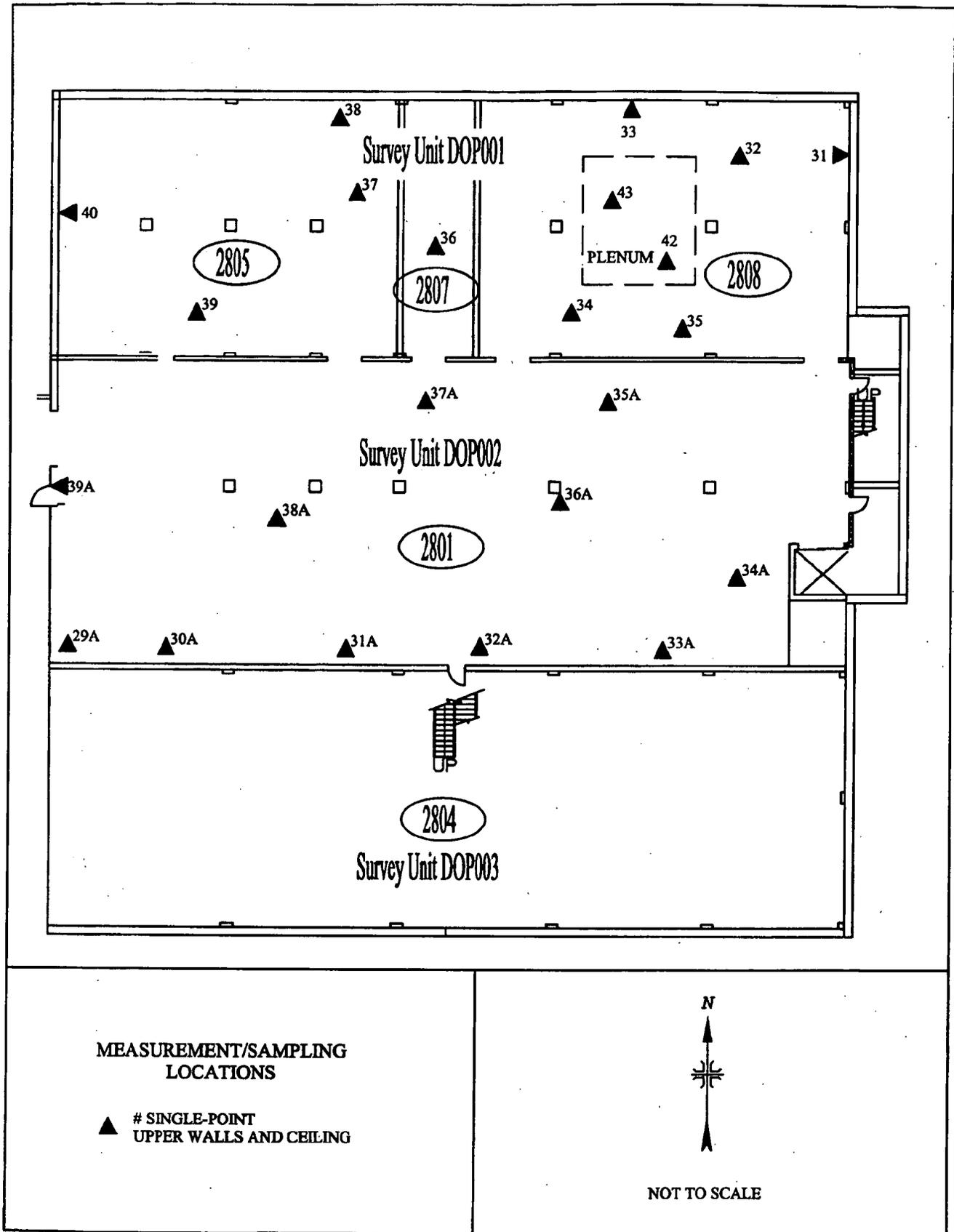


FIGURE 4: DOP Area Upper Walls and Ceiling - Measurement and Sampling Locations

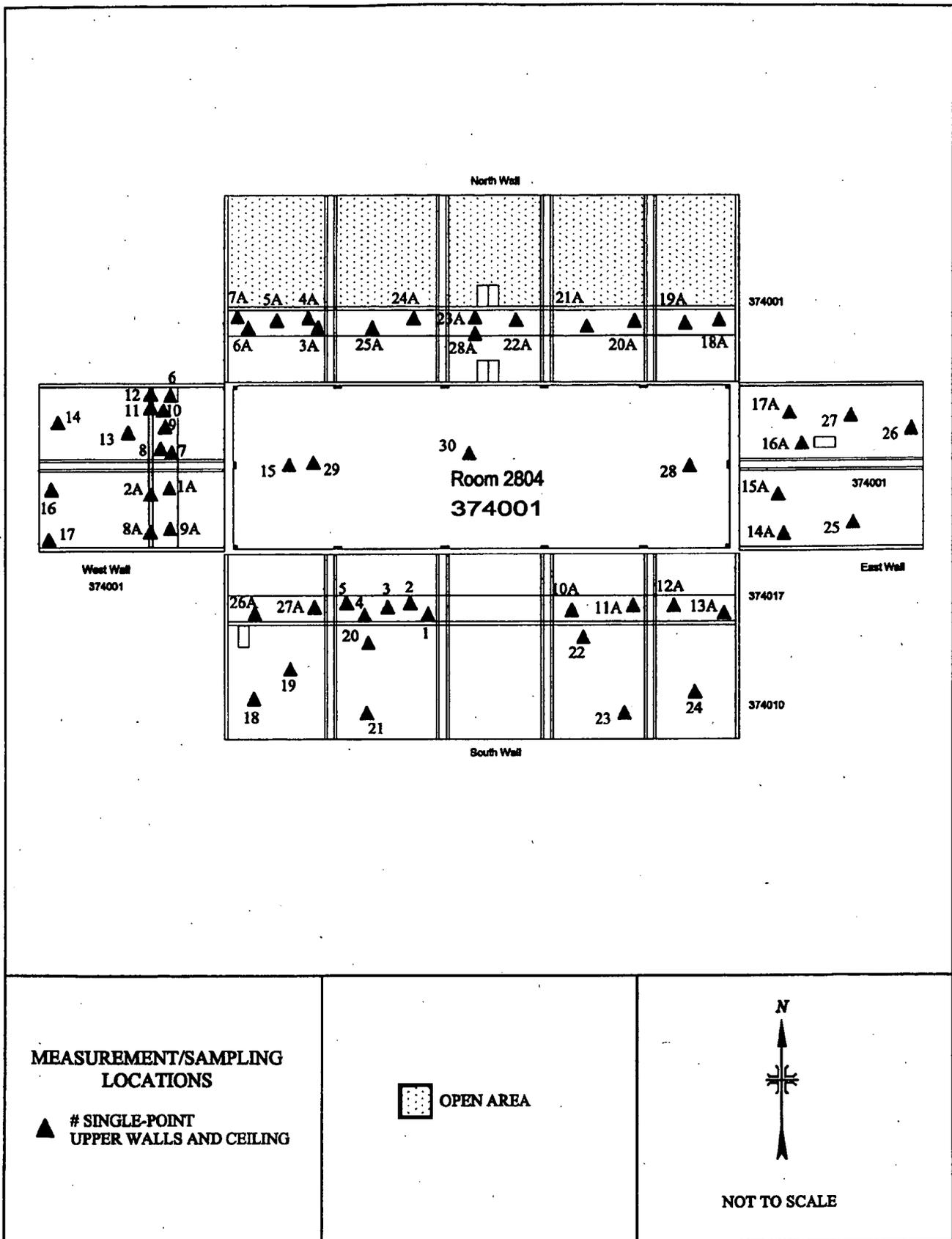
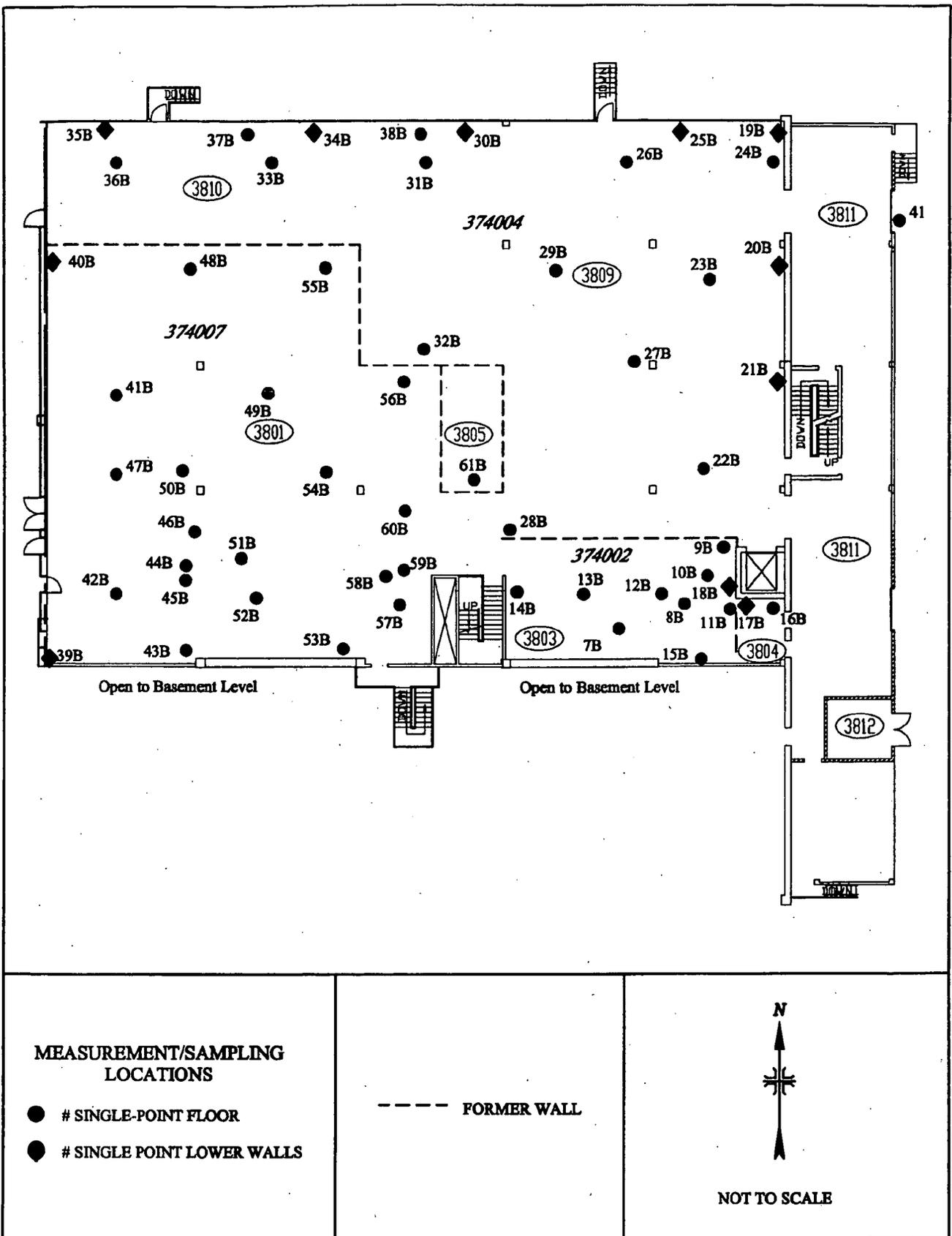


FIGURE 5: Room 2804 - Upper Walls and Ceiling - Measurement and Sampling Locations



**FIGURE 6: Ground Floor Level - Lower Walls and Floor - Measurement and Sampling Locations**

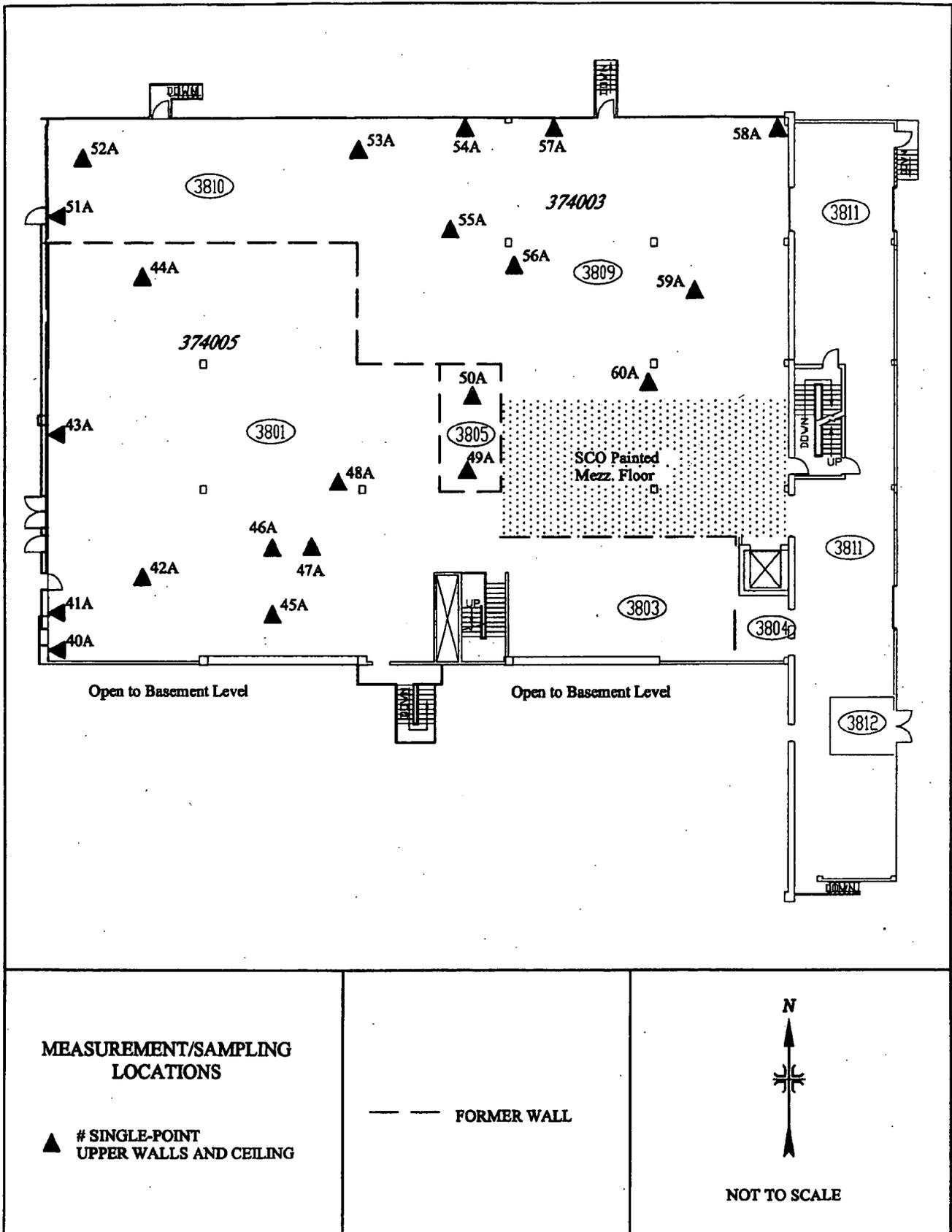
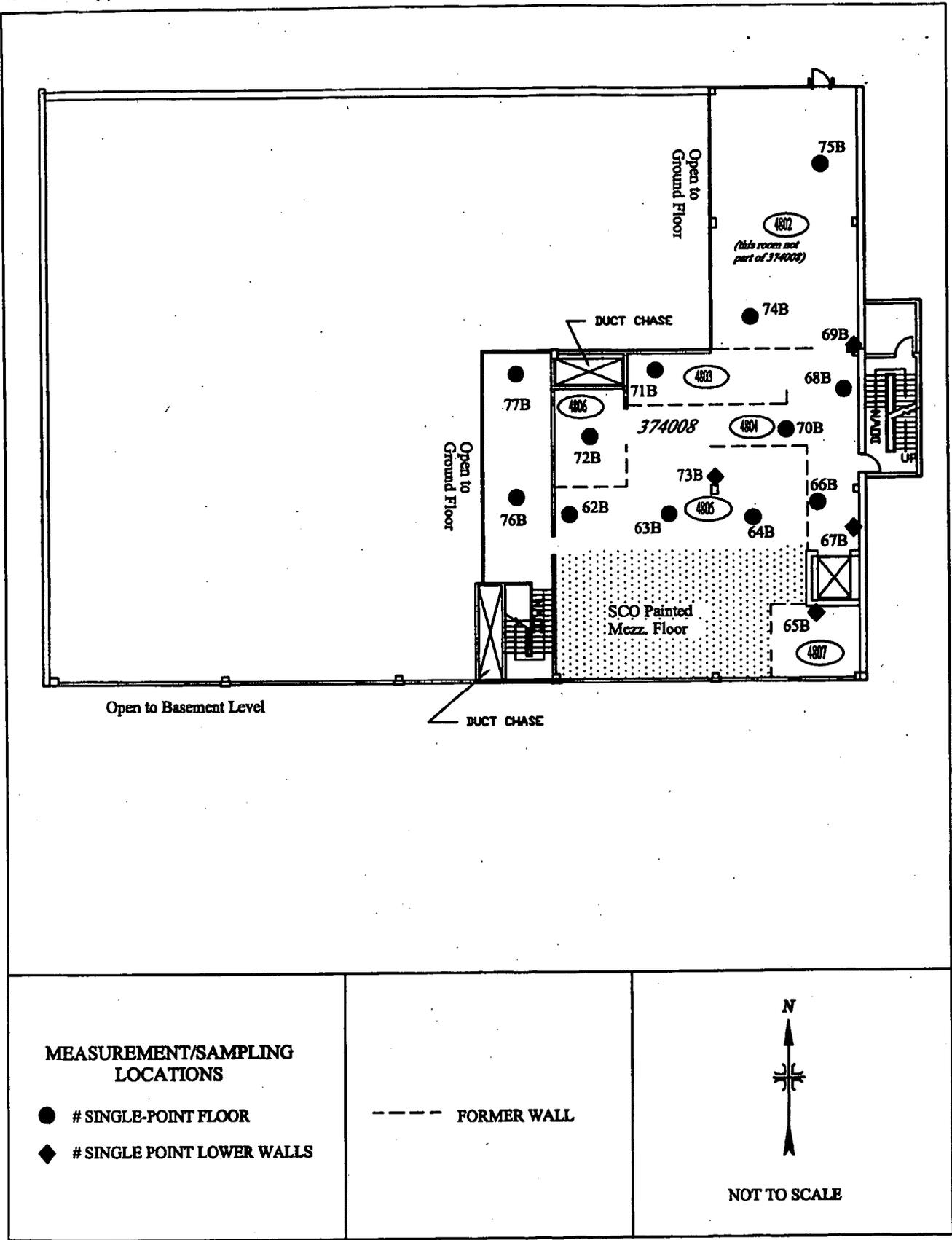


FIGURE 7: Ground Floor Level - Upper Walls and Ceiling - Measurement and Sampling Locations



**FIGURE 8: Mezzanine - Lower Walls and Floor - Measurement and Sampling Locations**

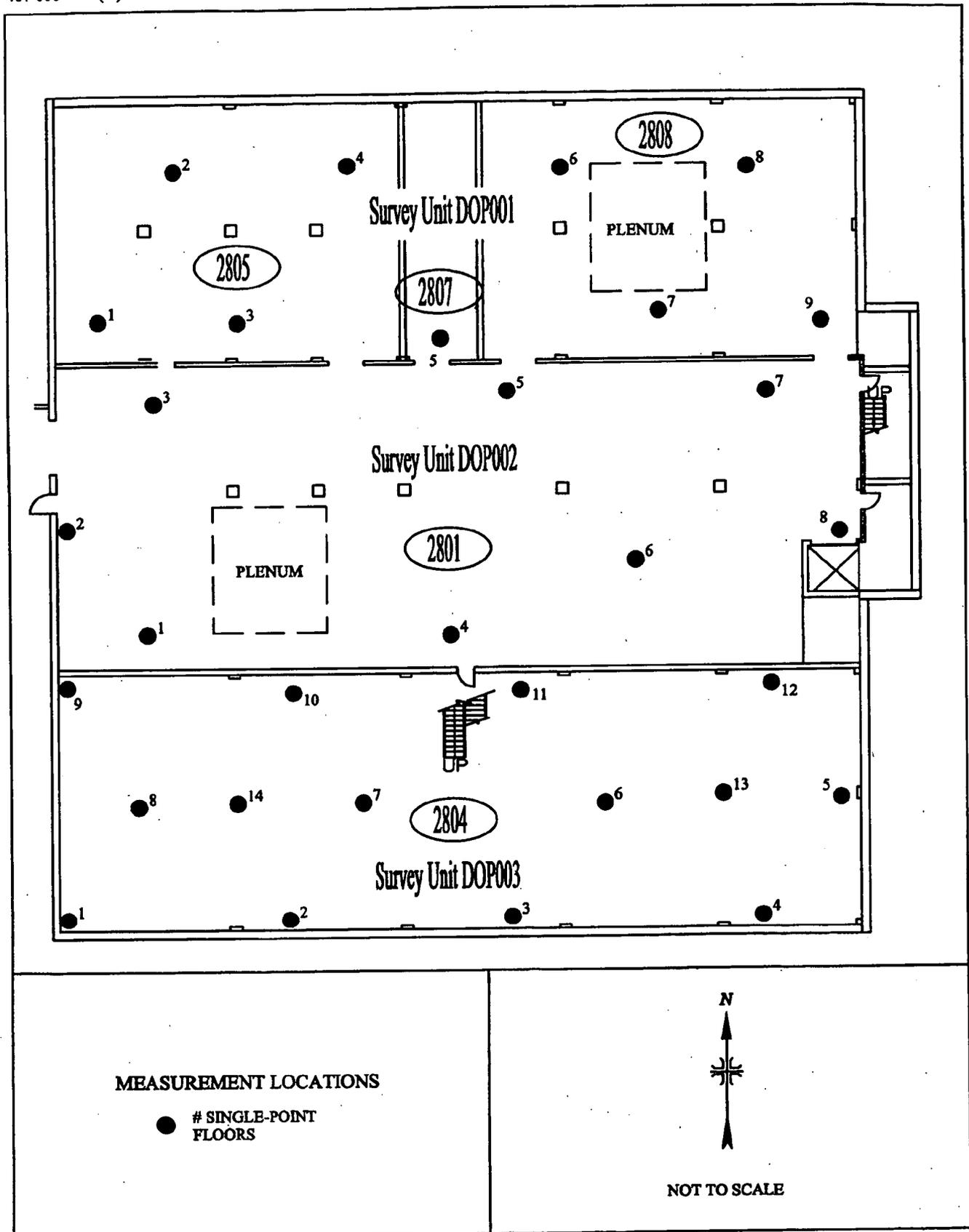


FIGURE 9: Basement Level - Measurement Locations

## **TABLES**

**TABLE 1**  
**SURFACE ACTIVITY LEVELS**  
**ROOM 2804 SOUTH WALL**  
**SURVEY UNIT 374017**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
1	16	0
2	160	0
1 m <sup>2</sup> average at loc. 2 <sup>c</sup>	46	--- <sup>d</sup>
3	24	0
4	24	1
5	40	0

<sup>a</sup>Refer to Figure 5.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

**TABLE 2**  
**SURFACE ACTIVITY LEVELS**  
**ROOM 2804 NORTH, EAST, AND WEST WALLS**  
**SURVEY UNIT 374001**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
6	87	0
7	56	1
8	24	0
9	32	0
10	40	0
11	370	3
1 m <sup>2</sup> average at loc. 11 <sup>c</sup>	230	--- <sup>d</sup>
12	260	0
1 m <sup>2</sup> average at loc. 12 <sup>c</sup>	110	--- <sup>d</sup>
1 m <sup>2</sup> average <sup>c and e</sup>	130	--- <sup>d</sup>
Post RA Average <sup>c</sup>	110	--- <sup>d</sup>
13	40	0
14	48	1
15	16	0
16	32	5
17	16	5
25	56	0
26	24	0
27	32	0
28	24	0
29	16	1
30	8	1
1A	230	0
1 m <sup>2</sup> average at loc. 1A <sup>c</sup>	170	--- <sup>d</sup>
2A	40	0

**TABLE 2 (Continued)**

**SURFACE ACTIVITY LEVELS  
ROOM 2804 NORTH, EAST, AND WEST WALLS  
SURVEY UNIT 374001  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

<b>Measurement Location<sup>a</sup></b>	<b>Total Alpha Surface Activity (dpm/100 cm<sup>2</sup>)<sup>b</sup></b>	<b>Total Removable Activity (dpm/100 cm<sup>2</sup>)</b>
3A	48	0
4A	71	0
5A	95	0
6A	480	0
7A	8	0
8A	0	0
9A	32	0
14A	29	0
15A	14	0
16A	0	3
17A	14	0
18A	0	0
19A	14	1
20A	7	0
21A	0	1
22A	-7	1
23A	200	3
24A	-7	0
25A	8,000	26
28A	170	3
1 m <sup>2</sup> average at loc. 28A <sup>c</sup>	140	--- <sup>d</sup>

<sup>a</sup>Refer to Figure 5.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

<sup>e</sup>Average incorporates both locations 11 and 12 due to their close proximity to each other.

**TABLE 3**  
**SURFACE ACTIVITY LEVELS**  
**ROOM 2804 UPPER SOUTH WALL**  
**SURVEY UNIT 374010**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

<b>Measurement Location<sup>a</sup></b>	<b>Total Alpha Surface Activity (dpm/100 cm<sup>2</sup>)<sup>b</sup></b>	<b>Total Removable Activity (dpm/100 cm<sup>2</sup>)</b>
18	16	0
19	32	0
20	40	0
21	32	1
22	16	5
23	79	0
24	8	1
10A	14	0
11A	22	0
12A	-14	1
13A	-7	0
26A	7	3
27A	14	1

<sup>a</sup>Refer to Figure 5.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

**TABLE 4**  
**SURFACE ACTIVITY LEVELS**  
**SURVEY UNIT DOP001**  
**ROOMS 2805, 2801, AND 2808**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

<b>Measurement Location<sup>a</sup></b>	<b>Total Alpha Surface Activity (dpm/100 cm<sup>2</sup>)<sup>b</sup></b>	<b>Total Removable Activity (dpm/100 cm<sup>2</sup>)</b>
31	16	0
32	0	1
33	100	1
34	8	1
35	32	0
36	16	0
37	48	0
38	16	3
39	32	0
40	79	3
42	370	80
43	16	0

<sup>a</sup>Refer to Figure 4.

<sup>b</sup>Total alpha surface activity measurements were calculated using an alpha efficiency determined in accordance with ESSAP's calibration procedures.

**TABLE 5**  
**SURFACE ACTIVITY LEVELS**  
**ROOM 2801—SURVEY UNIT DOP002**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
29A	1,000	5
n/a <sup>c</sup>	1,100 <sup>d</sup>	--- <sup>e</sup>
30A	380	9
31A	460	7
n/a <sup>c</sup>	72 <sup>e</sup>	--- <sup>e</sup>
32A	14	0
33A	-7	1
34A	14	1
35A	7	0
36A	29	1
37A	22	5
38A	14	0
39A	7	1

<sup>a</sup>Refer to Figure 4.

<sup>b</sup>Total alpha surface activity measurements were calculated using an alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Measurement location not applicable.

<sup>d</sup>Additional measurement was made to determine if activity was removable or was not spread due to smearing the dirty surfaces.

<sup>e</sup>—Second smear not required.

**TABLE 6**  
**SURFACE ACTIVITY LEVELS**  
**SURVEY UNIT 374002**  
**ROOMS 3801 AND 3805**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
39B	72	0
40B	43	0
41B	14	0
42B	1,800	3
43B	22	0
44B	430	0
45B	1,900	0
46B	1,200	0
47B	79	1
48B	65	0
49B	43	1
50B	1,800	3
51B	750	0
52B	170	0
1 m <sup>2</sup> average at loc. 52B <sup>c</sup>	84	--- <sup>d</sup>
53B	22	0
54B	79	0
55B	79	1
56B	43	0
57B	1,900	3
58B	1,100	1
59B	570	1
60B	740	0
61B	65	0

<sup>a</sup>Refer to Figure 6.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

**TABLE 7**  
**SURFACE ACTIVITY LEVELS**  
**SURVEY UNIT 374003**  
**ROOM 3801**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
40A	36	0
41A	0	0
42A	350	1
43A	29	0
44A	220	11
1 m <sup>2</sup> average at loc. 44A <sup>c</sup>	140	--- <sup>d</sup>
45A	270	18
1 m <sup>2</sup> average at loc. 45A <sup>c</sup>	230	--- <sup>d</sup>
46A	170	7
1 m <sup>2</sup> average at loc. 46A <sup>c</sup>	140	--- <sup>d</sup>
47A <sup>c</sup>	270	7
48A	270	7
1 m <sup>2</sup> average at loc. 48A <sup>c</sup>	240	--- <sup>d</sup>
49A	220	9
1 m <sup>2</sup> average at loc. 49A <sup>c</sup>	190	--- <sup>d</sup>
50A	240	7

<sup>a</sup>Refer to Figure 7.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

<sup>e</sup>No average activity calculated. Kaiser Hill representatives committed to clean all upper surfaces on the Ground Floor, Survey Unit 374003.

**TABLE 8**  
**SURFACE ACTIVITY LEVELS**  
**SURVEY UNIT 374004**  
**ROOMS 3809 AND 3810**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
19B	270	11
1 m <sup>2</sup> average at loc. 19B <sup>c</sup>	180	--- <sup>d</sup>
20B	36	1
21B	14	0
22B	79	3
23B	43	1
24B	36	0
25B	36	3
26B	14	0
27B	22	0
28B	58	1
29B	36	0
30B	29	0
31B	7	0
32B	22	1
33B	7	0
34B	58	1
35B	29	0
36B	-7	1
37B	400	1
38B	510	7

<sup>a</sup>Refer to Figure 4.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

**TABLE 9**  
**SURFACE ACTIVITY LEVELS**  
**SURVEY UNIT 374005**  
**ROOMS 3809 AND 3810**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

<b>Measurement Location<sup>a</sup></b>	<b>Total Alpha Surface Activity (dpm/100 cm<sup>2</sup>)<sup>b</sup></b>	<b>Total Removable Activity (dpm/100 cm<sup>2</sup>)</b>
51A	110 <sup>c</sup>	1
52A	220 <sup>c</sup>	11
53A	22	1
54A	170 <sup>c</sup>	5
55A	29	0
56A	65	1
57A	300 <sup>c</sup>	5
58A	29	0
59A	14	0
60A	22	0

<sup>a</sup>Refer to Figure 7.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>No average activity calculated. Kaiser Hill representatives committed to clean all upper surfaces on the Ground Floor, Survey Unit 374003.

**TABLE 10**  
**SURFACE ACTIVITY LEVELS**  
**ROOM 4802 MEZZANINE**  
**SURVEY UNIT 374005**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO.**

<b>Measurement Location<sup>a</sup></b>	<b>Total Alpha Surface Activity (dpm/100 cm<sup>2</sup>)<sup>b</sup></b>	<b>Total Removable Activity (dpm/100 cm<sup>2</sup>)</b>
74B	32	0
75B	56	0
76B	40	1
77B	79	1

<sup>a</sup>Refer to Figure 7.

<sup>b</sup>Total alpha surface activity measurements were calculated using an alpha efficiency determined in accordance with ESSAP's calibration procedures.

**TABLE 11**  
**SURFACE ACTIVITY LEVELS**  
**SURVEY UNIT 374006**  
**ROOM 3803**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
7B	460	1
8B	710	1
9B	260	1
1 m <sup>2</sup> average at loc. 9B <sup>c</sup>	140 <sup>c</sup>	--- <sup>d</sup>
10B	310	0
11B	65	1
12B	87	0
13B	79	0
14B	65	1
15B	14	0
16B	14	0
17B	0	1
18B	7	0

<sup>a</sup>Refer to Figure 3.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

**TABLE 12**  
**SURFACE ACTIVITY LEVELS**  
**MEZZANINE**  
**SURVEY UNIT 374008**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
62B	71	3
63B	32	0
64B	56	0
65B	330	1
1 m <sup>2</sup> average at loc. 65B <sup>c</sup>	83	--- <sup>d</sup>
66B	120	0
1 m <sup>2</sup> average at loc. 66B <sup>c</sup>	59	--- <sup>d</sup>
67B	8	0
68B	48	0
69B	32	0
70B	48	0
71B	40	0
72B	32	0
73B	330	3

<sup>a</sup>Refer to Figure 5.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

**TABLE 13**  
**SURFACE ACTIVITY LEVELS**  
**SURVEY UNIT 374011**  
**ROOM 3811**  
**ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE**  
**GOLDEN, COLORADO**

<b>Measurement Location<sup>a</sup></b>	<b>Total Alpha Surface Activity (dpm/100 cm<sup>2</sup>)<sup>b</sup></b>	<b>Total Removable Activity (dpm/100 cm<sup>2</sup>)</b>
41	510	5
1 m <sup>2</sup> average at loc. 41 <sup>c</sup>	330	--- <sup>d</sup>

<sup>a</sup>Refer to Figure 3.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

TABLE 14

SUMMARY OF SURFACE ACTIVITY LEVELS  
IN EXCESS OF GUIDELINES  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO

Room	Survey Unit	Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
2801	DOP002	29A	1,000	5
		29A <sup>c</sup>	1,100	--- <sup>d</sup>
		30A	380	9
		31A	460	7
		31A <sup>e</sup>	72	--- <sup>d</sup>
2808	Plenum	42	370	80
2804 South Wall	374017	2	160	0
		1 m <sup>2</sup> average at loc. 2 <sup>c</sup>	46	--- <sup>d</sup>
2804	374001	1A	230	0
		1 m <sup>2</sup> average at loc. 1A <sup>c</sup>	170	--- <sup>d</sup>
		6A	480	0
		11	370	3
		12	260	0
		1 m <sup>2</sup> average at loc. 11 & 12 <sup>c</sup>	130	--- <sup>d</sup>
		23A	200	3
		25A	8,000	26
		28A	170	3
		1 m <sup>2</sup> average at loc. 28A <sup>c</sup>	140	--- <sup>d</sup>

TABLE 14 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS  
IN EXCESS OF GUIDELINES  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO

Room	Survey Unit	Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
3805	374002	42B	1,800	3
		44B	430	0
		45B	1,900	0
		46B	1,200	0
		50B	1,800	3
		51B	750	0
		52B	170	0
		1 m <sup>2</sup> average at loc. 52B <sup>c</sup>	84	--- <sup>d</sup>
		57B	1,900	3
		58B	1,100	1
		59B	570	1
		42B	1,800	3
		60B	740	0
		3801	374003	42A
44A	220			11
1 m <sup>2</sup> average at loc. 44A <sup>c</sup>	140			--- <sup>d</sup>
45A	270			18
1 m <sup>2</sup> average at loc. 45A <sup>c</sup>	230			--- <sup>d</sup>
46A	170			7
1 m <sup>2</sup> average at loc. 46A <sup>c</sup>	140			--- <sup>d</sup>

TABLE 14 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS  
IN EXCESS OF GUIDELINES  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO

Room	Survey Unit	Measurement Location <sup>a</sup>	Total Alpha Surface Activity (dpm/100 cm <sup>2</sup> ) <sup>b</sup>	Total Removable Activity (dpm/100 cm <sup>2</sup> )
3801 (Continued)	374003 (Continued)	47A	270	7
		48A	270	7
		1 m <sup>2</sup> average at loc. 48A <sup>c</sup>	240	--- <sup>d</sup>
3805	374003	49A	220	9
		1 m <sup>2</sup> average at loc. 49A <sup>c</sup>	190	--- <sup>d</sup>
		50A	240	7
3809	374004	19B	270	11
		1 m <sup>2</sup> average at loc. 19B <sup>c</sup>	180	--- <sup>d</sup>
3810	374004	37B	400	1
		38B	510	7
3810	374005	51A	110	1
		52A	220	11
		54A	170	5
3809	374005	57A	300	5
3803	374006	7B	460	1
		8B	710	1
		9B	260	1
		1 m <sup>2</sup> average at loc. 9B <sup>c</sup>	140	--- <sup>d</sup>
		10B	310	0
4807	374008	65B	330	1
		1 m <sup>2</sup> average at loc. 65B <sup>c</sup>	83	--- <sup>d</sup>

**TABLE 14 (Continued)**

**SUMMARY OF SURFACE ACTIVITY LEVELS  
IN EXCESS OF GUIDELINES  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

<b>Room</b>	<b>Survey Unit</b>	<b>Measurement Location<sup>a</sup></b>	<b>Total Alpha Surface Activity (dpm/100 cm<sup>2</sup>)<sup>b</sup></b>	<b>Total Removable Activity (dpm/100 cm<sup>2</sup>)</b>
4801	374008	66B	120	0
		1 m <sup>2</sup> average at loc. 66B <sup>c</sup>	59	--- <sup>d</sup>
4805	374008	73B	330	3
3811	374011	41	510	5
		1 m <sup>2</sup> average at loc. 41 <sup>c</sup>	330	--- <sup>d</sup>

<sup>a</sup>Refer to Figures 4-8.

<sup>b</sup>Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.

<sup>c</sup>Average activity based on five measurement locations within contiguous square meter of flagged elevated result.

<sup>d</sup>--- No smear for removable activity required.

<sup>e</sup>Additional measurement was made to determine if activity was removable or was not spread due to smearing the dirty surfaces.

**TABLE 15**

**GAMMA SURFACE ACTIVITY LEVELS  
AND VOLUMETRIC CONCENTRATIONS  
SURVEY UNIT DOP001  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

<b>Location<sup>a</sup></b>	<b>FIDLER Result (cpm)</b>	<b>Volumetric Concentration (nCi/g)<sup>b</sup></b>
1	3,000	0.43
2	2,600	0.38
3	3,200	0.46
4	3,100	0.44
5	2,700	0.39
6	2,400	0.35
7	3,300	0.47
8	3,500	0.50
9	3,700	0.53

<sup>a</sup>Refer to Figure 9.

<sup>b</sup>Calculated based on assumptions in Rocky Flats Calculation Number 05-RS-0002 (K-H 2005b).

**TABLE 16**

**GAMMA SURFACE ACTIVITY LEVELS  
AND VOLUMETRIC CONCENTRATIONS  
SURVEY UNIT DOP002  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

<b>Location<sup>a</sup></b>	<b>FIDLER Result (cpm)</b>	<b>Volumetric Concentration (nCi/g)<sup>b</sup></b>
1	3,100	0.45
2	3,600	0.52
3	3,100	0.44
4	3,100	0.45
5	3,100	0.45
6	3,600	0.52
7	3,700	0.53
8	3,500	0.50

<sup>a</sup>Refer to Figure 9.

<sup>b</sup>Calculated based on assumptions in Rocky Flats Calculation Number 05-RS-0002 (K-H 2005b).

**TABLE 17**

**GAMMA SURFACE ACTIVITY LEVELS  
AND VOLUMETRIC CONCENTRATIONS  
SURVEY UNIT DOP003  
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE  
GOLDEN, COLORADO**

<b>Location<sup>a</sup></b>	<b>FIDLER Result (cpm)</b>	<b>Volumetric Concentration (nCi/g)<sup>b</sup></b>
1	3,400	0.61
2	3,400	0.61
3	3,500	0.63
4	2,700	0.48
5	3,600	0.64
6	3,300	0.59
7	3,000	0.53
8	3,300	0.60
9	3,300	0.60
10	3,200	0.57
11	3,200	0.58
12	3,400	0.61
13 (Sump #2)	6,800	1.22
14 (Sump #1)	13,000	2.34

<sup>a</sup>Refer to Figure 9.

<sup>b</sup>Calculated based on assumptions in Rocky Flats Calculation Number 05-RS-0002 (K-H 2005b).

## REFERENCES

- Kaiser-Hill Company (K-H). Rocky Flats Environmental Technology Site: Building 371/374 Closure Project Decommissioning Operations Plan. Golden, Colorado; December 12, 2003.
- Kaiser-Hill Company. Rocky Flats Environmental Technology Site: Pre-Demolition Survey Report (PDSR) Building 374, Room 3813 (Dock) and Building 374 Exterior. Golden, Colorado; October 14, 2004a.
- Kaiser-Hill Company. Rocky Flats Environmental Technology Site: Building 371/374 Closure Project Characterization Plan. Golden, Colorado; December 12, 2004b.
- Kaiser-Hill Company. Rocky Flats Environmental Technology Site: Pre-Demolition Survey Report (PDSR) Building 374 (Interior) Area AN Phase I. Golden, Colorado; January 5, 2005a.
- Kaiser-Hill Company. Rocky Flats Environmental Technology Site: Calculation Cover Sheet. Concrete Surface Activity Measurement Using G-5 Probe 05-RS-0002. Golden, Colorado; January 18, 2005b.
- Oak Ridge Institute for Science and Education (ORISE). The Independent Verification Program Plan for the U.S. Department of Energy Rocky Flats Project Office—Rocky Flats Environmental Technology Site Closure Project. Oak Ridge, Tennessee; March 12, 2004a.
- Oak Ridge Institute for Science and Education. Independent Verification Team Project-Specific Plan for the Building 371/374 Closure Project—Rocky Flats Environmental Technology Site. Oak Ridge, Tennessee; May 26, 2004b.
- Oak Ridge Institute for Science and Education. Letter Report—Type A Verification of the Building 374 Room 3813 (Dock) And Building 374 Exterior Pre-Demolition Survey Report, Rocky Flats Environmental Technology Site Closure Project, Golden, Colorado. Oak Ridge, Tennessee; October 25, 2004c.
- Oak Ridge Institute for Science and Education. Survey Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; September 2, 2004d.
- Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; August 31, 2004e.
- Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; August 31, 2004f.

## REFERENCES (Continued)

Oak Ridge Institute for Science and Education. Interim Letter Report—Verification Survey of the Building 374 Closure Project, Rocky Flats Environmental Technology Site, Golden, Colorado. Oak Ridge, Tennessee; February 22, 2005a.

Oak Ridge Institute for Science and Education. Email From P. Weaver to B. Wallin and W. Seyfert. "374 Preliminary Data Results" Oak Ridge, Tennessee; January 27, 2005b.

U.S. Department of Energy (DOE). Radiation Protection of the Public and the Environment. Washington, DC: DOE Order 5400.5; January 7, 1993.

U.S. Department of Energy. Memorandum from R. Pelletier to Distribution, "Application of DOE 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Material", November 17, 1995.

U.S. Department of Energy. Email From B. Wallin to P. Weaver and T. Vitkus. "ORISE Remediation Maps" Golden Colorado, January 24, 2005a.

U.S. Department of Energy. Facsimile From B. Wallin to P. Weaver. Golden Colorado, January 31, 2005b.

**APPENDIX A**  
**MAJOR INSTRUMENTATION**

## APPENDIX A

### MAJOR INSTRUMENTATION

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

#### SCANNING INSTRUMENT/DETECTOR COMBINATIONS

##### Alpha

Ludlum Ratemeter-Scaler Model 2221  
coupled to  
Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm<sup>2</sup>  
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Floor Monitor Model 239-1  
combined with  
Ludlum Ratemeter-Scaler Model 2221  
coupled to  
Ludlum Gas Proportional Detector Model 43-37, Physical Area: 550 cm<sup>2</sup>  
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Ratemeter-Scaler Model 2221  
coupled to  
Ludlum Alpha Scintillation Detector Model 43-89 or 43-90, Physical Area: 100 cm<sup>2</sup>  
(Ludlum Measurements, Inc., Sweetwater, TX)

##### Gamma

Ludlum Ratemeter-Scaler Model 2221  
(Ludlum Measurements, Inc., Sweetwater, TX)  
coupled to  
BICRON NaI Scintillation Detector  
Model G5 FIDLER  
(Bicron Corporation, Newburg, OH)

#### DIRECT MEASUREMENT INSTRUMENT

Low Background Gas Proportional Counter  
Model LB-5100-W  
(Canberra/Tennelec, Oak Ridge, TN)

**APPENDIX B**  
**SURVEY AND ANALYTICAL PROCEDURES**

## APPENDIX B

### SURVEY AND ANALYTICAL PROCEDURES

#### PROJECT HEALTH AND SAFETY

A walkdown of the project area was performed to evaluate the survey areas for potential health and safety issues that may not have been identified by the site. Additionally, the proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in applicable job hazard analyses (JHAs). The procedures entailed minimal potential hazards that were currently addressed in ESSAP JHAs.

Personnel adhered to the site health and safety requirements. Project training requirements were met prior to entry into the survey areas. General employee radiological training for site access was completed and the IVT completed beryllium worker qualification, including on-site physical, chest x-ray, and classroom lecture. In addition, the IVT received building specific entry and safety requirements. Confirmatory survey activities were conducted in areas that were not downposted for radiation or beryllium contamination and site dosimetric considerations were applicable.

#### QUALITY ASSURANCE

##### Calibration

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

- Survey Procedures Manual (September 2004)
- Laboratory Procedures Manual (August 2004)
- Quality Assurance Manual (August 2004)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1B and the U.S. Nuclear Regulatory Commission

Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Instrumentation had to be re-calibrated once at the site because of the effect of altitude on detection capability.

Detectors used for assessing total surface alpha activity were calibrated in accordance with ISO-7503<sup>1</sup> recommendations. The total efficiency ( $\epsilon_{total}$ ) was determined for each instrument/detector combination and consisted of the product of the  $2\pi$  instrument efficiency ( $\epsilon_i$ ) and surface efficiency ( $\epsilon_s$ ):  $\epsilon_{total} = \epsilon_i \times \epsilon_s$

The alpha calibration efficiency for detectors used for the project, calibrated to Am-241 was typically between 0.10 and 0.11. The alpha calibration source was selected based on the alpha energy distribution of the radionuclide of concern. ISO-7503 recommends an  $\epsilon_s$  of 0.25 when measuring alpha emitters. Calibration source emission rates were corrected for geometry when the sources used were smaller than the detector window area.

The gamma calibration efficiency for the FIDLER detector was determined to ISO-7503 recommendations. A NIST traceable Am-241 calibration source (maximum gamma energy of

---

<sup>1</sup>International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. August 1, 1988.

59.5 KeV) was used to develop the optimal instrument efficiency using a  $4\pi$  source activity. The calculated  $\epsilon_{\text{total}}$  ranged between 0.08 to 0.11, depending on the detector. The calibration source emission rates were corrected for geometry when a source larger than the detector was used.

## **SURVEY PROCEDURES**

### **Surface Scans**

Surface scans were performed by passing the detector slowly over the surface. The distance between the detectors and surface was maintained at a minimum, nominally about 1 cm. A large surface area, (600 cm<sup>2</sup>) gas proportional floor monitor was used in a qualitative posture to scan the floors. Other surfaces (walls, ceilings, ledges, etc.) were scanned using a small area 126 cm<sup>2</sup> hand-held gas proportional detector or using a 100 cm<sup>2</sup> alpha scintillator detector. DOP areas were scanned using a low-energy photon FIDLER detector with a probe area 127 cm<sup>2</sup>.

Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument.

Scanning for alpha emitters must be derived differently than scanning for beta and gamma emitters. For the most part, the background response of most alpha detectors is very close to zero, typically registering no more than 2 or 3 cpm. The equation for alpha scan MDC is based on the MARSSIM<sup>3</sup> equation in Appendix J:<sup>2</sup>

The nominal scan rate for alpha scan is determined to range from 2 to 5 cm/s. The probability of detecting one count should be specified as at least 90%, but frequently it will be 95% (i.e., 0.95).

Finally, the use of a 100 cm<sup>2</sup> hot spot size allows the calculation of alpha scan MDC in units of dpm/100 cm<sup>2</sup>.

<sup>2</sup>NUREG-1575. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), U.S. Nuclear Regulatory Commission. Washington, DC; June 2000.

In considering an evaluation of the scan MDC for Pu-239 on a concrete slab, a scan speed of 3 cm/s is assumed such that a residence time of 3.33 seconds is maintained over the contamination. Typically, an instrument efficiency is assumed to be 0.44 and the surface efficiency is 0.25 according to ISO-7503. The scan MDC is based on a 90% probability of detecting one count: Using these parameters this equation yields a scan MDC of 380 dpm/areas depicted as follows:

$$\alpha \text{ scan MDC} = \frac{[-\ln(1 - 0.9)] 60}{(0.44)(0.25)(3.33)} = 380 \text{ dpm}/100 \text{ cm}^2$$

For backgrounds greater than zero, e.g., 1 to 3 cpm, the calculational approach and scan MDC result are still valid, however, it is at the expense of an increased false positive rate. That is, the surveyor will be more likely to mistake background as contamination. For background count rate on the order of 5 to 10 cpm, a single count should not cause a surveyor to investigate further, primarily because there would be an inordinate amount of false positives.

Specific scan MDCs for the NaI scintillation detector for the radionuclide mixture in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma activity however, MDCs for radionuclides in the concrete would approximate those contained in NUREG-1507.

### **Surface Activity Measurements**

Measurements for total surface activity levels were primarily performed using gas proportional detectors with portable ratemeter-scalers. Surface activity measurements were performed on upper room surfaces, some equipment, and at locations of elevated direct radiation.

Gamma surface activity measurements were performed using the FIDLER detector. A Microshield™ program calculation was performed based upon calibration variables and detector attributes to determine a field action level. The result calculated a field action level of 250,000 cpm that was used to conduct additional investigation.

Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm<sup>2</sup>) by dividing the net rate by the total efficiency ( $\epsilon_i \times \epsilon_s$ ) and correcting for the active area of the detector.

Gamma count rates were integrated over one minute using the FIDLER. Count rates (cpm) were converted to nanocuries per gram (nCi/g) using the following equation:

$$\left( \frac{cpm}{\epsilon_T * \epsilon_p * 127cm^2} \right) * \left( \frac{127 m^2}{W} \right) * \left( \frac{nCi}{2220dpm} \right) * 8 \frac{Pu}{Am}$$

where:

$\epsilon_T$  = Total Efficiency = 0.08

$\epsilon_p$  = Attenuation Correction Factor for Painted Surfaces = 0.679

$W$  = Volume \* Density of Concrete = 127cm<sup>2</sup> \* 1 cm \* 2.35 g/cm<sup>3</sup> = 298.45 g

Note: Volume is calculated as physical detector area x DCGL depth

8 = ratio of Pu-239 to Am-241 for 35-year old WGP

### Removable Activity Measurements

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

### ANALYTICAL PROCEDURES

#### Gross Alpha

Smears were counted for two minutes on a low-background gas proportional system for gross alpha activity. The typical MDC of the procedure was 9 dpm/100 cm<sup>2</sup> for gross alpha activity.

### **Uncertainties and Detection Limits**

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 3 plus 4.65 times the standard deviation of the background count [ $3 + (4.65 \sqrt{BKG})$ ]. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

**APPENDIX C**

**SUMMARY OF DEPARTMENT OF ENERGY  
RESIDUAL RADIOACTIVE MATERIAL GUIDELINES**

## APPENDIX C

### RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5 (DOE 1990)

#### BASIC DOSE LIMITS

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

#### EXTERNAL GAMMA RADIATION

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

#### SURFACE CONTAMINATION GUIDELINES

##### Allowable Total Residual Surface Contamination (dpm/100 cm<sup>2</sup>)<sup>a</sup>

Radionuclides <sup>b</sup>	Average <sup>c,d</sup>	Maximum <sup>d,e</sup>	Removable <sup>d,f</sup>
Transuranics, Ra_226, Ra_228, Th_230 Th_228, Pa_231, Ac_227, I_125, I_129	100	300	20
Th_Natural, Th_232, Sr_90, Ra_223, Ra_224, U_232, I_126, I_131, I_133	1,000	3,000	200
U_Natural, U_235, U_238, and associated decay products	5,000	15,000	1,000
Beta_gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr_90 and others noted above	5,000	15,000	1,000

<sup>a</sup>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.

<sup>b</sup>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.

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

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

<sup>e</sup>The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>.

<sup>f</sup>The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm<sup>2</sup> 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.

LS  
LS