Nevada
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DOE/NV--1532

National Nuclear Security Administration

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 550: Smoky Contamination Area Nevada National Security Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

February 2015

UNCLASSIFIED

/s/ Joseph P. Johnston 02/09/2015
Joseph P. Johnston, N-I CO Date

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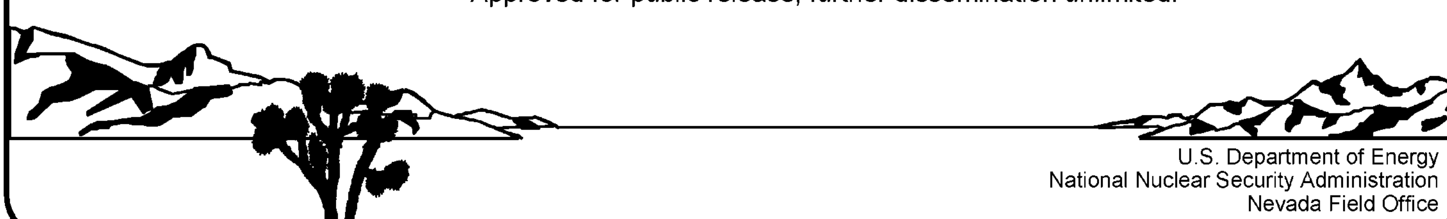

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CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 550: SMOKY CONTAMINATION AREA NEVADA NATIONAL SECURITY SITE, NEVADA

U.S. Department of Energy, National Nuclear Security Administration
Nevada Field Office
Las Vegas, Nevada

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CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 550: SMOKY CONTAMINATION AREA NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Tiffany A. Lantow Date: 2/9/2015

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List of Acronyms and Abbreviations

Ac	Actinium
ALARA	As low as reasonably achievable
ALM	Adult Lead Methodology
Am	Americium
ANPR	Advance Notice of Proposed Rulemaking
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
CA	Contamination area
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CD	Certificate of Disposal
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter
cm^3	Cubic centimeter
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cpm	Counts per minute
cps	Counts per second
CR	Certificate of Recycle

List of Acronyms and Abbreviations (Continued)

Cr(VI)	Hexavalent chromium
Cs	Cesium
CSM	Conceptual site model
day/yr	Days per year
DCB	Default contamination boundary
DOE	U.S. Department of Energy
dpm/100 cm^2	Disintegrations per minute per 100 square centimeters
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DRI	Desert Research Institute
EPA	U.S. Environmental Protection Agency
Eu	Europium
FADL	Field activity daily log
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
ft^2	Square foot
gal	Gallon
g/cm^3	Grams per cubic centimeter
g/day	Grams per day
GIS	Geographic Information Systems

List of Acronyms and Abbreviations *(Continued)*

GPS	Global Positioning System
GZ	Ground zero
HCA	High contamination area
hr/day	Hours per day
hr/yr	Hours per year
in.	Inch
kg	Kilogram
kt	Kiloton
L	Liter
lb	Pound
LCS	Laboratory control sample
LLW	Low-level waste
LVF	Load Verification Form
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
M&O	Management and operating
mrem	Millirem
mrem/IA-yr	Millirem per Industrial Area year
mrem/OU-yr	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
MLLW	Mixed low-level waste
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum

List of Acronyms and Abbreviations *(Continued)*

NDEP	Nevada Division of Environmental Protection
NIST	National Institute of Standards and Technology
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
OU	Occasional Use Area
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PPE	Personal protective equipment
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
r^2	Coefficient of determination
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
RfD	Reference dose
RRMG	Residual radioactive material guideline
RSL	Regional Screening Level
RWMC	Radioactive Waste Management Complex
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SVOC	Semivolatile organic compound
TBD	To be determined

List of Acronyms and Abbreviations *(Continued)*

Tc	Technetium
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
TLD	Thermoluminescent dosimeter
TMMC	Toxco Materials Management Center
TRS	Terrestrial radiological survey
U	Uranium
UCL	Upper confidence limit
UR	Use restriction
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
µR/hr	Microroentgens per hour

Executive Summary

This Corrective Action Decision Document/Closure Report presents information supporting the closure of Corrective Action Unit (CAU) 550: Smoky Contamination Area, Nevada National Security Site, Nevada. This document complies with the requirements of the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management. CAU 550 includes 19 corrective action sites (CASs), which consist of one weapons-related atmospheric test (Smoky), three safety experiments (Ceres, Oberon, Titania), and 15 debris sites (Table ES-1). The CASs were sorted into the following study groups based on release potential and technical similarities:

- Study Group 1, Atmospheric Test
- Study Group 2, Safety Experiments
- Study Group 3, Washes
- Study Group 4, Debris

The purpose of this document is to provide justification and documentation supporting the conclusion that no further corrective action is needed for CAU 550 based on implementation of the corrective actions listed in Table ES-1. Corrective action investigation (CAI) activities were performed between August 2012 and October 2013 as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 550: Smoky Contamination Area*; and in accordance with the *Soils Activity Quality Assurance Plan*. The approach for the CAI was to investigate and make data quality objective (DQO) decisions based on the types of releases present. The purpose of the CAI was to fulfill data needs as defined during the DQO process. The CAU 550 dataset of investigation results was evaluated based on a data quality assessment. This assessment demonstrated the dataset is complete and acceptable for use in fulfilling the DQO data needs.

Investigation results were evaluated against the final action levels (FALs) established in this document to determine the need for corrective action. A radiological dose-based FAL of 25 millirem per year was established based on the Occasional Use Area exposure scenario (80 hours of annual exposure). Chemical contamination FALs were established for individual constituents. Removable radioactive contamination that exceeds the definition criteria for a high contamination area (HCA)

Table ES-1
CAU 550 Corrective Action Summary

CAS Number	Release Description	Corrective Action
08-23-04	Smoky Atmospheric Test	No further action
08-23-03	Ceres Safety Experiment	Closure in place with FFACO UR
08-23-06	Oberon Safety Experiment	
08-23-07	Titania Safety Experiment	
08-01-01; 08-22-05; 08-22-07; 08-22-08; 08-22-09; 08-24-03; 08-24-04; 10-22-17; 10-22-18;10-22-20; 10-24-10	Debris	No further action
08-24-07	Batteries (3)	Clean closure
	Battery	
	Lead Bricks (2)	
08-24-08	Batteries (3)	Clean closure
08-26-01	Lead Bricks (200)	Closure in place with FFACO UR
10-22-19	Drum; Stains	No further action
	Drum w/Liquid Contents	
	Asphalt Pile 1	
	Asphalt PIle 2	

UR = Use restriction

(i.e., HCA conditions) is assumed to require corrective action, even though the area may not present a potential radiation dose to a receptor that exceeds the FAL.

The reporting of investigation results and the evaluation of DQO decisions are at the release level. The corrective action alternatives (CAAs) were evaluated at the FFACO CAS level.

The Smoky site (CAS 08-23-04) is the surface release of radioactivity associated with the Smoky weapons-related atmospheric test. The Smoky site was investigated using a large array of thermoluminescent dosimeters (TLDs) surrounding Smoky ground zero and several soil samples. None of the sample locations exceed the FAL of 25 millirem per Occasional Use Area year (mrem/OU-yr); therefore, no corrective action was required.

The safety experiment sites (CASs 08-23-03, 08-23-06, and 08-23-07) are the surface release of contamination associated with the three safety experiments: Ceres, Oberon, and Titania, respectively. A default contamination boundary (DCB) was established that encompasses these three CASs. HCA conditions are present, and it was assumed that contaminants of concern (COCs) are present in excess of the FAL within the DCB. As such, the area within the DCB required corrective action. A corrective action of closure in place with URs was implemented. A major drainage system is present on the eastern side of CAU 550. Surface water drains from northwest of CAU 550 across the atmospheric test and safety experiment sites and the majority of the debris CASs to washes on the eastern side of the site and ultimately to a large catchment area east of Circle Road. The washes outside the contamination area fence were investigated through the collection of grab soil samples and the placement of TLDs. None of the sample locations exceed the FAL of 25 mrem/OU-yr; therefore, no corrective action was required.

The 15 debris CASs are the potential releases of contamination from debris items. These items were evaluated for the possibility of potential source material and for COCs in underlying soil. Although many of the debris CASs are proximate to the atmospheric or safety experiment CASs, only one has been definitively linked to a historical test. CAS 08-26-01, Lead Bricks (200), is located near the Smoky test ground zero and is considered an integral part of the relatively untouched, post-detonation environment. Based on the investigation data, corrective action was required at this CAS and at two other CASs: 08-24-07, (Batteries [3]; Battery; Lead Bricks [2]); and 08-24-08, (Batteries [3]). The corrective action implemented at CAS 08-26-01 was closure in place with URs; the corrective action implemented at CASs 08-24-07 and 08-24-08 was clean closure.

The corrective actions implemented at CAU 550 were developed based on an evaluation of analytical data from the CAI, the assumed presence of COCs at select locations, a review of current and future operations at CAU 550, and the detailed and comparative analysis of the CAAs. The CAAs were selected based on technical merit focusing on performance, reliability, feasibility, safety, and cost. The implemented corrective actions meet all requirements for the technical components evaluated and meet all applicable federal and state regulations for closure of the site. Based on the implementation of these corrective actions, the DOE, National Nuclear Security Administration Nevada Field Office provides the following recommendations:

- No further corrective actions are necessary for CAU 550.
- The Nevada Division of Environmental Protection issue the DOE, National Nuclear Security Administration Nevada Field Office a Notice of Completion for closure of CAU 550.
- CAU 550 be moved from Appendix III to Appendix IV of the FFACO.

1.0 Introduction

This Corrective Action Decision Document (CADD)/Closure Report (CR) presents information supporting closure of Corrective Action Unit (CAU) 550, Smoky Contamination Area, located in Areas 8 and 10 of the Nevada National Security Site (NNSS).

CAU 550 includes the releases associated with19 corrective action sites (CASs), which consist of one weapons-related atmospheric test (Smoky), three safety experiments (Ceres, Oberon, Titania), and 15 debris sites (Figure 1-1). To facilitate site investigation and the evaluation of data quality objective (DQO) decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions were organized into four study groups, as presented in Table 1-1. A detailed discussion of the history of CAU 550 is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 550: Smoky Contamination Area* (NNSA/NSO, 2012a) and is not repeated herein.

The corrective actions described in this document were implemented in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) (1996, as amended) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management.

1.1 Purpose

The purpose of this CADD/CR is to provide documentation and justification that no further corrective action is needed for the closure of CAU 550 based on the implementation of corrective actions. This document includes a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed.

1.2 Scope

The scope of activities used to identify, evaluate, and select preferred corrective action alternatives (CAAs) for CAU 550 included the following:

- Performed visual surveys to identify and verify CAS components and biasing factors.
- Performed radiological surveys to identify biased sampling locations.

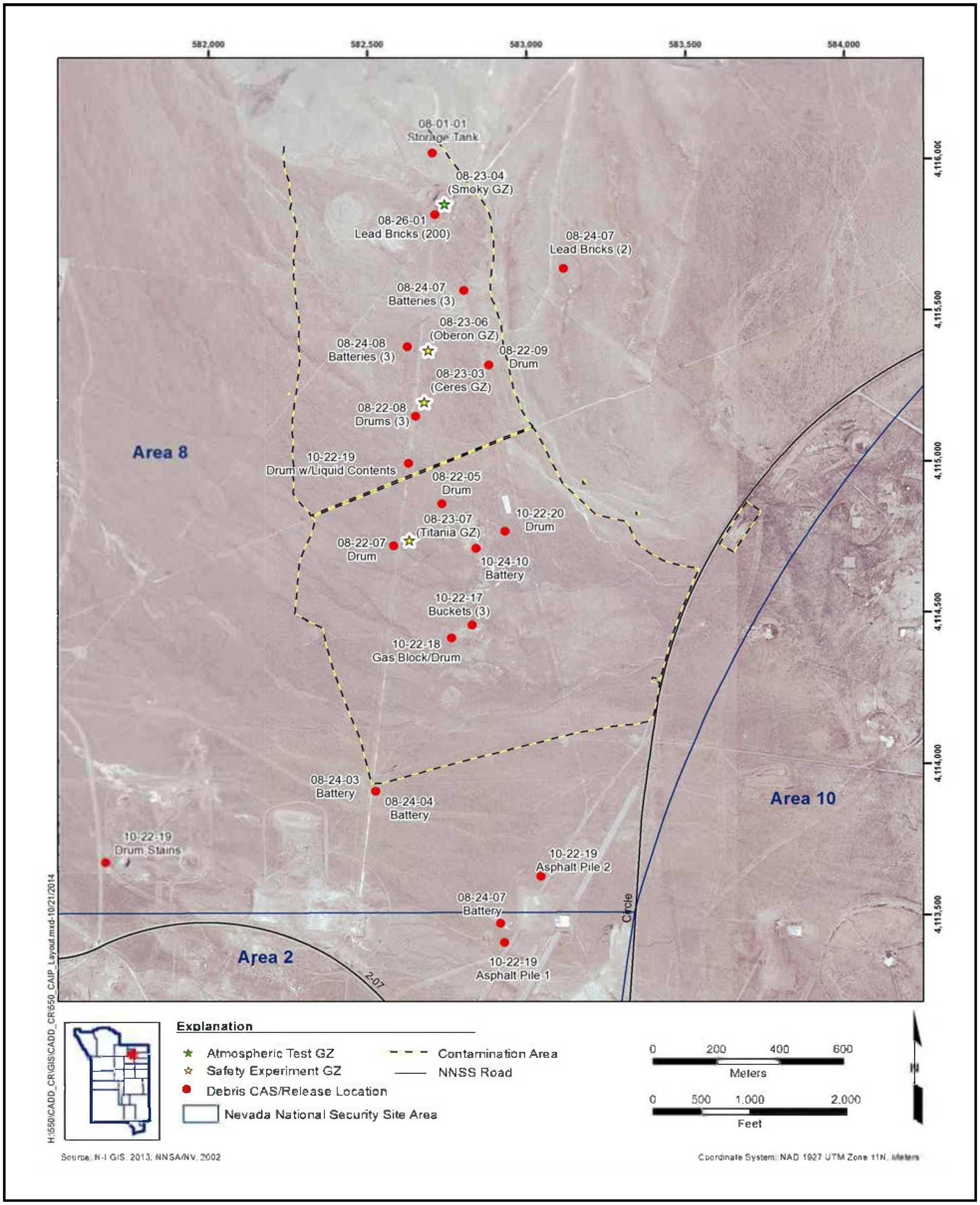

Figure 1-1
CAU 550 CAS and Releases

Table 1-1
CAU 550 Releases with Associated CASs and Study Groups

Release	CAS Number	FFACO CAS Description	Study Group	Release Type
Smoky Atmospheric Test	08-23-04	Atmospheric Test Site T-2C	1 Atmospheric Test	Surface release of radionuclides from atmospheric test tower
Ceres Safety Experiment	08-23-03	Atmospheric Test Site T-8B	2 Safety Experiments	Surface release of radionuclides from safety experiment towers
Oberon Safety Experiment	08-23-06	Atmospheric Test Site T-8A		
Titania Safety Experiment	08-23-07	Atmospheric Test Site T-8C		
Washes	--	--	3 Washes	Surface water and windborne migration from all releases
Storage Tank	08-01-01	Storage Tank	4 Debris	Surface and/or subsurface releases of radionuclides and/or chemicals from debris
Drum	08-22-05	Drum		
Drum	08-22-07	Drum		
Drums (3)	08-22-08	Drums (3)		
Drum	08-22-09	Drum		
Battery	08-24-03	Battery		
Battery	08-24-04	Battery		
Batteries (3)	08-24-07	Batteries (3)		
Battery				
Lead Bricks (2)				
Batteries (3)	08-24-08	Batteries (3)		
Lead Bricks (200)	08-26-01	Lead Bricks (200)		
Buckets (3)	10-22-17	Buckets (3)		
Gas Block/Drum	10-22-18	Gas Block/Drum		
Drum; Stains	10-22-19	Drum; Stains		
Drum w/Liquid Contents				
Asphalt Pile 1				
Asphalt Pile 2				
Drum	10-22-20	Drum		
Battery	10-24-10	Battery		

-- = Not applicable

- Collected environmental soil and thermoluminescent dosimeter (TLD) samples.
- Collected potential source material (PSM) samples.
- Removed PSM.
- Collected waste management samples to determine the proper disposal of waste.
- Collected quality control (QC) samples.
- Evaluated corrective action objectives based on the results of the corrective action investigation (CAI) and the CAA screening criteria.
- Selected and justified preferred CAAs.
- Implemented corrective actions.

The CAI for CAU 550 was completed by demonstrating through environmental soil and/or TLD sample analytical results the nature and extent of contaminants of concern (COCs) at each study group. For radiological releases, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding a final action level (FAL) of 25 millirem per year (mrem/yr). For chemical releases, a COC is defined as the presence of a contaminant above its corresponding FAL.

The CAI activities were completed in accordance with the CAIP (NNSA/NSO, 2012a), except as noted in Appendix A, and in accordance with the *Soils Activity Quality Assurance Plan* (QAP) (NNSA/NSO, 2012b), which establishes requirements, technical planning, and general quality practices. The evaluation of investigation results and the risk associated with site contamination was conducted in accordance with the *Soils Risk-Based Corrective Action* (RBCA) *Evaluation Process* (NNSA/NFO, 2014).

1.3 CADD/CR Contents

This document is divided into the following sections and appendices:

- Section 1.0, "Introduction," summarizes the purpose, scope, and contents of this document.
- Section 2.0, "Corrective Action Investigation Summary," summarizes the investigation field activities, the results of the investigation, and justifies that no further corrective action is needed.

- Section 3.0, "Conclusions and Recommendations," provides the basis for requesting that the CAU be moved from Appendix III to Appendix IV of the FFACO.
- Section 4.0, "References," provides a list of all referenced documents used in the preparation of this CADD/CR.
- Appendix A, *Corrective Action Investigation Results*, provides a description of the CAU 550 objectives, field investigation and sampling activities, investigation results, waste management, and quality assurance (QA).
- Appendix B, *Data Assessment*, provides a data quality assessment (DQA) that reconciles DQO assumptions and requirements to the investigation results.
- Appendix C, *Risk Assessment*, provides documentation of the chemical and radiological RBCA processes as applied to CAU 550.
- Appendix D, *Closure Activity Summary*, provides details on the completed closure activities, and includes the required verification activities and supporting documentation.
- Appendix E, *Evaluation of Corrective Action Alternatives*, provides a discussion of the results of the CAI, the alternatives considered, and the rationale for the selected alternative.
- Appendix F, *Sample Location Coordinates*, presents the CAI sample location coordinates.
- Appendix G, *Nevada Division of Environmental Protection* (NDEP) *Comments*, contains NDEP comments on the draft version of this document.

1.3.1 Applicable Programmatic Plans and Documents

All investigation activities were performed in accordance with the following documents:

- CAIP for CAU 550, Smoky Contamination Area (NNSA/NSO, 2012a)
- Soils Activity QAP (NNSA/NSO, 2012b)
- Soils RBCA document (NNSA/NFO, 2014)
- FFACO (1996, as amended)

1.3.2 Data Quality Assessment Summary

The CAIP contains the DQOs as agreed to by decision makers before the field investigation. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions with an appropriate level of confidence. A DQA was conducted that evaluated the degree of acceptability and usability of the reported data in the decision-making process. This DQA is presented in Appendix B and summarized in Section 2.2.2. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

Based on this evaluation, the nature and extent of COCs at CAU 550 have been adequately identified to implement corrective actions. Information generated during the investigation supports the conceptual site model (CSM) assumptions, and the data collected meet the DQOs and support their intended use in the decision-making process.

2.0 Corrective Action investigation Summary

The following subsections summarize the investigation activities and investigation results, and justify why no further corrective action is required at CAU 550. Detailed investigation activities and results for individual CAU 550 study groups are presented in Appendix A.

2.1 Investigation Activities

Investigation activities were conducted between August 2012 and October 2013. The purpose of the CAU 550 CAI was to provide the additional information needed to resolve the following CAU-specific DQOs:

- Determine whether COCs are present in the soils associated with CAU 550.
- Determine the extent of identified COCs.
- Ensure adequate data have been collected to evaluate CAAs under the FFACO.

Investigation activities at the four study groups in CAU 550 included visual surveys, terrestrial radiological surveys (TRSs), soil sampling, and/or TLD sampling. These activities were consistent with the CAIP (NNSA/NSO, 2012a) and provided the necessary information to establish the nature and extent of contamination associated with each study group. The field investigation was completed as specified in the CAIP with minor deviations as described in the study group-specific sections.

Data to calculate radiological dose were provided by TLD samples for external radiological dose and soil samples for internal radiological dose. Data to evaluate chemical risk were provided by analytical results of soil and/or PSM samples.

For DQO Decision I at potential release sites, sample locations were established judgmentally based on the presence of biasing factors (e.g., lead bricks, highest radiation survey values). Using the contamination levels from the judgmental locations of highest potential contamination provides a conservative estimate of the contaminant exposure a receptor would receive from working at the release site. Where samples were collected at sample plots, an additional level of conservatism was added by evaluating the judgmental sample results probabilistically using the 95 percent upper confidence limit [UCL] of the average sample result to resolve DQO Decision I.

Sample locations for DQO Decision II (the extent of COC contamination) for radiological COCs were selected judgmentally at locations estimated to provide a range of dose values from the highest dose to a level below the FAL. The extent of radiological COC contamination was defined as a boundary that encompasses radiation survey isopleths with a value that corresponds to a total effective dose (TED) of 25 mrem/yr. To accomplish this, the relationship between TED (the sum of internal and external dose) and radiation survey values is estimated from a simple linear regression of paired calculated TED and radiation survey values for each sample location. Then the radiation survey value that corresponds to 25 mrem/yr is calculated from the regression equation. Confidence in estimating the extent of Decision II was provided by a more conservative estimate of the radiation survey value corresponding to 25 mrem/yr. This is accomplished using the uncertainty of how well the calculated relationship between TED and radiation survey values (i.e., the regression) represents the assumed true relationship. This uncertainty includes the uncertainty of how well the calculated TED represents true TED and the uncertainty of how well the radiation survey instrument readings represent the calculated TED. This combined uncertainty was estimated using an uncertainty interval as defined in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance* (EPA, 2009). This process for using regression uncertainty in establishing a conservative estimate of the extent of COC contamination is presented in the Soils RBCA document (NNSA/NFO, 2014).

The calculated TED (the sum of internal and external dose) for each sample location is an estimation of the true radiological dose (true TED). The TED is defined in 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2013) as the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures).

As described in Appendix C, the TED to a receptor from site contamination is a function of the time the receptor is present at the site and exposed to the radioactively contaminated soil. Therefore, TED is reported in this document based on the following three exposure scenarios that address the potential exposure of site workers to contaminants in soil:

- **Industrial Area.** Assumes continuous industrial use of a site. This scenario assumes that the site is the regular assigned work area for the worker who will be on the site for an entire career (8 hours per day [hr/day] for 25 years, or 250 days per year [day/yr]). The worker is assumed to spend 1/3 of the workday outdoors exposed to contaminated soil. The TED values calculated using this exposure scenario are the TED an industrial worker receives during

2,000 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Industrial Area year (mrem/IA-yr).

- **Remote Work Area.** Assumes non-continuous work activities at a site. This scenario assumes that the site is an area where the worker regularly visits but is not an assigned work area where the worker spends an entire workday. A site worker under this scenario is assumed to be at the site for an equivalent of 336 hours per year (hr/yr) (or 8 hr/day for 42 day/yr) for an entire career (25 years). The worker is assumed to spend 1/3 of the workday outdoors exposed to contaminated soil. The TED values calculated using this exposure scenario are the TED a remote area worker receives during 336 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Remote Work Area year (mrem/RW-yr).

- **Occasional Use Area.** Assumes occasional work activities at a site. This scenario assumes that the site is an area where the worker does not regularly visit but may occasionally use for short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 80 hr/yr (or 8 hr/day for 10 day/yr) for 5 years. The TED values calculated using this exposure scenario are the TED an occasional use worker receives during 80 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Occasional Use Area year (mrem/OU-yr).

In accordance with the graded approach described in the Soils Activity QAP (NNSA/NSO, 2012b), the quality required of a dataset will be determined by its intended use in decision making. Data used to define the presence of COCs are classified as decisional and will be used to make corrective action decisions. Survey data are classified as decision supporting and are not used, by themselves, to make corrective action decisions. As presented in Appendix C, the radiological and chemical FALs are based on the Occasional Use Area and Industrial Area land use scenarios, respectively. Methods used for calculating internal, external, and total dose are presented in the Soils RBCA document (NNSA/NFO, 2014). The following subsections provide a summary of investigation activities conducted at each study group. Additional detail regarding the investigation is presented in Appendix A.

2.1.1 Study Group 1, Atmospheric Test

The CAI at Study Group 1 included visual surveys, TRSs, and the collection of surface soil samples and TLDs. Section A.3.1 provides details of the investigation activities conducted at Study Group 1.

Visual Surveys. Visual surveys of Study Group 1 were conducted at and surrounding Smoky ground zero (GZ) within and outside the contamination area (CA) fence. The locations of previously identified underground concrete bunkers, an aircraft carcass, two armored personnel carriers, scattered metal, and other test-related debris surrounding the Smoky atmospheric test site were confirmed during the CAI. Removable contamination surveys were performed on debris identified outside the CA fence. These surveys did not indicate the presence of CA conditions. Debris items identified during the CAI that were located inside the CA fence (e.g., underground bunkers, airplane carcass) are assumed to present CA conditions. The visual survey of these items did not reveal any evidence or suggestion of a release (e.g., visible soil staining, presence of PSM), and therefore did not warrant further investigation.

A preliminary assessment of cultural resources at the Smoky site was conducted in 2012 (Beck, 2014). This assessment documented the presence of structures and features of historical significance, to include underground concrete structures (Figure 2-1), metal debris (Figure 2-2), lead bricks (Figure 2-3), and other material associated with the Smoky test. The lead bricks identified at the Smoky site and shown in Figure 2-3 were investigated as a separate CAS in Study Group 4 (CAS 08-26-01, Lead Bricks [200]) due to the potential for lead contamination in the soil. Although the lead bricks were not investigated as part of Study Group 1 (CAS 08-23-04, Smoky Atmospheric Test), the lead bricks are directly related to the Smoky test and are considered an integral part of the Smoky historic landscape. Because the site has remained essentially unchanged since the Smoky atmospheric test, it is eligible to the National Register of Historic Places as a historical landscape (Ernstein, 2014).

Radiological Surveys. Comprehensive TRSs using the PRM-470 and field instrument for the detection of low-energy radiation (FIDLER) were conducted at Study Group 1 during the preliminary investigation in 2011 and were reported in the CAIP (NNSA/NSO, 2012a). These survey results were used to select the proposed Study Group 1 TLD and sample plot locations. Radiological surveys during the CAI were limited to localized measurements at proposed sample locations to ensure samples were collected at locations with the highest radioactivity levels.

Sampling. A total of 56 TLDs were placed at Study Group 1 to determine external dose. The TLDs were placed in the center of each sample plot and were arranged in a uniform grid pattern centered on

Figure 2-1
Underground Structure at CAS 08-23-04 (Smoky)

Figure 2-2
Metal Debris at CAS 08-23-04 (Smoky)

Figure 2-3
Lead Bricks at CAS 08-23-04 (Smoky)

the Smoky GZ area. A total of 17 composite soil samples were collected from 14 sample plots at Study Group 1. One of the sample plots (location A01) was established within the area of most elevated radioactivity as identified by the 1994 gross count aerial radiological survey and TRSs. Four samples were collected at this plot. Thirteen additional sample plots (locations A45 through A48 and A51 through A59) were established at locations within the TLD grid. These locations were established within an area of potential overlap between the contamination plumes of Study Group 1 (Atmospheric Test) and Study Group 2 (Safety Experiments). One composite soil sample was collected at each of these sample plots. Figure A.3-1 presents the TLD and soil sample locations for Study Group 1. Additional detail is provided in Section A.3.1. The results of the sampling at this study group are presented in Section 2.2.1.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 1 is consistent with the CSM in that the radiological dose is highest near GZ and generally decreases with distance from the release point in a roughly annular pattern. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was necessary.

2.1.2 Study Group 2, Safety Experiments

The CAI at Study Group 2 included visual surveys, TRSs, and the collection of surface soil samples and TLDs. Section A.4.1 provides details of the investigation activities conducted at Study Group 2.

A default contamination boundary (DCB) surrounding the three safety experiments was established based on historical removable contamination survey data, which suggested the presence of high contamination area (HCA) conditions within the DCB (NNSA/NSO, 2012a). The east and west boundaries of the DCB follow an existing fence line that is currently posted as a CA (see Figure A.4-1). However, the DCB does not coincide with a posted HCA. The responsibility for identifying, posting, and maintaining an HCA (or CA) rests with the DOE Occupational Radiation Protection program, which is governed by the requirements in 10 CFR 835, "Occupational Radiation Protection" (CFR, 2013). This program was established for worker health and safety, and is independent of the FFACO. However, the data collected in support of the program and the existing postings are relevant in determining the radiological conditions at a site.

Visual Surveys. Visual surveys of Study Group 2 were conducted at and surrounding the three safety experiment GZs. Several debris items were noted in the southern portion of the DCB, including an electrical junction box, wood pieces, metal scrap, and other solid debris. It is likely that these items were part of the tower structures or otherwise associated with the three safety experiments. Removable radioactive contamination consistent with HCA conditions was identified on the debris; however, the visual survey did not find evidence of chemical releases (e.g., stains, distressed vegetation) from any of the debris. There is no indication that the radioactive contamination on the debris is from a source other than the safety experiments. No biasing factors were identified at the locations of the debris items identified during the Study Group 2 visual survey that would indicate the presence of a potential release.

Radiological Surveys. Radiological surveys using a FIDLER were conducted at Study Group 2 during the preliminary investigation in 2011. These surveys were conducted inside the DCB at and surrounding the three safety experiment GZs. The results of these surveys are reported in the CAIP (NNSA/NSO, 2012a). The purpose of the FIDLER surveys was to obtain ground-based radiological data to confirm the spatial distribution of radiological contamination shown in the aerial radiation surveys of the area.

Radiological surveys during the CAI were limited to localized measurements at proposed sample plot locations to ensure samples were collected at locations with the highest radioactivity levels.

Sampling. A total of eight composite soil samples were collected from two sample plots (Locations B01 and B02) at Study Group 2. One TLD was placed at each of the two sample plots. The two sample plots were established outside the DCB at the areas of highest radiological measurements. Additional detail is provided in Section A.4.1, and sample locations are shown on Figure A.4-2. The results of the sampling at this study group are presented in Section 2.2.1.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was necessary.

2.1.3 Study Group 3, Washes

The CAI at Study Group 3 included visual and hydrological surveys, TRSs, and the collection of surface and subsurface soil samples and TLDs. Section A.5.1 provides details of the investigation activities conducted at Study Group 3.

Visual and Surface Hydrological Surveys. Study Group 3 is made up of three wash segments west of Circle Road and one depositional area east of Circle Road, as defined in the CAIP (NNSA/NSO, 2012a) and shown in Figure A.5-1. Visual surveys, including visual identification of hydrological drainage and sedimentation features, were conducted within and adjacent to each of these areas and within the large catchment area on the east side of Circle Road. The large catchment area east of Circle Road encompasses the following features where surface water and/or sediment accumulates during precipitation events: the U10a crater, the depositional area mentioned above, and the visible sedimentation accumulation areas presented in Figure A.5-1. Two small posted areas were noted on the flat area between the washes. These areas, each approximately 25 square feet (ft^2) in area, are posted with CA signs. No surface debris was identified within the posted areas. With the exception of sporadic occurrences of Trinity glass, no potential releases or PSM was identified in the visual survey at Study Group 3. (The term “Trinity glass” is commonly used to describe the glass-like substance formed from the sand melted by the heat of an atmospheric nuclear detonation.)

Radiological Surveys. Comprehensive TRSs, using the PRM-470 and FIDLER, were conducted at Study Group 3 during the preliminary investigation in 2011 and were reported in the CAIP (NNSA/NSO, 2012a). An additional FIDLER survey was completed in 2012 to provide better coverage of the southeastern segment of the largest wash. The results of the radiological surveys were used to bias the selection of sampling locations to areas with the highest radioactivity levels. The 2011 and 2012 survey results are presented in Figure A.5-2. In order to determine the impact of a significant rainfall event at CAU 550 in late summer 2013, an additional FIDLER survey was conducted within the Study Group 3 washes. This survey followed the same path as the 2011/2012 FIDLER surveys to allow for the evaluation of contaminant migration by a direct comparison of the two surveys. The results of these surveys are presented in further detail in Section A.5.6 and in Figure A.5-5.

A survey of the two small, posted CAs located on the flat area between the washes was conducted using a FIDLER. Elevated readings relative to the surrounding area were not noted; therefore, additional investigation of these two areas was not conducted.

A removable contamination swipe survey was also conducted within the washes and along the erosion paths east and west of Circle Road. None of these swipes exceeded the criteria for defining an HCA or CA.

Sampling. A total of 13 surface soil grab samples, seven subsurface soil grab samples, and 11 TLD samples were collected from 11 locations (C01 through C11) at Study Group 3 (Figure A.5-2). The grab samples and TLDs were collected at two sedimentation areas within each of the three wash segments and at the depositional area east of Circle Road in accordance with the CAIP (NNSA/NSO, 2012a). In addition, one six-point composite soil sample was collected at the edge of the U10a crater (Location W1) to further evaluate contaminant migration (see Figure A.5-1). Additional information is provided in Section A.5.6. The results of the sampling at this study group are presented in Section 2.2.1.3.

The information gathered during the CAI supports and refines the CSM as presented in the CAIP. The surface hydrological and radiological surveys of the washes at CAU 550 confirm that contaminant migration from the atmospheric and safety experiment GZs is occurring via surface water runoff. In addition, the surveys suggest that the drainage system endpoints include the depositional area and the U10a crater east of Circle Road. No modification to the CSM was necessary.

2.1.4 Study Group 4, Debris

The 15 debris CASs include the potential releases of contamination from debris items. These items were evaluated for the potential to be, or contain, PSM and for the presence of COCs in underlying soil. The CAI at Study Group 4 included visual surveys and the collection of soil and PSM samples. Seventeen soil samples, two solid PSM samples, and one liquid PSM sample were collected at the Study Group 4 CASs; the results of these samples are discussed in Section 2.2.1.4. Investigation samples were not collected at CAS 10-22-18 (Gas Block/Drum) or CAS 08-26-01 (Lead Bricks [200]). At CAS 10-22-18, no indication of a release was evident, and the gas block/drum was determined not to be PSM; therefore, no sample was collected and no further action is required. CAS 08-26-01 consists of approximately 200 lead bricks located near the Smoky test GZ. A sample was not collected at this site because the lead bricks are assumed to be PSM and the site requires corrective action.

Visual Surveys. As indicated in the CAIP (NNSA/NSO, 2012a), there was some uncertainty associated with the debris CASs as to whether the debris was still located at CAU 550 or had been removed during past corrective actions at the debris CASs. Visual surveys were performed at the Study Group 4 sites to confirm the presence or absence of debris at the CASs and to identify any other potential releases or PSM at CAU 550. Historical information—including Global Positioning System (GPS) coordinates, written driving directions, and field maps/notes—was used to navigate to each debris CAS to perform the visual surveys. The debris at nine of the 15 CASs was not found and is presumed to have been removed at some time before the CAI (Table 2-1). Debris consistent with the CAS descriptions were present at the other six debris CASs. Five previously unidentified potential releases were identified during the visual surveys at CAU 550. These included two asphalt piles, a broken battery, lead bricks (2), and one 55-gallon (gal) drum that contained a small amount of liquid. Figure A.6-1 presents the locations of the 15 debris CASs and the five previously unidentified potential releases. The five previously unidentified potential releases were not assigned a CAS number but were each placed into an existing Study Group 4 debris CAS for closure, as shown in Table 2-1.

Table 2-1
Study Group 4 Debris CASs
(Page 1 of 2)

CAS Number	Sample Location	Debris Description	Sample Number	Sample Matrix	Analyses	Status
08-01-01	D01	Storage Tank	D001	Soil	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
08-22-05	E01	Drum	E001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
08-22-07	F01	Drum	F001	Soil	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris removed; soil sample collected underneath debris
08-22-08	G01	Drums (3)	G001	Soil		Debris removed; soil sample collected underneath debris
08-22-09	H01	Drum	H001	Soil		Debris not present; soil sample collected at CAS location
08-24-03	I01	Battery	I001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
08-24-04	J01	Battery	J001	Soil		Debris not present; soil sample collected at CAS location
08-24-07	K01	Batteries (3)	K001	Soil	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris removed; soil sample collected underneath debris
	U1	Battery[a]	U01	Soil	RCRA metals, Cr(VI)	Debris removed; soil sample collected underneath debris
	T1	Lead Bricks (2)[a]	T01 T02 (FD)	Soil	RCRA metals, Cr(VI)	Debris removed; soil sample collected underneath debris
08-24-08	Y1	Batteries (3)	Y01	Soil	RCRA metals, Cr(VI)	Debris removed; soil sample collected underneath debris

Table 2-1
Study Group 4 Debris CASs
(Page 2 of 2)

CAS Number	Sample Location	Debris Description	Sample Number	Sample Matrix	Analyses	Status
08-26-01	--	Lead Bricks (200)	--	--	--	Debris left in place; no sample collected
10-22-17	N01	Buckets (3)	N001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
10-22-18	--	Gas Block/Drum	--	--	--	Debris left in place; no sample collected
10-22-19	P01	Drum; Stains	P001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
			P002 (FD)			
	X1	Drum w/Liquid Contents[a]	X01	Liquid (PSM)	Gamma spectroscopy, Tritium, Isotopic U, Isotopic Am, Isotopic Pu, Sr-90, SVOCs, RCRA metals, PCBs	Debris removed; liquid sample collected of drum contents
	S1	Asphalt Pile 1[a]	S101	Solid (PSM)	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, Cr(VI), TCLP metals, TCLP SVOCs, TCLP VOCs	Pile left in place; sample collected of pile
	S2	Asphalt Pile 2[a]	S201	Solid (PSM)		Pile left in place; sample collected of pile
10-22-20	Q01	Drum	Q001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
10-24-10	R01	Battery	R001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location

[a]Previously unidentified releases identified during CAI.

Am = Americium
Cr(VI) = Hexavalent chromium
FD = Field duplicate
PCB = Polychlorinated biphenyl
Pu = Plutonium
RCRA = *Resource Conservation and Recovery Act*
Sr = Strontium
SVOC = Semivolatile organic compound
TCLP = Toxicity Characteristic Leaching Procedure
U = Uranium
VOC = Volatile organic compound

-- = Not applicable

Sampling. A total of 17 soil samples, two solid PSM samples, and one liquid PSM sample were collected at the Study Group 4 (Figure A.6-1). The locations and associated samples are listed in Table 2-1 and discussed in further detail in Section A.6.1. The results of the sampling at this study group are presented in Section 2.2.1.4.

2.2 Results

The data summary provided in Section 2.2.1 presents the COCs identified at CAU 550. Section 2.2.2 summarizes the assessment found in Appendix B, which demonstrates that the investigation results satisfy the DQO data requirements.

The preliminary action levels (PALs) and FALs for radioactivity are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 550 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs for radioactivity were established in the CAIP (NNSA/NSO, 2012a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario that a site worker would be exposed to site contamination for 8 hr/day for 250 day/yr). The FALs for radioactivity were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 80 hours (i.e., the Occasional Use Area exposure scenario defines that a site worker would be exposed to site contamination for 8 hr/day for 10 day/yr). To be comparable to these action levels, the CAU 550 investigation results are presented in terms of the dose a receptor would receive from site contamination under the Industrial Area (mrem/IA-yr) and Occasional Use Area (mrem/OU-yr) exposure scenarios.

The chemical PALs are based on the U.S. Environmental Protection Agency (EPA) Region 9 Regional Screening Levels (RSLs) for chemical contaminants in industrial soils (EPA, 2013) except where natural background concentrations of RCRA metals exceed the screening level (e.g., arsenic on the NNSS). With the exception of lead and arsenic, the chemical FALs are established in Appendix C at the PAL concentrations.

2.2.1 Summary of Analytical Data

The following subsections present a summary of the analytical and computational results for soil and TLD samples at Study Groups 1 through 4. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). Results that are equal to or greater than the FAL are identified by bold text in the data tables.

Chemical results are reported as individual analytical results compared to their individual FALs. PSM samples are evaluated against the PSM criteria and assumptions defined in Section 2.3.1 to determine whether a release of the waste to the surrounding environmental media could cause the presence of a COC in the environmental media. Radiological results are reported as doses that are compared to the dose-based FAL of 25 mrem/OU-yr. Calculation of the TED for each sample was accomplished through summation of internal and external dose as described in Sections A.3.3.4, A.4.3.3, A.5.3.3, and A.6.3.1.

Judgmental sample results are reported as individual analytical results and as multiple contaminant analyses where the combined effect of contaminants are compared to FALs. Probabilistic sample results are reported as the average and the 95 percent UCL of the average results.

2.2.1.1 Study Group 1

Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-2. None of the Study Group 1 sample locations exceed the FAL of 25 mrem/OU-yr, as shown in Table 2-2 and Figure A.3-2.

Table 2-2
Study Group 1 TED at Sample Locations (mrem/yr)
(Page 1 of 3)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
A01	**87.1**	**96.0**	14.6	16.1	4.4	4.8
A04	3.0	5.0	0.5	0.8	0.1	0.3
A05	3.5	4.9	0.6	0.8	0.2	0.2

Table 2-2
Study Group 1 TED at Sample Locations (mrem/yr)
(Page 2 of 3)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
A06	6.0	7.6	1.0	1.3	0.3	0.4
A07	0.0	0.1	0.0	0.0	0.0	0.0
A08	2.5	3.7	0.4	0.6	0.1	0.2
A09	0.6	3.1	0.1	0.5	0.0	0.2
A10	0.0	1.3	0.0	0.2	0.0	0.1
A11	5.4	7.8	0.9	1.3	0.3	0.4
A12	0.3	1.7	0.0	0.3	0.0	0.1
A13	1.6	4.1	0.3	0.7	0.1	0.2
A14	5.9	7.3	1.0	1.2	0.3	0.4
A15	4.7	7.7	0.8	1.3	0.2	0.4
A16	15.7	16.8	2.6	2.8	0.8	0.8
A17	14.5	14.8	2.4	2.5	0.7	0.7
A18	**30.0**	**34.9**	5.0	5.9	1.5	1.7
A19	**26.6**	**29.5**	4.5	5.0	1.3	1.5
A20	9.4	14.1	1.6	2.4	0.5	0.7
A21	**27.6**	**30.2**	4.6	5.1	1.4	1.5
A22	15.4	16.8	2.6	2.8	0.8	0.8
A23	6.1	7.8	1.0	1.3	0.3	0.4
A24	11.6	13.7	2.0	2.3	0.6	0.7
A25	17.7	21.1	3.0	3.5	0.9	1.1
A26	11.9	15.4	2.0	2.6	0.6	0.8
A27	5.9	7.1	1.0	1.2	0.3	0.4
A28	7.6	11.5	1.3	1.9	0.4	0.6
A29	9.0	11.2	1.5	1.9	0.5	0.6
A31	1.4	2.5	0.2	0.4	0.1	0.1
A32	0.0	0.9	0.0	0.1	0.0	0.0
A33	2.9	4.5	0.5	0.8	0.1	0.2

Table 2-2
Study Group 1 TED at Sample Locations (mrem/yr)
(Page 3 of 3)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
A34	9.3	9.8	1.6	1.6	0.5	0.5
A35	13.0	15.2	2.2	2.5	0.6	0.8
A36	**37.0**	**40.6**	6.2	6.8	1.9	2.0
A37	**34.6**	**39.6**	5.8	6.7	1.7	2.0
A38	19.5	22.3	3.3	3.8	1.0	1.1
A39	10.1	12.5	1.7	2.1	0.5	0.6
A40	2.7	2.9	0.5	0.5	0.1	0.1
A41	1.4	3.2	0.2	0.5	0.1	0.2
A42	17.5	18.2	2.9	3.1	0.9	0.9
A43	**45.7**	**52.9**	7.7	8.9	2.3	2.6
A44	**59.4**	**61.8**	10.0	10.4	3.0	3.1
A45	**43.8**	**49.7**	7.4	8.3	2.2	2.5
A46	**40.0**	**41.5**	6.7	7.0	2.0	2.1
A47	**27.3**	**30.0**	4.6	5.0	1.4	1.5
A48	17.8	19.6	3.0	3.3	0.9	1.0
A49	5.0	5.3	0.8	0.9	0.2	0.3
A50	4.4	7.2	0.7	1.2	0.2	0.4
A51	14.0	17.4	2.4	2.9	0.8	0.9
A52	11.7	14.8	2.0	2.5	0.6	0.8
A53	22.1	24.6	3.7	4.1	1.1	1.2
A54	**30.4**	**32.0**	5.1	5.4	1.5	1.6
A55	12.9	15.6	2.2	2.6	0.7	0.8
A56	9.3	11.0	1.6	1.8	0.5	0.6
A57	21.5	22.9	3.6	3.9	1.2	1.3
A58	10.6	12.6	1.8	2.1	0.6	0.7
A59	7.2	8.7	1.2	1.5	0.4	0.5

Bold indicates the values exceeding 25 mrem/yr.

2.2.1.2 Study Group 2

Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-3. None of the Study Group 1 sample locations exceed the FAL of 25 mrem/OU-yr.

Table 2-3
Study Group 2 TED at Sample Locations (mrem/yr)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
B01	11.4	12.5	1.9	2.1	0.6	0.6
B02	10.4	11.9	1.7	2.0	0.6	0.6

2.2.1.3 Study Group 3

Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-4. None of the Study Group 3 sample locations exceed the FAL of 25 mrem/OU-yr, as shown in Table 2-4 and Figure A.5-3.

Table 2-4
Study Group 3 TED at Sample Locations (mrem/yr)
(Page 1 of 2)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
C01	18.5	20.7	3.1	3.5	1.0	1.1
C02	8.6	11.1	1.5	1.9	0.4	0.6
C03	**27.6**	**37.8**	4.6	6.4	1.4	1.9
C04	12.5	13.1	2.1	2.2	0.6	0.7
C05	20.3	**26.5**	3.4	4.5	1.0	1.3
C06	13.2	15.0	2.2	2.5	0.7	0.8
C07	24.0	**27.7**	4.0	4.6	1.2	1.4
C08	**29.7**	**34.3**	5.0	5.7	1.5	1.7

Table 2-4
Study Group 3 TED at Sample Locations (mrem/yr)
(Page 2 of 2)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
C09	23.7	**26.2**	4.0	4.4	1.2	1.3
C10	22.1	**25.8**	3.7	4.3	1.1	1.3
C11	21.9	24.4	3.7	4.1	1.2	1.3

Bold indicates the values exceeding 25 mrem/yr.

A radiological dose was also calculated for the grab sample collected near the U10a crater, as part of the surface hydrological survey. The TED at the U10a crater (Location W1) was estimated at 0.0 mrem/OU-yr and 0.2 mrem/IA-yr. The results of the surface hydrological survey are presented in Section A.5.6.

2.2.1.4 Study Group 4

Analytical results for chemical constituents in soil, solid PSM, and liquid PSM samples collected at Study Group 4 that were detected above minimum detectable concentrations (MDCs) are presented in Tables 2-5 through 2-9. For soil samples, the individual analytical result was compared directly to the chemical FAL to determine whether a COC was present. As shown in Tables 2-5 and 2-6, none of the chemical constituents were detected above their respective FALs; therefore, no chemical COCs were identified in soil at any of the sampled debris CASs.

The soil samples collected at the locations listed in Table 2-7 were analyzed for radionuclides to determine whether a release from the debris has resulted in a dose exceeding the FAL. Values for the average internal, external, and total dose for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios at the Study Group 4 debris sample locations are presented in Table 2-7. Based on these results, the samples from Study Group 4 do not contain COCs in excess of the FAL and the radionuclides present are consistent with those detected in the soil sample plots for Study Groups 1 and 2 (i.e., a mixture of fission radionuclides and plutonium). Therefore, the radiological results demonstrate that the debris items are not a source of radiological COCs.

Table 2-5
Study Group 4 Soil Sample Results for Metals Detected above MDCs

Sample Location	Sample Number	Matrix	COPCs (mg/kg)							
			Arsenic	Barium	Beryllium	Cadmium	Lead	Mercury	Selenium	Silver
FALs			**23**[a]	**190,000**	**2,000**	**800**	**5,739**	**43**	**5,100**	**5,100**
D01	D001	Soil	2.3 (J-)	75 (J)	0.37 (J-)	0.14	9.2	0.022 (J-)	--	--
E01	E001	Soil	5.6	160 (J)	0.44 (J-)	0.31 (J-)	10	0.022 (J-)	0.88	--
F01	F001	Soil	7.1	160 (J)	0.64	0.3	76	0.032 (J-)	1.7	--
G01	G001	Soil	5.9	150 (J)	0.74	6.4	27	0.033 (J-)	0.37	--
H01	H001	Soil	5.9	300 (J)	0.94	0.3	21	0.04 (J-)	0.55	--
I01	I001	Soil	4.5	130 (J)	0.53	0.19	11	0.022 (J-)	0.62	--
J01	J001	Soil	5.5	150 (J)	0.54	0.25	13	0.023 (J-)	--	--
K01	K001	Soil	3.9	99 (J)	0.47 (J-)	0.12	84	0.042 (J-)	--	--
N01	N001	Soil	6.2	180 (J)	0.7	0.28 (J-)	20	0.026 (J-)	0.8	--
P01	P001	Soil	3 (J-)	130 (J)	0.59	0.21	11	0.021 (J-)	0.5	--
	P002 (FD)	Soil	4	130 (J)	0.65	0.26	11	0.019 (J-)	--	--
Q01	Q001	Soil	6	160 (J)	0.54	0.33 (J-)	12	0.025 (J-)	0.62	--
R01	R001	Soil	6.4	180 (J)	0.78	0.23 (J-)	16	0.034 (J-)	--	--
T1	T01	Soil	5.6	200	--	0.62	27 (J)	0.027	--	--
	T02 (FD)	Soil	5.3	190	--	0.57	24 (J)	0.032	--	--
U1	U01	Soil	5.2	140	--	0.11 (J-)	1,400 (J)	0.036	0.56 (J+)	--
Y1	Y01	Soil	6.8	360 (J)	--	27 (J)	150 (J)	--	1.7 (J)	0.24 (J-)

[a] Based on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).

COPC = Contaminant of potential concern
mg/kg = Milligrams per kilogram

J = Estimated value.
J+ = The result is an estimated quantity, but the result may be biased high.
J- = The result is an estimated quantity, but the result may be biased low.
-- = Not detected above MDC.

Table 2-6
Study Group 4 Soil Sample Results for SVOCs and PCBs Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent (mg/kg)	
			SVOCs	PCBs
			2,4-Dinitrotoluene	Aroclor 1260
FALs			5.5	0.74
F01	F001	Soil	--	0.013 (J)
G01	G001	Soil	1.1	0.026
P01	P002 (FD)	Soil	--	0.013 (J)

-- = Not detected above MDCs.

Table 2-7
Study Group 4 TED (mrem/yr)

Sample Location	Industrial Area			Remote Work Area			Occasional Use Area		
	Average Internal	External	Average TED	Average Internal	External	Average TED	Average Internal	External	Average TED
D01	0.0	7.6	7.6	0.0	1.3	1.3	0.0	0.4	0.4
E01	0.2	2.0	2.2	0.0	0.3	0.4	0.0	0.1	0.1
F01	**45.0**	15.4	**60.4**	7.6	2.6	10.2	2.7	0.8	3.5
G01	3.6	3.0	6.5	0.6	0.5	1.1	0.2	0.1	0.4
H01	0.2	2.5	2.8	0.0	0.4	0.5	0.0	0.1	0.1
I01	0.0	1.8	1.9	0.0	0.3	0.3	0.0	0.1	0.1
J01	0.0	2.1	2.1	0.0	0.3	0.3	0.0	0.1	0.1
K01	0.5	18.6	19.1	0.1	3.1	3.2	0.0	0.9	1.0
N01	0.2	1.7	1.8	0.0	0.3	0.3	0.0	0.1	0.1
P01	0.1	1.5	1.6	0.0	0.2	0.3	0.0	0.1	0.1
Q01	1.6	2.4	4.0	0.3	0.4	0.7	0.1	0.1	0.2
R01	0.0	0.9	0.9	0.0	0.2	0.2	0.0	0.0	0.0

Bold indicates the value exceeds 25 mrem/yr.

Analytical results for chemical constituents in the two solid PSM samples were compared directly to the FAL using a simplifying assumption that the concentration of the contaminant when released to soil would be equal to the concentration of the contaminant in the waste. The chemical analytical results for the solid PSM are presented in Tables 2-8 and 2-9. The concentrations of chemical

Table 2-8
Study Group 4 Solid PSM Sample Results for Metals Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent (mg/kg)					
			Arsenic	Barium	Cadmium	Lead	Mercury	Selenium
FALs			23	190,000	800	5,739	43	5,100
S1	S101	Solid	4.4	110	0.16 (J-)	6.7	0.013	--
S2	S201	Solid	4.5	110	0.12 (J-)	6.6	0.015	0.99

J- = Estimated value, biased low.
-- = Not detected above MDCs.

Table 2-9
Study Group 4 Solid PSM Sample Results for SVOCs Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent (mg/kg)						
			Chrysene	Phenanthrene[a]	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Benzo(g,h,i)perylene[b]
FALs			210	170,000	2.1	2.1	21	0.21	17,000
S1	S101	Solid	0.016 (J)	0.0084 (J)	0.056	0.033	0.0094 (J)	0.08	0.027 (J)
S2	S201	Solid	--	--	0.045	0.026 (J)	--	0.052	0.016 (J)

[a]FAL is for anthracene (surrogate for phenanthrene).
[b]FAL is for pyrene (surrogate for benzo[g,h,i]perylene).
J = Estimated value.
-- = Not detected above MDCs.

contaminants in the solid PSM did not exceed the chemical FALs. Radiological dose for the solid PSM samples was calculated in accordance with Section A.2.4. The calculated dose for each of the solid PSM samples was 0.0 mrem/OU-yr, which is less than the FAL. As a result, the two asphalt piles were determined not to be PSM.

For the liquid PSM sample, in order to determine whether the contents of the 55-gal drum could result in a release that would cause the soil to exceed a FAL, NNSS-specific input parameters were used to calculate a resulting concentration of contaminants in soil. This estimated concentration in soil was then compared to the FALs. The resulting concentrations of chemical constituents in the soil from the liquid PSM did not exceed the FALs (Table 2-10). The calculated dose for the soil was 0.0 mrem/OU-yr, which is less than the FAL. As a result, the contents of the 55-gal drum were determined not to be PSM. A detailed discussion is found in Section A.6.3.2.2.

Table 2-10
Study Group 4 Estimated Liquid PSM Concentrations in Soil for Chemical Constituents Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent			
			SVOCs (mg/kg)		Metals (mg/kg)	
			Phenanthrene[a]	2-Methylnapthalene	Barium	Lead
FALs			**170,000**	**2,200**	**190,000**	**5,739**
X1	X01	Liquid	0.009	0.006	0.006	0.009

[a]FAL is for anthracene (surrogate for phenanthrene).

2.2.2 Data Assessment Summary

The DQA is presented in Appendix B and includes an evaluation of the data quality indicators (DQIs) to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process defines the type, quality, and quantity of data needed to support the resolution of DQO decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA process is composed of the following steps:

1. Review DQOs and sampling design.
2. Conduct a preliminary data review.
3. Select the test.
4. Verify the assumptions.
5. Draw conclusions from the data.

The results of the DQI evaluation show that criteria were met for all of the DQI parameters. Thus, the CAU 550 dataset is of sufficient quality to support its intended use in the decision-making process.

Based on the results of the DQA, the nature and extent of COCs at CAU 550 have been adequately identified to develop and evaluate CAAs. The DQA also determined that information generated during the investigation supports the CSM assumptions, and the data collected met the DQOs.

2.3 Justification for No Further Action

No further corrective action is needed for the CASs within CAU 550 due to the absence of contamination exceeding risk-based levels (presented in Section 2.3.1) or implementation of corrective actions which were based on an evaluation of risk, feasibility, and cost effectiveness (see Appendix E). The need for corrective action is evaluated for each release location by the resolution of DQO decisions as presented in Sections 2.3.2.1 through 2.3.2.4. A summary of corrective actions for CAU 550 CASs is presented in Table 2-11. The implementation of corrective actions at CAU 550 ensures protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2012a).

2.3.1 Final Action Levels

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NFO, 2014) and Appendix C. This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012b). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012c) requires the use of ASTM International (ASTM) Method E1739 (ASTM, 1995) to “conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective

Table 2-11
CAU 550 Corrective Action Summary

CAS Number	Release Description	Corrective Action	Rationale
08-23-04	Smoky Atmospheric Test	No further action	No constituents exceed FALs
08-23-03	Ceres Safety Experiment	Closure in place with FFACO UR	HCA conditions for removable radioactive contamination
08-23-06	Oberon Safety Experiment		
08-23-07	Titania Safety Experiment		
08-01-01; 08-22-05; 08-22-07; 08-22-08; 08-22-09; 08-24-03; 08-24-04; 10-22-17; 10-22-18;10-22-20; 10-24-10	Debris	No further action	No constituents exceed FALs and/or no indication of release identified
08-24-07	Batteries (3)	Clean closure	PSM removed; no constituents exceed FALs
	Battery	Clean closure	PSM removed; no constituents exceed FALs
	Lead Bricks (2)	Clean closure	PSM removed; no constituents exceed FALs
08-24-08	Batteries (3)	Clean closure	PSM removed; no constituents exceed FALs
08-26-01	Lead Bricks (200)	Closure in place with FFACO UR	Lead exceeds FAL
10-22-19	Drum; Stains	No further action	No constituents exceed FALs
	Drum w/Liquid Contents	No further action	Not PSM
	Asphalt Pile 1	No further action	Not PSM
	Asphalt PIle 2	No further action	Not PSM

UR = Use restriction

action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses. These tiers are defined in Appendix C.

A Tier 1 evaluation was conducted for all detected contaminants to determine whether contaminant levels satisfy the criteria for closure or warrant a more site-specific assessment. For radiological contaminants, this was accomplished by comparing the radiological PAL of 25 mrem/IA-yr to the

TED at each sample location calculated using the industrial area exposure scenario. For chemical contaminants, this was accomplished by comparing individual contaminant concentration results to the Tier 1 action levels (the PALs established in the CAIP [NNSA/NSO, 2012a]). The only contaminants detected at CAU 550 that exceeded Tier 1 action levels were radiological dose and lead. The FALs for all non-radiological contaminants except lead were established as the Tier 1 action levels. The PALs for radiological contaminants and lead were passed on to a Tier 2 evaluation.

The Tier 2 evaluations were conducted in accordance with the Soils RBCA document (NNSA/NFO, 2014). These evaluations, presented in Appendix C, were based on risk to receptors. The risk to receptors from contaminants at CAU 550 is due to chronic exposure to contaminants (e.g., receiving a dose over time). Therefore, the risk to a receptor is directly related to the amount of time a receptor is exposed to the contaminants. A review of the current and projected use of CAU 550 sites determined that workers may be present at these sites for only a limited number of hours per year, and it is not reasonable to assume that any worker would be present at this site on a full-time basis (DOE/NV, 1996).

Based on current site usage, it was determined in the CAU 550 DQOs that the Occasional Use Area exposure scenario is appropriate in calculating receptor exposure time. In order to quantify the maximum number of hours a site worker may be present at CAU 550, current and anticipated future site activities were evaluated in Appendix C. This evaluation concluded that the most exposed worker under current land usage is a utility maintenance worker, who has the potential to be present at the site for up to 80 hr/yr. As a result, it was determined that the most exposed worker would not be exposed to site contamination for more time than is assumed under the Occasional Use Area exposure scenario (80 hr/yr). Therefore, the radiological Tier 2 action levels and the TEDs at each location were calculated using an exposure time of 80 hr/yr. However, as explained in the Soil RBCA document, the Tier 2 evaluation for lead used a longer exposure time of 44 days per year (NNSA/NFO, 2014).

The Tier 2 evaluation for lead compared the analytical results to the Tier 2 action levels. The Tier 2 action level was calculated using EPA's Adult Lead Methodology (ALM) to estimate the concentration of lead in the blood of pregnant women and their developing fetuses who might be exposed to lead-contaminated soils (EPA, 2003). This calculation used a site-specific soil ingestion rate (of 0.067 grams/day [g/day]) and an exposure frequency of 44 day/yr. The FAL for lead established in Appendix C using this methodology is 5,739 mg/kg.

The PALs and FALs for CAU 550 COPCs are shown in Table 2-12.

Table 2-12
Definition of PALs and FALs for CAU 550 COPCs

COPCs	PALs	FALs
VOCs	RSLs [a]	RSLs [a]
SVOCs	RSLs [a]	RSLs [a]
RCRA metals (other than lead and arsenic)	RSLs [a]	RSLs [a]
Arsenic	23 mg/kg [b]	23 mg/kg [b]
Lead	800 mg/kg (Tier 1)	5,739 mg/kg (Tier 2)
Radionuclides - Total Dose	25 mrem/IA-yr (Tier 1)	25 mrem/OU-yr (Tier 2)

[a] EPA Region 9 RSLs (EPA, 2013).
[b] Based on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).

The RBCA dose evaluation does not address the potential for removable contamination to be transported to other areas. Although the dose contribution from removable contamination at a site is accounted for in the dose-based FAL, the risk associated with removable contamination that may be transported to another location (i.e., off site) is not. A discussion on the risks associated with removable radioactive contamination is presented in the Soils RBCA document (NNSA/NFO, 2014).

A separate FAL for removable contamination has not been developed. Instead, the threshold criteria for posting HCAs and CAs found in 10 CFR 835 (CFR, 2013) have been adopted as guidelines at sites where removable contamination is present. The DOE Occupational Radiation Protection program requires that areas with removable alpha radioactive contamination at levels > 20 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) or > 2,000 dpm/100 cm^2 be posted with CA and HCA signs, respectively. These are the numerical threshold criteria for posting HCA and CAs under 10 CFR 835. In order to ensure removable contamination is adequately considered in the FFACO process, these criteria are used to determine whether HCA or CA conditions are present at a site and whether corrective action is necessary to reduce the potential for the inadvertent offsite transfer of contamination. For CAU 550, it is assumed that releases which contain removable contamination at levels that meet HCA posting criteria (i.e., exhibit HCA conditions) require corrective action. This requires corrective action for areas that exceed HCA criteria even though the area may not present a potential radiation dose to a receptor that exceeds the FAL. Therefore, it is assumed that removable contamination that exceeds HCA criteria requires corrective action. An assumption was made that corrective action is required within the DCB surrounding the three safety experiment CASs in Study Group 2 as defined in the CAIP (NNSA/NSO, 2012a).

A corrective action may also be required if a waste present within a study group contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and release the contaminants to the surrounding media. The criteria used for determining whether a waste is PSM is defined in the Soils RBCA document (NNSA/NFO, 2014).

2.3.2 Resolution of DQO Decisions

The following subsections compare the results presented in Section 2.2 to the FALs for the resolution of DQO decisions and the need for corrective action.

2.3.2.1 Study Group 1, Atmospheric Test

Decision I. None of the Study Group 1 sample locations exceeded the FAL of 25 mrem/OU-yr. Thus, no radiological COCs were identified, and no corrective action is required.

2.3.2.2 Study Group 2, Safety Experiments

Decision I. Neither of the two sample locations at Study Group 2 exceeded the FAL of 25 mrem/OU-yr. However, due to the presence of HCA conditions for removable contamination, radiological COCs are assumed to be present, and corrective action is required at Study Group 2.

Decision II. The extent of HCA conditions for removable contamination was defined by historical removable contamination surveys, as stated in the CAIP (NNSA/NSO, 2012a). Removable contamination surveys of debris located within the DCB confirm HCA conditions on the debris (see Section A.4.1.1). In addition, swipe surveys of personal protective equipment (PPE) used inside the DCB indicate HCA levels of contamination (see Section A.9.0). There is sufficient information available to predict potential remediation waste types and volumes to evaluate CAAs.

2.3.2.3 Study Group 3, Washes

Decision I. None of the Study Group 3 sample locations exceeded the FAL of 25 mrem/OU-yr. Thus, no radiological COCs were identified, and no corrective action is required.

2.3.2.4 Study Group 4, Debris

Decision I. None of the soil samples collected at the Study Group 4 releases exceeded the chemical or radiological FALs. However, PSM was identified, or assumed to be present, at three release locations. These locations are CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]), CAS 08-24-08 (Batteries [3]), and CAS 08-26-01 (Lead Bricks [200]).

Decision II. The PSM was removed at CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]) and CAS 08-24-08 (Batteries [3]) and a soil sample was collected underneath the debris. None of the soil sample results exceeded the FALs, so Decision I and II were resolved for these locations. The debris at CAS 08-26-01 (Lead Bricks [200]) was left in place. The extent of contamination was determined visually and was defined as the area where the lead bricks are visible on the surface. There is no record of mechanical soil movement (e.g., excavation, burial) in the area of CAS 08-26-01, so it is reasonable to conclude that the lead bricks used during the Smoky experiment are located on, or near, the ground surface. In addition, there is sufficient information available to predict potential remediation waste types and volumes to evaluate CAAs.

3.0 Conclusions and Recommendations

Corrective actions were developed based on an evaluation of analytical data from the CAI, the assumed presence of COCs at select locations, a review of current and future operations at CAU 550, the risk assessment presented in Appendix C, and the comparative analysis of the CAAs presented in Appendix E.

3.1 Conclusions

Although the CAI was conducted by study group, FFACO decisions regarding site closure are made at the release level and applied at the CAS level. Based upon results of the closure activities, no further closure activities are necessary for CAU 550. The corrective action decisions for CAU 550 are based on the current and future land use assumptions presented in Appendix C. Stakeholder concurrence, including NDEP, must be obtained in advance of an alteration or change in future land use that results in a more intensive use of the site.

3.1.1 CAS 08-23-04 (Atmospheric Test)

No further action is required at CAS 08-23-04. Based upon the samples collected, no sample location at this CAS exceeded the FAL of 25 mrem/OU-yr. To ensure potential exposure to future site users is minimized, an administrative UR will be established as a best management practice (BMP). The administrative UR at CAS 08-23-04 includes the area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr and/or any area where removable radioactive contamination is present that exceeds CA criteria (alpha > 20 dpm/100 cm^2 but < 2,000 dpm/100 cm^2).

3.1.2 CASs 08-23-03, 08-23-06, and 08-23-07 (Safety Experiments)

Based upon results of the CAI, no sample location exceeded the FAL of 25 mrem/OU-yr outside the DCB at these CASs. However, because HCA conditions for removable contamination (alpha > 2,000 dpm/100 cm^2) are present within the DCB, corrective action is required. The selected corrective action for the three safety experiment CASs is closure in place with an FFACO UR. The UR boundary is defined as the extent of the DCB, as shown in Attachment D-1. Because there is the potential for migration of contamination across the road that intersects the DCB, the road is included in the UR boundary. Due to the long half-lives of removable radioactive contaminants within the DCB, including Pu-239 (24,000 years), the FFACO UR is expected to remain in place indefinitely.

As a BMP, an administrative UR was established in the areas north and south of the DCB. The administrative UR includes the area where removable radioactive contamination is present that meets CA criteria (alpha > 20 dpm/100 cm^2 but < 2,000 dpm/100 cm^2).

3.1.3 Debris CASs

The 15 debris CASs and their recommended corrective actions are listed in Table 2-11. None of the results from the soil samples collected at the debris CASs exceeded the FALs. Therefore, no COCs were identified, and corrective action was not required. However, PSM was assumed to be present at three CASs that contained lead debris items. These items were evaluated for the possibility of PSM and for COCs in underlying soil. Based on investigation data, corrective action was required at CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]), CAS 08-24-08 (Batteries [3]) and CAS 08-26-01 (Lead Bricks [200]). Debris at CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]) and CAS 08-24-08 (Batteries [3]) was removed, and no COCs were identified in the underlying soil. Thus, these CASs are clean closed, and no further corrective action is required. The selected corrective action for CAS 08-26-01 (Lead Bricks [200]) was closure in place with FFACO URs.The UR boundary for CAS 08-26-01 is presented in Attachment D-1.

3.2 FFACO Use Restrictions

The FFACO UR boundaries and the locations where FFACO UR signs were posted are presented on Plate 1.

The FFACO URs require annual inspections to certify that postings are in place, intact, and readable. Based on the implementation of corrective actions at CAU 550, no further corrective action is required. The corrective actions for CAU 550 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer valid, additional evaluation may be necessary.

All URs are recorded in the FFACO database; the Management and Operating (M&O) Contractor Geographic Information Systems (GIS); and the DOE, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) CAU/CAS files. The development of URs for CAU 550 is based on current land use. Any proposed activity within a use restricted area that would result in a more intensive use of the site would require NDEP approval.

3.3 Administrative Use Restriction

In accordance with the Soils RBCA document (NNSA/NFO, 2014) and the CAIP (NNSA/NSO, 2012a), an administrative UR was implemented as a BMP for any area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr (i.e., the PAL) and/or any area where removable radioactive contamination is present that meets CA criteria (alpha > 20 dpm/100 cm^2 but < 2,000 dpm/100 cm^2). Based on the results of the CAI, administrative URs were established for CAS 08-23-04 (Smoky); the area outside the DCB at the three safety experiments (CASs 08-23-03, 08-23-06, and 08-23-07); and at the drainage system located east of these CASs. The process for determining the extent of the administrative UR at each location is discussed in Sections A.3.5, A.4.5, and A.5.5. A single administrative UR boundary for CAU 550 was established to encompass each of the CAS-specific administrative URs. The administrative UR is presented in Attachment D-1 and Plate 1. An administrative UR is not part of any FFACO corrective action. An administrative UR is recorded and controlled in the same manner as the FFACO URs, but does not require posting or inspections. The extent of the administrative UR at CAU 550 is primarily based on the presence of removable radioactive contamination that meets CA criteria. Due to the long half-lives of removable radioactive contaminants, including Pu-239 (24,000 years), the administrative UR is expected to remain in place indefinitely.

3.4 Recommendations

The NNSA/NFO requests that NDEP issue a Notice of Completion for CAU 550 and approve transferring the CAU from Appendix III to Appendix IV of the FFACO. The DOE, under its regulatory authority for management of radioactive waste materials associated with environmental remediation activities, approves these actions (USC, 2012).

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Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 550, Smoky Contamination Area. This CAU is located in Areas 8 and 10 of the NNSS and includes the releases associated with 19 CASs (Figure A.1-1). To facilitate site investigation and the evaluation of DQO decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions were organized into four study groups. These study groups and the release sources specific to CAU 550 are presented in Table A.1-1. Although the need for corrective action is evaluated separately for each release, corrective actions are applied to each FFACO CAS.

The corrective actions described in this document were implemented in accordance with the FFACO (1996, as amended) that was agreed to by the State of Nevada; DOE, Environmental Management; U.S. Department of Defense; and DOE, Legacy Management.

A detailed history of this CAU is presented in the *Corrective Action Investigation Plan for Corrective Action Unit 550: Smoky Contamination Area* (NNSA/NSO, 2012a) and is not repeated herein.

A.1.1 Investigation Objectives

The objective of the investigation was to provide sufficient information to complete corrective actions and support the closure of each CAS in CAU 550. This objective was achieved by determining the presence of COCs and the vertical and lateral extent of the COCs, if present.

For radiological contamination, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding the FAL of 25 mrem/yr. For chemical contamination, a COC is defined as the presence of a contaminant at a concentration exceeding its corresponding FAL concentration (see Section A.2.4).

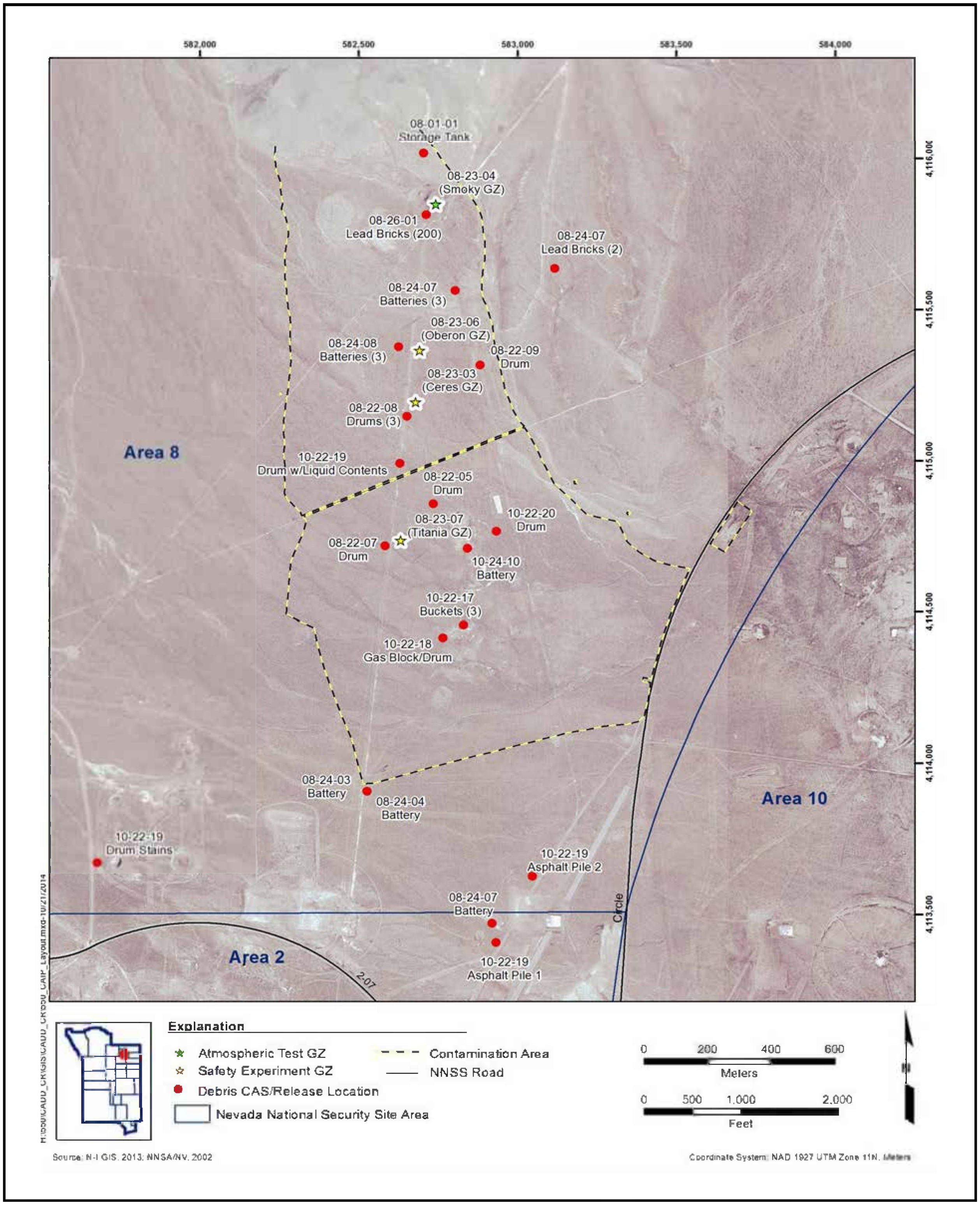

Figure A.1-1
CAU 550 CAS and Releases

Table A.1-1
CAU 550 Releases with Associated CASs and Study Groups

Release	CAS Number	FFACO CAS Description	Study Group	Release Type
Smoky Atmospheric Test	08-23-04	Atmospheric Test Site T-2C	1 Atmospheric Test	Surface release of radionuclides from atmospheric test tower
Ceres Safety Experiment	08-23-03	Atmospheric Test Site T-8B	2 Safety Experiments	Surface release of radionuclides from safety experiment towers
Oberon Safety Experiment	08-23-06	Atmospheric Test Site T-8A		
Titania Safety Experiment	08-23-07	Atmospheric Test Site T-8C		
Washes	--	--	3 Washes	Surface water and windborne migration from all releases
Storage Tank	08-01-01	Storage Tank	4 Debris	Surface and/or subsurface releases of radionuclides and/or chemicals from debris
Drum	08-22-05	Drum		
Drum	08-22-07	Drum		
Drums (3)	08-22-08	Drums (3)		
Drum	08-22-09	Drum		
Battery	08-24-03	Battery		
Battery	08-24-04	Battery		
Batteries (3)	08-24-07	Batteries (3)		
Battery				
Lead Bricks (2)				
Batteries (3)	08-24-08	Batteries (3)		
Lead Bricks (200)	08-26-01	Lead Bricks (200)		
Buckets (3)	10-22-17	Buckets (3)		
Gas Block/Drum	10-22-18	Gas Block/Drum		
Drum; Stains	10-22-19	Drum; Stains		
Drum w/Liquid Contents				
Asphalt Pile 1				
Asphalt Pile 2				
Drum	10-22-20	Drum		
Battery	10-24-10	Battery		

-- = Not applicable

A.1.2 Contents

The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and the contents of the appendix.
- Section A.2.0 provides an investigation overview.
- Sections A.3.0 through A.6.0 provide information by study group regarding field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.7.0 summarizes waste management activities.
- Section A.8.0 discusses the QA and QC processes followed, and the results of QA/QC activities.
- Section A.9.0 is a summary of the investigation results.
- Section A.10.0 lists the cited references.

The complete field documentation and laboratory data, including field activity daily logs (FADLs), sample collection logs (SCLs), analysis request/chain-of-custody forms, laboratory certificates of analyses, and analytical results are retained in project files as hard copy files or electronic media.

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 550 CAI were conducted between August 2012 and October 2013. Investigation activities included visual surveys, radiological surveys, surface and subsurface soil sampling, and TLD sampling.

The investigation and sampling program adhered to the requirements set forth in the CAIP (NNSA/NSO, 2012a) (except any deviations described herein) and in accordance with the Soils Activity QAP (NNSA/NSO, 2012c), which establishes requirements, technical planning, and general quality practices. The evaluation of investigation results and the risk associated with site contamination was conducted in accordance with the Soils RBCA document (NNSA/NFO, 2014).

In accordance with the graded approach described in the Soils Activity QAP (NNSA/NSO, 2012c), the quality required of a dataset will be determined by its intended use in decision making. Data used to define the presence of COCs are classified as decisional and will be used to make corrective action decisions. Survey data are classified as decision supporting and are not used, by themselves, to make corrective action decisions. The radiological and chemical FALs established for CAU 550 are presented in Appendix C.

The field investigation was completed as specified in the CAIP (NNSA/NSO, 2012a) with minor deviations as described in Sections A.3.0 through A.6.0.

A.2.1 Sample Locations

All sample locations for CAU 550 were selected judgmentally, using biasing factors such as radiological survey results and/or the presence of debris. At Study Groups 1 and 2 where soil sample plots were established, soil samples were collected following a probabilistic approach. One or more composite samples were collected within each sample plot, and TLDs were located at the center of each sample plot. The subsample aliquot locations were identified using a predetermined random-start, triangular grid pattern.

At Study Groups 3 and 4, judgmental sample locations were selected based on visual biasing factors, such as sedimentation areas in washes, debris, or by elevated radiological readings. One or more grab or composite samples were collected at each judgmental sample location.

All sample locations and points of interest were surveyed with a GPS instrument. Appendix F presents these GPS data in a tabular format. Additional information on the selection of sample locations is found in the CAIP (NNSA/NSO, 2012a) and the study group-specific sections (Sections A.3.0 through A.6.0). Except as noted in the following sections, CAU 550 sampling locations were accessible and sampling activities at planned locations were not restricted.

A.2.2 Investigation Activities

Investigation activities at the four study groups in CAU 550 were consistent with the CAIP (NNSA/NSO, 2012a) and provided the necessary information to establish the nature and extent of contamination associated with each study group. The following subsections describe the CAI activities that were conducted at each study group.

A.2.2.1 Visual Surveys

Visual surveys were performed at each of the study groups during the course of the CAI. The majority of items recorded by the visual surveys had been identified in previous site visits. The objective of the visual surveys was to identify and record any indicators of a potential release of contaminants (e.g., stained soil, distressed vegetation), PSM (e.g., drum, battery), or other site condition that would warrant further investigation. The results of the visual surveys are discussed in the subsequent study group-specific sections of this appendix.

A.2.2.2 Radiological Surveys

Radiological surveys using the PRM-470 and FIDLER were performed at each study group during the preliminary investigation at CAU 550 in 2011. These survey results, in conjunction with existing aerial radiation survey results, were used to identify proposed sample locations as discussed in the CAIP (NNSA/NSO, 2012a). Additional ground-based surveys were conducted during the CAI to refine the specific locations of maximum radioactivity for Decision I soil and TLD samples. The various field radiological instruments and their applications are discussed in detail in the CAIP. In general, the PRM-470 was used to refine sample locations where fission and activation radionuclides were expected (Study Group 1), and the FIDLER was used where radionuclide fuel components were expected (Study Group 2). Due to the potential for overlapping contamination, however, the radiological surveys completed in 2011 were conducted using both instruments. Individual study group radiological survey results are presented and discussed in Sections A.3.0 through A.6.0.

The PRM-470 and FIDLER survey data presented in the CAIP were shown as discrete data points collected along the path that was walked/driven by the field technician. While these data are useful in identifying points of elevated radioactivity, they do not readily illustrate the radiological conditions of the area surveyed. Using the inverse weighted interpolation technique described in Section A.3.5, the discrete data points were processed to generate a continuous spatial distribution (i.e., interpolated surface) which is more easily compared to other datasets (e.g., soil sample data, aerial survey data). Figures A.2-1 and A.2-2 present the resulting PRM-470 and FIDLER interpolated surfaces, respectively, which illustrate the overall distribution of radioactivity at CAU 550. The interpolated surfaces generated from the FIDLER and PRM-470 point data were also used in the Study Group 1 correlations discussed in Section A.3.5.

Low-volume area air samplers were deployed at CAU 550 for three days during preliminary investigation activities in 2011. No airborne radioactivity was detected by the air samplers. Personal breathing zone air samplers were worn by all personnel who worked inside the contamination areas at CAU 550 throughout the investigation. Of the 55 individual breathing zone air samplers worn during the preliminary investigation and the CAI, radioactive material was detected on two of the samplers. The detected levels were not sufficient to require the determination of a potential uptake, so no follow-up action was required. Removable contamination surveys of waste and used PPE (e.g., gloves, booties) measured removable contamination at levels consistent with CA and HCA conditions.

A.2.2.3 Field Screening

Field screening was conducted at Study Group 3 (Washes) to evaluate the presence of buried contamination and select subsurface samples to be submitted to the laboratory for analysis. Field screening was limited to radiological parameters and was conducted using an NE Electra instrument.

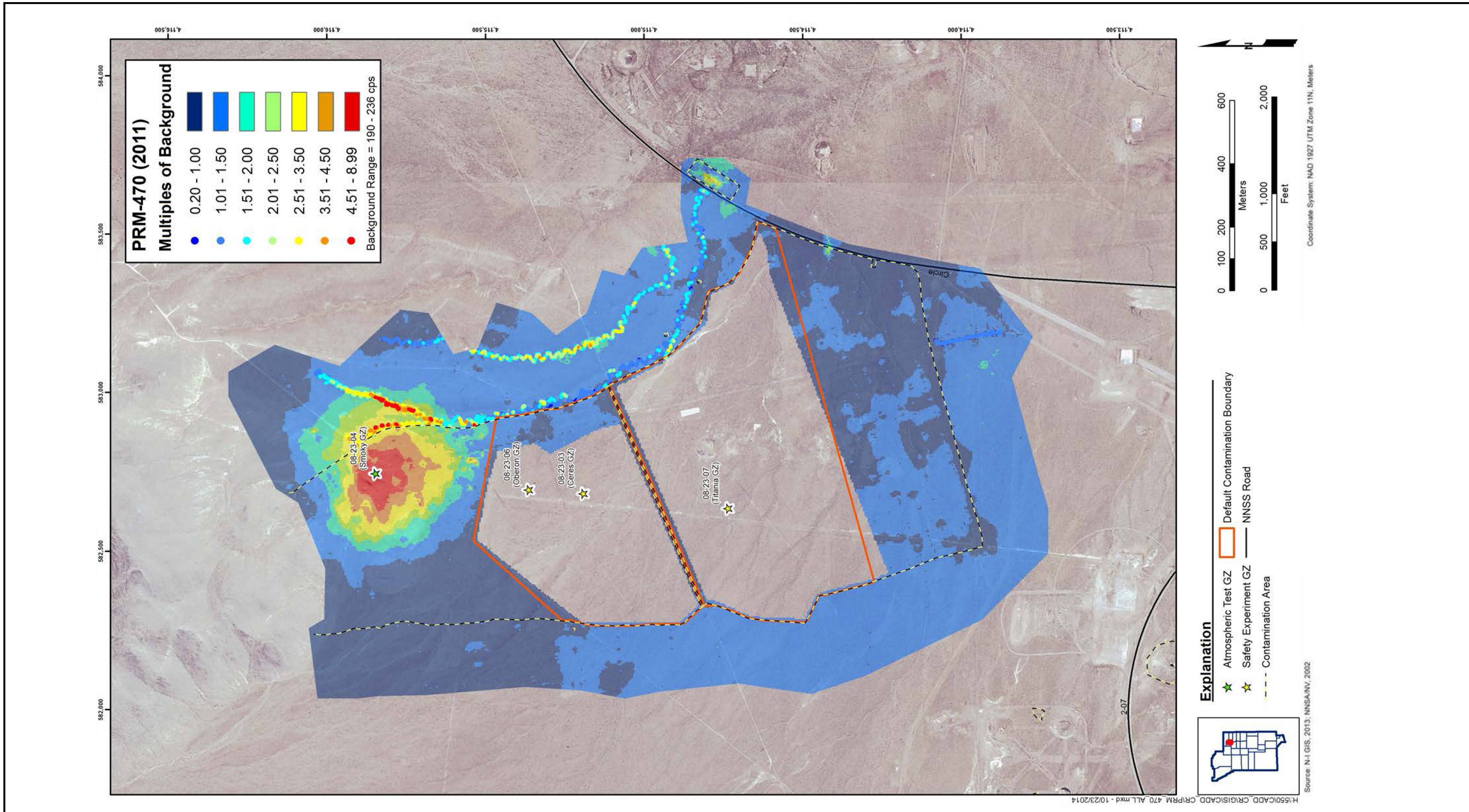

Figure A.2-1
PRM-470 Survey Data - All Study Groups

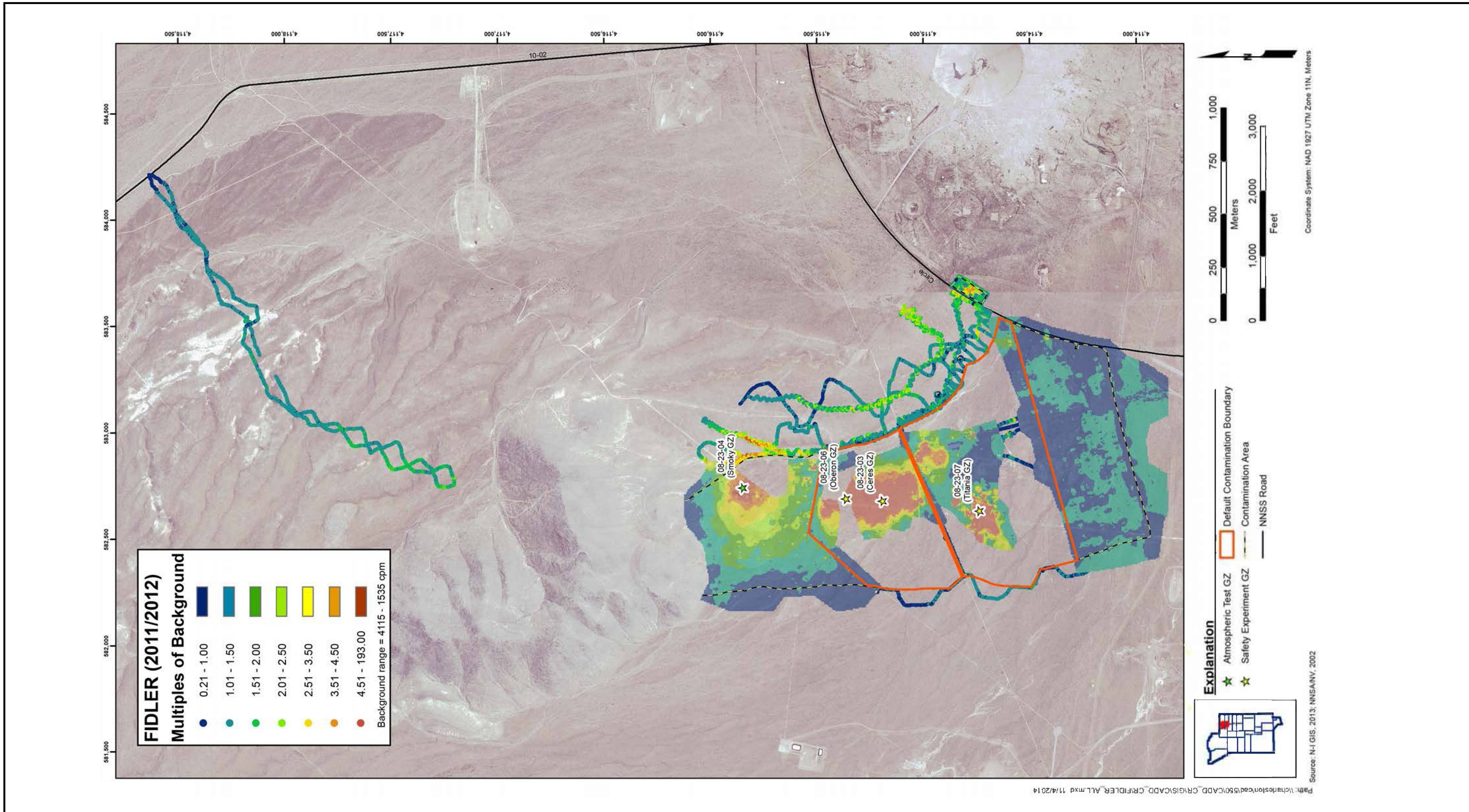

Figure A.2-2
FIDLER Survey Data - All Study Groups

The application of field screening to the sampling process for Study Group 3 is discussed in detail in Section A.5.1.4. Field-screening results (FSRs) are recorded on SCLs that are retained in project files.

Site-specific field-screening levels (FSLs) were determined each day before soil sampling began. An area was selected in the vicinity of the site with a minimal probability of being impacted from releases or site operations. Ten or more surface soil aliquots, from the top 5 centimeters (cm) of soil, were collected at random locations within the selected area. The aliquots were then mixed, and 10 one-minute static counts obtained for both alpha and beta/gamma measurements. The FSLs for both alpha and beta/gamma were calculated by multiplying the sample standard deviation by 2 and adding that value to the sample average.

A.2.2.4 TLD Sampling

TLDs were staged at CAU 550 with the objective of collecting *in situ* measurements to determine the external radiological dose. TLDs were placed at Study Group 1, 2, and 3 sample locations; TLDs were not placed at Study Group 4 (Debris) sample locations. One TLD was placed in the center of each sample plot established for Study Groups 1 (Atmospheric Test) and 2 (Safety Experiments). The Study Group 1 investigation also included a grid of 55 additional TLDs positioned around Smoky GZ to provide dose information on the extent of the Smoky release. At Study Group 3 (Washes), TLDs were placed at grab sample locations.

TLDs were also placed at three background locations to measure background radiation (Table A.2-1 and Figure A.2-3). The background TLDs measure dose from natural sources in areas unaffected by CAU-related releases during field deployment. As illustrated in the CAIP (NNSA/NSO, 2012a), a background isopleth map generated from the 1994 aerial radiation survey was used to verify that background TLDs represent the background dose estimated at CAU 550 TLD locations. The background TLDs were placed in areas beyond the influence of study group releases. It was determined that the background TLD locations are representative of the general area and can be used as a good estimate of true average background dose for all of the environmental TLDs. Therefore, the background TLD results were used in the calculation of radiological dose at all the study groups in CAU 550.

Table A.2-1
Background TLD Samples

TLD Location	TLD Number	Date Placed	Date Removed	Purpose
A02	1022	09/18/2012	01/08/2013	Background
A03	4667	09/19/2012	01/08/2013	Background
A30	5146	09/20/2012	01/07/2013	Background

Each TLD was placed at a height of 1 meter above the ground surface, which is consistent with TLD placement in the NNSS routine environmental monitoring program. Once retrieved from the field locations, the TLDs were analyzed by automated TLD readers that are calibrated and maintained by the NNSS M&O contractor. This approach allowed for the use of existing QC procedures for TLD processing. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.8.5.

A.2.2.5 Soil Sampling

Soil sampling at CAU 550 included the collection of soil samples within sample plots, in washes, and at debris locations. A total of 16 sample plots were established during the CAI: 14 at Study Group 1 and two at Study Group 2. One composite sample was collected from each of 13 sample plots at Study Group 1, and four composite samples were collected at each of the other three sample plots. Each composite sample was composed of nine randomly located subsample aliquots. Each subsample aliquot was collected using a “vertical-slice cylinder and bottom-trowel” method. This required the insertion of a 3.5-inch (in.) inside diameter cylinder to a depth of 5 cm, excavation of the outside soil along one side of the cylinder to permit trowel placement, and horizontal insertion of a trowel along the bottom of the cylinder. This method captures a cylindrical-shaped section of the soil from 0 to 5 cm below ground surface (bgs). After collection, each subsample aliquot was carefully placed atop a #4 mesh sieve fitted into a bottom pan with a plastic liner. Oversized material that did not pass through the sieve was returned to the original sample location.

Surface soil grab samples were collected at sample locations in Study Groups 3 (Washes) and 4 (Debris). Subsurface soil grab samples were also collected at Study Group 3 sediment sample locations. These subsurface samples were collected at 5-cm intervals vertically from the surface to a

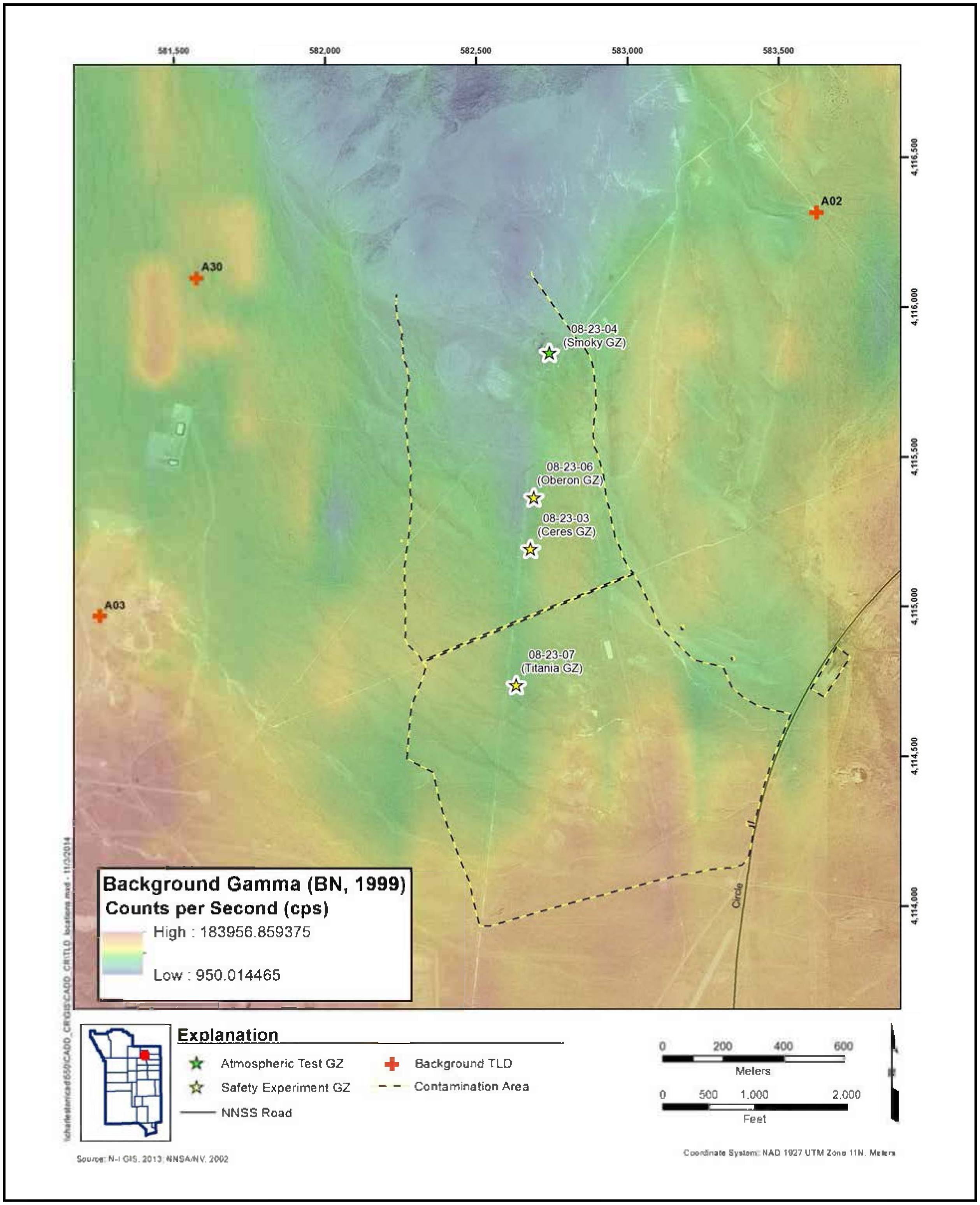

Figure A.2-3
Background TLD Locations

maximum depth of 20 cm. FSRs from each interval were used to select subsurface soil samples for submission to the laboratory for analysis.

A.2.3 Dose Calculations

Soil and TLD data are used to calculate a TED that could potentially be received by a human receptor at the site. The following subsections discuss the process for evaluating the soil and TLD data in terms of dose, so the data may be compared directly to the dose-based radiological FAL.

A.2.3.1 Internal Dose Calculations

Internal dose was calculated using the radionuclide analytical results from soil samples and the corresponding residual radioactive material guideline (RRMG) (NNSA/NFO, 2014). The internal dose RRMG concentration for a particular radionuclide is that concentration in surface soil that would cause an internal dose to a receptor of 25 mrem/yr under the appropriate exposure scenario, independent of any other radionuclide and assuming that no other radionuclides contribute dose. The internal dose RRMG for each detected radionuclide (in picocuries per gram [pCi/g] of soil) was derived using RESRAD computer code (Yu et al., 2001) under the appropriate exposure scenario (NNSA/NFO, 2014).

The total internal dose corresponding to each surface soil sample was calculated by adding the dose contribution from each radionuclide. For each sample, the radionuclide-specific analytical result was divided by its corresponding internal dose RRMG to yield a fraction of the 25-mrem/yr dose and then multiplied by 25 to yield an internal dose estimate in mrem/yr at that sample location, in accordance with the following formula:

$$\textit{Internal Dose (mrem/yr)} = [\textit{Analytical result (pCi/g)} / \textit{Internal Dose RRMG (pCi/g)}] \times 25 \textit{ mrem/yr}$$

Soil concentrations of plutonium isotopes are inferred from gamma spectroscopy results as described in the representativeness discussion in Section B.1.1.1.1. The internal doses for all radionuclides detected in a soil sample were then summed to yield an internal dose for that sample. For probabilistic samples, a 95 percent UCL was calculated for the internal dose in each sample plot using the results of all soil samples collected in that plot (NNSA/NFO, 2014). For judgmental sample locations where only one sample was collected, statistical inferences could not be calculated, and the single analytical result was used to calculate internal dose.

At locations where a TLD was placed but soil samples were not collected, the internal dose was estimated using the external dose measurement from the TLD and the internal to external dose ratio from the sample plot with the maximum internal dose within the corresponding release. The internal dose for each of these locations was calculated by multiplying this ratio by the external dose value specific to each location using the following formula:

$$Internal\ dose_{\mathrm{est}} = External\ dose_{\mathrm{est}} \times [Internal\ dose\ /\ External\ dose]_{\mathrm{max}}$$

where

est = location for the estimate of internal dose
max = location of maximum internal dose

Use of this method to estimate internal dose will overestimate the internal dose (and therefore TED) as the internal to external dose ratio generally decreases with decreasing TED values.

A.2.3.2 External Dose Calculations

The TLDs placed at CAU 550 contain four individual elements. External dose at each TLD location is determined using the readings from TLD elements 2, 3, and 4; data from element 1 are not relevant to the determination of the external dose for the purpose of the CAU 550 CAI. Each of the elements is considered to be a separate, independent sample measurement of external dose. A 95 percent UCL of the average of these measurements was calculated for each TLD location.

For subsurface sample locations, a TLD-equivalent external dose was calculated using the subsurface sample results. This was accomplished by establishing a correlation between RESRAD-calculated external dose from surface samples and the corresponding TLD readings. The RESRAD-calculated external dose from the subsurface samples was then adjusted to TLD-equivalent values using the following formula:

$$Equivalent\ Subsurface_{\mathrm{TLD}} = Subsurface_{\mathrm{RR}} \times (Surface_{\mathrm{TLD}}\ /\ Surface_{\mathrm{RR}})$$

where

TLD = external dose based on TLD readings
RR = external dose based on RESRAD calculation from analytical soil concentrations

Estimates of external dose at the CAU 550 sites are presented as net values (i.e., background radiation dose has been subtracted from the raw result). The background dose at CAU 550 was determined to be the average of the background TLD results from locations A02, A03, and A30 (Section A.2.2.4).

A.2.3.3 Total Effective Dose

The calculated TED represents the sum of the internal dose and the external dose for each sample location. For surface soil sample locations where TLD results are not available (i.e., a TLD was not placed at the soil sample location), external dose is estimated using the RRMGs in the following formula:

$$Total\ Dose\ (mrem/yr) = [Analytical\ result\ (pCi/g)/TED\ RRMG\ (pCi/g)] \times 25\ mrem/yr$$

The calculated TED is an estimate of the true (unknown) TED. It is uncertain how well the calculated TED represents the true TED. If a calculated TED were directly compared to the FAL, any significant difference between the true TED and the measured TED could lead to decision errors. To reduce the probability of a false-negative decision error for probabilistic sampling results, a conservative estimate of the true TED (i.e., the 95 percent UCL) is used to compare to the FAL. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED. The probabilistic sampling design as described in the CAIP (NNSA/NSO, 2012a) conservatively prescribes using the 95 percent UCL of the TED for DQO decisions (e.g., determining the presence or absence of COCs [Decision I]). For sample locations where a TLD and multiple soil samples are collected (e.g., sample plots), TED is calculated as the sum of the 95 percent UCLs of the internal and external doses. For grab sample locations where a TLD sample was collected, TED is calculated as the sum of the 95 percent UCL of the external dose and the single internal dose estimate.

A minimum number of samples is required to assure sufficient confidence in dose statistics for probabilistic sampling such as the average and 95 percent UCL (EPA, 2006). As stated in the CAIP (NNSA/NSO, 2012a), if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of the minimum sample size is described in Section B.1.1.1.1.

To reduce the probability of a false-negative decision error for judgmental sampling results, samples were biased to locations of higher radioactivity. Samples from these locations will produce TED results that are higher than from adjacent locations of lower radioactivity within the exposure area that is being characterized for dose. This will conservatively overestimate the true TED of the exposure area and protect against false-negative decision errors.

A.2.4 Comparison to Action Levels

The results of the CAU 550 investigation were compared to the radiological and chemical action levels specified in the CAIP (NNSA/NSO, 2012a). The radiological PALs and FALs are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 550 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario in which a site worker is exposed to site contamination for 8 hr/day and 250 day/yr). The FALs were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 80 hours (i.e., the Occasional Use Area exposure scenario in which a site worker is exposed to site contamination for 10 day/yr and 8 hr/day).

A COC is defined as any contaminant present in environmental media exceeding a FAL. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NFO, 2014). If COCs are present, corrective action must be considered for the CAS.

At sites where removable radioactive contamination is present, it is assumed that a corrective action is required if the site exceeds HCA criteria, even though the area may not present a potential radiation dose to a receptor that exceeds the FAL. Removable contamination is defined as radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing (NNSA/NSO, 2012b). A discussion on the risks associated with removable radioactive contamination is presented in the Soils RBCA document (NNSA/NFO, 2014). At CAU 550, the DCB surrounding the three safety experiment CASs (Study Group 2) was established based on historical removable contamination survey data, which suggested the presence of HCA conditions within the boundary (NNSA/NSO, 2012a).

A corrective action may also be required if a waste present within a study group contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and release the contaminants to the surrounding media. The following were used as the criteria for determining whether a waste is PSM:

- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.
- Based on process knowledge and/or professional judgment, some waste may be assumed to not be PSM if it is clear that it could not result in soil contamination exceeding a FAL.
- If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:
  - For non-liquid wastes, the concentration of any chemical contaminant in soil (following degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the potentially contaminated soil. If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.
  - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (following degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the potentially contaminated soil (for each radioactive contaminant) and calculating the combined resulting dose using the appropriate RRMGs. If the resulting dose exceeds the FAL, then the waste would be considered to be PSM.
  - For liquid wastes, the concentration of any chemical contaminant in soil (following degradation of any physical containment and release of contaminants into soil) will be calculated using the following equation based on the concentration of contaminants in the waste, the soil water holding capacity of the soil (field capacity), and the soil bulk density. If the resulting soil concentration exceeds the FAL, then the liquid waste would be considered to be PSM.

$$C_s = \frac{C_l \times FC_s}{P_b}$$

where

C_s = estimated constituent concentration in soil (mg/kg)
C_l = constituent concentration in liquid PSM (mg/L)
FC_s = soil field capacity (0.2 kg/1,000 cm^3)
P_b = soil bulk density (1.5 kg/1,000 cm^3)

The analytical results for each of the study groups are presented in Sections A.3.3, A.4.3, A.5.3, and A.6.3. Chemical analytical results are reported as individual concentrations that are compared to the individual chemical FALs. Radiological data are compared to a dose-based FAL criteria to determine the need for corrective action. Results that are equal to or greater than FALs are identified by bold text in the study group-specific results tables.

A.2.5 Correlation of Dose to Radiation Survey Isopleths

A boundary for a corrective action or an administrative UR for a particular release site may be established by using radiation survey isopleths if it can be shown that a sufficient correlation exists between TED and radiation survey values. A continuous spatial distribution (i.e., interpolated surface) is estimated using an inverse distance weighted interpolation technique. The average Industrial Area TED value for each study site is matched with a radiation survey value from the interpolated surface at the corresponding geographic location. A correlation is then calculated between these data pairs for each radiation survey. Correlation statistics are then used to establish the relationship between the paired values as well as an indicator of the strength of the relationship (i.e., the coefficient of determination [r^2]). The minimum strength of the relationship for a valid correlation is defined in the CAIP as an r^2 value of 0.8 (NNSA/NSO, 2012a).

The TED values used in the correlation are the average of the TED for probabilistic samples or the calculated TED for judgmental samples from biased sample locations. To protect against a Decision II false-negative decision error (the potential for a receptor to receive a dose exceeding the 25-mrem/yr FAL outside the defined boundary), the Soils Activity uses a conservative estimate of the radiation survey value corresponding to 25 mrem/yr. This is accomplished using the uncertainty of how well the calculated relationship between TED and emitted radiation (i.e., the regression) represents the assumed true relationship. This uncertainty includes the uncertainty of how well the calculated TED represents true TED and the uncertainty of how well the radiation survey instrument readings represent emitted radioactivity.

Based on the sampling design for the CAU 550 CAI, only the results from Study Group 1 were subjected to a correlation study as described above. The results of this study are discussed in Section A.3.5.

A.3.0 Study Group 1, Atmospheric Test

Study Group 1 is defined as the release of contaminants associated with the Smoky weapons-related test conducted on August 31, 1957. The 44-kiloton (kt)-yield test was conducted from a tower at a height of 700 feet (ft) at Test Site T-2C (DOE/NV, 2000b). Radioactive contamination from the test was released to the atmosphere and deposited on the surface in an annular pattern around GZ (BN, 1999).

A.3.1 Investigation Activities

The CAI at Study Group 1 included visual surveys, TRSs, and the collection of surface soil samples and TLDs.

A.3.1.1 Visual Surveys

Visual surveys of Study Group 1 were conducted at and surrounding Smoky GZ, within and outside the CA fence. The extent of the visual surveys was bounded on the east and west by the extent of the TLD grid, on the north by Smoky Hill, and on the south by the upper boundary of the DCB (Figure A.3-1). Many of the debris items identified during the surveys have been recorded in previous site visits. The locations of underground concrete bunkers, an aircraft carcass, two armored personnel carriers, scattered metal, and other test-related debris surrounding Smoky GZ were confirmed during the CAI. The visual survey of these items did not reveal any evidence or suggestion of a release (e.g., visible soil staining, presence of PSM) and therefore did not warrant further investigation.

A preliminary assessment of cultural resources at the Smoky site was conducted in 2012. This assessment documented the presence of structures and features of historical significance, to include underground concrete structures, metal debris, lead bricks, and other material associated with the Smoky atmospheric test. The Smoky site encompasses CAS 08-26-01, Lead Bricks [200]. The lead bricks were investigated as a separate CAS in Study Group 4 (Debris) due to the potential for lead contamination in the soil. Although the lead bricks were not investigated as part of Study Group 1 (CAS 08-23-04, Smoky Atmospheric Test), the lead bricks are directly related to the Smoky test and are considered an integral part of the Smoky historic landscape. Because the Smoky site has remained

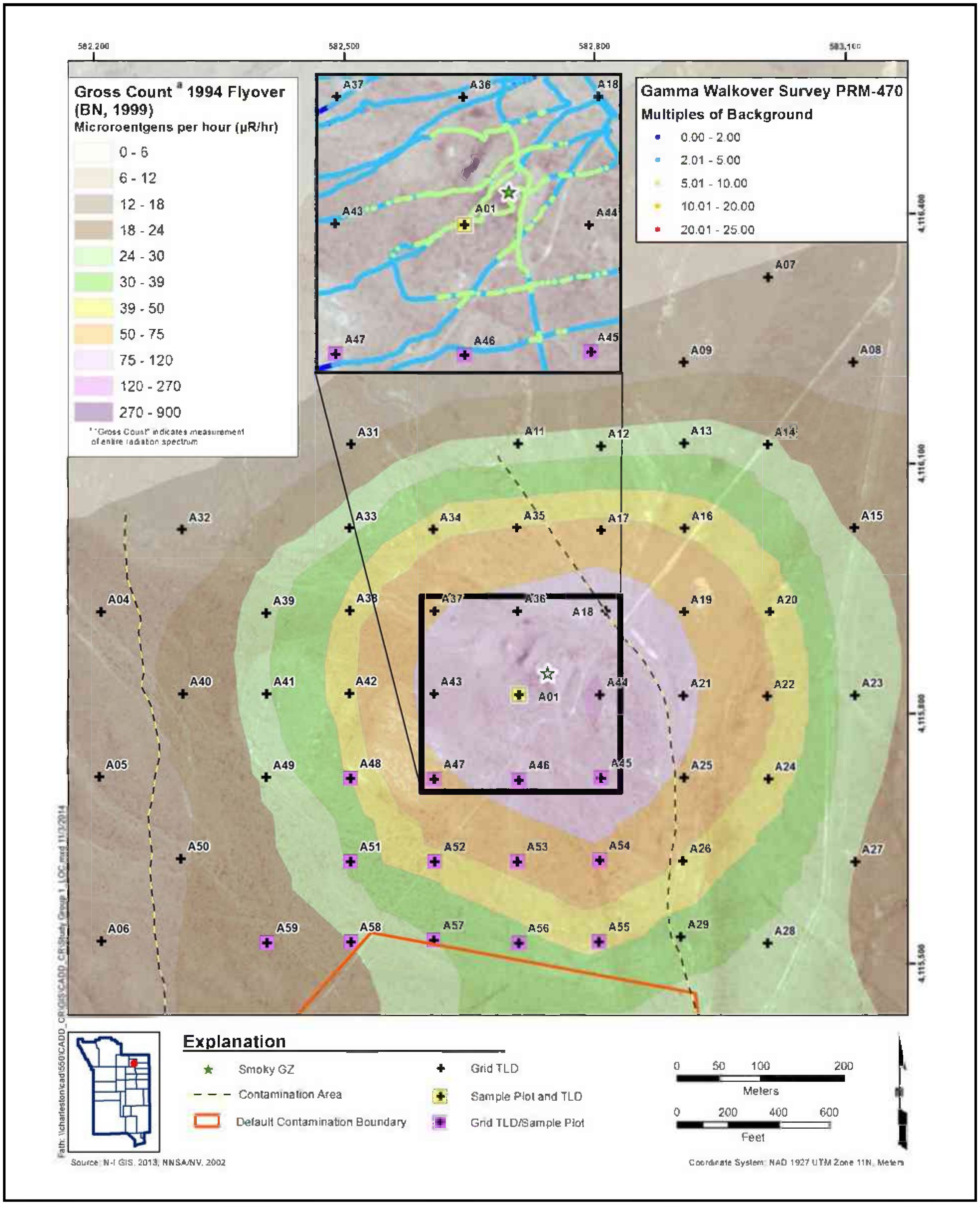

Figure A.3-1
Study Group 1 TLD and Soil Sample Locations

essentially unchanged since the Smoky atmospheric test, the site is eligible for the National Register of Historic Places as a historical landscape (Ernstein, 2014).

A.3.1.2 Radiological Surveys

Radiological surveys using the PRM-470 and FIDLER were conducted at Study Group 1 during the preliminary investigation in 2011 and are presented in the CAIP (NNSA/NSO, 2012a). These surveys were conducted inside the CA fence north of the DCB to the base of Smoky Hill, and to the east and west of the CA fence. The site-wide PRM-470 and FIDLER survey results are presented in Figures A.2-1 and A.2-2, respectively. These survey results were used to guide the selection of the Study Group 1 TLD and sample plot locations, as discussed in Sections A.3.1.3 and A.3.1.4.

Radiological surveys at Study Group 1 during the CAI were limited to localized measurements at proposed sample locations to ensure samples were collected at areas with the highest radioactivity levels. This was accomplished by navigating to the proposed sample location and surveying the immediate area with the PRM-470 instrument to identify the location with the highest reading. The PRM-470 instrument was used because it measures the radiation from fission and activation products resulting from the Smoky test.

A.3.1.3 TLD Samples

A total of 56 TLDs were placed at Study Group 1 to determine external dose (Table A.3-1). The TLDs were set out in a relatively uniform grid pattern centered on Smoky GZ, as proposed in the CAIP (NNSA/NSO, 2012a). The TLD grid was designed to obtain multiple data points from each of the radiation isopleths within the Smoky radiation plume as shown in the 1994 aerial radiation survey (Figure A.3-1). This allowed for completion of the correlation study described in Section A.3.5 that was used to determine the extent of contamination at the site.

A.3.1.4 Soil Samples

A total of 17 composite soil samples were collected from sample plots at Study Group 1 (Table A.3-2). The location of sample plot A01 was proposed in the CAIP at the area of most elevated radioactivity as identified by the 1994 aerial radiological survey and the PRM-470 TRS (Figure A.3-1) (NNSA/NSO, 2012a). Before this sample plot was established, the area around the

Table A.3-1
Study Group 1 TLD Samples
(Page 1 of 2)

TLD Location	TLD Number	Date Placed	Date Removed	Purpose
A01	6067	09/20/2012	01/07/2013	Grid/Sample Plot
A04	4409	09/19/2012	01/07/2013	Grid
A05	4942	09/19/2012	01/07/2013	Grid
A06	4796	09/19/2012	01/07/2013	Grid
A07	6119	09/19/2012	01/08/2013	Grid
A08	4598	09/19/2012	01/08/2013	Grid
A09	6033	09/19/2012	01/08/2013	Grid
A10	5189	09/19/2012	01/08/2013	Grid
A11	4877	09/19/2012	01/08/2013	Grid
A12	3520	09/19/2012	01/08/2013	Grid
A13	4463	09/19/2012	01/08/2013	Grid
A14	4859	09/19/2012	01/08/2013	Grid
A15	6420	09/19/2012	01/08/2013	Grid
A16	5128	09/19/2012	01/08/2013	Grid
A17	6289	09/19/2012	01/08/2013	Grid
A18	6350	09/19/2012	01/08/2013	Grid
A19	3837	09/19/2012	01/08/2013	Grid
A20	3407	09/19/2012	01/08/2013	Grid
A21	4916	09/19/2012	01/08/2013	Grid
A22	6144	09/19/2012	01/08/2013	Grid
A23	4345	09/19/2012	01/08/2013	Grid
A24	6198	09/19/2012	01/08/2013	Grid
A25	5018	09/19/2012	01/08/2013	Grid
A26	6303	09/19/2012	01/08/2013	Grid
A27	4579	09/19/2012	01/08/2013	Grid
A28	6174	09/19/2012	01/08/2013	Grid
A29	6365	09/19/2012	01/08/2013	Grid
A31	6418	09/20/2012	01/07/2013	Grid
A32	6264	09/20/2012	01/07/2013	Grid

Table A.3-1
Study Group 1 TLD Samples
(Page 2 of 2)

TLD Location	TLD Number	Date Placed	Date Removed	Purpose
A33	6378	09/20/2012	01/07/2013	Grid
A34	5017	09/20/2012	01/07/2013	Grid
A35	6423	09/20/2012	01/07/2013	Grid
A36	6431	09/20/2012	01/07/2013	Grid
A37	6424	09/20/2012	01/07/2013	Grid
A38	6015	09/20/2012	01/07/2013	Grid
A39	6430	09/20/2012	01/07/2013	Grid
A40	4972	09/20/2012	01/07/2013	Grid
A41	6078	09/20/2012	01/07/2013	Grid
A42	6199	09/20/2012	01/07/2013	Grid
A43	6017	09/20/2012	01/07/2013	Grid
A44	6208	09/20/2012	01/07/2013	Grid
A45	6073	09/20/2012	01/07/2013	Grid/Sample Plot
A46	6412	09/20/2012	01/07/2013	Grid/Sample Plot
A47	6258	09/20/2012	01/07/2013	Grid/Sample Plot
A48	6229	09/20/2012	01/07/2013	Grid/Sample Plot
A49	6327	09/20/2012	01/07/2013	Grid
A50	6299	09/20/2012	01/07/2013	Grid
A51	6304	09/20/2012	01/07/2013	Grid/Sample Plot
A52	6049	09/20/2012	01/07/2013	Grid/Sample Plot
A53	6452	09/20/2012	01/07/2013	Grid/Sample Plot
A54	6183	09/20/2012	01/07/2013	Grid/Sample Plot
A55	6212	09/20/2012	01/07/2013	Grid/Sample Plot
A56	6330	09/20/2012	01/07/2013	Grid/Sample Plot
A57	6282	09/20/2012	01/07/2013	Grid/Sample Plot
A58	6041	09/20/2012	01/07/2013	Grid/Sample Plot
A59	4940	09/20/2012	01/07/2013	Grid/Sample Plot

Table A.3-2
Study Group 1 Soil Samples

Sample Location	Sample Number	Depth (cm bgs)	Purpose	Analyses
A01	A601	0.0 - 0.5	Sample Plot	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241 (Sample A603 also analyzed for Tc-99 and Sr-90)
	A602	0.0 - 0.5		
	A603	0.0 - 0.5		
	A604	0.0 - 0.5		
A45	A617	0.0 - 0.5	Sample Plot	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241
A46	A616	0.0 - 0.5	Sample Plot	
A47	A615	0.0 - 0.5	Sample Plot	
A48	A614	0.0 - 0.5	Sample Plot	
A51	A613	0.0 - 0.5	Sample Plot	
A52	A612	0.0 - 0.5	Sample Plot	
A53	A611	0.0 - 0.5	Sample Plot	
A54	A610	0.0 - 0.5	Sample Plot	
A55	A609	0.0 - 0.5	Sample Plot	
A56	A608	0.0 - 0.5	Sample Plot	
A57	A607	0.0 - 0.5	Sample Plot	
A58	A606	0.0 - 0.5	Sample Plot	
A59	A605	0.0 - 0.5	Sample Plot	

Tc = Technetium

location was surveyed with a PRM-470 instrument to ensure it was placed at the location of the highest radiological measurement. The location of this plot did not change from that proposed in the CAIP. Four composite samples, consisting of nine aliquots each, were collected at this sample plot in accordance with the CAIP sample plot sampling protocol. Thirteen additional sample plots were established at locations within the TLD grid (locations A45 through A48; A51 through A59). The locations of these sample plots did not change from those proposed in the CAIP. These locations are within an area of potential overlap between the contamination plumes of Study Group 1 (Atmospheric Test) and Study Group 2 (Safety Experiments). The purpose of these samples was to distinguish the contamination from the two release sources (i.e., the Smoky weapons-related test versus the three safety experiments; see Section A.3.3.3 for comparison discussion). One composite soil sample, consisting of nine aliquots, was collected at each of these sample plots in accordance with the CAIP sample plot sampling protocol. All Study Group 1 soil samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am. The sample locations are shown on Figure A.3-1.

A.3.2 Deviations/Revised Conceptual Site Model

Investigation samples were collected at Study Group 1 as outlined in the CAIP (NNSA/NSO, 2012a), with the following exception: The CAIP indicated one sample plot would be established at Study Group 1 and four composite samples collected from the plot. After further review of the contamination plumes shown by the aerial radiological surveys, it was determined that additional sample plots would be placed at Study Group 1 in an attempt to distinguish the weapons-related plume at Smoky (Study Group 1) from the safety experiments plume (Study Group 2) where they potentially overlapped. Thirteen existing grid TLD locations to the south of Smoky GZ were selected, and one sample plot was placed at each location. The data from these sample locations were also to be used to determine the extent of contamination at Study Groups 1 and 2, if appropriate.

The CAIP states that an initial corrective action boundary will be established using the correlation of the 95 percent UCL of the TED and an appropriate radiation survey. Although establishment of a corrective action boundary at CAS 08-23-04 (Smoky) is not necessary based on the CAI results, the administrative UR boundary for this CAS was established using the regression correlation method described in Section A.2.5.

These deviations were not a result of a change to the CSM. The contamination pattern of the radionuclides at Study Group 1 is consistent with the CSM in that the radiological dose is highest near GZ and generally decreases with distance from the release point in an roughly annular pattern. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was necessary.

A.3.3 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses that are comparable to the dose-based FAL of

25 mrem/OU-yr. Results that are equal to or greater than the FAL are identified by bold text in the data tables. Establishment of the FAL is presented in Appendix C.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location in accordance with Section A.2.3. External doses for TLD locations are summarized in Section A.3.3.1 and internal doses for each sample plot are summarized in Section A.3.3.2. The TED for each sample location is summarized in Section A.3.3.4.

A.3.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each Study Group 1 TLD sample location were determined as described in Section A.2.3.2. External dose was calculated for the Industrial Area exposure scenario and then scaled (based on exposure duration) to the Remote Work Area and Occasional Use Area exposure scenarios for each TLD location. The standard deviation, number of samples, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.3-3. The minimum sample size criterion was met for all TLD samples.

Table A.3-3
Study Group 1 95% UCL External Dose for Each Exposure Scenario
(Page 1 of 3)

TLD Location	Standard Deviation (OU Scenario)	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A01	0.3	3	3	**95.3**	16.0	4.8
A04	0.1	3	3	5.0	0.8	0.3
A05	0.0	3	3	4.9	0.8	0.2
A06	0.0	3	3	7.6	1.3	0.4
A07	0.0	3	3	0.1	0.0	0.0
A08	0.0	3	3	3.7	0.6	0.2
A09	0.1	3	3	3.1	0.5	0.2
A10	0.0	3	3	1.3	0.2	0.1
A11	0.1	3	3	7.8	1.3	0.4

Table A.3-3
Study Group 1 95% UCL External Dose for Each Exposure Scenario
(Page 2 of 3)

TLD Location	Standard Deviation (OU Scenario)	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A12	0.0	3	3	1.7	0.3	0.1
A13	0.1	3	3	4.1	0.7	0.2
A14	0.0	3	3	7.2	1.2	0.4
A15	0.1	3	3	7.7	1.3	0.4
A16	0.0	3	3	16.7	2.8	0.8
A17	0.0	3	3	14.7	2.5	0.7
A18	0.1	3	3	**34.7**	5.8	1.7
A19	0.1	3	3	**29.4**	4.9	1.5
A20	0.1	3	3	14.0	2.4	0.7
A21	0.1	3	3	**30.0**	5.0	1.5
A22	0.0	3	3	16.7	2.8	0.8
A23	0.1	3	3	7.8	1.3	0.4
A24	0.1	3	3	13.7	2.3	0.7
A25	0.1	3	3	21.0	3.5	1.1
A26	0.1	3	3	15.3	2.6	0.8
A27	0.0	3	3	7.1	1.2	0.4
A28	0.1	3	3	11.4	1.9	0.6
A29	0.1	3	3	11.1	1.9	0.6
A31	0.0	3	3	2.5	0.4	0.1
A32	0.0	3	3	0.9	0.1	0.0
A33	0.0	3	3	4.5	0.8	0.2
A34	0.0	3	3	9.7	1.6	0.5
A35	0.1	3	3	15.1	2.5	0.8
A36	0.1	3	3	**40.4**	6.8	2.0
A37	0.2	3	3	**39.5**	6.6	2.0
A38	0.1	3	3	22.2	3.7	1.1
A39	0.1	3	3	12.5	2.1	0.6
A40	0.0	3	3	2.9	0.5	0.1
A41	0.1	3	3	3.2	0.5	0.2

Table A.3-3
Study Group 1 95% UCL External Dose for Each Exposure Scenario
(Page 3 of 3)

TLD Location	Standard Deviation (OU Scenario)	Number of Samples	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A42	0.0	3	3	18.1	3.0	0.9
A43	0.2	3	3	**52.6**	8.8	2.6
A44	0.1	3	3	**61.5**	10.3	3.1
A45	0.2	3	3	**49.2**	8.3	2.5
A46	0.0	3	3	**40.9**	6.9	2.0
A47	0.1	3	3	**28.6**	4.8	1.4
A48	0.1	3	3	15.7	2.6	0.8
A49	0.0	3	3	5.3	0.9	0.3
A50	0.1	3	3	7.2	1.2	0.4
A51	0.1	3	3	11.4	1.9	0.6
A52	0.1	3	3	12.8	2.2	0.6
A53	0.1	3	3	24.2	4.1	1.2
A54	0.0	3	3	**31.1**	5.2	1.6
A55	0.1	3	3	14.7	2.5	0.7
A56	0.0	3	3	9.9	1.7	0.5
A57	0.0	3	3	8.1	1.4	0.4
A58	0.1	3	3	9.2	1.5	0.5
A59	0.0	3	3	6.4	1.1	0.3

Bold indicates the values exceeding 25 mrem/yr.

OU = Occasional Use Area

A.3.3.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each Study Group 1 sample location were determined as described in Section A.2.3.1. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose for sample plot A01 are presented in Table A.3-4. Evaluation of the data suggests that sample plot A01 best represents the release of fission products associated with the Smoky test, as opposed to data from a sample plot placed closer to the three safety experiments in Study Group 2 that represent radiological fuel components. As a

Table A.3-4
Study Group 1 95% UCL Internal Dose at Sample Plot A01 for Each Exposure Scenario

Sample Plot	Standard Deviation (OU Scenario)	Minimum Sample Size (OU Scenario)	Number of Samples	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A01	0.01	3	4	0.6	0.1	0.0

result, the ratio of internal to external dose from sample plot A01 located at Smoky GZ was used to estimate internal dose at TLD-only locations (Figure A.3-1) for Study Group 1.

The internal doses for the remainder of the sample plot locations are presented in Table A.3-5. Because only one sample was collected from these 13 sample plots, a statistical evaluation of the data was not performed. As a result, only the average internal dose from these plots was calculated.

Table A.3-5
Study Group 1 Average Internal Dose at Other Sample Plots for Each Exposure Scenario

Sample Plot	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A45	0.5	0.1	0.0
A46	0.7	0.1	0.0
A47	1.4	0.2	0.1
A48	3.9	0.7	0.2
A51	6.0	1.0	0.4
A52	1.9	0.3	0.1
A53	0.4	0.1	0.0
A54	0.9	0.2	0.1
A55	0.8	0.1	0.0
A56	1.1	0.2	0.1
A57	14.8	2.5	0.9
A58	3.5	0.6	0.2
A59	2.3	0.4	0.1

A.3.3.3 Internal and External Dose Contribution

Table A.3-6 presents a comparison of the internal and external doses in mrem/OU-yr at each sample plot. This demonstrates that the TED at Study Group 1 comprises almost entirely external dose. The exception is location A57, which is located within the area of plume overlap between the safety experiments and the Smoky test. At this location, internal dose contributes more to the TED than external dose.

None of the Study Group 1 sample locations exceed the FAL of 25 mrem/OU-yr (Figure A.3-2).

Table A.3-6
Study Group 1 Ratio of Calculated Internal Dose to External Dose at Each Sample Plot (mrem/OU-yr)

Sample Plot	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
A01	0.0	4.3	4.4	0.006
A45	0.0	2.2	2.2	0.013
A46	0.0	2.0	2.0	0.021
A47	0.1	1.3	1.4	0.066
A48	0.2	0.7	0.9	0.340
A51	0.4	0.4	0.8	0.896
A52	0.1	0.5	0.6	0.238
A53	0.0	1.1	1.1	0.022
A54	0.1	1.5	1.5	0.036
A55	0.0	0.6	0.7	0.082
A56	0.1	0.4	0.5	0.162
A57	0.9	0.3	1.2	2.669
A58	0.2	0.4	0.6	0.581
A59	0.1	0.2	0.4	0.579

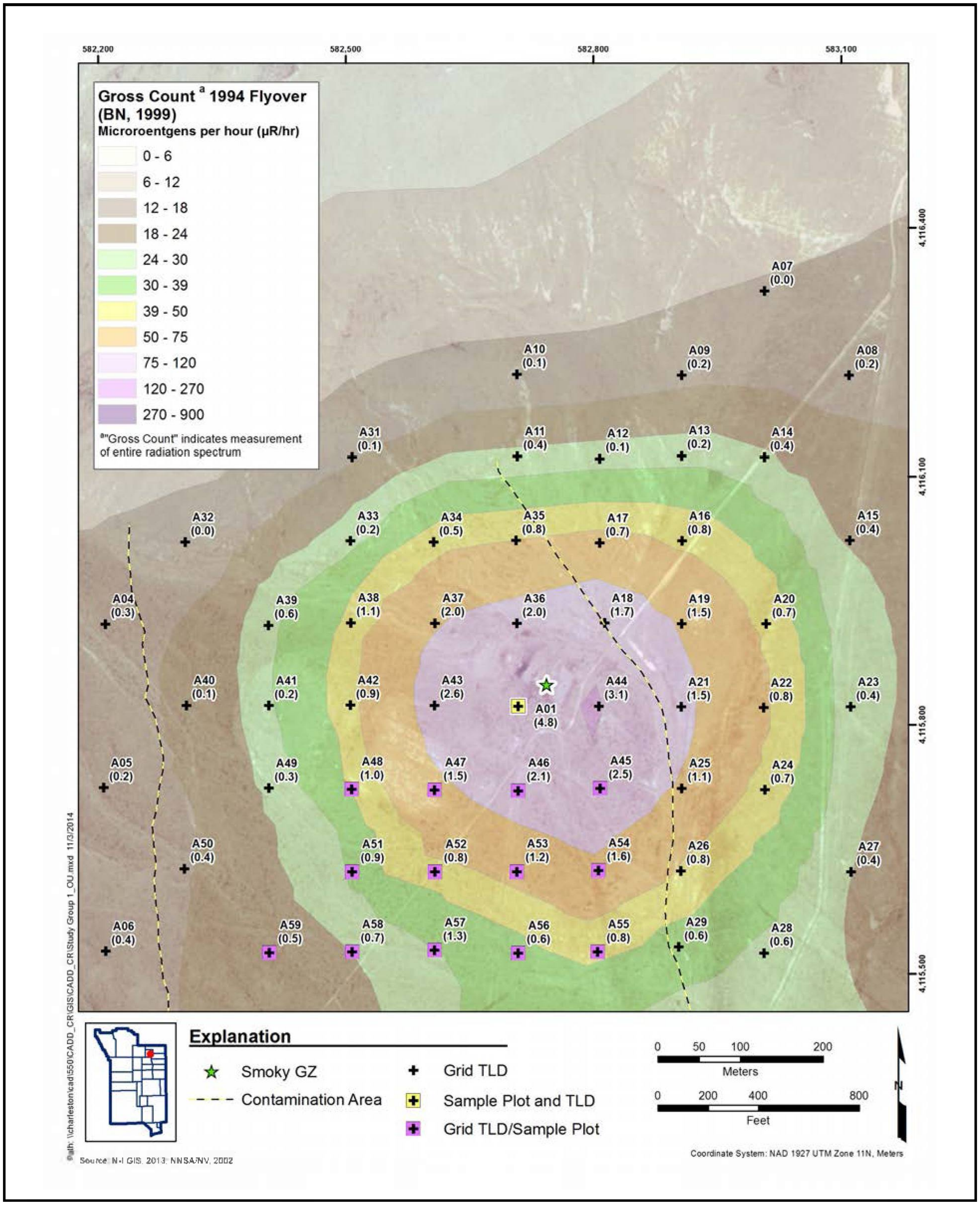

Figure A.3-2
Study Group 1 95% UCL of the TED
(mrem/OU-yr)

A.3.3.4 Total Effective Dose

The TED for each sample location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.3-7.

Table A.3-7
Study Group 1 TED at Sample Locations (mrem/yr)
(Page 1 of 2)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
A01	**87.1**	**96.0**	14.6	16.1	4.4	4.8
A04	3.0	5.0	0.5	0.8	0.1	0.3
A05	3.5	4.9	0.6	0.8	0.2	0.2
A06	6.0	7.6	1.0	1.3	0.3	0.4
A07	0.0	0.1	0.0	0.0	0.0	0.0
A08	2.5	3.7	0.4	0.6	0.1	0.2
A09	0.6	3.1	0.1	0.5	0.0	0.2
A10	0.0	1.3	0.0	0.2	0.0	0.1
A11	5.4	7.8	0.9	1.3	0.3	0.4
A12	0.3	1.7	0.0	0.3	0.0	0.1
A13	1.6	4.1	0.3	0.7	0.1	0.2
A14	5.9	7.3	1.0	1.2	0.3	0.4
A15	4.7	7.7	0.8	1.3	0.2	0.4
A16	15.7	16.8	2.6	2.8	0.8	0.8
A17	14.5	14.8	2.4	2.5	0.7	0.7
A18	**30.0**	**34.9**	5.0	5.9	1.5	1.7
A19	**26.6**	**29.5**	4.5	5.0	1.3	1.5
A20	9.4	14.1	1.6	2.4	0.5	0.7
A21	**27.6**	**30.2**	4.6	5.1	1.4	1.5
A22	15.4	16.8	2.6	2.8	0.8	0.8
A23	6.1	7.8	1.0	1.3	0.3	0.4
A24	11.6	13.7	2.0	2.3	0.6	0.7
A25	17.7	21.1	3.0	3.5	0.9	1.1
A26	11.9	15.4	2.0	2.6	0.6	0.8
A27	5.9	7.1	1.0	1.2	0.3	0.4

Table A.3-7
Study Group 1 TED at Sample Locations (mrem/yr)
(Page 2 of 2)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
A28	7.6	11.5	1.3	1.9	0.4	0.6
A29	9.0	11.2	1.5	1.9	0.5	0.6
A31	1.4	2.5	0.2	0.4	0.1	0.1
A32	0.0	0.9	0.0	0.1	0.0	0.0
A33	2.9	4.5	0.5	0.8	0.1	0.2
A34	9.3	9.8	1.6	1.6	0.5	0.5
A35	13.0	15.2	2.2	2.5	0.6	0.8
A36	**37.0**	**40.6**	6.2	6.8	1.9	2.0
A37	**34.6**	**39.6**	5.8	6.7	1.7	2.0
A38	19.5	22.3	3.3	3.8	1.0	1.1
A39	10.1	12.5	1.7	2.1	0.5	0.6
A40	2.7	2.9	0.5	0.5	0.1	0.1
A41	1.4	3.2	0.2	0.5	0.1	0.2
A42	17.5	18.2	2.9	3.1	0.9	0.9
A43	**45.7**	**52.9**	7.7	8.9	2.3	2.6
A44	**59.4**	**61.8**	10.0	10.4	3.0	3.1
A45	**43.8**	**49.7**	7.4	8.3	2.2	2.5
A46	**40.0**	**41.5**	6.7	7.0	2.0	2.1
A47	**27.3**	**30.0**	4.6	5.0	1.4	1.5
A48	17.8	19.6	3.0	3.3	0.9	1.0
A49	5.0	5.3	0.8	0.9	0.2	0.3
A50	4.4	7.2	0.7	1.2	0.2	0.4
A51	14.0	17.4	2.4	2.9	0.8	0.9
A52	11.7	14.8	2.0	2.5	0.6	0.8
A53	22.1	24.6	3.7	4.1	1.1	1.2
A54	**30.4**	**32.0**	5.1	5.4	1.5	1.6
A55	12.9	15.6	2.2	2.6	0.7	0.8
A56	9.3	11.0	1.6	1.8	0.5	0.6
A57	21.5	22.9	3.6	3.9	1.2	1.3
A58	10.6	12.6	1.8	2.1	0.6	0.7
A59	7.2	8.7	1.2	1.5	0.4	0.5

Bold indicates the values exceeding 25 mrem/yr.

A.3.4 Nature and Extent of Contaminants of Concern

Based on the data evaluation, no sample location exceeded the FAL of 25 mrem/OU-yr; therefore, no COCs were identified at Study Group 1 (Atmospheric Test).

A.3.5 Best Management Practices

As a BMP, an administrative UR was established at Study Group 1 that includes any area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr (i.e., the PAL) and/or any area where removable radioactive contamination is present that meets CA conditions.

At Study Group 1, the PAL of 25 mrem/IA-yr was exceeded at 12 locations surrounding Smoky GZ (Figure A.3-3 and Table A.3-7). In order to determine the extent of the area where the Industrial Area TED exceeds the PAL, a correlation of radiation survey values to the average Industrial Area TED values was conducted for the following radiation surveys, as described in Section A.2.5:

- Gross-count values from the 1994, 2002, and 2010 aerial radiation surveys
- Man-made values from the 1994, 2002, and 2010 aerial radiation surveys
- PRM-470 survey
- FIDLER survey

A continuous spatial distribution (i.e., interpolated surface) was estimated from each of the listed radiation surveys using an inverse distance weighted interpolation technique. Each average Industrial Area TED value was then matched with a radiation survey value from the interpolated surface at the corresponding geographic location. A correlation was then calculated between these data pairs for each radiation survey. These correlation results are shown in Table A.3-8. The radiation survey that exhibited the best correlation is the 2010 gross-count aerial survey, with a correlation (r^2 value) of 0.923. This correlation exceeds the minimum criteria of 0.8 as established in the CAIP (NNSA/NSO, 2012a). Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr PAL is 51,588 counts per second (cps), as shown on Figure A.3-3.

A portion of Study Group 1 contains removable contamination at levels that meet CA conditions. As such, the administrative UR for the site will encompass this area as well as the area that exceeds 25 mrem/IA-yr. Due to the large land area included in CAU 550 and the multiple administrative UR

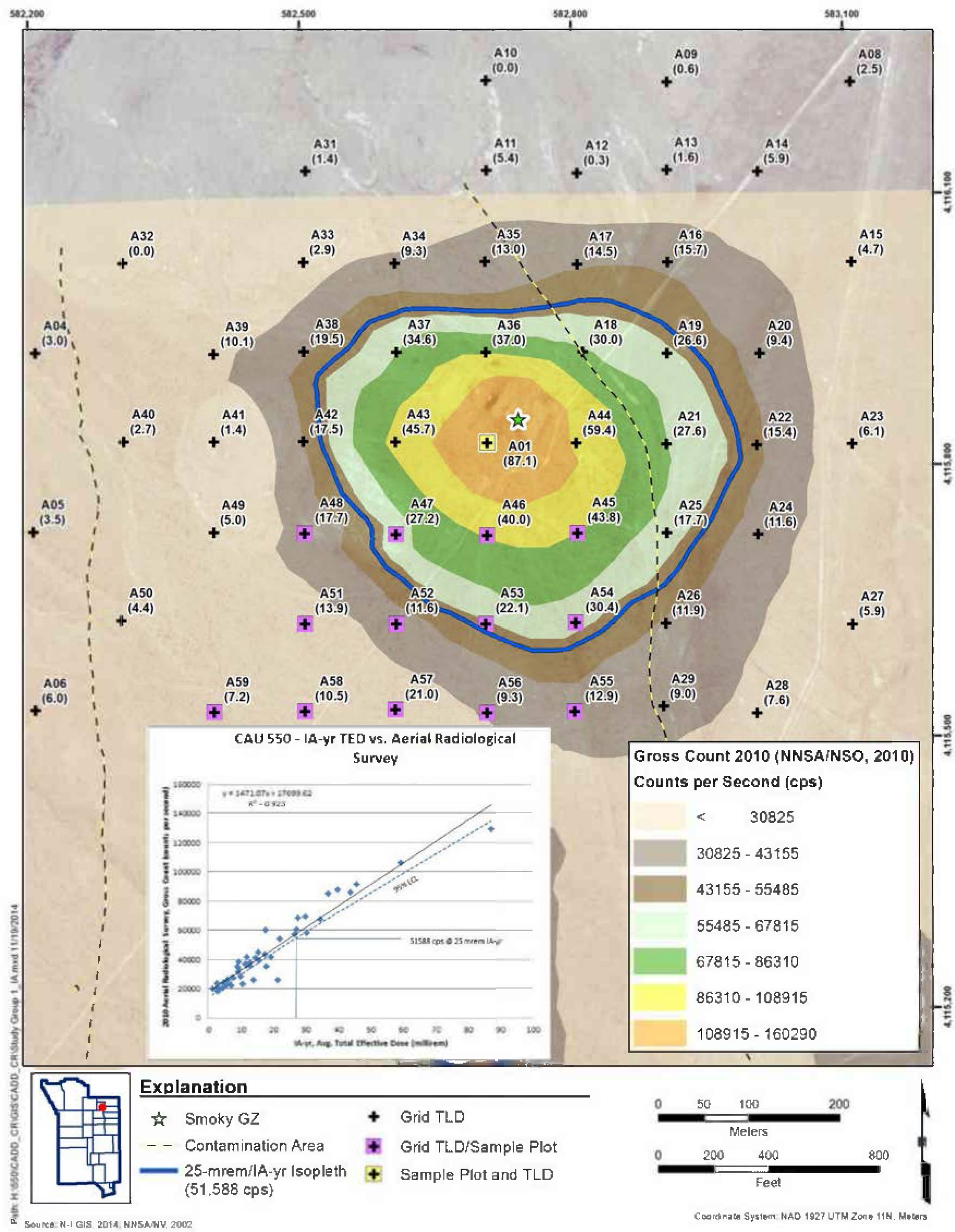

Figure A.3-3
Study Group 1 Average of the TED and 25-mrem/IA-yr Isopleth (mrem/IA-yr)

Table A.3-8
Correlations of 95% UCL TED with Radiation Surveys

Dataset	Correlation Coefficient (r^2)
1994 Aerial Survey - Man-Made	0.792
1994 Aerial Survey - Gross-Count	0.796
2002 Aerial Survey - Man Made	0.731
2002 Aerial Survey - Gross-Count	0.677
2010 Aerial Survey - Man-Made	0.905
2010 Aerial Survey - Gross-Count	0.923
2011 Ground-Based PRM-470 Survey	0.834
2011 Ground-Based FIDLER Survey	0.680

boundaries identified as BMPs in this CADD/CR, a single administrative UR boundary was established for the CAU, as shown in Attachment D-1. Although the need for an administrative UR was identified for CAS 08-23-04 (Smoky) based on dose, the extent of the administrative UR at CAU 550 is primarily based on the presence of removable radioactive contamination that meets CA conditions. Due to the long half-lives of the removable radioactive contaminants, which include Pu-239 with a half-life of 24,000 years, radioactive decay will not allow for removal of the administrative UR in the foreseeable future.

A.4.0 Study Group 2, Safety Experiments

Study Group 2 is defined as the release of contaminants associated with three safety experiments conducted in October 1958 (DOE/NV, 2000b). Radioactive contamination from the tests was released to the atmosphere and deposited on the ground surface. Additional detail on the history of Study Group 2 is provided in the CAIP (NNSA/NSO, 2012a).

A.4.1 Investigation Activities

The CAI at Study Group 2 included visual surveys, TRSs, and the collection of surface soil samples and TLDs.

A DCB surrounding the three safety experiments was proposed in the CAIP (NNSA/NSO, 2012a) based on historical removable contamination survey data, which suggested the presence of HCA conditions within the DCB (Figure A.4-1). The DCB is separated into two sections by a dirt road. The northern section includes the GZs for CAS 08-23-03 (Ceres) and CAS 08-23-06 (Oberon); the southern section includes the GZ for CAS 08-23-07 (Titania).

A.4.1.1 Visual Surveys

Visual surveys of Study Group 2 were conducted at and surrounding the three safety experiment GZs. The extent of the visual surveys consisted of the area inside the DCB and outside the perimeter of the DCB boundary to the east, west, and south. Several items were noted in the southern portion of the DCB, including an electrical junction box, wood pieces, metal scrap, and other solid debris. Removable contamination swipes collected from these items indicated the presence of HCA conditions. Due to the nature of the three safety experiments and the location of the identified debris within the DCB, the presence of removable radioactive contamination was expected. Given that no post-experiment cleanup occurred, it is likely that these items were part of the tower structures or otherwise associated with the experiments. The radioactive contamination on the experiment debris consists primarily of alpha radiation, which is consistent with the type of material (e.g., plutonium) associated with the safety experiments. In addition, the visual survey did not find evidence of chemical releases (e.g., stained soil) from any of the items.

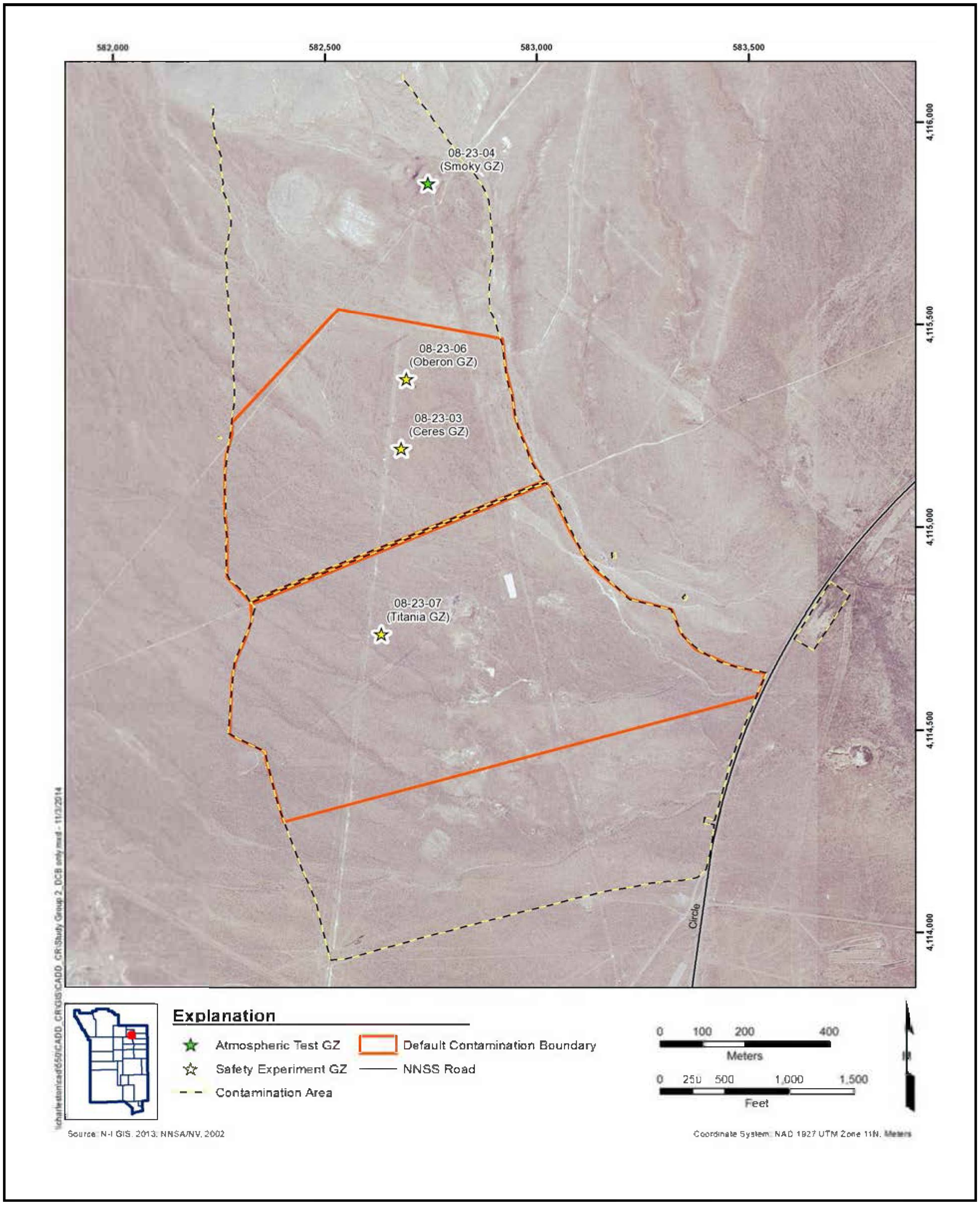

Figure A.4-1
Study Group 2 DCB

A.4.1.2 Radiological Surveys

Radiological surveys using a FIDLER were conducted at Study Group 2 during the preliminary investigation in 2011 and are reported in the CAIP (NNSA/NSO, 2012a). These surveys were conducted inside the DCB and surrounding the three safety experiment GZs. The site-wide FIDLER survey results are shown in Figure A.2-2. The purpose of the FIDLER surveys was to obtain ground-based radiological data to confirm the spatial distribution of radiological contamination shown in the aerial radiation surveys of the area.

Radiological surveys at Study Group 2 during the CAI were limited to localized measurements at the two proposed sample plot locations outside the DCB to ensure samples were collected at areas with the highest radioactivity levels. This was accomplished by navigating to the proposed sample location and surveying the area with the FIDLER to identify the location with the highest reading.

A.4.1.3 TLD Samples

One TLD was placed at each of the two soil sample plots (locations B01 and B02) at Study Group 2 to determine external dose, as detailed in Table A.4-1. The sample locations are shown in Figure A.4-2.

Table A.4-1
Study Group 2 TLD Samples

TLD Location	TLD Number	Date Placed	Date Removed	Purpose
B01	6311	09/19/2012	01/07/2013	Sample Plot
B02	3821	09/20/2012	01/07/2013	Sample Plot

A.4.1.4 Soil Samples

A total of eight composite soil samples were collected from two sample plots at Study Group 2 (Table A.4-2). Both sample plots were established outside the DCB to determine whether COCs were present outside the DCB. As stated in the CAIP (NNSA/NSO, 2012a), it is assumed that the area inside the DCB contains COCs that exceed the FALs. The location of sample plot B01 was proposed in the CAIP as west of the DCB at the highest radiological measurement based on the 2002 aerial americium survey. Sample plot B02 was proposed north of the DCB at the highest radiological

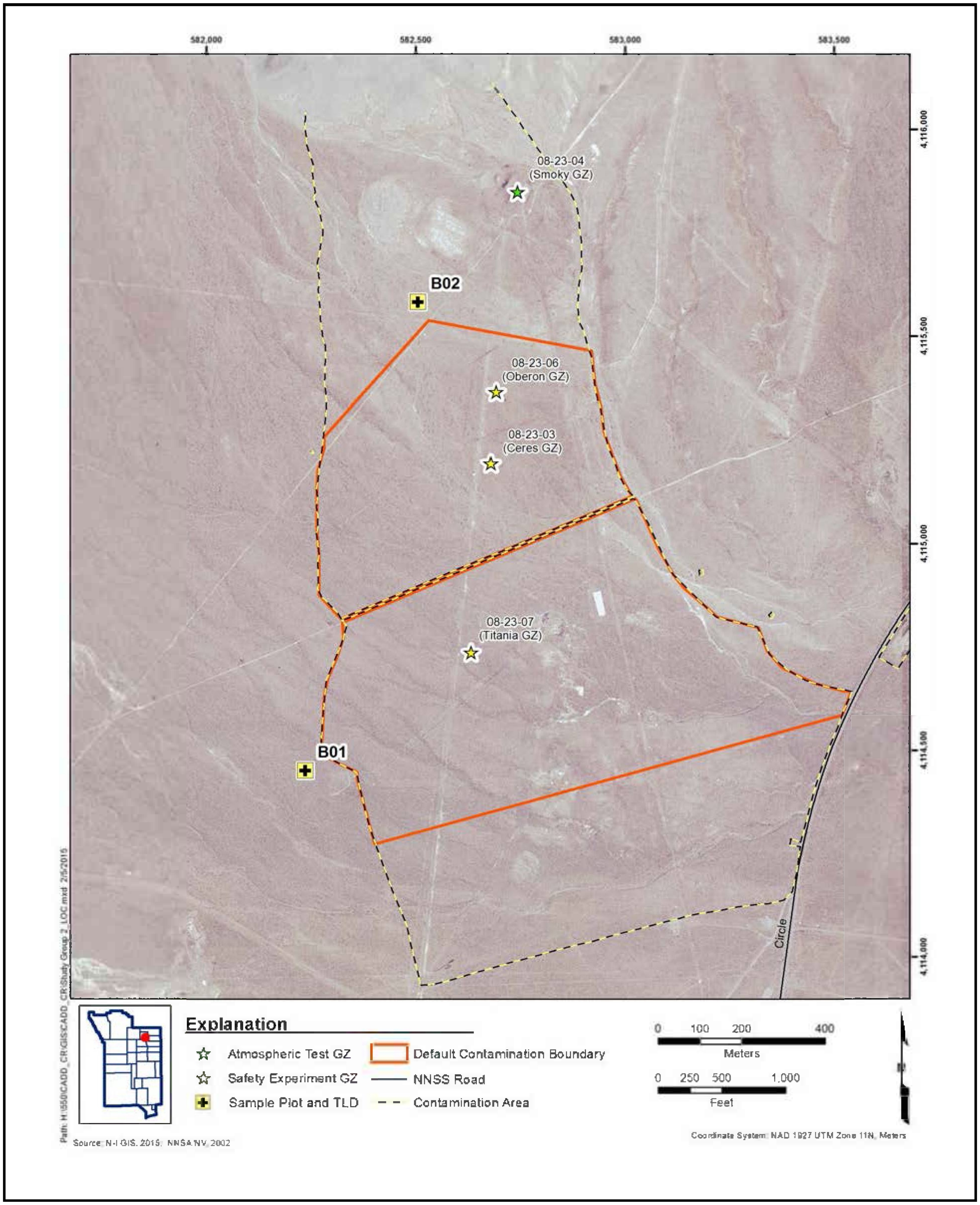

Figure A.4-2
Study Group 2 TLD and Soil Sample Locations

measurement from the 2002 KIWI survey. The 2002 radiological surveys are displayed in the CAIP with the proposed sample locations. Before this sample plot was established during the CAI, the area around each location was surveyed with a FIDLER to ensure the plots were placed at the location of the highest radiological measurement. The location of sample plot B01 was moved approximately 150 ft southwest of that proposed in the CAIP, based on FIDLER measurements used to locate the area with the highest radiological readings. The location of sample plot B02 did not change from that proposed in the CAIP. The two sample plot locations are shown on Figure A.4-2.

Table A.4-2
Study Group 2 Soil Samples

Sample Location	Sample Number	Depth (cm bgs)	Purpose	Analyses
B01	B601	0.0 - 0.5	Sample Plot	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241 (Sample B608 also analyzed for Tc-99 and Sr-90)
	B602	0.0 - 0.5		
	B603	0.0 - 0.5		
	B604	0.0 - 0.5		
B02	B605	0.0 - 0.5	Sample Plot	
	B606	0.0 - 0.5		
	B607	0.0 - 0.5		
	B608	0.0 - 0.5		

A.4.2 Deviations/Revised Conceptual Site Model

There were no deviations from the CAIP (NNSA/NSO, 2012a) during the CAI at Study Group 2.

The CAIP requirements were met at this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.4.3 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location. External doses for TLD locations are summarized in Section A.4.3.1, and internal doses for each sample plot are summarized in Section A.4.3.2. The TED for each sample location is summarized in Section A.4.3.3.

A.4.3.1 External Radiological Dose Calculations

The external dose that a receptor would receive at the two Study Group 2 TLD sample locations were determined as described in Section A.2.3.2. External dose was calculated for the Industrial Area exposure scenario and then scaled (based on exposure duration) to the Remote Work Area and Occasional Use Area exposure scenarios for each TLD location. The standard deviation, minimum sample size, number of samples, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.4-3. The minimum sample size criterion was met for both locations.

Table A.4-3
Study Group 2 95% UCL External Dose for Each Exposure Scenario

TLD Location	Standard Deviation (OU Scenario)	Minimum Sample Size (OU Scenario)	Number of Elements	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B01	0.02	3	3	11.0	1.8	0.5
B02	0.04	3	3	6.9	1.2	0.3

A.4.3.2 Internal Radiological Dose Calculation

The internal dose that a receptor would receive at each sample plot were determined as described in Section A.2.3.1. The standard deviation, minimum sample size, number of samples, and 95 percent UCL of the internal dose for each exposure scenario is presented in Table A.4-4. The minimum sample size criterion was met for both locations.

Table A.4-4
Study Group 2 95% UCL Internal Dose for Each Exposure Scenario

Sample Location	Standard Deviation (OU Scenario)	Minimum Sample Size (OU Scenario)	Number of Samples	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B01	0.02	3	4	1.6	0.3	0.1
B02	0.02	3	4	5.0	0.8	0.3

A.4.3.3 Total Effective Dose

The TED for each sample location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.4-5. The TED at sample locations in Study Group 2 do not exceed the 25-mrem/OU-yr FAL.

Table A.4-5
Study Group 2 TED at Sample Locations (mrem/yr)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
B01	11.4	12.5	1.9	2.1	0.6	0.6
B02	10.4	11.9	1.7	2.0	0.6	0.6

A.4.4 Nature and Extent of Contaminants of Concern

Based on the data evaluation, no sample location exceeded the FAL of 25 mrem/OU-yr; therefore, no COCs were identified at Study Group 2 sample locations. However, HCA conditions are present inside the DCB, and it is assumed that the area within the DCB contains COCs that exceed the 25 mrem/OU-yr FAL. Therefore, corrective action is required. The extent of HCA conditions was defined by historical removable contamination surveys, as stated in the CAIP (NNSA/NSO, 2012a). Removable contamination surveys of debris located within the DCB confirm HCA conditions on the debris (see Section A.4.1.1). In addition, swipe surveys of PPE used inside the DCB indicate HCA conditions on the PPE (see Section A.9.0).

A.4.5 Best Management Practices

As a BMP, an administrative UR was established at Study Group 2 that includes any area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr (i.e., the PAL) and/or any area where removable radioactive contamination is present that meets CA conditions.

Land to the north and south of the DCB contains removable alpha contamination that meets CA conditions and is fenced and posted for radiological control. The fence line, however, is discontinuous across the northern portion of the site (Figure A.4-1), and it was uncertain as to the extent of CA conditions in this area of the CAU. According to a 2000 radiological survey report, the northern portion of the CA was not fenced due to the extremely steep terrain north of the site (DOE/NV, 2000a). In order to determine the northern extent of the area with CA conditions, removable contamination swipes were collected around the base of Smoky Hill. As shown in Figure A.4-3, three of the southernmost swipe locations meet CA criteria. None of the other swipe locations around the base of the hill meet CA criteria. This suggests that CA conditions are present at the southern base of Smoky Hill and potentially extend to higher elevations on the southern side of the hill, but do not extend beyond the base of the hill in the west, north, and east directions. As a conservative measure, the northern portion of the administrative UR boundary was established around the base of Smoky Hill. This administrative UR is wholly encompassed within the single CAU 550 administrative UR boundary as shown in Attachment D-1.

The extent of the administrative UR at CAU 550 is primarily based on the presence of removable radioactive contamination that meets CA criteria. Due to the long half-lives of removable radioactive contaminants, including Pu-239 (24,000 years), the administrative UR is expected to remain in place indefinitely.

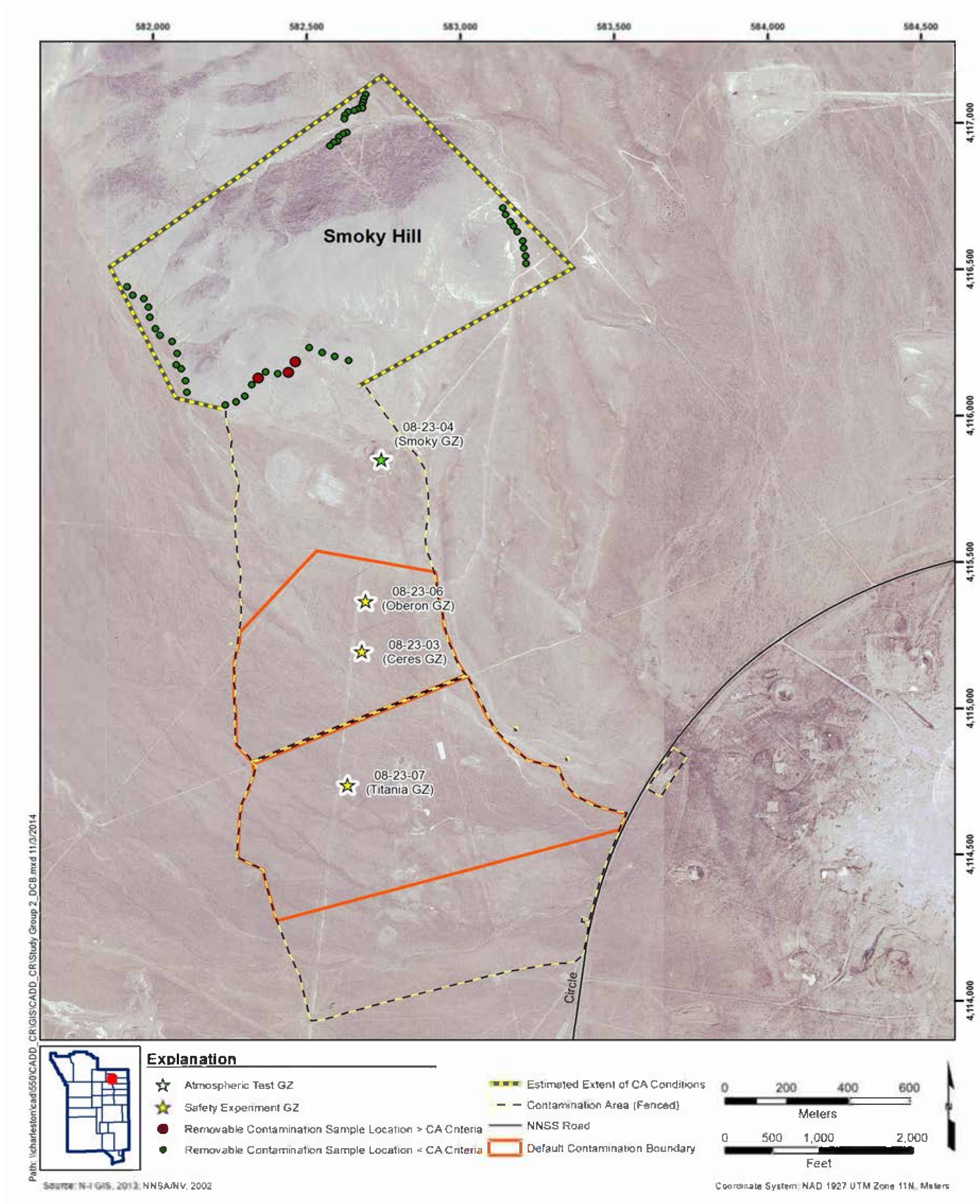

Figure A.4-3
Study Group 2 Estimated Northern Extent of CA Conditions

A.5.0 Study Group 3, Washes

Study Group 3 is made up of three wash segments on the west side of Circle Road and one depositional area on the east side of Circle Road, as defined in the CAIP (NNSA/NSO, 2012a) and shown in Figure A.5-1.

A.5.1 Investigation Activities

The CAI at Study Group 3 included visual and hydrological surveys, TRSs, the collection of surface and subsurface soil samples, and the collection of TLD samples.

A.5.1.1 Visual and Surface Hydrological Surveys

Visual surveys were conducted within and adjacent to each of the Study Group 3 wash segments, the depositional area east of Circle Road, and within the large catchment area on the east side of Circle Road. The large catchment area encompasses the following features where surface water and/or sediment accumulates during precipitation events: the U10a crater, the depositional area, and the visible sedimentation accumulation areas presented in Figure A.5-1. No potential releases or PSM were identified in the visual survey at Study Group 3; however, two small posted areas were noted on the flat area between the washes. These areas, each approximately 25 ft^2 in area, are posted with CA signs (Figure A.5-1 inset). No surface debris was identified within the posted areas.

After a severe rainfall event at NNSS in late July 2013, a hydrological survey of CAU 550 was conducted in order to better understand surface water flow and potential migration of contaminants from the site. A site visit identified erosion so significant that the surface water flow path could be tracked visually from the washes to the east side of Circle Road. The extent of the erosion and sedimentation in this area was recorded using a GPS instrument during the visual survey (Figure A.5-1). Using existing hydrologic maps and predicted drainage patterns, Desert Research Institute (DRI) mapped three watershed subbasins at CAU 550. Consideration of these subbasins, existing drainage channels, and onsite observations allowed for the documentation of stormwater flow across the CAU 550 site. The largest segment of the Study Group 3 washes is mostly contained within the east basin, as are the Smoky, Oberon, and Ceres GZs (Figure A.5-1). Based on this watershed model and onsite observations, contaminants from the CAU 550 releases would tend to

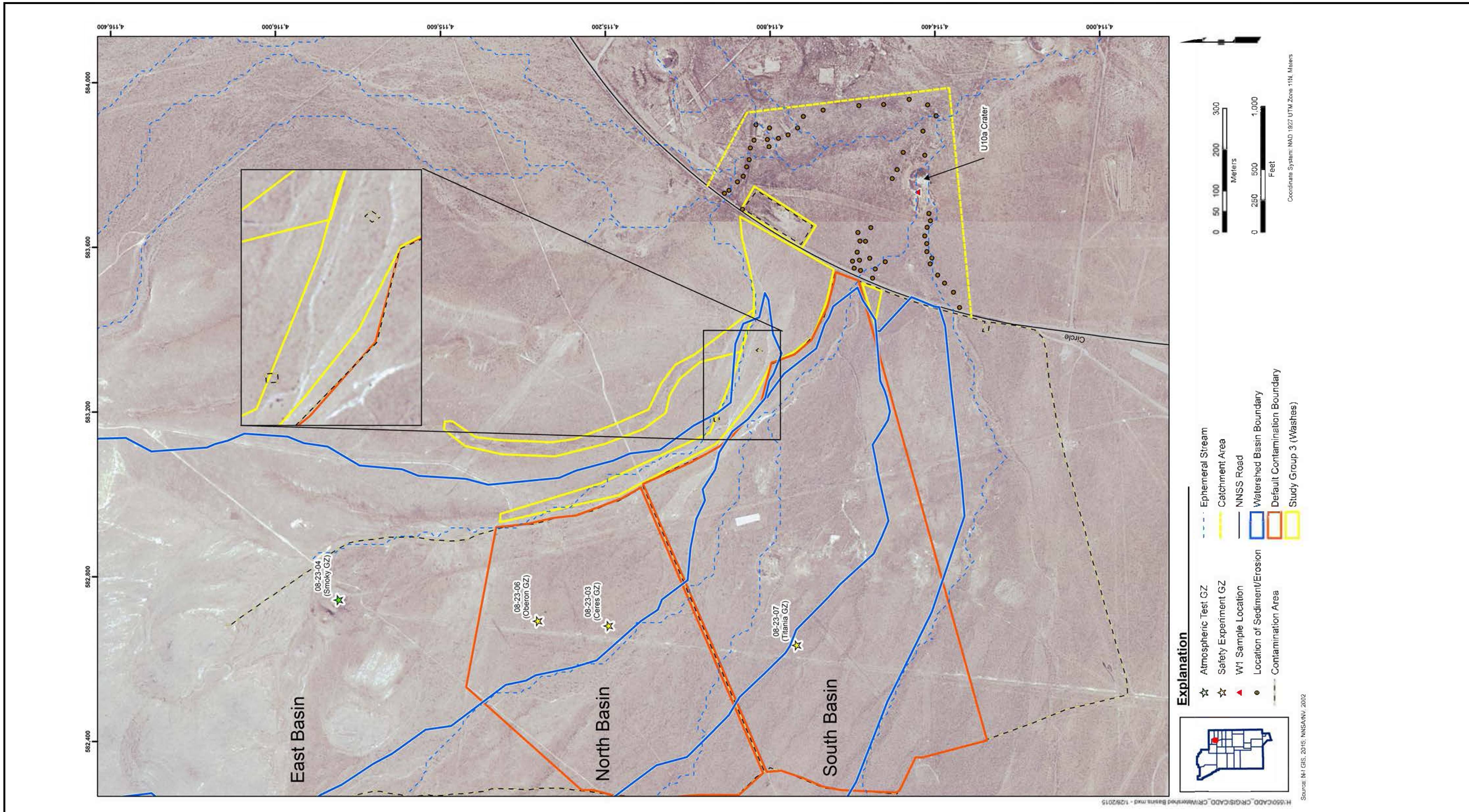

Figure A.5-1
CAU 550 Watershed Subbasins

drain to the largest wash segment, toward Circle Road, and possibly as far as the depositional area east of Circle Road. The north subbasin drains water from the area in between the Ceres and Titania GZs and converges near the smallest Study Group 3 wash segment, which is within the existing CA fence. Titania GZ and the majority of the Titania plume fall within the south subbasin that drains toward the U10a crater. The U10a crater appears to collect surface water and sediment from CAU 550 during times of heavy rainfall. The surface hydrologic survey suggests that the east side of Circle Road serves as a large catchment area for surface water flow across the paved surface of Circle Road from CAU 550. Currently, there are no engineered drainage features (e.g., culverts under Circle Road) that control the flow of surface water from the site. Radiological surveys, using a FIDLER and removable contamination swipes, were conducted in this area to determine existing site conditions. The results of these surveys are discussed in Section A.5.5.

A.5.1.2 Radiological Surveys

Radiological surveys using the PRM-470 and FIDLER were conducted at Study Group 3 during the preliminary investigation in 2011 and are presented in the CAIP (NNSA/NSO, 2012a). The site-wide survey results are shown in Figures A.2-1 and A.2-2. The surveys were completed in each of the three wash segments, inside the two posted CAs between the washes, and in the depositional area across Circle Road. In addition to these surveys, a targeted FIDLER survey was completed in 2012 during the CAI to provide better coverage of the southern segment of the main wash. The results of the radiological surveys were used to bias the selection of proposed sampling locations to areas with the highest radioactivity levels. The results of the 2011/2012 FIDLER survey at Study Group 3 are presented in Figure A.5-2.

A survey of the two small, posted CAs located on the flat area between the washes was conducted using a FIDLER. Elevated readings relative to the surrounding area were not noted; therefore, additional investigation of these two areas was not conducted.

In order to assess the impact of the rainfall events that occurred in late summer 2013, an additional FIDLER survey was conducted within the Study Group 3 washes. This survey followed the same path as the 2011/2012 FIDLER surveys to allow for the evaluation of contaminant migration by a direct comparison of the surveys. The results of the 2013 FIDLER survey and a discussion of potential contaminant migration from Study Group 3 are presented in Section A.5.6.

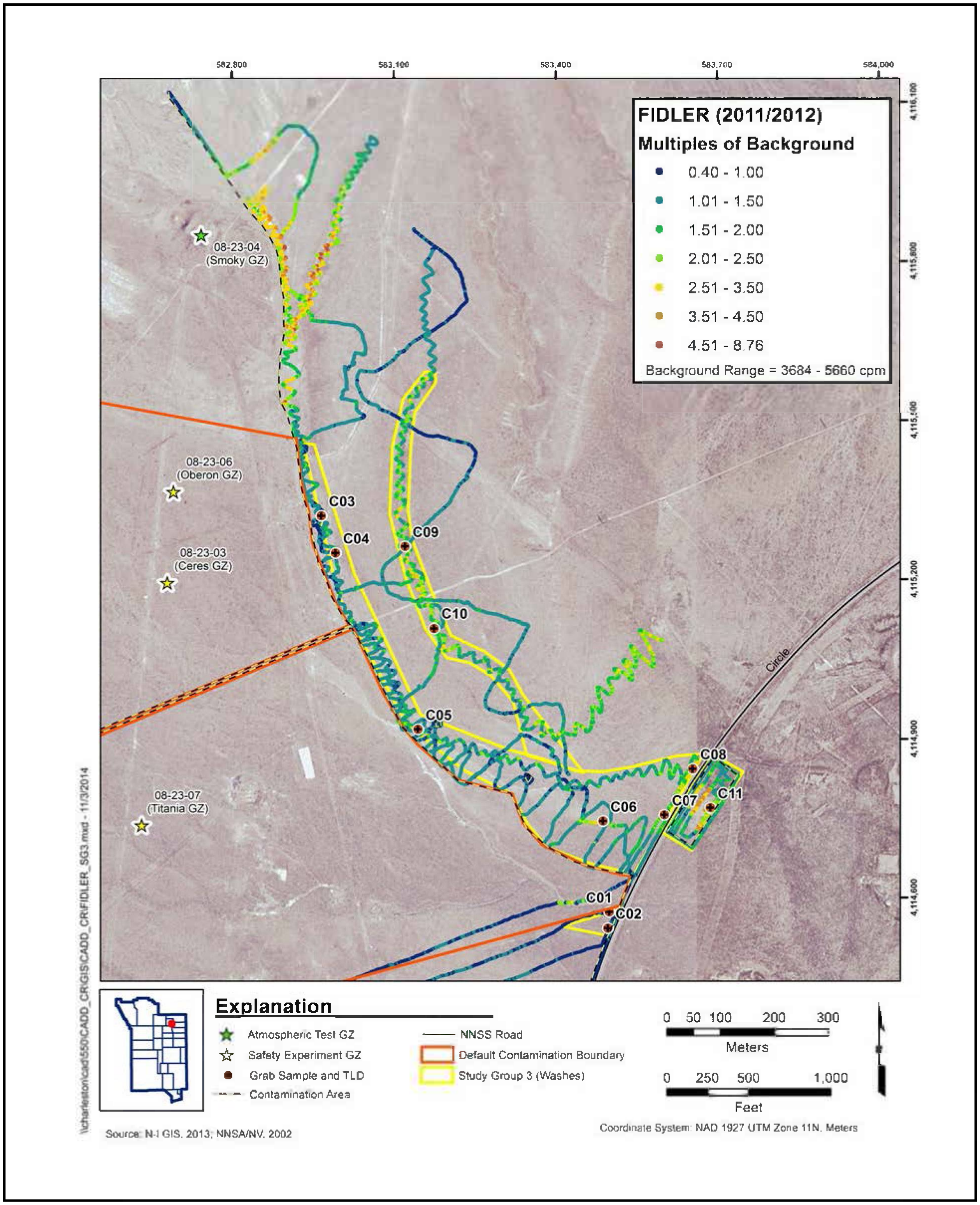

Figure A.5-2
Study Group 3 FIDLER Survey Results

A removable contamination swipe survey was also conducted during the CAI, within the washes, along the erosion paths east and west of Circle Road, and on the road surface. This survey is discussed in Section A.5.6.

A.5.1.3 TLD Samples

A total of 11 TLD sample locations were established at Study Group 3 (Figure A.5-2). In accordance with the CAIP (NNSA/NSO, 2012a), a minimum of two TLDs were placed in each of the three wash segments and one TLD in the depositional area across Circle Road at sediment accumulation locations with the highest radiological measurements from the 2011 FIDLER survey. After completion of the additional FIDLER survey of the southern portion of the largest wash segment in 2012 (Section A.5.1.2), four additional TLDs (locations C05 through C08) were placed at locations of sediment accumulation that showed the highest radiological measurements from this survey. Table A.5-1 presents the TLD information for the 11 TLDs placed at Study Group 3.

Table A.5-1
Study Group 3 TLD Samples

TLD Location	TLD Number	Date Placed	Date Removed	Purpose
C01	5177	09/18/2012	01/08/2013	Sediment
C02	4829	09/18/2012	01/08/2013	Sediment
C03	6202	09/18/2012	01/08/2013	Sediment
C04	4772	09/18/2012	01/08/2013	Sediment
C05	6477	09/18/2012	01/08/2013	Sediment
C06	3850	09/18/2012	01/08/2013	Sediment
C07	5164	09/18/2012	01/08/2013	Sediment
C08	2000	09/18/2012	01/08/2013	Sediment
C09	4893	09/18/2012	01/08/2013	Sediment
C10	3969	09/18/2012	01/08/2013	Sediment
C11	6492	09/20/2012	01/08/2013	Sediment

A.5.1.4 Soil Samples

Eleven soil sample locations were co-located with TLD sample locations in the washes and depositional area. An additional soil sample location (Location W1) was established at the U10a crater. A total of 13 surface soil samples (including one QC sample) and seven subsurface soil samples were collected at Study Group 3 (Table A.5-2).

Table A.5-2
Study Group 3 Soil Samples

Sample Location	Sample Number	Depth (cm bgs)	Analyses
C01	C001	0.0 - 5.0	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241 (Sample C005 was also analyzed for Tc-99 and Sr-90)
C02	C002	0.0 - 5.0	
	C003 (FD)	0.0 - 5.0	
C03	C004	0.0 - 5.0	
	C005	5.0 - 10.0	
C04	C006	0.0 - 5.0	
	C007	5.0 - 10.0	
C05	C008	0.0 - 5.0	
	C009	10.0 - 15.0	
C06	C010	0.0 - 5.0	
C07	C011	0.0 - 5.0	
	C012	5.0 - 10.0	
	C013	15.0 - 20.0	
C08	C015	0.0 - 5.0	
	C016	10.0 - 15.0	
	C017	15.0 - 20.0	
C09	C019	0.0 - 5.0	
C10	C018	0.0 - 5.0	
C11	C014	0.0 - 5.0	
W1	W001	0.0 - 5.0	Gamma spectroscopy, Isotopic Am, Isotopic Pu

Due to the potential for buried contamination at sediment accumulation areas, subsurface soil samples from each sample location were field screened for radioactivity. Soil was removed from the sample location to areas with low background readings and screened for radioactivity in 5-cm depth increments up to a total depth of 20 cm bgs. The FSRs were used to determine whether a subsurface contamination layer(s) could be distinguished from surface contamination. Buried contamination was considered to be present only if the depth interval FSR exceeded the daily FSL and there was a greater than 20 percent difference between the depth interval FSR and the surface soil FSR. For locations where FSRs suggested buried contamination, the depth interval with the highest FSR and the surface sample were submitted for offsite laboratory analyses. The results of the subsurface soil samples are discussed in Section A.5.3.2.

The soil sample from the U10a crater (Location W1) was collected to determine whether COCs from CAU 550 were migrating with surface water across Circle Road and being deposited into this crater. The U10a crater is located on the east side of Circle Road, southeast of CAU 550. Based on the drainage patterns observed after the substantial precipitation event in late summer 2013, it appeared that the crater was receiving surface water flow from CAU 550. The soil sample from this location was a six-point composite collected at the surface (0 to 5 cm bgs) within the U10a crater (Figure A.5-1).

A.5.2 Deviations/Revised Conceptual Site Model

There were no deviations from the CAIP (NNSA/NSO, 2012a) during the CAI at Study Group 3. The information gathered during the CAI supports the CSM as presented in the CAIP. No revisions were necessary to the CSM. The surface hydrological and radiological surveys of the washes at CAU 550 confirm that contaminant migration from the atmospheric and safety experiment GZs is occurring via surface water runoff. In addition, the surveys suggest that the drainage system endpoints include the depositional area and the U10a crater east of Circle Road.

A.5.3 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples collected at Study Group 3 (Washes). All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. Establishment of the FAL is presented in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the data tables.

The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location in accordance with Section A.2.3. External doses for TLD locations are summarized in Section A.5.3.1 and internal doses for each sample location are summarized in Section A.5.3.2. The TED for each sample location is summarized in Section A.5.3.3.

A.5.3.1 External Radiological Dose Calculations

The external dose that a receptor would receive at each Study Group 3 TLD sample location were determined as described in Section A.2.3.2. The method for calculating a TLD-equivalent subsurface external dose was used for three locations (C03, C07, and C08) because the highest internal dose from soil samples at these locations was from a subsurface sample (see Section A.5.3.2). All other external doses were calculated using data from TLDs placed on the surface.

External dose was calculated for the Industrial Area exposure scenario and then scaled (based on exposure duration) to the Remote Work Area and Occasional Use Area exposure scenarios for each TLD location. The standard deviation, minimum sample size, number of samples, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.5-3.

Table A.5-3
Study Group 3 95% UCL External Dose for Each Exposure Scenario
(Page 1 of 2)

TLD Location	Standard Deviation (OU Scenario)	Minimum Sample Size (OU Scenario)	Number of Samples	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C01	0.1	3	3	11.4	1.9	0.6
C02	0.1	3	3	9.8	1.7	0.5
C03[a]	0.2	3	3	**36.2**	6.1	1.8
C04	0.0	3	3	12.6	2.1	0.6
C05	0.2	3	3	**25.2**	4.2	1.3
C06	0.1	3	3	13.2	2.2	0.7

Table A.5-3
Study Group 3 95% UCL External Dose for Each Exposure Scenario
(Page 2 of 2)

TLD Location	Standard Deviation (OU Scenario)	Minimum Sample Size (OU Scenario)	Number of Samples	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C07[a]	0.1	3	3	**25.6**	4.3	1.3
C08[a]	0.1	3	3	**32.3**	5.4	1.6
C09	0.1	3	3	24.8	4.2	1.2
C10	0.1	3	3	**25.2**	4.2	1.3
C11	0.1	3	3	13.9	2.3	0.7

[a]A TLD-equivalent external dose for these locations was calculated to correspond to the internal doses from subsurface soil samples.

Bold indicates the values exceeding 25 mrem/yr.

A.5.3.2 Internal Radiological Dose Calculations

The internal dose that a receptor would receive at each Study Group 3 sample location was calculated as described in Section A.2.3.1. Buried contamination was indicated by field screening at five sample locations (C03, C04, C05, C07, and C08) within the washes. In accordance with the CAIP (NNSA/NSO, 2012a), both surface and subsurface soil samples were analyzed at these locations. Table A.5-4 presents a radionuclide-specific comparison of surface and subsurface soil data for the five locations. Internal dose was calculated for each sample (surface and subsurface) and the sample with the highest estimated internal dose at that sample location was selected as representative of that particular sample location. At locations C04 and C05, the surface samples yielded the highest internal dose; at locations C03, C07, and C08, subsurface samples yielded the highest internal dose. Thus, contamination at depth was confirmed at sample locations C03 (5 to 10 cm bgs), C07 (5 to 10 cm bgs), and C08 (10 to 15 cm bgs).

The internal dose for each exposure scenario is presented in Table A.5-5.

A.5.3.3 Total Effective Dose

The TED for each grab sample location and TLD location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the

Table A.5-4
Study Group 3 Analytical Results for Subsurface Soil Sample Locations

Sample Location	Sample Number	Sample Depth (cm bgs)	Am-241	Cs-137	Eu-152	Pu-238	Pu-239/240	Pu-241	Co-60
			pCi/g						
C03	C004	0.0 - 5.0	23.1	30.4	5.8	4.9	139.4	58.6	--
	C005	5.0 - 10.0	38.4	34.9	9.1	7.8	231.7	97.4	--
C04	C006	0.0 - 5.0	9.3	26.4	1.5	8.2	56.1	23.6	0.2
	C007	5.0 - 10.0	6.7	17.3	1.7	3.6	40.6	17.1	--
C05	C008	0.0 - 5.0	26.4	65.3	3.3	20.4	159.3	66.9	0.5
	C009	10.0 - 15.0	16.6	56	4.2	8.9	100.2	42.1	0.4
C07	C011	0.0 - 5.0	38.3	34.7	2.3	12.1	231.1	97.1	0.4
	C012	5.0 - 10.0	45.5	48.3	1.4	26.6	274.6	115.4	0.7
	C013	15.0 - 20.0	46.5	25.7	3.0	9.9	280.6	117.9	0.3
C08	C015	0.0 - 5.0	29.4	32.4	1.3	15.4	177.4	74.5	0.4
	C016	10.0 - 15.0	40.9	47.9	1.0	38.9	246.8	103.7	0.6
	C017	15.0 - 20.0	31.2	45.2	0.7	21.1	188.3	79.1	0.4

Co = Cobalt
Cs = Cesium
Eu = Europium

-- = Not detected

Table A.5-5
Study Group 3 Average Internal Dose for Each Exposure Scenario
(Page 1 of 2)

Sample Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C01	9.3	1.6	0.6
C02	1.3	0.2	0.1
C03[a]	1.7	0.3	0.1
C04	0.4	0.1	0.0
C05	1.3	0.2	0.1
C06	1.8	0.3	0.1
C07[b]	2.1	0.4	0.1
C08[c]	2.0	0.3	0.1
C09	1.4	0.2	0.1

Table A.5-5
Study Group 3 Average Internal Dose for Each Exposure Scenario
(Page 2 of 2)

Sample Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C10	0.6	0.1	0.0
C11	10.5	1.8	0.6

[a]The maximum internal dose at this location was from the subsurface soil sample obtained at 5 to 10 cm bgs.
[b]The maximum internal dose at this location was from the subsurface soil sample obtained at 5 to 10 cm bgs.
[c]The maximum internal dose at this location was from the subsurface soil sample obtained at 10 to 15 cm bgs.

TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.5-6.

Table A.5-6
Study Group 3 TED (mrem/yr)

Sample Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
C01	18.5	20.7	3.1	3.5	1.0	1.1
C02	8.6	11.1	1.5	1.9	0.4	0.6
C03	**27.6**	**37.8**	4.6	6.4	1.4	1.9
C04	12.5	13.1	2.1	2.2	0.6	0.7
C05	20.3	**26.5**	3.4	4.5	1.0	1.3
C06	13.2	15.0	2.2	2.5	0.7	0.8
C07	24.0	**27.7**	4.0	4.6	1.2	1.4
C08	**29.7**	**34.3**	5.0	5.7	1.5	1.7
C09	23.7	**26.2**	4.0	4.4	1.2	1.3
C10	22.1	**25.8**	3.7	4.3	1.1	1.3
C11	21.9	24.4	3.7	4.1	1.2	1.3

Bold indicates the values exceeding 25 mrem/yr.

None of the Study Group 3 sample locations exceed the FAL of 25 mrem/OU-yr (Figure A.5-3).

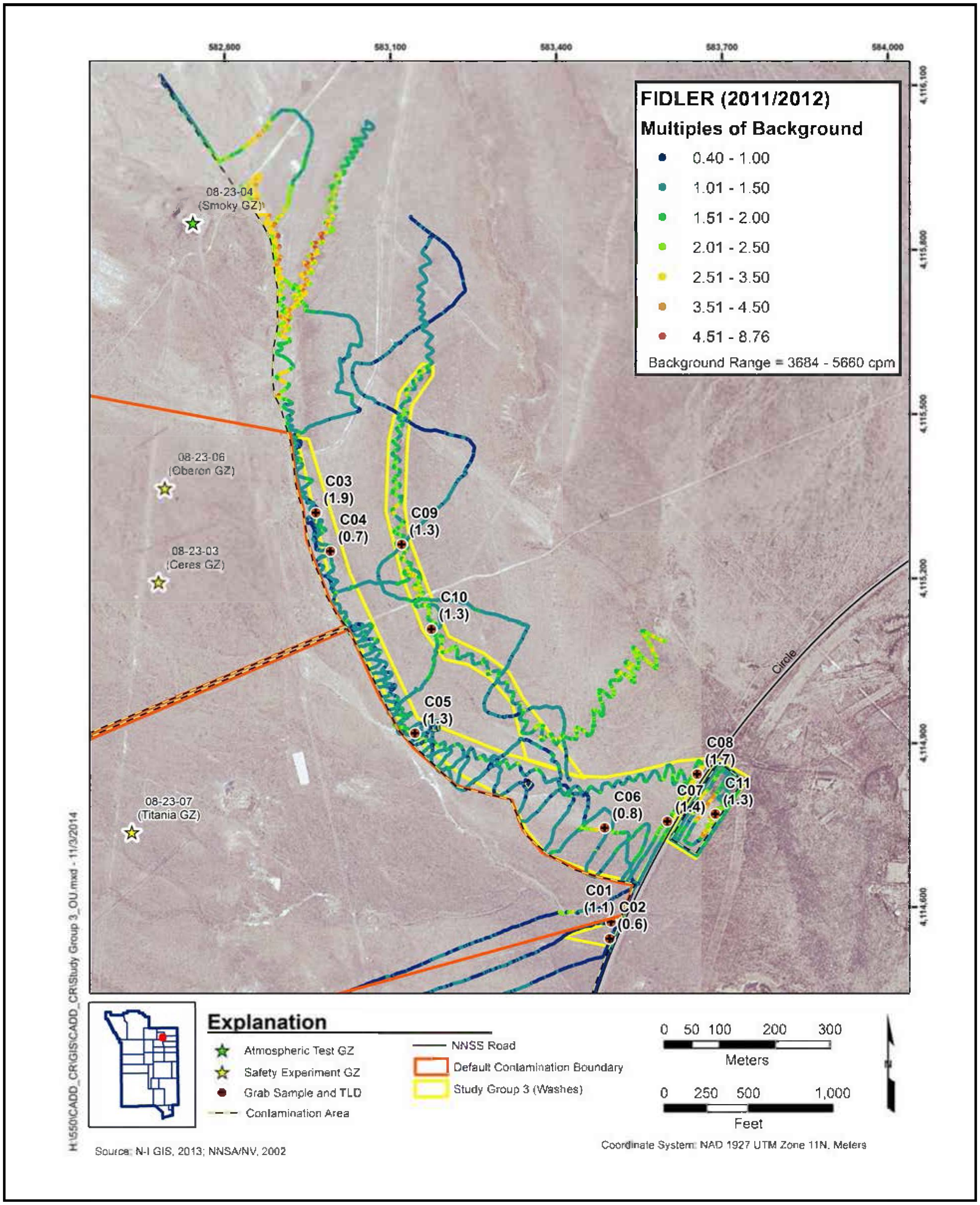

Figure A.5-3
Study Group 3 95% UCL of the TED
(mrem/OU-yr)

A.5.4 Nature and Extent of Contaminants of Concern

Based on the data evaluation, no sample location exceeded the FAL of 25 mrem/OU-yr; therefore, no COCs were identified at Study Group 3. As such, corrective action is not required.

A.5.5 Best Management Practices

As a BMP, an administrative UR was established at Study Group 3 that includes any area where an industrial land use of the area (2,000 hr/yr) could cause a future site worker to receive a dose exceeding 25 mrem/yr (i.e., the PAL) and/or any area where removable radioactive contamination is present that meets CA conditions. The dose-based PAL of 25 mrem/IA-yr was exceeded at six locations (C03, C05, C07, C08, C09, and C10) within the washes (Table A.5-6 and Figure A.5-4). At a minimum, these locations would be controlled by an administrative UR. The removable contamination criteria for a CA was not met by swipes collected in the washes during the CAI but was exceeded by four swipes collected near Circle Road by the NNSS M&O contractor. In addition, the depositional area to the east of Circle Road contains removable contamination at levels that meet CA conditions. Therefore, the administrative UR was established to include all three wash segments, the portion of Circle Road that receives surface water flow from the wash segments, the depositional area east of Circle Road, and the sedimentation/erosion area west of the U10a crater. The extent of the administrative UR on the east side of Circle Road was determined visually and was based on the locations of sediment accumulation (Figure A.5-1). The GPS coordinates for the locations of sediment accumulation within the large catchment area were recorded as part of the hydrological survey discussed in Section A.5.1.1.

Due to the large land area included in CAU 550 and the need for multiple administrative URs identified as BMPs in this CADD/CR, a single administrative UR boundary was established for the CAU, as shown in Attachment D-1. The extent of the administrative UR at CAU 550 is primarily based on the presence of removable radioactive contamination that meets CA conditions. Due to the long half-lives of the removable radioactive contaminants, which include plutonium, radioactive decay will not allow for removal of the administrative UR in the foreseeable future.

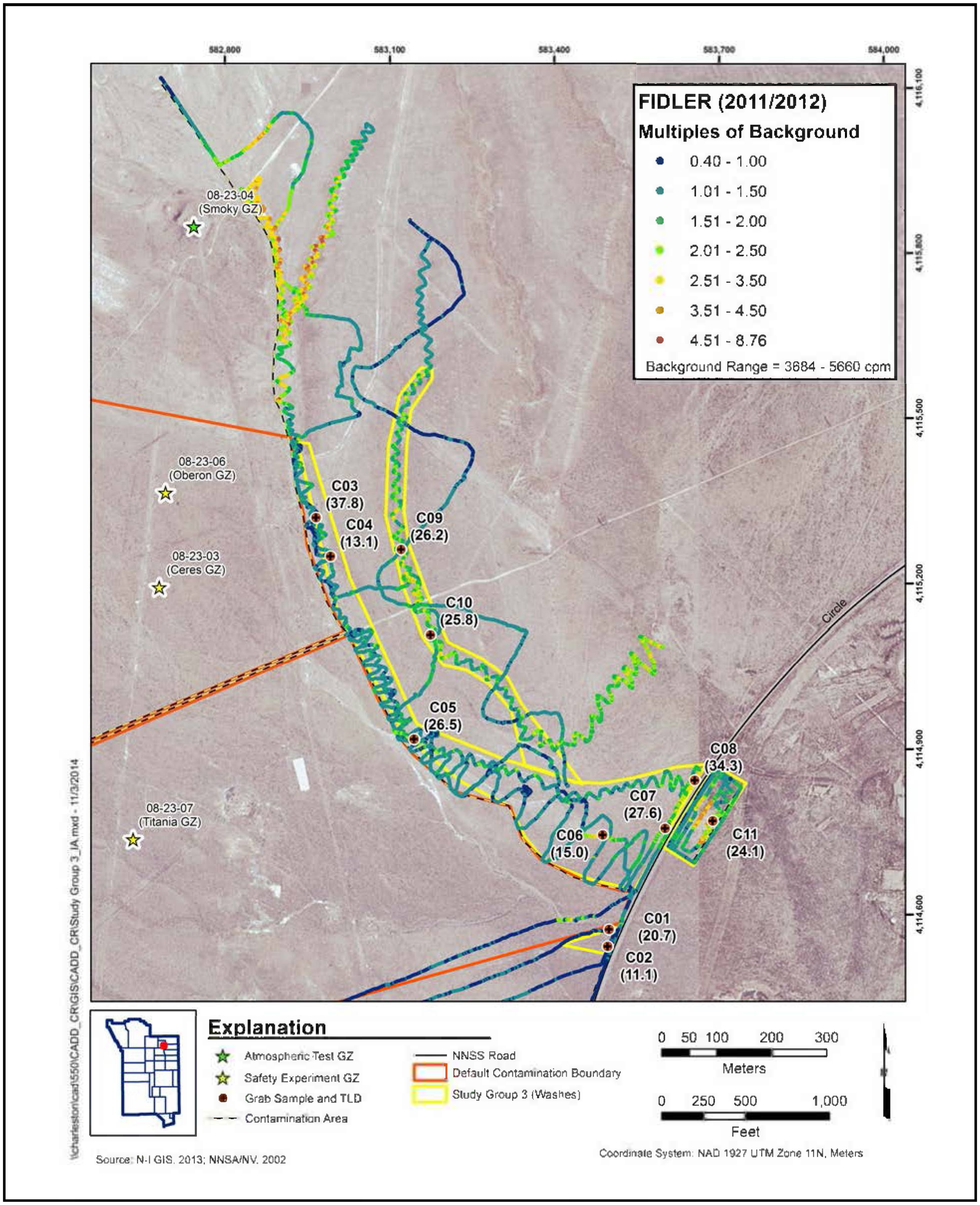

Figure A.5-4
Study Group 3 95% UCL of the TED
(mrem/IA-yr)

A.5.6 Surface Hydrological Survey Results

The washes entering and leaving Study Group 3 are generally dry but are subject to infrequent but intense stormwater flows. During the 55 years since the atmospheric and safety tests were conducted, several large storm events have occurred. Evidence of a substantial precipitation event at the CAU 550 site was observed during a site visit in early August 2013. Earthen barriers within the Study Group 3 washes had been breached; soil and sediment had washed eastward across Circle Road; and standing water was observed within the U10a crater east of Circle Road, southeast of the CAU 550 washes. Data from the CAU 550 meteorological station were reviewed to identify the most recent storm event. The station recorded a major precipitation event on July 28, 2013, during which a total of 1.38 in. of rain fell. The majority of the rainfall occurred between 3 and 5 p.m., suggesting an intense deluge. In order to determine whether significant migration of contamination had occurred, FIDLER surveys of the washes were repeated along the same path as the 2011/2012 surveys. This allowed the surveys to be directly compared to each other. As seen in Figure A.5-5, the radioactivity detected by the FIDLER in 2011 was noticeably higher than that measured at the same locations in August 2013. This suggests that the contaminants have been buried by sediment and/or redistributed laterally through the washes or into the large catchment area east of Circle Road. The extent of the FIDLER survey conducted in 2013 included two large areas east of Circle Road where sedimentation and erosion were observed. In addition, a surface soil sample was collected in a sedimentation area on the west side of the U10a crater (Location W1) and analyzed for isotopic Pu, isotopic Am, and gamma spectroscopy. The radionuclides detected above the MDCs are presented in Table A.5-7. A radiological dose was calculated for this sample using the sample results for internal dose and the RRMGs. The dose at the U10a crater was estimated at 0.0 mrem/OU-yr and 0.2 mrem/IA-yr.

The soil and TLD samples collected in the Study Group 3 washes were collected before the July 2013 rain event. The dose calculated based on these data does not exceed the FAL of 25 mrem/OU-yr, but exceeds the PAL of 25 mrem/IA-yr at some locations. Review of the pre- and post-event FIDLER survey data suggests that contamination that was present on the surface in the washes in 2011/2012 may no longer be in the same location. Thus, current dose on the ground surface within the washes is likely to be less than pre-event levels. Because the contaminants from the tests (plutonium, americium, cesium) have a high affinity for soil and tend to adhere to soil particles, it is

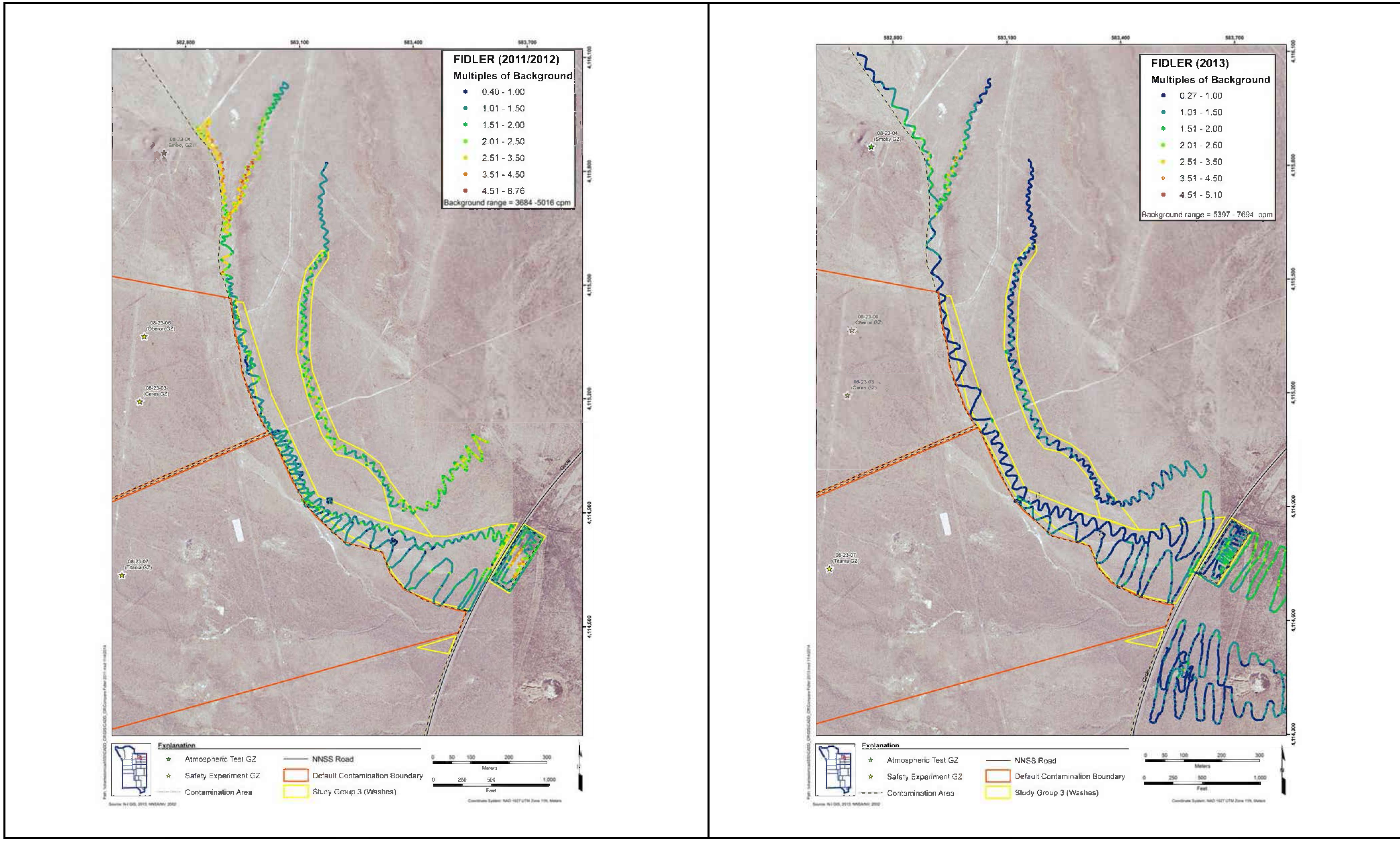

Figure A.5-5
Comparison of Pre- and Post-Precipitation Event FIDLER Surveys

Table A.5-7
Sample Results for Radionuclides Detected above MDCs at U10a Crater

Sample Location	Sample Number	Radionuclides (pCi/g)				
		Ac-228	Am-241	Cs-137	Pu-238	Pu-239/240
W1	W01	1.41	0.276	0.28	0.087	0.97

Ac = Actinium

expected that they will generally travel with the soil and be diluted by stormwater and uncontaminated soil as they travel. As a result of this dilution, there is no reason to suspect that the dose associated with migrating contaminants will be greater than that previously calculated. An exception to this dilution process is Trinity glass. Trinity glass has been observed near the Smoky GZ and sporadically within the washes at Study Group 3. The migration of Trinity glass through the washes to an endpoint could result in the concentration of radionuclides, rather than dilution, due to the physical form of the glass. However, this phenomenon has not been observed at Study Group 3, nor does the dose in the washes suggest elevated radiation levels attributable to Trinity glass.

Another consideration at CAU 550 is the potential for migration of removable radioactive contamination from the CA and/or HCA to uncontrolled areas. A removable radioactive contamination swipe survey was not conducted in the washes before the July 2013 precipitation event, so it is not known whether removable contamination migrated to the washes previously. Seventy-three swipes were collected during the CAI in September 2013 within the washes and at points east and west of Circle Road where erosion was observed (Figure A.5-6). The purpose of this swipe survey was to determine whether HCA or CA conditions existed outside the current CA fence and whether further swipe surveys were warranted. None of the swipe samples met HCA or CA definition criteria, so additional surveys were not conducted.

Additional swipes on the west shoulder and surface of Circle Road were collected by the NNSS M&O contractor as part of the DOE Occupational Radiation Protection program (CFR, 2013). The purpose of this survey was to ensure existing radiological postings were in compliance with radiological control regulations. Although these data were not collected as part of the CAU 550 CAI, the data are provided here for completeness. A total of 312 swipes were collected on September 9, 10,

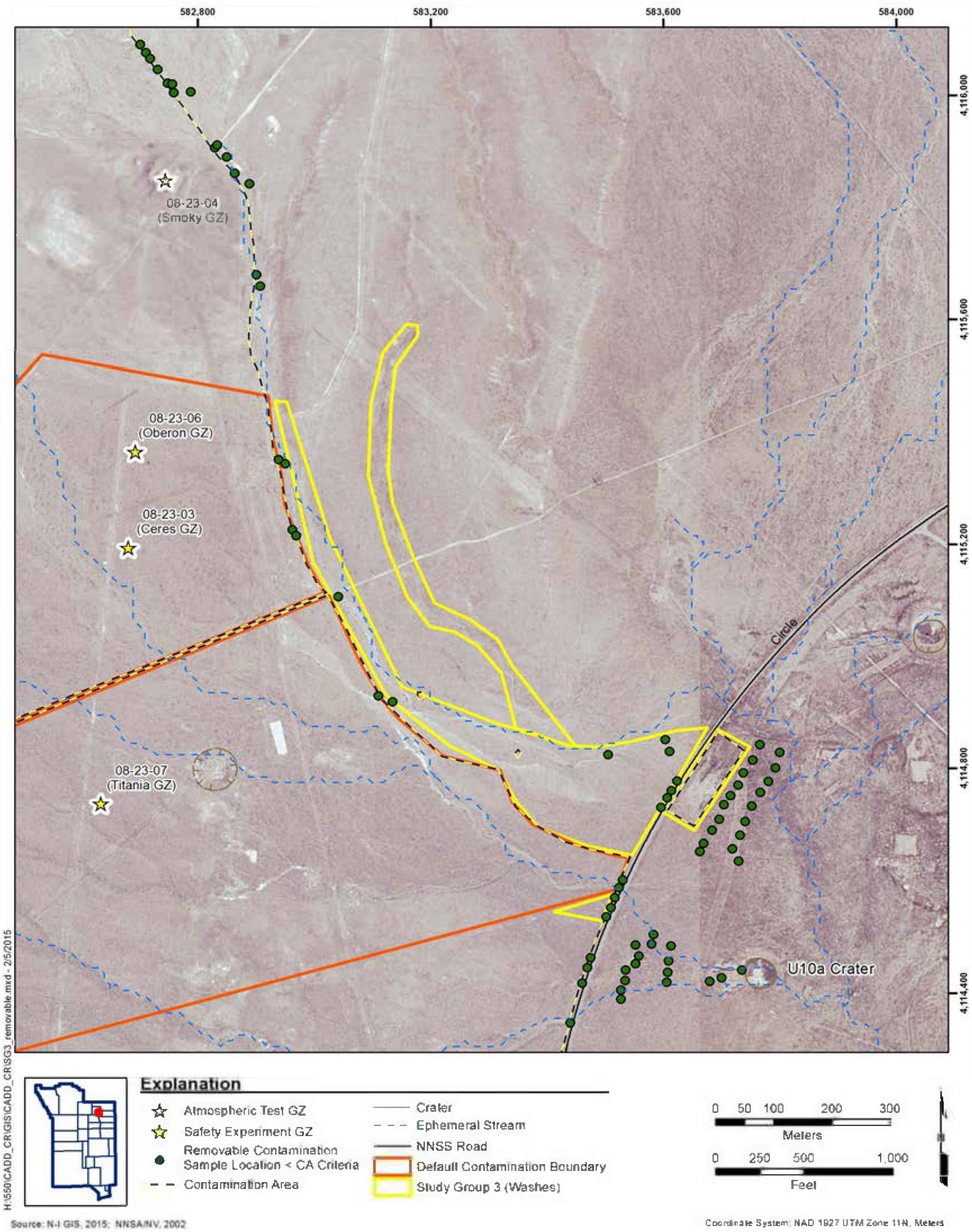

Figure A.5-6
Study Group 3 Removable Radioactive Contamination Swipe Survey Locations

11, and 23, 2013, along the shoulder of Circle Road and on the surface of the road itself. Of these, four swipes measured alpha removable contamination that met CA posting criteria. These data suggest that removable contamination is migrating outside the existing CA fence at CAU 550.

In August 2013, DRI collected soil samples along the CAU 550 wash downstream of a flume installed to measure surface water flow during storm events. The samples were analyzed for particle size distribution and isotopic Am-241, Pu-238, and Pu-239/240. Analysis of the results concluded that the smallest soil particles are associated with the highest radionuclide concentrations, suggesting that the radionuclides of interest preferentially bind to the finer soil particles (Miller et al., 2014). Based on this conclusion, it is reasonable to predict that the highest radionuclide concentrations will migrate with the most mobile particulates (i.e., fine soil particles).

In summary, evaluation of the data collected at Study Group 3 suggests that radioactive contamination from the Smoky test and the three safety experiments has migrated, and has the potential to migrate in the future. However, current radiation dose and removable contamination levels do not require corrective action. Based on the physical properties of the contaminants and the expected decrease in contaminant concentrations over time with dispersion by stormwater and uncontaminated soil, the dose and removable contamination levels are not expected to exceed actions levels in the future.

A.6.0 Study Group 4, Debris

A.6.1 Investigation Activities

The 15 debris CASs consist of the potential releases of contamination from debris. Each potential release location was evaluated for the presence of PSM and for COCs in underlying soil. The CAI at Study Group 4 included visual surveys and the collection of soil and PSM samples. Table A.6-1 presents the 15 debris CASs.

Table A.6-1
Study Group 4 Debris CASs
(Page 1 of 3)

CAS Number	Sample Location	Debris Description	Sample Number	Sample Matrix	Analyses	Status
08-01-01	D01	Storage Tank	D001	Soil	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
08-22-05	E01	Drum	E001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
08-22-07	F01	Drum	F001	Soil	Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris removed; soil sample collected underneath debris
08-22-08	G01	Drums (3)	G001	Soil		Debris removed; soil sample collected underneath debris
08-22-09	H01	Drum	H001	Soil		Debris not present; soil sample collected at CAS location
08-24-03	I01	Battery	I001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
08-24-04	J01	Battery	J001	Soil		Debris not present; soil sample collected at CAS location

Table A.6-1
Study Group 4 Debris CASs
(Page 2 of 3)

<table>
<tr><th>CAS Number</th><th>Sample Location</th><th>Debris Description</th><th>Sample Number</th><th>Sample Matrix</th><th>Analyses</th><th>Status</th></tr>
<tr><td rowspan="4">08-24-07</td><td>K01</td><td>Batteries (3)</td><td>K001</td><td>Soil</td><td>Gamma spectroscopy, Isotopic U, Isotopic Am, Isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)</td><td>Debris removed; soil sample collected underneath debris</td></tr>
<tr><td>U1</td><td>Battery[a]</td><td>U01</td><td>Soil</td><td>RCRA metals, Cr(VI)</td><td>Debris removed; soil sample collected underneath debris</td></tr>
<tr><td rowspan="2">T1</td><td rowspan="2">Lead Bricks (2)[a]</td><td>T01</td><td rowspan="2">Soil</td><td rowspan="2">RCRA metals, Cr(VI)</td><td rowspan="2">Debris removed; soil sample collected underneath debris</td></tr>
<tr><td>T02 (FD)</td></tr>
<tr><td>08-24-08</td><td>Y1</td><td>Batteries (3)</td><td>Y01</td><td>Soil</td><td>RCRA metals, Cr(VI)</td><td>Debris removed; soil sample collected underneath debris</td></tr>
<tr><td>08-26-01</td><td>--</td><td>Lead Bricks (200)</td><td>--</td><td>--</td><td>--</td><td>Debris left in place; no sample collected</td></tr>
<tr><td>10-22-17</td><td>N01</td><td>Buckets (3)</td><td>N001</td><td>Soil</td><td>Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)</td><td>Debris not present; soil sample collected at CAS location</td></tr>
<tr><td>10-22-18</td><td>--</td><td>Gas Block/Drum</td><td>--</td><td>--</td><td>--</td><td>Debris left in place; no sample collected</td></tr>
<tr><td rowspan="5">10-22-19</td><td rowspan="2">P01</td><td rowspan="2">Drum; Stains</td><td>P001</td><td rowspan="2">Soil</td><td rowspan="2">Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)</td><td rowspan="2">Debris not present; soil sample collected at CAS location</td></tr>
<tr><td>P002 (FD)</td></tr>
<tr><td>X1</td><td>Drum w/Liquid Contents[a]</td><td>X01</td><td>Liquid (PSM)</td><td>Gamma spectroscopy, Tritium, Isotopic U, Isotopic Am, Isotopic Pu, Sr-90, SVOCs, RCRA metals, PCBs</td><td>Debris removed; liquid sample collected of drum contents</td></tr>
<tr><td>S1</td><td>Asphalt Pile 1[a]</td><td>S101</td><td>Solid (PSM)</td><td rowspan="2">Gamma spectroscopy, VOCs, SVOCs, RCRA metals, Cr(VI), TCLP metals, TCLP SVOCs, TCLP VOCs</td><td>Pile left in place; sample collected of pile</td></tr>
<tr><td>S2</td><td>Asphalt Pile 2[a]</td><td>S201</td><td>Solid (PSM)</td><td>Pile left in place; sample collected of pile</td></tr>
</table>

Table A.6-1
Study Group 4 Debris CASs
(Page 3 of 3)

CAS Number	Sample Location	Debris Description	Sample Number	Sample Matrix	Analyses	Status
10-22-20	Q01	Drum	Q001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location
10-24-10	R01	Battery	R001	Soil	Gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, Beryllium, Cr(VI)	Debris not present; soil sample collected at CAS location

[a]Previously unidentified releases identified during CAI.

-- = Not applicable

Twelve of the 15 debris CASs are located within the CA fence at CAU 550; nine of these are within the DCB (i.e., within the area with HCA conditions). Figure A.6-1 shows the debris CASs. Due to their proximity to the nuclear tests conducted at the site, it was expected that the debris surfaces and potentially impacted soil at these debris CASs would be radiologically contaminated. There is no historical information to suggest that this radiological contamination is from a source other than the Smoky test and/or the three safety experiments. The radiological contamination from the Smoky test and the three safety experiments was investigated as Study Groups 1 and 2, respectively. As discussed in Section A.6.3, the CAI results indicate that radionuclides detected in the samples from Study Group 4 are consistent with those detected in the soil sample plots for Study Groups 1 and 2 (i.e., a mixture of fission radionuclides and plutonium).

A.6.1.1 Visual Surveys

As indicated in the CAIP (NNSA/NSO, 2012a), there was some uncertainty associated with the debris CASs as to whether the debris was still located at CAU 550 or had been removed during past corrective actions at the CASs. Visual surveys were performed at the Study Group 4 sites to confirm the presence or absence of debris defined by the CAS and to identify any other potential releases or PSM at CAU 550. Historical information—including GPS coordinates, written driving directions, and field maps/notes—was used to navigate to each debris CAS to perform the visual surveys. The debris at nine of the 15 CASs was not found and is presumed to have been removed at some time

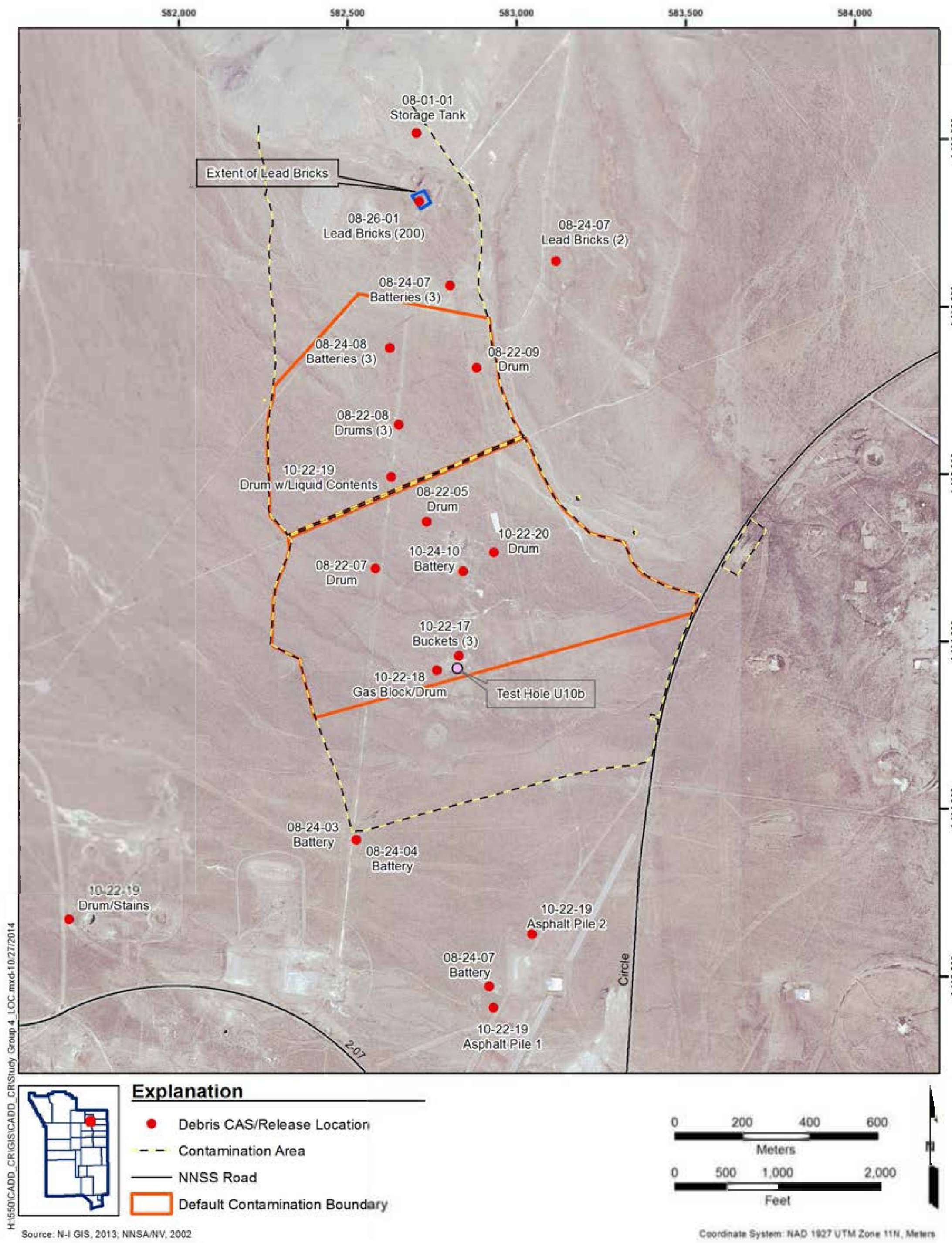

Figure A.6-1
Debris Locations

before the CAI (Table A.6-1). Debris consistent with the CAS descriptions was present at the other six debris CASs. Five previously unidentified potential releases were identified during the visual surveys at CAU 550. These included two asphalt piles, a broken battery, a location with two lead bricks, and one 55-gal drum that contained a small volume of liquid. The five previously unidentified potential releases were not assigned a new CAS number, but were placed into existing Study Group 4 debris CASs 08-24-07 and 10-22-19, as shown in Table A.6-1. Figure A.6-1 presents the locations of the 15 debris CASs and the five previously unidentified potential releases.

A.6.1.2 Soil and PSM Samples

Seventeen soil samples (including QC samples), two solid PSM samples, and one liquid PSM sample were collected at the Study Group 4 CASs. Table A.6-1 lists the debris locations and associated samples. Investigation samples at the debris CASs were analyzed for the COPCs specified in the CAIP (NNSA/NSO, 2012a); newly identified debris/material samples were analyzed based on the nature of the potential release, as described in the following CAS-specific subsections.

As discussed in Section A.6.1, the radiological contamination in the area surrounding the debris CASs is attributed to the nuclear tests conducted at the site. As a result, radiological field-screening measurements were not used as biasing factors when selecting sample locations at the debris CASs or associated releases.

A.6.1.2.1 CAS 08-01-01

This CAS is described as a 30-gal metal aboveground storage tank located north of Smoky GZ within the CA fence (REECo, 1991). No debris, including the storage tank, was found at the CAS location (Figure A.6-2). One grab sample, D001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, isotopic U, isotopic Am, isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

Figure A.6-2
CAS 08-01-01 (Storage Tank)

A.6.1.2.2 CAS 08-22-05

This CAS is described as an empty, metal 55-gal drum located within the southern DCB (REECo, 1991). No debris, including the drum, was found at the reported CAS location (Figure A.6-3). One grab sample, E001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

A.6.1.2.3 CAS 08-22-07

This CAS is described as an empty, metal 55-gal drum located within the southern DCB (REECo, 1991). One empty, 55-gal drum was found at the CAS location (Figure A.6-4). No visible staining or other biasing factor was observed in the surrounding soil. The drum was removed and one grab sample, F001, was collected of the surface soil (0 to 5 cm bgs) underneath the drum. The sample was analyzed for gamma spectroscopy, isotopic U, isotopic Am, isotopic Pu, Pu-241, Sr-90,

Figure A.6-3
CAS 08-22-05 (Drum)

Figure A.6-4
CAS 08-22-07 (Drum)

VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

A.6.1.2.4 CAS 08-22-08

This CAS is described as three empty, metal 10-gal drums located within the northern DCB adjacent to the airplane carcass (REECo, 1991). The three drums were found at the CAS location (Figure A.6-5). No visible staining or other biasing factor was observed in the surrounding soil. The three drums were removed and one composite sample, G001, was collected of the surface soil (0 to 5 cm bgs) underneath the drums. The sample was analyzed for gamma spectroscopy, isotopic U, isotopic Am, isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

A.6.1.2.5 CAS 08-22-09

This CAS is described as an empty, metal 30-gal drum located within the northern DCB (REECo, 1991). No debris, including the drum, was found at the CAS location (Figure A.6-6). One grab sample, H001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, isotopic U, isotopic Am, isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

A.6.1.2.6 CAS 08-24-03

This CAS is described as a battery located just outside the southwestern corner of the CA fence, at the same location as CAS 08-24-04 (REECo, 1991). No debris, including the battery, was found at the CAS location (Figure A.6-7). One grab sample, I001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

Figure A.6-5
CAS 08-22-08 (Drums [3])

Figure A.6-6
CAS 08-22-09 (Drum)

Figure A.6-7
CASs 08-24-03 (Battery) and 08-24-04 (Battery)

A.6.1.2.7 CAS 08-24-04

This CAS is described as a battery located just outside the southwestern corner of the CA fence, at the same location as CAS 08-24-03 (REECo, 1991). No debris, including the battery, was found at the reported CAS location (Figure A.6-7). One grab sample, J001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

A.6.1.2.8 CAS 08-24-07

This CAS is described as three batteries located within the CA fence south of Smoky GZ (REECo, 1991). Three large, intact batteries were found at this location (Figure A.6-8). The batteries were similar in appearance: dry with hairline cracks and missing their caps. No visible staining was observed in the surrounding soil. The three batteries were removed and one grab sample, K001, was collected of the surface soil (0 to 5 cm bgs) underneath one of the batteries. The sample was analyzed for gamma spectroscopy, isotopic U, isotopic Am, isotopic Pu, Pu-241, Sr-90, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

Two previously unidentified potential releases were assigned to this CAS as a result of the visual survey at CAU 550: a broken battery (Battery) and lead bricks (Lead Bricks [2]). The broken lead-acid battery was identified south of the CAU 550 CA fence, west of Circle Road (Figure A.6-1). The battery was dry, and broken pieces were strewn about the area (Figure A.6-9). The battery pieces were removed and a six-point composite soil sample, U01, of the surface soil (0 to 5 cm bgs) within the visible extent of the pieces was collected and analyzed for RCRA metals and Cr(VI).

The lead bricks location consisted of two lead bricks outside the CA fence southeast of Smoky GZ. One brick was lying on the ground surface; the other brick was inside an open metal box (Figure A.6-10). Various small pieces of metal debris, including machine parts and melted aluminum, were also noted in the vicinity. The bricks were removed and one grab sample, T01, was collected of the surface soil (0 to 5 cm bgs) underneath the brick lying on the ground. The sample was analyzed for RCRA metals and Cr(VI).

Figure A.6-8
CAS 08-24-07 (Batteries [3])

Figure A.6-9
CAS 08-24-07 (Battery)

Figure A.6-10
CAS 08-24-07 (Lead Bricks [2])

A.6.1.2.9 CAS 08-24-08

This CAS is described as three batteries mixed in with other debris, located within the northern DCB (REECo, 1991). A pile of metal debris that contains lead plates (presumably from lead-acid batteries), scrap metal, and small electrical equipment including battery pieces, was found at the CAS location (Figure A.6-11). All of the lead debris (i.e., lead battery plates, lead scrap) was removed from the CAS. The debris that did not contain lead (steel scrap, electrical equipment) was left at the site adjacent to the original location of the debris pile. A nine-point composite confirmation soil sample, Y01, from underneath the removed debris pile was collected and analyzed for RCRA metals and Cr(VI).

A.6.1.2.10 CAS 08-26-01

This CAS is described as over 200 lead bricks scattered near Smoky GZ within the CA fence (REECo, 1991). Several lead bricks were identified on the surface at this location (Figure A.6-12). Partially buried lead bricks are also visible, suggesting that additional lead bricks are present in the shallow subsurface at this location. One soil sample was collected at this site in 2002 and analyzed for

Figure A.6-11
CAS 08-24-08 (Batteries [3])

Figure A.6-12
CAS 08-26-01 (Lead Bricks [200])

gamma spectroscopy and RCRA metals as part of a preliminary assessment (IT, 2002). The lead result from this sample was 4,000 mg/kg (IT, 2002). Because the lead bricks are located in a CA and to minimize the potential for worker exposure, a soil sample was not collected at this location during the CAI and the lead bricks were left in place.

A.6.1.2.11 CAS 10-22-17

This CAS is described as three empty 5-gal metal buckets located within the southern portion of the DCB (REECo, 1991). Historical documentation confirms the presence of the three buckets (two containing a black, oily substance) in 2002 (Shaw, 2003). The buckets are assumed to have been removed before the CAI, as no debris, including the buckets, was found at the CAS location (Figure A.6-13). One grab sample, N001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

Figure A.6-13
CAS 10-22-17 (Buckets [3])

A.6.1.2.12 CAS 10-22-18

This CAS is described as a drum filled with wire and concrete (also referred to as a gas block) located within the southern DCB near test hole U10b (Figure A.6-1) (REECo, 1991). The gas block was found atop a concrete pad at this location (Figure A.6-14) and appears to have been associated with the Handcar test at U10b. The Handcar test was an underground nuclear test conducted in 1964 as part of the Plowshare program (DOE/NV, 2000b). Historical documents indicate that after the Handcar test, there were two accidental releases of short-lived radioactive gases (krypton-87 and -88, and xenon-133 and -135) (Schoengold et al., 1996). The first release occurred from surface GZ cables at the time of detonation; the second release occurred during post-detonation drilling operations. A FIDLER survey adjacent to the concrete pad did not indicate elevated radiation levels. No visible staining was observed at this location. Because there was no indication of a chemical or radiological release and to minimize the potential for worker exposure to HCA conditions, this CAS was not sampled, and the gas block/drum was left in place.

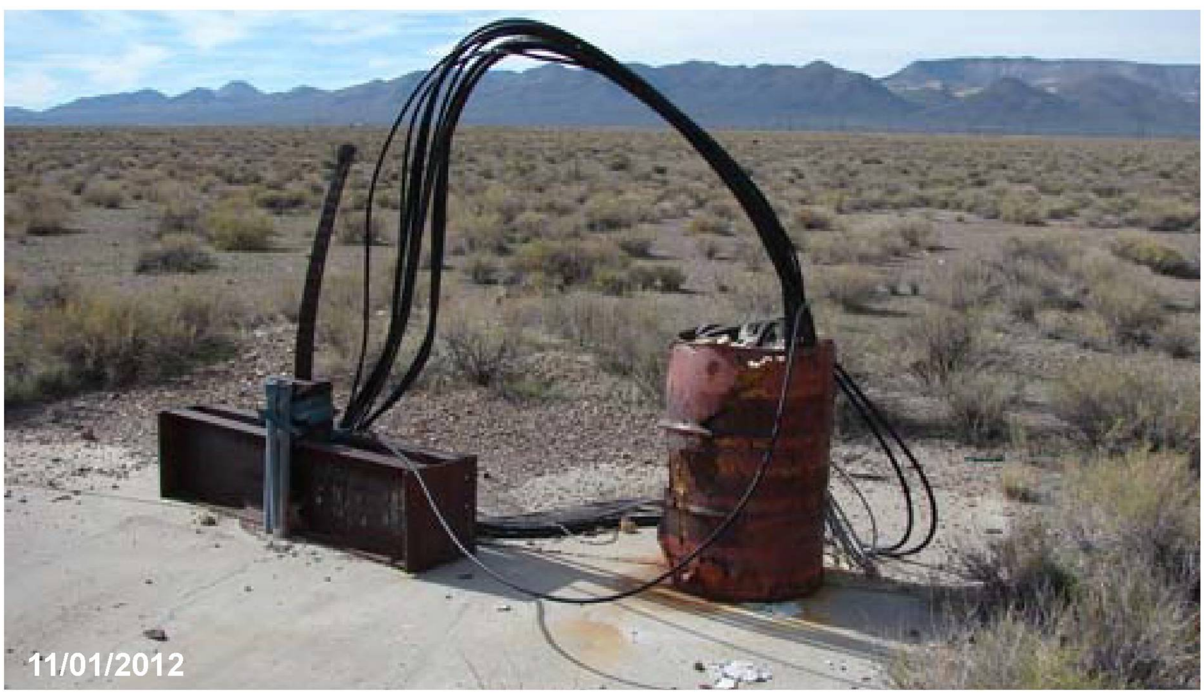

Figure A.6-14
CAS 10-22-18 (Gas Block/Drum)

A.6.1.2.13 CAS 10-22-19

This CAS is described in the CAIP as drum/stains located approximately 0.5 miles southwest of the southwest corner of the CA fence at CAU 550 (Figure A.6-1). No debris, including the drum, or any staining was found at the CAS location (Figure A.6-15). One grab sample, P001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the reported location of the CAS. GPS coordinates were not available for this CAS; therefore, driving directions were used to locate the site. The soil sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

Figure A.6-15
CAS 10-22-19 (Drum; Stains)

A 55-gal drum containing a small volume of liquid was identified in the northern portion of the DCB near the dirt road that transects the site. The drum was found on its side in a drainage (Figure A.6-16). Based on the GPS coordinates collected at the drum location when it was identified in 2011 and when it was investigated in 2013, the drum appears to have moved approximately 30 ft. Its location within a drainage suggests that it may have moved over time with surface water flow, perhaps during rain

Figure A.6-16
CAS 10-22-19 (Drum w/Liquid Contents)

events. The drum contained approximately 2 to 3 gal of aqueous fluid. The drum was closed, and there was no visual evidence of a release at the location of the drum. A sample of the contents of the drum, X01, was collected as PSM and analyzed for gamma spectroscopy, tritium, isotopic U, isotopic Am, isotopic Pu, Sr-90, SVOCs, RCRA metals, and PCBs. This comprehensive list of analyses was selected because the drum contents were unknown and it was located within the DCB.

Two asphalt piles were also identified during visual surveys south of the CAU 550 CA fence, west of Circle Road (Figure A.6-1). The asphalt piles are shown in Figures A.6-17 and A.6-18. One six-point composite sample of each pile (S101 and S201) was collected as PSM. Each aliquot was collected from 0 to 5 cm into the side of the pile around the pile perimeter. Each sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, Cr(VI), TCLP metals, TCLP VOCs, and TCLP SVOCs. This list of analyses was selected because the contents of the asphalt piles were unknown.

Figure A.6-17
CAS 10-22-19 (Asphalt Pile 1)

Figure A.6-18
CAS 10-22-19 (Asphalt Pile 2)

A.6.1.2.14 CAS 10-22-20

This CAS is described as an empty, metal 55-gal drum located within the southern portion of the DCB (REECo, 1991). No debris, including the drum, was found at the reported CAS location (Figure A.6-19). One grab sample, Q001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

A.6.1.2.15 CAS 10-24-10

This CAS is described as a battery located within the southern portion of the DCB (REECo, 1991). No debris, including the battery, was found at the reported CAS location (Figure A.6-20). One grab sample, R001, was collected of the surface soil from 0 to 5 cm bgs. There was no soil staining or other biasing factor present; therefore, the sample was collected at the GPS coordinates of the CAS. The sample was analyzed for gamma spectroscopy, VOCs, SVOCs, RCRA metals, PCBs, beryllium, and Cr(VI), in accordance with the CAIP (NNSA/NSO, 2012a).

Figure A.6-19
CAS 10-22-20 (Drum)

Figure A.6-20
CAS 10-24-10 (Battery)

A.6.2 Deviations/Revised Conceptual Site Model

There were no deviations from the CAIP (NNSA/NSO, 2012a) during the CAI at Study Group 4. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.6.3 Investigation Results

This section provides the analytical results for the 16 soil samples, two solid PSM samples, and one liquid PSM sample collected at Study Group 4. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The chemical contaminant results are reported as individual concentrations that are comparable to their corresponding FALs. Results that are equal to or greater than FALs are identified by bold text in the data tables.

A.6.3.1 Soil Samples

Analytical results for metals, SVOCs and PCBs in soil samples collected at Study Group 4 that were detected above MDCs are presented in Tables A.6-2 and A.6-3. For soil samples, the individual analytical result was compared directly to the chemical FAL to determine whether a COC was present. None of the chemical constituents were detected above their respective FALs; therefore, no chemical COCs were identified at any of the sampled debris CASs.

Table A.6-2
Study Group 4 Soil Sample Results for Metals Detected above MDCs
(Page 1 of 2)

Sample Location	Sample Number	Matrix	COPCs (mg/kg)							
			Arsenic	Barium	Beryllium	Cadmium	Lead	Mercury	Selenium	Silver
FALs			**23[a]**	**190,000**	**2,000**	**800**	**5,739**	**43**	**5,100**	**5,100**
D01	D001	Soil	2.3 (J-)	75 (J)	0.37 (J-)	0.14	9.2	0.022 (J-)	--	--
E01	E001	Soil	5.6	160 (J)	0.44 (J-)	0.31 (J-)	10	0.022 (J-)	0.88	--
F01	F001	Soil	7.1	160 (J)	0.64	0.3	76	0.032 (J-)	1.7	--
G01	G001	Soil	5.9	150 (J)	0.74	6.4	27	0.033 (J-)	0.37	--
H01	H001	Soil	5.9	300 (J)	0.94	0.3	21	0.04 (J-)	0.55	--

Table A.6-2
Study Group 4 Soil Sample Results for Metals Detected above MDCs
(Page 2 of 2)

Sample Location	Sample Number	Matrix	COPCs (mg/kg)							
			Arsenic	Barium	Beryllium	Cadmium	Lead	Mercury	Selenium	Silver
FALs			**23**[a]	**190,000**	**2,000**	**800**	**5,739**	**43**	**5,100**	**5,100**
I01	I001	Soil	4.5	130 (J)	0.53	0.19	11	0.022 (J-)	0.62	--
J01	J001	Soil	5.5	150 (J)	0.54	0.25	13	0.023 (J-)	--	--
K01	K001	Soil	3.9	99 (J)	0.47 (J-)	0.12	84	0.042 (J-)	--	--
N01	N001	Soil	6.2	180 (J)	0.7	0.28 (J-)	20	0.026 (J-)	0.8	--
P01	P001	Soil	3 (J-)	130 (J)	0.59	0.21	11	0.021 (J-)	0.5	--
	P002 (FD)	Soil	4	130 (J)	0.65	0.26	11	0.019 (J-)	--	--
Q01	Q001	Soil	6	160 (J)	0.54	0.33 (J-)	12	0.025 (J-)	0.62	--
R01	R001	Soil	6.4	180 (J)	0.78	0.23 (J-)	16	0.034 (J-)	--	--
T1	T01	Soil	5.6	200	--	0.62	27 (J)	0.027	--	--
	T02 (FD)	Soil	5.3	190	--	0.57	24 (J)	0.032	--	--
U1	U01	Soil	5.2	140	--	0.11 (J-)	1,400 (J)	0.036	0.56 (J+)	--
Y1	Y01	Soil	6.8	360 (J)	--	27 (J)	150 (J)	--	1.7 (J)	0.24 (J-)

[a] Based on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).

J = Estimated value.
J+ = The result is an estimated quantity, but the result may be biased high.
J- = The result is an estimated quantity, but the result may be biased low.
-- = Not detected above MDC.

The soil samples collected at the locations listed in Table A.6-4 were analyzed for radionuclides to determine whether a release from the debris has resulted in a dose exceeding the FAL. The internal dose was determined using soil sample analytical results as described in Section A.2.3.1. TLDs were not established at any of the Study Group 4 sample locations; therefore, external dose was calculated by using the TED RRMG in the equation presented in Section A.2.3.3. Values for the average internal, external, and total dose for the Industrial Area, Remote Work Area, and Occasional Use Area

Table A.6-3
Study Group 4 Soil Sample Results for SVOCs and PCBs Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent (mg/kg)	
			SVOCs	PCBs
			2,4-Dinitrotoluene	Aroclor 1260
FALs			**5.5**	**0.74**
F01	F001	Soil	--	0.013 (J)
G01	G001	Soil	1.1	0.026
P01	P002 (FD)	Soil	--	0.013 (J)

-- = Not detected above MDC.

Table A.6-4
Study Group 4 TED (mrem/yr)

Sample Location	Industrial Area			Remote Work Area			Occasional Use Area		
	Average Internal	External	Average TED	Average Internal	External	Average TED	Average Internal	External	Average TED
D01	0.0	7.6	7.6	0.0	1.3	1.3	0.0	0.4	0.4
E01	0.2	2.0	2.2	0.0	0.3	0.4	0.0	0.1	0.1
F01	**45.0**	15.4	**60.4**	7.6	2.6	10.2	2.7	0.8	3.5
G01	3.6	3.0	6.5	0.6	0.5	1.1	0.2	0.1	0.4
H01	0.2	2.5	2.8	0.0	0.4	0.5	0.0	0.1	0.1
I01	0.0	1.8	1.9	0.0	0.3	0.3	0.0	0.1	0.1
J01	0.0	2.1	2.1	0.0	0.3	0.3	0.0	0.1	0.1
K01	0.5	18.6	19.1	0.1	3.1	3.2	0.0	0.9	1.0
N01	0.2	1.7	1.8	0.0	0.3	0.3	0.0	0.1	0.1
P01	0.1	1.5	1.6	0.0	0.2	0.3	0.0	0.1	0.1
Q01	1.6	2.4	4.0	0.3	0.4	0.7	0.1	0.1	0.2
R01	0.0	0.9	0.9	0.0	0.2	0.2	0.0	0.0	0.0

Bold indicates the value exceeds 25 mrem/yr.

exposure scenarios at the Study Group 4 debris sample locations are presented in Table A.6-4. Based on these results, the samples from Study Group 4 do not contain COCs in excess of the FAL and the radionuclides present are consistent with those detected in the soil sample plots for Study Groups 1 and 2 (i.e., a mixture of fission radionuclides and plutonium). Therefore, the radiological results demonstrate that the debris items are not a source of radiological COCs.

A.6.3.2 PSM Samples

Two solid and one liquid PSM samples were collected at CAU 550. Analytical results for chemical constituents detected above MDCs in the solid and liquid PSM samples are presented in Tables A.6-5 through A.6-8.

A.6.3.2.1 Solid PSM Samples

The two solid PSM samples were collected from the two asphalt piles and consisted of a dry, asphalt-like material intermixed with soil. Analytical results for chemical constituents in these two samples were compared directly to the FAL assuming that the mass of the contaminant in the soil was equal to the mass of the contaminant in the PSM (i.e., waste) (see Section A.2.4). This is a conservative assumption that does not take into account any decrease in contaminant concentration (i.e., dilution) when the PSM/waste is released to uncontaminated soil. Analytical results for metals and SVOCs detected above MDCs in the solid PSM samples are presented in Tables A.6-5 and A.6-6, respectively. The concentrations of chemical constituents in the solid PSM do not exceed the chemical FALs.

Radiological dose for the solid PSM samples was calculated in accordance with Section A.2.4. The calculated dose for each of the solid PSM samples was 0.0 mrem/OU-yr, which is less than the FAL. As a result, the two asphalt piles were determined not to be PSM.

A.6.3.2.2 Liquid PSM Sample

The liquid PSM sample was collected from inside a 55-gal metal drum. The sample was primarily aqueous with a sheen/film and had a faint hydrocarbon odor. Analytical results for metals and SVOCs detected above MDCs in the liquid PSM sample are presented in Table A.6-7. In order to determine whether the contents of the 55-gal drum could result in a release that would cause the soil to exceed a

Table A.6-5
Study Group 4 Solid PSM Sample Results for Metals Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent (mg/kg)					
			Arsenic	Barium	Cadmium	Lead	Mercury	Selenium
FALs			23	190,000	800	5,739	43	5,100
S1	S101	Solid	4.4	110	0.16 (J-)	6.7	0.013	--
S2	S201	Solid	4.5	110	0.12 (J-)	6.6	0.015	0.99

J- = Estimated value, biased low.
-- = Not detected above MDC.

Table A.6-6
Study Group 4 Solid PSM Sample Results for SVOCs Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent (mg/kg)						
			Chrysene	Phenanthrene[a]	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Benzo(g,h,i)perylene[b]
FALs			210	170,000	2.1	2.1	21	0.21	17,000
S1	S101	Solid	0.016 (J)	0.0084 (J)	0.056	0.033	0.0094 (J)	0.08	0.027 (J)
S2	S201	Solid	--	--	0.045	0.026 (J)	--	0.052	0.016 (J)

[a]FAL is for anthracene (surrogate for phenanthrene).
[b]FAL is for pyrene (surrogate for benzo[g,h,i]perylene).

J = Estimated value.
-- = Not detected above MDC.

FAL, NNSS-specific input parameters were used to calculate a resulting concentration of contaminants in soil.

Table A.6-7
Study Group 4 Liquid PSM Sample Results for Chemical Constituents Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent			
			SVOCs (mg/L)		Metals (mg/L)	
			Phenanthrene	2-Methylnapthalene	Barium	Lead
X1	X01	Liquid	0.064	0.045	0.042 (J-)	0.069 (J)

J = Estimated value.
J- = Estimated value, biased low.

For each chemical constituent detected above the MDC, the concentration in soil resulting from a release was calculated as follows (NNSA/NFO, 2014):

$$C_s\ (mg/kg) = C_l\ (mg/L) \times [FC_s / P_b] \times 1L/1kg$$

where

C_s = Estimated constituent concentration in soil
C_l = Constituent concentration in liquid PSM
FC_s = Soil field capacity (0.2 g/cm^3)
P_b = Soil bulk density (1.5 g/cm^3)

This estimated concentration in soil was then compared to the FALs (Table A.6-8). The concentrations of chemical constituents in the soil from the liquid PSM did not exceed the FALs.

The radionuclide concentration in soil was calculated using the same formula as for chemical constituents, with the necessary adjustments for unit conversion. A radiological dose was then calculated for the soil in accordance with Section A.2.4. The calculated dose for the soil was 0.0 mrem/OU-yr, which is less than the FAL. As a result, the contents of the 55-gal drum were determined not to be PSM.

Table A.6-8
Study Group 4 Estimated Liquid PSM Sample Concentrations in Soil for Chemical Constituents Detected above MDCs

Sample Location	Sample Number	Matrix	Constituent			
			SVOCs (mg/kg)		Metals (mg/kg)	
			Phenanthrene[a]	2-Methylnapthalene	Barium	Lead
FALs			**170,000**	**2,200**	**190,000**	**5,739**
X1	X01	Liquid	0.009	0.006	0.006	0.009

[a]FAL is for anthracene (surrogate for phenanthrene).

-- = Not applicable

The waste characterization analytical results for TCLP VOCs, TCLP SVOCs, and TCLP metals for the liquid PSM sample are discussed in Section A.7.0.

A.6.4 Nature and Extent of Contaminants of Concern

The 15 debris CASs were evaluated for the possibility of PSM and for COCs in underlying soil. Seventeen soil samples were collected at the debris CASs (Table A.6-1), and none of the results exceeded the chemical or radiological FALs. Thus, COCs were not identified in the soil at any of the CASs and corrective action is not required. However, PSM was sampled at CAS 10-22-19 and PSM was assumed to be present at three CASs that contained lead debris items.

Two solid PSM samples and one liquid PSM sample were collected at CAS 10-22-19. The PSM sample results do not contain COCs above the FALs; therefore, the materials are not PSM and do not require corrective action.

Three CASs were assumed to contain COCs above the FAL, based on the nature of the debris identified at the locations: CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]); CAS 08-24-08 (Batteries [3]); and CAS 08-26-01 (Lead Bricks [200]):

- **CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2])** consists of three cracked lead-acid batteries, pieces of a battery scattered over an area, and two lead bricks. This debris was assumed to be PSM based on the inherent lead content. Thus, the CAS was assumed to contain lead above the FALs and require corrective action. The debris was removed from each location, and a soil sample was collected to determine the extent of potential contamination. None of the soil sample results exceeded the FALs, so the CAS is considered clean closed.

- **CAS 08-24-08 (Batteries [3])** consists of a debris pile that contains lead plates (presumably from lead-acid batteries), scrap metal, and small electrical equipment (Figure A.6-11). This CAS was assumed to contain lead at concentrations above the FAL; therefore, the debris pile contains PSM and requires corrective action. A corrective action of clean closure was implemented at CAS 08-24-08. All of the lead debris (i.e., lead battery plates, lead scrap) was removed from the CAS. The debris that did not contain lead (steel scrap, electrical equipment) was left at the site adjacent to the original location of the debris pile. A nine-point composite soil sample from underneath the debris pile was collected. None of the soil sample results exceeded the FALs, so the CAS is considered clean closed.

- **CAS 08-26-01 (Lead Bricks [200])** is located near Smoky GZ. The numerous lead bricks in the area are included in the historical landscape of the Smoky test site (see Section E.2.0). The CAS was assumed to contain lead at concentrations above the FAL, due to the presence of numerous lead bricks on the ground surface. The lead bricks are considered PSM and require corrective action. The extent of contamination was determined visually and was defined as the area where the lead bricks are visible on the surface. There is no record of mechanical soil movement (e.g., excavation, burial) in the area of CAS 08-26-01, so it is reasonable to conclude that the lead bricks used during the Smoky experiment are located on, or near, the ground surface. The selected corrective action for CAS 08-26-01 was closure in place with URs.

A.6.5 Best Management Practices

Debris that was determined not to be PSM was removed during the CAI as a best management practice. The following debris was removed:

- **CAS 08-22-07 (Drum).** One 55-gal metal drum was removed.

- **CAS 08-22-08 (Drums [3]).** Three 10-gal metal drums were removed.

- **CAS 10-22-19 (Drum w/Liquid Contents).** One 55-gal metal drum with solidified contents was removed.

A.7.0 Waste Management

This section addresses the characterization and management of wastes generated during investigation and corrective action activities. Waste management activities were conducted as specified in the CAIP (NNSA/NSO, 2012a).

A.7.1 Waste Generation

The waste listed in Table A.7-1 was generated during the CAI and corrective action activities at CAU 550. These wastes were characterized based on process knowledge, analytical data, and FSRs. Waste was segregated to the greatest extent possible, and waste minimization techniques were integrated into the field activities to reduce the amount of waste generated. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste. Decontamination activities were planned and executed to minimize the volume of rinsate generated.

The amount, type, and source of waste placed into each container was recorded in a waste container log that is maintained in the CAU 550 file. Waste was segregated into the following waste streams:

- **Industrial Solid Waste.** PPE, disposable sampling equipment
- **Low-Level Waste (LLW).** PPE, disposable sampling equipment, metal
- **Mixed Low-Level Waste (MLLW).** Lead bricks, lead battery plates
- **Recycle materials.** Lead bricks, lead-acid batteries

A.7.1.1 Waste Characterization and Disposal

Waste characterization and disposal was based on process knowledge, radiological surveys, and analytical data in accordance with federal and state regulations, permit limitations, and disposal or recycle facility acceptance criteria. The executed waste shipping and disposal documents for CAU 550 are in Attachment D-2. Waste characterization documentation, including analytical results and comparison to regulatory criteria, is maintained in the CAU 550 project file.

The generated waste streams were characterized as Industrial Solid Waste, LLW, MLLW, and Recycle Materials.

Table A.7-1
Waste Summary Table
(Page 1 of 2)

Container Number	Waste Description	Waste Characterization	Waste Disposition			
			Disposal Facility	Waste Volume or Weight	Disposal Date	Disposal Document[a]
153R12	Debris (PPE and disposable sampling equipment)	Industrial Solid Waste	Area 9, U10c	20 gal (placed in roll-off container)	07/15/2013	LVF
550A01	Debris (PPE and disposable sampling equipment)	LLW	Area 5, RWMC	55 gal	10/10/2012	CD
550A02				55 gal		
550A03				55 gal		
550A04				55 gal		
550A05				55 gal	11/14/2013	CD
550A06				55 gal		
550A07				55 gal		
550A08				55 gal		
550A09	Debris (Metal and PPE)	LLW	Area 5, RWMC	55 gal	08/28/2013	CD
550A10				85 gal		
550A11				55 gal		
550A12				55 gal		
550A13	Debris (PPE)	LLW	Area 5, RWMC	55 gal	TBD	CD
550A14	Scrap Lead (Bricks, batteries)	Recycle Materials	TMMC	300 lb	09/17/2013	CR

Table A.7-1
Waste Summary Table
(Page 2 of 2)

Container Number	Waste Description	Waste Characterization	Waste Disposition			
			Disposal Facility	Waste Volume or Weight	Disposal Date	Disposal Document[a]
550A15	Scrap Lead (Batteries)	Recycle Materials	TMMC	310 lb	09/17/2013	CR
550A16	Debris (55-gal drum containing solidified liquid waste)	LLW	Area 5, RWMC	55 gal	TBD	CD
550A17	Debris (PPE)	LLW	Area 5, RWMC	55 gal	TBD	CD
550A18	Debris (PPE)	LLW	Area 5, RWMC	55 gal	TBD	CD
550A19	Radioactive Lead Scrap (Bricks)	MLLW	Area 5, RWMC	54 lb	TBD	CD
550A20	Radioactive Lead Scrap (Lead battery plates)	MLLW	Area 5, RWMC	55 gal	TBD	CD
550A21	Debris (PPE)	LLW	Area 5, RWMC	55 gal	TBD	CD

[a]Copies of waste disposal documents are located in Attachment D-2. Those that are not available as of the date of this document will be included in Attachment D-2.

CD = Certificate of Disposal
CR = Certificate of Recycle
lb = Pound
LVF = Load Verification Form
RWMC = Radioactive Waste Management Complex
TBD = To be determined
TMMC = Toxco Materials Management Center

A.7.1.1.1 Industrial Solid Waste

Approximately 20 gal of PPE and disposable sampling equipment was generated and characterized as industrial solid waste. The PPE and disposable sampling equipment was field screened, as generated, and determined to meet the materials unrestricted release limits of Table 4.2 of the *Nevada National Security Site Radiological Control Manual* (NNSA/NSO, 2012b). The waste was characterized as industrial solid waste that meets the chemical and radiological waste acceptance criteria of the Area 9, U10c solid waste landfill. The solid waste was bagged, marked, and placed in a roll-off container (#153R12) located at Building 23-153 for final disposal at the Area 9, U10c landfill.

A.7.1.1.2 LLW

Twelve drums of PPE and disposable sampling equipment and five drums of metal debris were generated. The material was characterized as LLW based on radiological survey results and associated soil sample results. This material meets the waste acceptance criteria for disposal at the Area 5 RWMC.

A.7.1.1.3 MLLW

Mixed low-level waste generated consists of two drums of radioactively contaminated elemental lead. The elemental lead included two lead bricks and lead plates from broken, deteriorated lead-acid batteries. The materials were characterized based on radiological survey results and process knowledge (i.e., materials of construction). The radiological results exceed the recycle acceptance criteria, so the waste will be treated using macroencapsulation and disposed at the Area 5 RWMC.

A.7.1.1.4 Recycle Materials

Recycle materials generated at CAU 550 consist of three containers of scrap metal (lead). The elemental lead included lead plates from dry lead-acid batteries and lead bricks. The materials were characterized as radioactive lead scrap metal based on radiological survey results. Because the radiological survey results meet the recycle acceptance criteria of the TMMC located in Oak Ridge, Tennessee, the materials will be recycled and reused as shielding within the DOE or U.S. commercial nuclear industry.

A.8.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 550 CAI. The following subsections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in Appendix B.

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of any COPCs present. Rigorous QA/QC was implemented for all laboratory sample data, including documentation, verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the Soils Activity QAP (NNSA/NSO, 2012c).

A.8.1 Data Validation

Data validation was performed in accordance with the Soils Activity QAP (NNSA/NSO, 2012c) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 550 were evaluated for data quality in a tiered process. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results were evaluated using validation criteria. Documentation of the data qualifications resulting from these reviews is retained in CAU 550 files as a hard copy and electronic media.

All data analyzed as part of this investigation were subjected to Tier I and Tier II evaluations. A Tier III evaluation was performed on approximately 5 percent of the data analyzed.

A.8.1.1 Tier I Evaluation

Tier I evaluation for chemical and radiochemical analysis examines, but is not limited to, the following items:

- Sample count/type consistent with chain of custody.
- Analysis count/type consistent with chain of custody.
- Correct sample matrix.
- Significant problems and/or nonconformances stated in cover letter or case narrative.
- Completeness of certificates of analysis.

- Completeness of Contract Laboratory Program (CLP) or CLP-like packages.
- Completeness of signatures, dates, and times on chain of custody.
- Condition-upon-receipt variance form included.
- Requested analyses performed on all samples.
- Date received/analyzed given for each sample.
- Correct concentration units indicated.
- Electronic data transfer supplied.
- Results reported for field and laboratory QC samples.
- Whether or not the deliverable met the overall objectives.

A.8.1.2 Tier II Evaluation

Tier II evaluation for chemical and radiochemical analysis examines, but is not limited to, the following items:

- Correct detection limits achieved.
- Blank contamination evaluated and, if significant, qualifiers are applied to sample results.
- Certificate of Analysis consistent with data package documentation.
- QC sample results (duplicates, laboratory control samples [LCSs], laboratory blanks) evaluated and used to determine laboratory result qualifiers.
- Sample results, uncertainty, and MDC evaluated.
- Detector system calibrated with National Institute of Standards and Technology (NIST)-traceable sources.
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations.
- Detector system response to daily or weekly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system.
- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements.
- Documentation of all QC sample preparation complete and properly performed.
- Spectra lines, photon emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration.

A.8.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 5 percent of the sample data was performed by Analytical Quality Associates, Inc. Tier II and Tier III results were compared and where differences were noted, data were reviewed and changes were made accordingly. This review included the following additional evaluations:

- Review
  - case narrative, chain of custody, and sample receipt forms;
  - lab qualifiers (applied appropriately);
  - method of analyses performed as dictated by the chain of custody;
  - raw data, including chromatograms, instrument printouts, preparation logs, and analytical logs;
  - manual integrations to determine whether the response is appropriate; and
  - data package for completeness.
- Determine sample results qualifiers through the evaluation of (but not limited to)
  - tracers and QC sample results (e.g., duplicates, LCSs, blanks, matrix spikes) evaluated and used to determine sample results qualifiers;
  - sample preservation, sample preparation/extraction and run logs, sample storage, and holding time;
  - instrument and detector tuning;
  - initial and continuing calibrations;
  - calibration verification (initial, continuing, second source);
  - retention times;
  - second column and/or second detector confirmation;
  - mass spectra interpretation;
  - interference check samples and serial dilutions;

- post-digestion spikes and method of standard additions; and
- breakdown evaluations.

- Perform calculation checks of
  - at least one analyte per QC sample and its recovery;
  - at least one analyte per initial calibration curve, continuing calibration verification, and second source recovery; and
  - at least one analyte per sample that contains positive results (hits); radiochemical results only require calculation checks on activity concentrations (not error).
- Verify that target compound detects identified in the raw data are reported on the results form.
- Document any anomalies for the laboratory to clarify or rectify. The contractor should be notified of any anomalies.

A.8.2 Field QC Samples

Analysis of QC preparation blanks, LCSs, and laboratory duplicate samples was performed on each sample delivery group (SDG). Initial and continuing calibration and LCSs were performed for each SDG. The results of these analyses were used to qualify associated environmental sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in CAU 550 files as both hard copy and electronic media.

During the CAI, three FDs were sent as blind samples to the laboratory to be analyzed for the same investigation parameters as their associated sample. For these samples, the duplicate results precision (i.e., relative percent differences between the environmental sample results and their corresponding FD sample results) were evaluated.

A.8.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.8.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to inconsistencies in the analytical instrumentation operation, sample preparations, extractions, missed holding times, and fluctuations in internal standard and calibration results. All laboratory nonconformances were reviewed for relevance and, where appropriate, data were qualified.

A.8.5 TLD Data Validation

The data from the TLD measurements met rigorous data quality requirements. TLDs were obtained from, and measured by, the Environmental Technical Services group at the NNSS. This group is responsible for a routine environmental monitoring program at the NNSS. TLDs were submitted to the Environmental Technical Services group for analysis using automated TLD readers that are calibrated and maintained by the National Security Technologies, LLC, Radiological Control Department in accordance with existing QC procedures for TLD processing. A summary of the routine environmental monitoring TLD QC program can be found in the *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003). Certification is maintained through the DOE Laboratory Accreditation Program for dosimetry.

The determination of the external dose component of the TED by TLDs was determined to be the most accurate method because of the following factors:

1. *TLDs are exposed at the sample plots for an extended time period that approximates the 2,000 hours of exposure time used for the Industrial Area exposure scenario.* This eliminates errors in reading dose-rate meter scale graduations and needle fluctuations that would be magnified when as-read meter values are multiplied from units of “per-hour” to 2,000 hours.

2. *The use of a TLD to determine an individual’s external dose is the standard in radiation safety and serves as the “legal dose of record” when other measurements are available.* Specifically, 10 CFR Part 835.402 (CFR, 2013) indicates that personal dosimeters must be provided to monitor individual exposures and that the monitoring program that uses the dosimeters must be accredited in accordance with a DOE Laboratory Accreditation Program.

A.9.0 Summary

The results of the CAI by CAS are summarized in Table A.9-1 and described below.

Table A.9-1
Summary of Corrective Actions at CAU 550

CAS Number	Release Description	Investigation Results	Corrective Action
08-23-04	Smoky Atmospheric Test	No COCs identified	No further action
08-23-03	Ceres Safety Experiment	HCA conditions present	Closure in place with FFACO UR
08-23-06	Oberon Safety Experiment		
08-23-07	Titania Safety Experiment		
08-01-01	Storage Tank	No COCs identified	No further action
08-22-05	Drum	No COCs identified	No further action
08-22-07	Drum	No COCs identified	No further action
08-22-08	Drums (3)	No COCs identified	No further action
08-22-09	Drum	No COCs identified	No further action
08-24-03	Battery	No COCs identified	No further action
08-24-04	Battery	No COCs identified	No further action
08-24-07	Batteries (3)	PSM removed; no COCs identified	Clean closure
	Battery	PSM removed; no COCs identified	Clean closure
	Lead Bricks (2)	PSM removed; no COCs identified	Clean closure
08-24-08	Batteries (3)	PSM removed; no COCs identified	Clean closure
08-26-01	Lead Bricks (200)	Lead above FAL	Closure in place with FFACO UR
10-22-17	Buckets (3)	No COCs identified	No further action
10-22-18	Gas Block/Drum	No COCs identified	No further action
10-22-19	Drum; Stains	No COCs identified	No further action
	Drum w/Liquid Contents	Not PSM	No further action
	Asphalt Pile 1	Not PSM	No further action
	Asphalt Pile 2	Not PSM	No further action
10-22-20	Drum	No COCs identified	No further action
10-24-10	Battery	No COCs identified	No further action

CAS 08-23-04 (Study Group 1, Atmospheric Test)

Based on analytical results of soil samples and TLDs, radiological contamination at CAS 08-23-04 does not exceed the FAL for radiological dose (25 mrem/OU-yr) at any location. Therefore, no corrective action is required.

As a BMP, an administrative UR was established to include any area where an industrial land use of the area (2,000 hours of exposure per year) could cause a site worker to receive a dose exceeding 25 mrem/yr. To determine the extent of this area, a correlation of 2010 gross-count aerial radiation survey values to the average of the Industrial Area TED values was conducted for the CAS. Based on this correlation, the radiation survey value that corresponds to the 25-mrem/IA-yr PAL is 51,588 counts per second. This value was used to estimate the administrative UR boundary for CAS 08-23-04 (Figure A.3-3). Due to the large land area included in CAU 550 and the multiple administrative UR boundaries established as BMPs in this CADD/CR, a single administrative UR boundary was established for the CAU, as shown in Attachment D-1. The administrative UR for CAS 08-23-04 is wholly encompassed by the CAU 550 administrative UR boundary.

CASs 08-23-03, 08-23-06, and 08-23-07 (Study Group 2, Safety Experiments)

Based on analytical results of soil samples and TLDs, radiological contamination at the three safety experiment CASs does not exceed the FAL for radiological dose (25 mrem/OU-yr) at either of the two sample locations outside the DCB. However, HCA conditions for removable radioactive contamination inside the DCB are assumed to be present, as are COCs in excess of the FAL; therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with FFACO URs.

As a BMP, an administrative UR was established to include the area outside the DCB but inside the CA fence. The northern portion of the administrative UR boundary was estimated based on data acquired during the CAI, as discussed in Section A.4.5. The administrative UR associated with these CASs is wholly encompassed by the CAU 550 administrative UR boundary shown in Attachment D-1.

No CAS Number (Study Group 3, Washes)

Evaluation of the data collected at Study Group 3 suggests that radioactive contamination from the Smoky test (CAS 08-23-04) and the three safety experiments (CASs 08-23-03, 08-23-06, and 08-23-07) has migrated into the washes and depositional area, and has the potential to migrate in the future. However, current radiation dose does not exceed the FAL, and HCA conditions for removable contamination are not present and are not expected to be present in the future. Therefore, the washes and depositional area do not require corrective action.

As a BMP, an administrative UR was established to include the washes, depositional area, and a large erosion/sedimentation area east of Circle Road near the U10a crater. This administrative UR is wholly encompassed by the CAU 550 administrative UR boundary shown in Attachment D-1.

Debris CASs (Study Group 4, Debris)

A summary of the corrective actions implemented at the debris CASs is found in Table A.9-1. None of the results from the soil samples collected at the debris CASs exceeded the FALs. Therefore, no COCs were identified, and corrective action is not required. However, PSM was sampled at CAS 10-22-19, and PSM was assumed to be present at three CASs that contained lead debris items.

PSM sample results from the two asphalt piles indicate that the piles are not PSM and do not require corrective action. The liquid PSM sample results from the 55-gal drum indicate that the contents are not PSM, and corrective action is not required.

Three CASs were assumed to contain COCs above the FAL, based on the nature of the debris identified at the locations: CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]), CAS 08-24-08 (Batteries [3]), and CAS 08-26-01 (Lead Bricks [200]).

- **CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2])** consists of three cracked lead-acid batteries, pieces of a battery scattered over an area, and two lead bricks. This debris was assumed to be PSM based on the inherent lead content. Thus, the CAS was assumed to contain lead above the FALs and require corrective action. The debris was removed from each location, and a soil sample was collected to determine the extent of potential contamination. None of the soil sample results exceeded the FALs, so the CAS is considered clean closed.

- **CAS 08-24-08 (Batteries [3])** consists of a debris pile that contains lead plates (presumably from lead-acid batteries), scrap metal, and small electrical equipment (Figure A.6-11). This CAS was assumed to contain lead at concentrations above the FAL; therefore, the debris pile contains PSM and requires corrective action. A corrective action of clean closure was implemented at CAS 08-24-08. All of the lead debris (i.e., lead battery plates, lead scrap) was removed from the CAS. The debris that did not contain lead (steel scrap, electrical equipment) was left at the site adjacent to the original location of the debris pile. A nine-point composite soil sample from underneath the debris pile was collected. None of the soil sample results exceeded the FALs, so the CAS is considered clean closed.

- **CAS 08-26-01 (Lead Bricks [200])** is located near Smoky GZ. The numerous lead bricks in the area are included in the historical landscape of the Smoky test site (see Section E.2.0). The CAS was assumed to contain lead at concentrations above the FAL, due to the presence of numerous lead bricks on the ground surface. The lead bricks are considered PSM and require corrective action. The extent of contamination was determined visually and was defined as the area where the lead bricks are visible on the surface. There is no record of mechanical soil movement (e.g., excavation, burial) in the area of CAS 08-26-01, so it is reasonable to conclude that the lead bricks used during the Smoky experiment are located on, or near, the ground surface. The selected corrective action for CAS 08-26-01 was closure in place with URs.

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Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 550 CAIP (NNSA/NSO, 2012a) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA involves five steps that begin with a review of the DQOs and end with an answer to the DQO decisions. These steps are briefly summarized as follows:

1. *Review DQOs and Sampling Design.* Review the DQO process to provide context for analyzing the data. State the primary statistical hypotheses; confirm the limits on decision errors for committing false-negative (Type I) or false-positive (Type II) decision errors; and review any special features, potential problems, or deviations to the sampling design.

2. *Conduct a Preliminary Data Review* Perform a preliminary data review by reviewing QA reports and inspecting the data both numerically and graphically, validating and verifying the data to ensure that the measurement systems performed in accordance with the criteria specified, and using the validated dataset to determine whether the quality of the data is satisfactory.

3. *Select the Test.* Select the test based on the population of interest, population parameter, and hypotheses. Identify the key underlying assumptions that could cause a change in one of the DQO decisions.

4. *Verify the Assumptions.* Perform tests of assumptions. If data are missing or are censored, determine the impact on DQO decision error.

5. *Draw Conclusions from the Data.* Perform the calculations required for the test.

B.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A of the CAIP (NNSA/NSO, 2012a). The DQO decisions are presented with the DQO provisions to limit false-negative or false-positive decision errors. Special features, potential problems, or any deviations to the sampling design are also presented.

B.1.1.1 Decision I

The Decision I statement as presented in the CAIP (NNSA/NSO, 2012a) is as follows: "Is any COC present in environmental media within the study group?" For the judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. For probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. A COC may be assumed to be present based on the presence of waste that has the potential release COC concentrations in the future (i.e., PSM) or the presence of removable contamination that has the potential to exceed the defining criteria for an HCA. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple contaminant analysis (NNSA/NFO, 2014). If a COC is detected, then Decision II must be resolved.

B.1.1.1.1 DQO Provisions To Limit False-Negative Decision Error

A false-negative decision error (when it is concluded that contamination exceeding FALs is not present when it actually is) was controlled by meeting the following criteria:

1a) For Decision I, having a high degree of confidence that sample locations selected will identify COCs if present anywhere within the CAS (judgmental sampling).

1b) Maintaining a false-negative decision error rate of 0.05 (probabilistic sampling).

2) Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.

3) Having a high degree of confidence that the dataset is of sufficient quality and completeness.

Criteria 1b, 2, and 3, were assessed based on the entire dataset. Therefore, these assessments apply to both Decision I and Decision II.

Criterion 1a (Confidence That Judgmental Sample Locations Identify COCs)

Decision I for Study Groups 1 and 2 (as stipulated in the DQOs) was already resolved for the areas within the DCB because those areas were already identified as requiring corrective action. Therefore, Decision I sampling only applied to those areas outside the DCB. To resolve Decision I (determine whether a COC is present at a release), samples were collected and analyzed following these two criteria:

- Samples must be collected in areas most likely to contain a COC (judgmental sampling).
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

To satisfy the criteria that samples must be collected in areas most likely to contain a COC, judgmental sample locations were selected at each study group as follows:

Study Group 1

In accordance with the sampling design for Study Group 1 (Atmospheric Test), Decision I was addressed during the CAI with the establishment of a single sample plot near Smoky GZ. The location of the plot was selected based on the highest radioactivity measurements indicated by the PRM-470 TRS performed during the CAI.

Study Group 2

Decision I for Study Group 2 (Safety Experiments) was evaluated separately for areas inside the DCB and areas outside the DCB. Decision I was resolved for areas inside the DCB with the establishment of the DCB during the DQOs. It was assumed that corrective action was required at areas within the DCB. Decision I was resolved for areas outside the DCB through establishment of two sample plots and associated TLDs. The location of the two sample plots was selected based on the highest radioactivity measurements outside the DCB indicated by the 2002 americium aerial survey, 2002 KIWI survey, and FIDLER TRSs performed during the CAI.

Study Group 3

Decision I for Study Group 3 (Washes) was resolved with judgmental samples and TLDs placed at sedimentation areas and locations of elevated radioactivity. The sedimentation areas were selected visually and sample locations were selected based on the highest radioactivity measurements indicated by the FIDLER and PRM-470 TRSs performed during the CAI.

Study Group 4

Sampling locations at Study Group 4 (Debris) were selected based on the presence of debris and/or indication of PSM or a release.

The analytical methods were chosen during the DQO process as the analyses required to detect any of the COPCs listed in the CAIP (NNSA/NSO, 2012a) that were defined as the contaminants that could reasonably be expected at the site that could contribute to a dose or risk exceeding FALs. The COPCs were identified based on operational histories, waste inventories, release information, investigative background, contaminant sources, release mechanisms, and migration pathways as presented in the CAIP. This provides assurance that the analyses conducted for each sample has the capability of identifying any COPC present in the sample.

All samples were analyzed using the analytical methods listed in Section 3.2 of the CAIP with the following exception:

- *Historical information identified Pu-241, Tc-99, and Sr-90 as being used as tracers in nuclear testing on the NNSS.* Because it is not known at which test locations these tracers were used, Pu-241, Tc-99, and Sr-90 were included in the analysis request for select samples in Study Groups 1, 2, and 3 (Tables A.3-2, A.4-2, and A.5-2).

Criterion 1b (Confidence in Probabilistic False-Negative Decision Error Rate)

Control of the false-negative decision error for probabilistic samples was accomplished by ensuring the following:

- The samples are collected from unbiased locations.
- A sufficient sample size was collected.
- A false rejection rate of 0.05 was used in calculating the 95 percent UCLs and minimum sample size.

Selection of the sample aliquot locations within sample plots at Study Groups 1 and 2 was accomplished using a random-start, systematic triangular grid pattern for sample placement. This permitted an unbiased, equal-weighted chance that any given location within the boundaries of the sample plot would be chosen. Although the TLD locations were not established at random locations (i.e., they were placed at the center of the sample plot), they provided three independent measurements of dose per TLD, that integrate unbiased measurements from each sample location.

The minimum number of samples required was calculated for probabilistic sample locations. The minimum sample size (*n*) was calculated using the following EPA sample size formula (EPA, 2006):

$$n = \frac{s^2 (z_{.95} + z_{.80})^2}{(\mu - C)^2} + \frac{z^2_{.95}}{2}$$

where

s = standard deviation
$z_{.95}$ = z score associated with the false-negative rate of 5 percent
$z_{.80}$ = z score associated with the false-positive rate of 20 percent
μ = dose level where false-positive decision is not acceptable (12.5 mrem/yr)
C = FAL (25 mrem/yr)

The use of this formula requires the input of basic statistical values associated with the sample data. Data from a minimum of three samples are required to calculate these statistical values and, as such, the least possible number of samples required to apply the formula is three. Therefore, in instances where the formula resulted in a value less than three, three is adopted as the minimum number of samples required. The results of the minimum sample size calculations and the number of samples collected for sample plots in Study Groups 1 and 2 are presented in Tables A.3-4 and A.4-4, respectively. As shown in these tables, the minimum number of sample plot samples was exceeded at both study groups. The results of the minimum sample size calculations and the number of samples collected for TLD locations in Study Groups 1, 2, and 3 are presented in Tables A.3-3, A.4-3, and A.5-3, respectively. The minimum number of TLD samples was met at all locations.

The minimum sample size calculations were conducted as stipulated in the CAIP (NNSA/NSO, 2012a) based on the following parameters:

- A false rejection rate of 0.05
- A false acceptance rate of 0.20
- The maximum acceptable gray region set to one-half the FAL (12.5 mrem/yr)
- The calculated standard deviation

Criterion 2 (Confidence in Detecting COCs Present in Samples)

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Soils Activity QAP (NNSA/NSO, 2012b). The sensitivity acceptance criterion is that analytical detection limits will be less than the corresponding FAL. For radionuclides, the criterion is that all detection limits are less than their corresponding Occasional Use Area internal dose RRMGs. All of the analytical detection limits for radionuclides were less than their corresponding RRMGs; therefore, the DQI for sensitivity has been met for radionuclides. For chemical analytes, the criterion is that all detection limits are less than their corresponding chemical FALs, as defined in Appendix C. All of the analytical detection limits for chemical analytes were less than their corresponding FALs; therefore, the DQI for sensitivity has been met for chemicals. No CAU 550 data were rejected due to sensitivity.

Criterion 3 (Confidence That Dataset Is of Sufficient Quality and Complete)

To satisfy the third criterion, the dataset was assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the Soils Activity QAP (NNSA/NSO, 2012b). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NSO, 2012a). The individual DQI results are presented in the following subsections.

Precision

Precision was evaluated as described in Section 6.2.3 of the CAIP (NNSA/NSO, 2012a) and Section 4.2 of the Soils Activity QAP (NNSA/NSO, 2012b). Table B.1-1 provides the results for all constituents that were qualified for precision. Of these, Am-241, Am-243, Pu-238, and Pu-239/240 did not meet the DQI criteria of 80 percent for precision. As stipulated in Section 4.3 of the Soils Activity QAP, when analyses of a particular contaminant do not meet the DQI criteria and the highest reported activity for that contaminant exceeds one-half its corresponding FAL, the data assessment must include explanations or justifications for their use or rejection. There were no analytical data qualified for precision that exceeded one-half the FAL. Therefore, the CAIP criterion for precision was met for all contaminants. The potential for a false-negative DQO decision error is negligible, and use of the results that were qualified for precision can be confidently used.

Table B.1-1
Precision Measurements[a]

Parameter	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Cadmium	Metals	1	17	94.1
Lead	Metals	3	17	82.4
Selenium	Metals	1	17	94.1
Am-241	Americium	16	48	66.7
Am-243	Americium	3	4	25.0
Pu-238	Plutonium	13	48	72.9
Pu-239/240	Plutonium	16	48	66.7

[a]SW-846 Methods (EPA, 2004 and 2008)

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NSO, 2012a) and Section 4.2 of the Soils Activity QAP (NNSA/NSO, 2012b).

The sample results that were qualified for accuracy are presented in Table B.1-2. The CAIP criterion of 80 percent accuracy was not met for barium. The samples qualified for barium accuracy were estimated based on the matrix spike failing to meet QC criteria.

Table B.1-2
Accuracy Measurements[a]

Parameter	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Lead	Metals	1	17	94.1
Barium	Metals	14	17	17.6

[a]SW-846 Methods (EPA, 2004 and 2008)

As stipulated in Section 4.3 of the Soils Activity QAP, when analyses of a particular contaminant does not meet the DQI criteria and the highest reported activity for that contaminant exceeds one-half its corresponding FAL, the data assessment must include explanations or justifications for their use or rejection. The analytical results for barium that were qualified for accuracy were less than one-half the FAL. Therefore, the CAIP criterion for accuracy was met for all contaminants. The potential for a false-negative DQO decision error is negligible, and use of the results that were qualified for accuracy can be confidently used.

Comparability

Field sampling, as described in the CAIP (NNSA/NSO, 2012a), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per DOE were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NNSS. Therefore, CAU 550 datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements.

Also, standard, approved field and analytical methods ensured that data were appropriate for comparison to the investigation action levels specified in the CAIP.

Completeness

The CAIP (NNSA/NSO, 2012a) defines acceptable criteria for completeness to be that the dataset is sufficiently complete to be able to make the DQO decisions. This is initially evaluated as 80 percent of release-specific analytes identified in the CAIP having valid results. No CAU 550 data were rejected or failed the criterion of sensitivity. Therefore, all of the CAU 550 data used to make DQO decisions met the criteria for completeness. Thus, sufficient information is available to make the DQO decisions.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NSO, 2012a) was used to address sampling and analytical requirements for CAU 550. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination [judgmental sampling] or that represent contamination of the sample plot [probabilistic sampling] and locations that bound COCs) (Section A.2.1). The sampling locations identified in the Criterion 1a discussion meet this criterion.

Special consideration is needed for americium and plutonium isotope concentrations related to representativeness. This is due to the nature of these contaminants in soil. These isotopes may be present in soil in the form of small particles that may or may not be captured in a small soil sample of 1 to 2 grams. As individual particles of these radionuclides can make a significant impact on analytical results, small soil samples taken from the same site can produce analytical results that are very different (i.e., poor accuracy). However, the americium and plutonium isotopes are co-located (e.g., Am-241 is a daughter product of Pu-241), and the relative concentrations between different samples from the same site (i.e., the ratio of americium to plutonium isotope concentrations) should be equal. Based on process knowledge and demonstrated by analytical results from previously sampled Soils sites, the ratios between americium and plutonium isotopes in soil contamination from any given source is expected to be the same throughout the contaminant plume at any given time. Therefore, if the ratios are known and one of these isotopic concentrations is known, the concentrations of the other isotopes can be estimated.

Am-241 is reported by the gamma spectrometry method as well as the isotopic americium method. As the gamma spectrometry measurement is based on a much larger soil sample (usually 1 liter), the particle distribution problem discussed above is greatly diminished and the probability of the result being representative of the sampled site is much improved. Therefore, the ratios between the americium and plutonium isotopes will be established using the isotopic analytical results and these ratios will be used to infer concentrations of plutonium isotopes using the gamma spectrometry results for Am-241. These inferred plutonium values will be more representative of the sampled area than the isotopic results.

Based on the methodical selection of sample locations and the use of americium and plutonium concentrations that are more representative of the sampled area, the analytical data acquired during the CAU 550 CAI are considered representative of the population parameters.

B.1.1.1.2 DQO Provisions To Limit False-Positive Decision Error

The false-positive decision error was controlled by assessing the potential for false-positive analytical results. QA/QC samples such as method blanks were used to determine whether a false-positive analytical result may have occurred. This provision is evaluated during the data validation process and appropriate qualifications are applied to the data when applicable. There were no data qualifications that would indicate a potential false-positive analytical result.

Proper decontamination of sampling equipment also minimized the potential for cross contamination that could lead to a false-positive analytical result.

B.1.1.2 Decision II

Decision II as presented in the CAIP (NNSA/NSO, 2012a) is as follows: "If a COC is present, is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include the following:

- The lateral and vertical extent of COC contamination
- The information needed to predict potential remediation waste types and volumes
- Any other information needed to evaluate the feasibility of remediation alternatives

A corrective action will be determined for any site containing a COC or assumed to contain a COC. The evaluation of the need for corrective action will include the potential for wastes that are present at the site to cause the future contamination of site environment media if the wastes were to be released.

At Study Groups 1 and 3, Decision II does not need to be resolved because no COCs were detected.

At Study Group 2, there were no COCs detected outside the DCB. The extent of the DCB (Decision II) in Study Group 2 was defined as the area where HCA conditions for removable contamination are present.

No COCs were detected in soil samples from any of the Study Group 4 release locations. However, PSM was identified, or assumed to be present, at three release locations. These locations are CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]); CAS 08-24-08 (Batteries [3]); and CAS 08-26-01 (Lead Bricks [200]). The extent of COC contamination (Decision II) was determined either by collecting soil samples from underneath the debris or visually estimating extent. The PSM was removed at CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]) and CAS 08-24-08 (Batteries [3]), and a soil sample was collected underneath the debris. None of the soil sample results exceeded the FALs, so Decision I and II were resolved for these locations. Based on the remoteness of the site, the proximity to the public, depth to groundwater, and recognition of the sites' historical value, the debris at CAS 08-26-01 (Lead Bricks [200]) was left in place. The extent of contamination at this CAS was determined visually to be the area where debris (i.e., lead bricks) is visible on the surface. There is no record of mechanical soil movement (e.g., excavation, burial) in the area of CAS 08-26-01, so it is reasonable to conclude that the lead bricks used during the Smoky experiment are located on, or near, the ground surface. The information needed to predict potential remediation waste types and volumes and information needed to evaluate the feasibility of remediation alternatives at these locations was provided by the analytical results from soil samples and the identification of metallic lead at CAS 08-26-01.

B.1.1.3 Sampling Design

The CAIP (NNSA/NSO, 2012a) stipulated that the following sampling processes would be implemented:

- Sampling of sample plots will be conducted by a combination of judgmental and probabilistic sampling approaches.

  Result. The location of soil sample plots were selected judgmentally, and sample aliquots were collected within each plot probabilistically as described in Section A.2.0.

- Judgmental sampling will be conducted at locations of potential contamination identified during the CAI.

  Result. Judgmental sampling was conducted at Study Group 3 (Washes) and Study Group 4 (Debris) sites. Sample locations were selected based on elevated radiological measurements and/or the presence of sediment, debris, or PSM.

B.1.2 Conduct a Preliminary Data Review

A preliminary data review was conducted by reviewing QA reports and inspecting the data. The contract analytical laboratories generate a QA nonconformance report when data quality does not meet contractual requirements. All data received from the analytical laboratories met contractual requirements, and a QA nonconformance report was not generated.

Data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified in the Soils Activity QAP (NNSA/NSO, 2012b). The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO decisions relating to radiological dose was the comparison of the TED to the FAL of 25 mrem/OU-yr. For chemical contamination, the test for making DQO decisions was the comparison of analyte results to the corresponding FALs. All radiological FALs were based on an exposure duration to a site worker using the Occasional Use Area exposure scenario. All chemical FALs, except for lead, were based on an exposure duration to a site worker using the Industrial Area exposure scenario. The FAL for lead was based on an exposure duration to a site worker using the Remote Work Area exposure scenario.

The key assumptions that could impact a DQO decision are listed in Table B.1-3.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 550 DQOs and Table B.1-3. All data collected during the CAI supported the CSM, and no revisions to the CSM were necessary.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NSO, 2012a) made the following commitments for each study group:

Study Group 1 (Atmospheric Test)

- Decision I for the primary release will be evaluated by establishing one soil sample plot and TLD within the area of the highest gamma values from the PRM-470 survey.

  Result: Decision I was resolved by the placement of TLDs and collection of environmental samples at a single sample plot as required in the CAIP. Additional soil samples were collected from 13 plots established at TLD grid locations.

- Approximately 50 TLDs will be installed in a grid pattern to measure external dose.

  Result. A total of 56 TLDs were placed in a grid pattern surrounding Smoky GZ.

Table B.1-3
Key Assumptions

Exposure Scenario	Occasional Use Area
Affected Media	Surface and subsurface soil; wash sediments
Location of Contamination/Release Points	Surface soil surrounding the atmospheric test and three safety experiment locations, surface and subsurface soil within the washes and depositional area, and surface soil directly below or adjacent to contaminated debris or PSM.
Transport Mechanisms	Surface water runoff serves as the major driving force for lateral migration of contaminants while percolation of precipitation or runoff through subsurface media provides a driver for vertical transport of contaminants. Wind may cause limited resuspension and transport of windborne contaminants; however, this transport mechanism is less likely to cause migration of contamination at levels exceeding FALs.
Preferential Pathways	Lateral transport is expected to dominate over vertical transport due to the relatively large PET value as compared to the annual precipitation rate. The depth to the uppermost aquifer precludes groundwater as a significant pathway.
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.
Groundwater Impacts	None
Future Land Use	Nuclear Test Zone
Other DQO Assumptions	Debris and/or soil within the DCB contains removable alpha radiological contamination that meets the defining criteria for an HCA.

Study Group 2 (Safety Experiments)

- Establish soil sample plots and TLDs at two locations outside the DCB based on the highest americium signature from the 2002 KIWI survey (northern plot) and the 2002 americium aerial radiation survey (western plot).

  Result. Two sample plots were established outside the DCB.

Study Group 3 (Washes)

- A more comprehensive FIDLER survey of the washes will be completed and will include the bank/barrier area adjacent to Circle Road.

  Results. Initial FIDLER and PRM-470 surveys were conducted in 2011; additional FIDLER surveys were completed in the washes and area adjacent to Circle Road in 2012. A site visit in early August 2013 revealed severe erosion of washes indicative of a recent, major precipitation event. An additional FIDLER survey was completed along the same path as the 2011/2012 surveys to enable the comparison of pre- and post-event surveys.

- A minimum of two sedimentation areas within each drainage segment will be sampled and TLDs placed.

  Results. Soil samples were collected, and one TLD each was placed at 10 sedimentation areas within the washes. Subsurface samples were also collected at locations where buried contamination was indicated. An additional sediment location was sampled at the U10a crater.

- One grab sample and TLD will be collected at the depositional area east of Circle Road at the location of the most-elevated radiation reading from the 2002 americium aerial survey, KIWI survey, and FIDLER survey.

  Results. One grab sample and TLD were collected in the depositional area.

Study Group 4 (Debris)

- Sample locations for debris releases will be determined based upon the likelihood of a contaminant release. These locations will be selected based on the identification of biasing factors during the investigation.

  Result. Two lead bricks, a broken battery, and three intact batteries were identified in Study Group 4. These debris were assumed to be PSM due to their lead content. The debris was removed during the CAI and verification samples were collected.

B.1.5 Draw Conclusions from the Data

This section resolves Decision I and II for each of the CAU 550 CASs.

B.1.5.1 Decision Rules for Both Decision I and II

Decision rule. If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in the CAIP (NNSA/NSO, 2012a), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling.

- **Result.** The COC contamination was found to be consistent with the CSM and to not extend beyond the spatial boundaries.

B.1.5.2 Decision Rules for Decision I

Decision rule. If the population parameter of any COPC in the Decision I population of interest exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that COPC in that population.

- **Result.** Because COCs were assumed to be present within the established DCB at Study Group 2 (Safety Experiments), Decision II needed to be resolved. No COCs were identified at Study Groups 1 and 3; therefore, Decision II activities were not required for these study groups.

Decision rule. If a COC exists at any study group, then a corrective action will be determined, else no further action is required.

- **Result.** Because COCs were identified at Study Groups 2 and 4, corrective actions are required.

Decision rule. If a waste is present that, if released, has the potential to cause the future contamination of site environmental media, then a corrective action will be determined, else no further corrective action will be necessary.

- **Result.** PSM was identified at three debris CASs. A corrective action of debris removal was completed at the three release locations at CAS 08-24-07 during the CAI. A corrective action of debris removal was also completed at CAS 08-24-08 as part of site closure. A corrective action of closure in place was selected for CAS 08-26-01.

B.1.5.3 Decision Rules for Decision II

Decision rule. If the population parameter (the observed concentration of any COC) in the Decision II population of interest exceeds the corresponding FAL or potential remediation waste types have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

- **Result.** The extent of COC contamination for Study Group 2 is defined by the DCB. The DCB is the area where HCA conditions for removable alpha contamination are present. This area was defined by historical removable contamination surveys. No additional samples were needed to define extent or potential remediation waste volumes.

- **Result.** At the locations where PSM was identified or assumed to be present, the extent of contamination at each location was determined either by collecting soil samples from underneath the debris or visually estimating extent. At each of the three release locations at CAS 08-24-07 and at the release at CAS 08-24-08, a soil sample was collected from underneath the PSM. The extent of contamination at CAS 08-26-01 was determined visually to be the area where debris (i.e., lead bricks) is visible on the surface. No additional samples were needed to define extent or potential remediation waste volumes at these locations.

Decision rule. If valid analytical results are available for the waste characterization samples, then the decision will be that sufficient information exists to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, else collect additional waste characterization samples.

- **Result.** Valid analytical data are adequate to determine waste types and evaluate alternatives.

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

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Appendix C

Risk Assessment

C.1.0 Risk Assessment

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NFO, 2014). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2012b) requires the use of ASTM Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard. In addition, at CAU 550 sites where removable radioactive contamination is present, it is assumed that a corrective action is required if HCA conditions are present at the site, even though the area may not present a potential radiation dose to a receptor that exceeds the FAL.

The ASTM Method E1739 defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- **Tier 1 evaluation.** Sample results from source areas (highest concentrations) are compared to Tier 1 action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 550 CAIP [NNSA/NSO, 2012]). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.

- **Tier 2 evaluation.** Conducted by calculating Tier 2 action levels using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 action levels are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis.

- **Tier 3 evaluation.** Conducted by calculating Tier 3 action levels on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

The RBCA decision process stipulated in the Soils RBCA document (NNSA/NFO, 2014) is summarized in Figure C.1-1. It is assumed that contamination exceeding the FAL is present and requires corrective action within the DCB. The following PSM is assumed to contain sufficient quantities of hazardous chemicals to cause the underlying soil to exceed a FAL when the PSM is eventually released to the soil:

- Lead bricks at CAS 08-26-01
- Lead-acid batteries at 08-24-08

The contamination associated with these releases is assumed to exceed FALs and require corrective action. Therefore, the need for corrective action will not be included in this risk evaluation. However, they will be included in the evaluation of corrective actions. This risk assessment is intended for use in making corrective action decisions for CAU 550 at the conclusion of the CAI (i.e., following any corrective actions carried out during the CAI).

C.1.1 Scenario

CAU 550, Smoky Contamination Area, comprises 19 CASs within Areas 8 and 10 of the NNSS. The 19 CASs consist of one weapons-related atmospheric test (Smoky), three safety experiments (Ceres, Oberon, Titania), and 15 debris sites. The Smoky site (CAS 08-23-04) is the surface release of radioactivity associated with the Smoky weapons-related atmospheric test. The safety experiment sites (CAS 08-23-03 [Ceres safety experiment], CAS 08-23-06 [Oberon safety experiment], and CAS 08-23-07 [Titania safety experiment]) are the surface releases of radioactive contamination associated with the three safety experiments. The Smoky test and the three safety experiments resulted in the contamination of surface soil at CAU 550 with radionuclides, including fission products and unfissioned nuclear fuel.

The 15 debris CASs include potential releases that contain debris, such as batteries, lead bricks, drums, and asphalt. This debris was likely used to support testing activities at CAU 550 and was abandoned in place after completion of the tests. The debris was investigated to determine its potential as a source for the release of chemical and/or radiological contamination to the soil.

C.1.2 Site Assessment

CAU 550 investigation activities at all study groups included an evaluation of radiological and chemical contamination resulting from potential releases at each site. Before the investigation, historical records and photographs were reviewed to determine the potential significant transport and

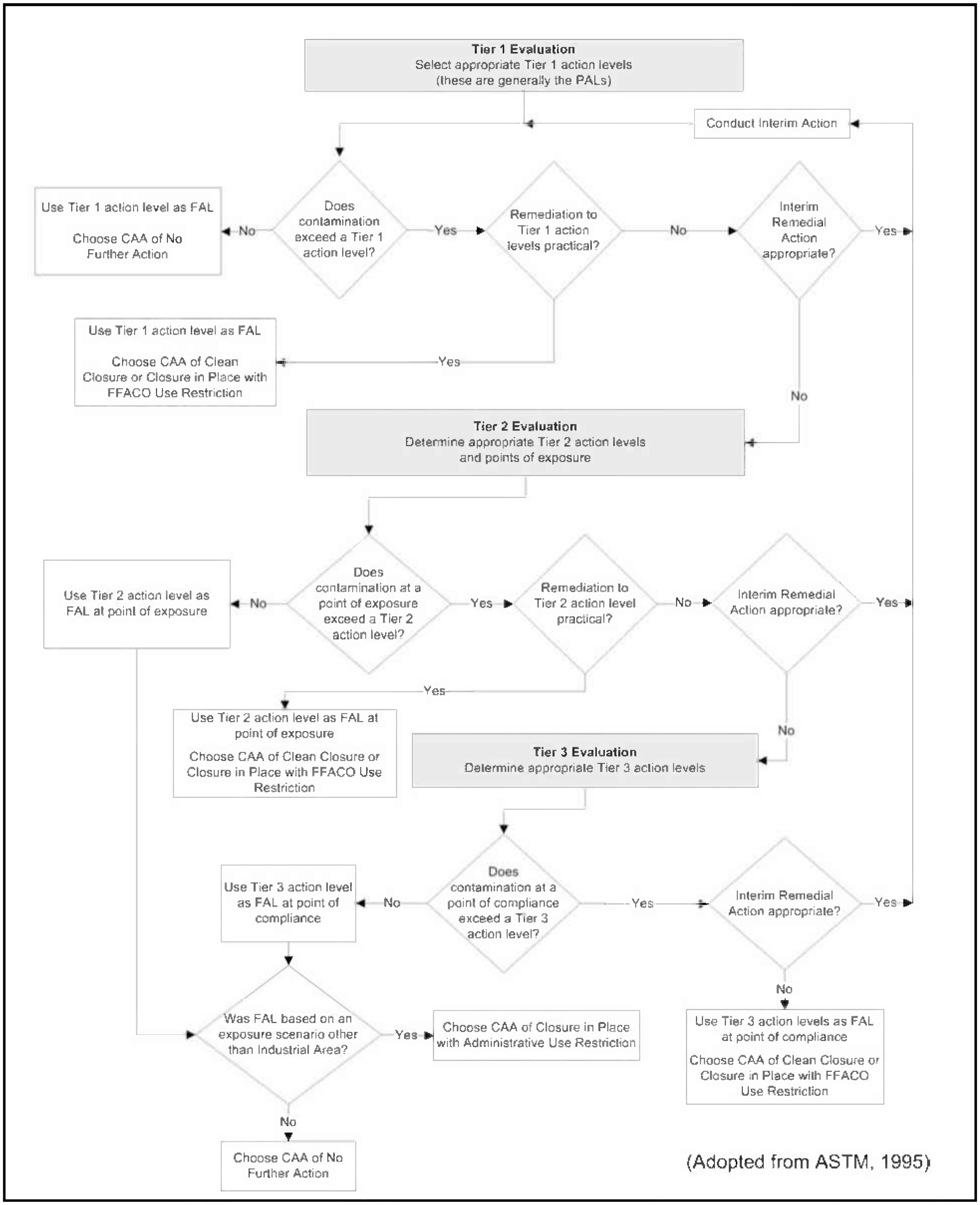

Figure C.1-1
RBCA Decision Process

exposure pathways, the regional hydrogeologic and geologic characteristics of the site, and the current or potential future use of the site. Visual surveys and TRSs were conducted to determine the appropriate locations for the collection of soil samples. Samples were collected, and the results were reviewed to determine whether COCs were present. The radioactive contaminants at CAU 550 include radioisotopes from nuclear weapons-effects and safety experiments (i.e., fission products and unfissioned nuclear fuel). The 25-mrem/OU-yr FAL was not exceeded at any Study Group; however, the 25-mrem/IA-yr FAL was exceeded at Study Groups 1 and 3, and at one debris location (F01) in Study Group 4. HCA conditions for removable radioactive contamination are present within an area surrounding the Study Group 2 GZs. This area was defined as a DCB and is assumed to require corrective action. PSM debris in the form of metallic lead (e.g., lead bricks, lead-acid batteries) was identified at Study Group 4 release locations; no other chemical COCs were identified at CAU 550.

A major drainage system is present on the eastern side of CAU 550. Surface water drains from northwest of CAU 550 across the atmospheric test and safety experiment sites and the majority of the debris CASs to washes on the eastern side of the site and ultimately to a large catchment area east of Circle Road. The CAI confirmed the Study Group 3 washes as a surface migration pathway for contamination from CAU 550. Radioactive contamination has migrated via surface water flow through the washes and across Circle Road, and has been deposited in areas east of Circle Road (including the depositional area and the U10a crater). Current radiological dose within the washes in surface and subsurface soil does not exceed the 25-mrem/OU-yr FAL, and removable contamination levels do not require corrective action. Based on the CAI results, the washes and depositional areas are not expected to exceed action levels in the future.

C.1.3 Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are (1) Classification 1, immediate threat to human health, safety, and the environment; (2) Classification 2, short-term (0 to 2 years) threat to human health, safety, and the environment; (3) Classification 3, long-term (greater than 2 years) threat to human health, safety, and the environment; and (4) Classification 4, no demonstrated long-term threats. Based on the CAI, contamination is present at CAU 550 within the radiologically controlled areas (i.e., CA and HCA fences) at levels that pose an unacceptable risk to human health. Based on the present controlled access to these sites, no interim response actions are necessary at these sites. However, these sites will require FFACO corrective actions to protect potential receptors from exposure to site contamination. As a result, these sites have been determined to be Classification 2 sites as defined by ASTM Method E1739.

C.1.4 Development of Tier 1 Action Level Lookup Table

Tier 1 action levels are defined as the PALs listed in the CAIP (NNSA/NSO, 2012) as established during the DQO process. The PALs represent a very conservative estimate of risk, are preliminary in nature, and are generally used for site screening purposes. Although the PALs are not intended to be used as FALs, FALs may be defined as the Tier 1 action level (i.e., PAL) value if implementing a corrective action based on the Tier 1 action level would be appropriate.

The PALs are based on the Industrial Area exposure scenario, which assumes that a full-time industrial worker is present at a particular location for his or her entire career (8 hr/day, 250 day/yr for a duration of 25 years). The 25-mrem/yr dose-based Tier 1 action level for radiological contaminants is determined by calculating the dose a site worker would receive if exposed to the site contaminants over an annual exposure period of 2,000 hours.

The Tier 1 action levels for chemical contaminants are the following PALs as defined in the CAIP:

- EPA Region 9 RSLs (EPA, 2013a).
- Background concentrations for RCRA metals are evaluated when natural background exceeds the PAL, as is often the case with arsenic at the NNSS. Background is considered the mean plus two times the standard deviation of the mean based on data published in Mineral and Energy Resource Assessment of the Nellis Air Force Range (NBMG, 1998; Moore, 1999).
- For COPCs without established RSLs, a protocol similar to EPA Region 9 is used to establish an action level; otherwise, an established value from another source may be chosen.

Although the PALs are based on an industrial scenario, no industrial activities are conducted at the CAU 550 sites and there are no assigned work stations in the surrounding area. Therefore, the use of an industrial scenario is overly conservative and is not representative of current land use.

C.1.5 Exposure Pathway Evaluation

For all releases, the DQOs stated that site workers could be exposed to COCs through oral ingestion, inhalation, or dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials. The potential exposure pathways would be through worker contact with the contaminated soil or various debris currently present at the site. The limited migration demonstrated by the analytical results, elapsed time since the releases, and depth to groundwater support the selection and evaluation of only surface and shallow subsurface contact as the complete exposure pathways. Ingestion of groundwater is not considered to be a significant exposure pathway.

C.1.6 Comparison of Site Conditions with Tier 1 Action Levels

Radiological results from environmental samples were compared to Tier 1 action levels, which are based on the Industrial Area scenario (2,000 hr/yr). CAU 550 sample locations that exceed the Tier 1 radiological dose-based action level (i.e., PAL) are listed in Table C.1-1. Based on the unrealistic but conservative assumption that a site worker would be exposed to the maximum dose measured at any sampled location within each study group, this site worker would receive a 25-millirem (mrem) dose in the exposure times listed in Table C.1-2.

Chemical results from environmental samples were compared to Tier 1 action levels, which are based on the EPA Region 9 RSLs (EPA, 2013b). All chemical analytical results were less than the Tier 1 action level, with one exception: The lead concentration in sample U01 was 1,400 mg/kg, which exceeded the Tier 1 action level (PAL) of 800 mg/kg for lead (Table A.6-2). This sample was collected at sample location U1, which contained broken lead-acid battery pieces.

C.1.7 Evaluation of Tier 1 Results

For chemical contamination, it was determined that remediation to the Tier 1 action levels was feasible and appropriate for all constituents except lead. Thus, the FALs for chemical contaminants other than lead at CAU 550 were established at the Tier 1 action levels and the lead action level was further evaluated considering site-specific conditions. For radiological contamination, NNSA/NFO determined that remediation to the Tier 1 action level is not appropriate. This is because the risk to a receptor at the CASs and locations listed in Table C.1-1 is directly related to the amount of time a

Table C.1-1
Sample Locations Where TED Exceeds the Tier 1 Action Level (mrem/IA-yr)

CAS or Location	Sample Location	Industrial Area	
		Average TED	95% UCL of TED
08-23-04 (Atmospheric Test)	A01	87.1	96.0
	A18	30.0	34.9
	A19	26.6	29.5
	A21	27.6	30.2
	A36	37.0	40.6
	A37	34.6	39.6
	A43	45.7	52.9
	A44	59.4	61.8
	A45	43.8	49.7
	A46	40.0	41.5
	A47	27.3	30.0
	A54	30.4	32.0
Washes	C03	27.6	37.8
	C05	20.3	26.5
	C07	24.0	27.7
	C08	29.7	34.3
	C09	23.7	26.2
	C10	22.1	25.8
08-22-07 (Drum)	F01	60.4	N/A

N/A = Not applicable

Table C.1-2
Minimum Exposure Time to Receive a 25-mrem Dose

Study Group	Location of Maximum Dose	Maximum TED (mrem/IA-yr)	Minimum Exposure Time (hours)
Atmospheric Test	A01	96.0	521
Safety Experiments	F01	60.4	828
Washes	C03	37.8	1,323
Debris	F01	60.4	828

receptor is exposed to the contaminants. The Tier 1 action level is based on an exposure duration of 2,000 hr/yr. A review of the current and projected use at all sites in CAU 550 determined that workers are expected to be present at these sites for a time period much less than 2,000 hr/yr (see Section C.1.10) (NNSA/NFO, 2014).

C.1.8 Tier 1 Remedial Action Evaluation

No remedial actions are proposed based on Tier 1 action levels.

C.1.9 Tier 2 Evaluation

No additional data were needed to complete a Tier 2 evaluation.

C.1.10 Development of Tier 2 Action Levels

The Tier 2 action levels are typically compared to contaminant values that are representative of areas at which an individual or population may come in contact with a COC originating from a CAS. This concept is illustrated in the EPA's Human Health Evaluation Manual (EPA, 1989). This document states that "the area over which the activity is expected to occur should be considered when averaging the monitoring data for a hot spot. For example, averaging soil data over an area the size of a residential backyard (e.g., an eighth of an acre) may be most appropriate for evaluating residential soil pathways." When evaluating industrial receptors, the area over which an industrial worker is exposed may be much larger than for residential receptors. For a site that is limited to industrial uses, the receptor would be a site worker, and patterns of employee activity would be used to estimate the area over which the receptor is exposed. This can be very complicated to calculate, as industrial workers may perform routine activities at many locations where only a portion of these locations may be contaminated. A more practical measure of integrated risk to radiological dose for an industrial worker is to calculate the portion of total work time that the worker is in proximity to elevated contaminant levels.

For the development of Tier 2 radiological action levels, the annual dose limit for a site worker is 25 mrem/yr. The Tier 2 evaluation is based on a receptor exposure time that is more specific to actual site conditions. The maximum potential exposure time for the most exposed worker at any CAU 550 release location was determined based on an evaluation of current and reasonable future activities that may be conducted at the site.

Activities on the NNSS are strictly controlled through a formal work control process. This process requires facility managers to authorize all work activities that take place on the land or at the facilities within their purview. As such, these facility managers are aware of all activities conducted at the site. The facility managers responsible for the area of CAU 550 identified the general types of work activities that are currently conducted at the site, to include demarcation activities (e.g., removable contamination surveys, fencing/posting maintenance) to ensure compliance with the site-wide radiological control program, utility maintenance/repair along the dirt road the transects the HCA/DCB, road maintenance along Circle Road, and activities associated with the meteorological station and sediment sampler at the site. Site activities that may occur in the future were identified by assessing tasks related to maintenance of existing infrastructure and long-term stewardship of the site (e.g., inspection and maintenance of UR signs, trespasser). In order to estimate the amount of time a site worker might spend conducting current or future activities, the NNSA/NFO and/or M&O contractor departments responsible for these activities were consulted. Under the current and projected future land use at each of the CAU 550 CASs, the following workers were identified as being potentially exposed to site contamination:

- **Inspection and Maintenance Worker.** Workers sent to conduct the annual inspection of the FFACO postings and fencing around the CASs with URs. The UR requires a periodic inspection to ensure that the fencing is intact and the signs are legible. A site worker completing these inspections is estimated to be on site up to 10 hr/yr and will generally be working along the outside perimeter of the CA fence. As a conservative measure, the maximum calculated TED at location A01 (Smoky GZ) was used to estimate dose for this worker. The maximum potential radiological dose to this worker is estimated at 0.6 mrem/yr.

- **Demarcation Worker.** Approximately 3.5 miles of the CAU 550 site is fenced and posted as a CA. Radiological surveys are scheduled on a biennial basis to confirm the postings and inspect and maintain the fences and signs. A site worker completing these activities is estimated to be on site for up to 40 hr/yr and has the potential to be anywhere on site, including inside the CA fence. The maximum calculated TED at location A01 (Smoky GZ) was used to estimate dose for this worker. The maximum potential radiological dose to this worker is estimated at 2.4 mrem/yr.

- **Utility Maintenance Worker.** Electric utility poles run along side the dirt road that transects the DCB and washes at CAU 550. This utility line requires service on an as-needed basis. A site worker completing maintenance or repair activities on utilities along this road is estimated to be on site for up to 80 hr/yr and will be limited to work along this road. As a conservative measure, the maximum calculated TED of the debris CASs within the DCB (location F01) was used to estimate dose. The maximum potential radiological dose to this worker is estimated at 3.5 mrem/yr.

- **Road Maintenance Worker.** During severe rainfall events, sections of Circle Road are covered with sediment and soil from erosion occurring via the washes at CAU 550. A site worker involved in clearing the road after such events is estimated to be on site for up to 20 hr/yr and will be limited to work along Circle Road. The maximum calculated TED in the washes at location C03 was used to estimate dose. The maximum potential radiological dose to this worker is estimated at 0.4 mrem/yr.

- **Meteorological Station Maintenance Worker.** One meteorological station and one sediment sampler are in place at CAU 550. The meteorological station is located just southeast of the CA fence; the sediment sampler is located within a wash inside the southern portion of the DCB. Data are collected from these stations on an as-needed basis and the stations require periodic maintenance. A site worker conducting these activities is estimated to be on site for up to 20 hr/yr and will be limited to work within the southern DCB. As a conservative measure, the maximum calculated TED of the debris CASs within the DCB (location F01) was used to estimate dose. The maximum potential radiological dose to this worker is estimated at 0.9 mrem/yr.

- **Trespasser.** This would include workers or individuals who do not have a specific work assignment at one of the CASs. Although the sites will be posted with warning signs, workers could potentially inadvertently enter these CAS areas and come in contact with site contamination. This is assumed to be an infrequent occurrence (i.e., once per year) that would result in a potential exposure of less than a day (8 hours). A trespasser has the potential to be anywhere on site. The maximum calculated TED at location A01 (Smoky GZ) was used to estimate dose for a trespasser. The maximum potential radiological dose to this worker is estimated at 0.5 mrem/yr.

In order to estimate the maximum potential dose a site worker could receive at each study group, it was assumed that the worker would be exposed to the maximum dose measured at the closest study group for the entire exposure time. For Study Groups 1 (Atmospheric Test) and 4 (Debris), the maximum calculated dose at sample plot location A01 (4.8 mrem/OU-yr) was used to estimate dose. For Study Groups 2 (Safety Experiments) and 3 (Washes), the maximum calculated dose (3.5 mrem/OU-yr) at debris sample location F01 was used to estimate dose. These locations were selected based on the assumed location of the site worker during performance of their duties. For example, because the utility line is present only along the road that transects the DCB, this road is the only location at CAU 550 where the utility maintenance worker will be present. The maximum calculated dose closest to this road is at debris location F01. Therefore, the maximum TED that this sample location was used to calculate potential dose. Similarly, a demarcation worker has the potential to work at any location at CAU 550, so the maximum calculated TED for the entire CAU (4.8 mrem/OU-yr) was used in the calculation. The maximum potential doses for workers at each study group are listed in Table C.1-3. Under the current land use at each of the CAU 550 CASs, the most exposed worker would be a utility maintenance worker, who could be exposed to site contamination for a maximum of 80 hr/yr.

Table C.1-3
Maximum Potential Dose to Most Exposed Worker at CAU 550 Study Groups

Study Group	Most Exposed Worker	Maximum Calculated TED (mrem/OU-yr)	Exposure Time (hr/yr)	Maximum Potential Dose (mrem/yr)
Atmospheric Test	Demarcation Worker	4.8	40	2.4
Safety Experiments	Utility Maintenance Worker	3.5	80	3.5
Washes	Utility Maintenance Worker	3.5	80	3.5
Debris	Demarcation Worker	4.8	40	2.4

In the CAU 550 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in the CAIP [NNSA/NSO, 2012]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 550 CASs. This exposure scenario assumes exposure to site workers who are not assigned to the area as a regular work site but may occasionally use the site for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 80 hr/yr, which is equivalent to the exposure time estimated for the most exposed individual. As a result, the development and evaluation of Tier 2 radiological action levels were based on the Occasional Use Area exposure scenario.

The EPA’s risk assessment tool for lead (the Adult Lead Methodology [ALM] calculator) was used to calculate a Tier 2 action level for lead (EPA, 2009a). This methodology is recommended by EPA because a reference dose (RfD) value for lead is not available. In the commercial/industrial setting, the most sensitive receptor is the fetus of a worker who has a non-residential exposure to lead. Based on the available scientific data, a fetus is more sensitive to the adverse effects of lead than an adult (National Academy of Sciences, 1993). The EPA assumes that cleanup levels that are protective of a fetus will also afford protection for male or female adult workers. An outdoor industrial soil Tier 2 action level was calculated for lead at CAU 550 using EPA's ALM to estimate the concentration of lead in the blood of pregnant women and developing fetuses who might be exposed to lead-contaminated soils (EPA, 2009b). The methodology for using the ALM to establish action levels for lead in soil is described in the Soils RBCA document. This document lists all the input parameters to be used in the ALM including the EPA-established lead concentration limits in fetal blood.

Although the Tier 2 action levels for other contaminants were developed using the Occasional Use Area exposure scenario, the Tier 2 action level for lead was developed using the Remote Work Area exposure scenario. The Remote Work Area exposure scenario was used to calculate the Tier 2 action level for lead because EPA states that the minimum frequency of exposure of 1 day per week is recommended for short-term exposures. The recommended full-time exposure frequency of 219 day/yr equates to approximately 44 weeks per year. At 1 day per week, this minimum exposure frequency of 44 day/yr is equivalent to the Remote Work Area exposure scenario.

Therefore, the Remote Work Area exposure scenario soil ingestion rate (0.067 g/day) and the exposure frequency of 44 day/yr were used to calculate a Tier 2 action level for lead of 8,356 mg/kg.

C.1.11 Comparison of Site Conditions with Tier 2 Action Levels

The 95 percent UCL TEDs calculated using the Occasional Use Area exposure scenario were compared to the 25-mrem/OU-yr Tier 2 radiological action level. None of the TED values exceeded the 25-mrem/OU-yr Tier 2 action level (Tables A.3-7, A.4-5, A.5-6, and A.6-4).

The lead concentration in soil (1,400 mg/kg) at sample location U1, which is associated with broken battery pieces, does not exceed the Tier 2 action level for lead of 5,739 mg/kg (Table A.6-2).

C.1.12 Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation, the surface soils at CAU 550 beyond that assumed to be present within the DCB and the PSM at the site do not pose an unacceptable risk to human health and the environment. As corrective actions are practical for lead and radiological contamination at CAU 550, the Tier 2 action levels are established as the FALs for radionuclide contamination, and corrective actions will be implemented. Because all FALs were established at the Tier 1 or Tier 2 action levels, a Tier 3 evaluation was not necessary.

C.2.0 Summary

The Tier 2 action levels are typically compared to results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Points of exposure are defined as those locations or areas at which an individual or population may come in contact with a COC originating from a release. However, for CAU 550, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from single point locations.

Because the TED values for surface soils at the CAU 550 CASs are less than the corresponding dose-based FALs at all locations (using the Occasional Use Area exposure scenario), it was determined that surface soil contamination at these locations does not warrant corrective action based on dose to a receptor. However, the DCB established at CAU 550 and locations where PSM is present are assumed to require corrective action (Section A.4.4). As corrective actions are practical for these releases, the Tier 2 action level is established as the FAL, and corrective actions are proposed.

The corrective actions for CAU 550 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions no longer are valid, additional evaluation may be necessary.

The radiological dose FAL is based on an exposure time of 80 hr/yr of site worker exposure to CAS surface soils. The lead FAL is based on an exposure time of 336 hr/yr of site worker exposure to CAS surface soils. Should the land use at CAU 550 change such that an industrial land use type of activity were conducted, a site worker could potentially be exposed to contamination for longer exposure times and receive an unacceptable level of risk. Therefore, an administrative UR was implemented at CAU 550 as a BMP that would restrict a more intensive use of this site without NDEP notification. The administrative UR boundary encompasses each of the CAS-specific areas that require administrative URs, resulting in a single administrative UR boundary for CAU 550. The CAU 550 URs are included in Attachment D-1.

C.3.0 References

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Appendix D

Closure Activity Summary

D.1.0 Closure Activity Summary

The following subsections document closure activities completed for CAU 550 at the following CASs:

- Three safety experiment sites (CASs 08-23-03, 08-23-06, and 08-23-07)
- CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]), CAS 08-24-08 (Batteries [3])
- CAS 08-26-01 (Lead Bricks [200])

The best management practice of establishing a CAU 550 administrative UR boundary is also discussed.

D.1.1 CASs 08-23-03, 08-23-06, and 08-23-07 Closure Activities

A corrective action of closure in place with an FFACO UR was implemented at the three safety experiment sites (CASs 08-23-03, 08-23-06, and 08-23-07). The UR boundary is defined as the extent of the DCB, including the portion of the dirt road that transects the DCB. Due to the large area encompassed by the UR and to keep exposure to site workers who will be inspecting and maintaining the UR signs as low as reasonably achievable (ALARA), the signs were placed at the points of ingress to the DCB (e.g., Circle Road, dirt road that transects DCB). The established FFACO UR for the three safety experiment CASs is defined by the coordinates listed in the FFACO UR form and presented in Attachment D-1. The number and location of UR signs for CAU 550 are presented on Plate 1.

D.1.2 CAS 08-24-07 Closure Activities

A corrective action of clean closure was implemented at CAS 08-24-07 (Batteries [3]; Battery; Lead Bricks [2]). This CAS consisted of three cracked lead-acid batteries, pieces of a battery scattered over an area, and two lead bricks. All of the debris was removed and soil samples (K001, U01, and T01) were collected from underneath the debris at each location. None of the soil sample results were in excess of the FAL. As a result, the corrective action of clean closure is complete at this CAS and no further action is required.

D.1.3 CAS 08-24-08 Closure Activities

A corrective action of clean closure was implemented at CAS 08-24-08 (Batteries [3]). All of the lead debris (i.e., lead battery plates, lead scrap) was removed from the CAS. The debris that did not contain lead (steel scrap, electrical equipment) was left at the site adjacent to the original location of the debris pile. A 9-point composite confirmation soil sample (Y01) from underneath the debris pile was collected. None of the soil sample results were in excess of the FAL. As a result, the corrective action of clean closure is complete at this CAS and no further action is required.

D.1.4 CAS 08-26-01 Closure Activities

A corrective action of closure in place with an FFACO UR was implemented for CAS 08-26-01 that encompasses the extent of the lead bricks visible on the ground surface. In order to keep radiation exposure to site workers who will be inspecting and maintaining the UR signs ALARA, and due to the remoteness of the site, a total of 19 UR signs were placed on the existing fence at practical routes of ingress to the area containing the UR (see Plate 1). Ten of these UR signs were placed on the CA fence that parallels Circle Road because this is a heavily trafficked road and the primary route by which a pedestrian could reasonably access the site. The placement of UR signs on the CA fence will preclude site workers from having to enter the CA to perform inspection and/or maintenance duties. The established FFACO UR for this CAS is defined by the coordinates listed in the FFACO UR form and is presented in Attachment D-1. The number and location of UR signs for CAU 550 are presented on Plate 1.

D.1.5 FFACO URs

FFACO URs are recorded in the FFACO database; the M&O Contractor GIS; and the NNSA/NFO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require NDEP notification. UR signs were placed at the locations shown on Plate 1. The FFACO UR signs for the two FFACO URs in CAU 550 read as follows:

WARNING

RADIOLOGICAL and LEAD CONTAMINATION

FFACO Site CAU 550,

Smoky Contamination Area

No activities that may alter or modify the containment control are permitted in this area without U.S. Government permission.

Before working in this area,

Contact Real Estate Services at 702-295-2528

D.1.6 Administrative UR

A single, site-wide administrative UR (as presented in Attachment D-1) was established at CAU 550 to prevent a future site worker from receiving a dose exceeding 25 mrem/yr if there were a more intensive use of the site in the future. This administrative UR boundary encompasses all of the administrative URs established in this document. The administrative UR does not include the FFACO URs established for the three safety experiments (CASs 08-23-03, 08-23-06, and 08-23-07) or CAS 08-26-01 (Lead Bricks [200]).

Attachment D-1

Use Restrictions

(9 Pages)

Use Restriction Information

CAU Number/Description: CAU 550, Smoky Contamination Area
Applicable CAS Number/Description: CAS 08-23-03 (Atmospheric Test Site T-8B), CAS 08-23-06 (Atmospheric Test Site T-8A), and CAS 08-23-07 (Atmospheric Test Site T-8C)
Contact (DOE AL/Activity): NNSA/NFO Soils Federal Activity Lead

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
1	4,114,782	583,440
2	4,114,471	582,323
3	4,114,682	582,203
4	4,115,073	582,191
5	4,115,455	582,203
6	4,115,735	582,453
7	4,115,662	582,841
8	4,115,305	582,946
9	4,114,994	583,240
10	4,114,838	583,460

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction (UR) is to protect workers from receiving a dose exceeding 25 mrem/yr from contamination that is present at this site. This is based on the current land use scenario of Occasional Use Area (OU), which is an assumed maximum exposure period of 80 hours per year. Dose was not calculated for the High Contamination Area (HCA) (i.e., area within the Default Contamination Boundary), but is assumed to exceed the action level of 25 mrem/OU-yr. The analytical results and locations of all samples are presented in the CADD/CR for CAU 550. This use restriction also protects workers from inadvertent exposure to removable contamination that exceeds the criteria for establishing a HCA.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 550 CAS 08-23-03 (Atmospheric Test Site T-8B), CAS 08-23-06 (Atmospheric Test Site T-8A), and CAS 08-23-07 (Atmospheric Test Site T-8C)			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED (plutonium, americium)	Unknown	25	mrem/OU-yr
Removable alpha radiological contaminants (e.g., plutonium, americium)	Unknown	2,000	dpm/100 cm^2

Site Controls: Activities that are not conducted under the provisions of 10 CFR Part 835, Occupational Radiation Protection, are restricted within the area defined by the coordinates listed above and depicted in the attached figure without prior notification and approval of NDEP. The FFACO UR is recorded in the FFACO database, M&O Contractor GIS, and the NNSA Nevada Field Office CAU/CAS files. Warning signs for the FFACO UR are posted at the site.

Description: Warning signs for the FFACO UR will be inspected to ensure postings are in place, intact, and legible. Signs will be repaired or replaced as needed.

Use Restriction Information

Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure postings are in place, intact, and legible.

Administrative Use Restriction Physical Description*:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
N/A		

Depth: N/A

Survey Source (GPS, GIS, etc): N/A

*Coordinates for the Administrative Use Restriction exclude the area defined by the FFACO Use Restriction coordinates.

Basis for Administrative Use Restriction(s):

Summary Statement: N/A.

Contaminants Table:

Maximum Concentration of Contaminants			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
N/A			

Site Controls: N/A

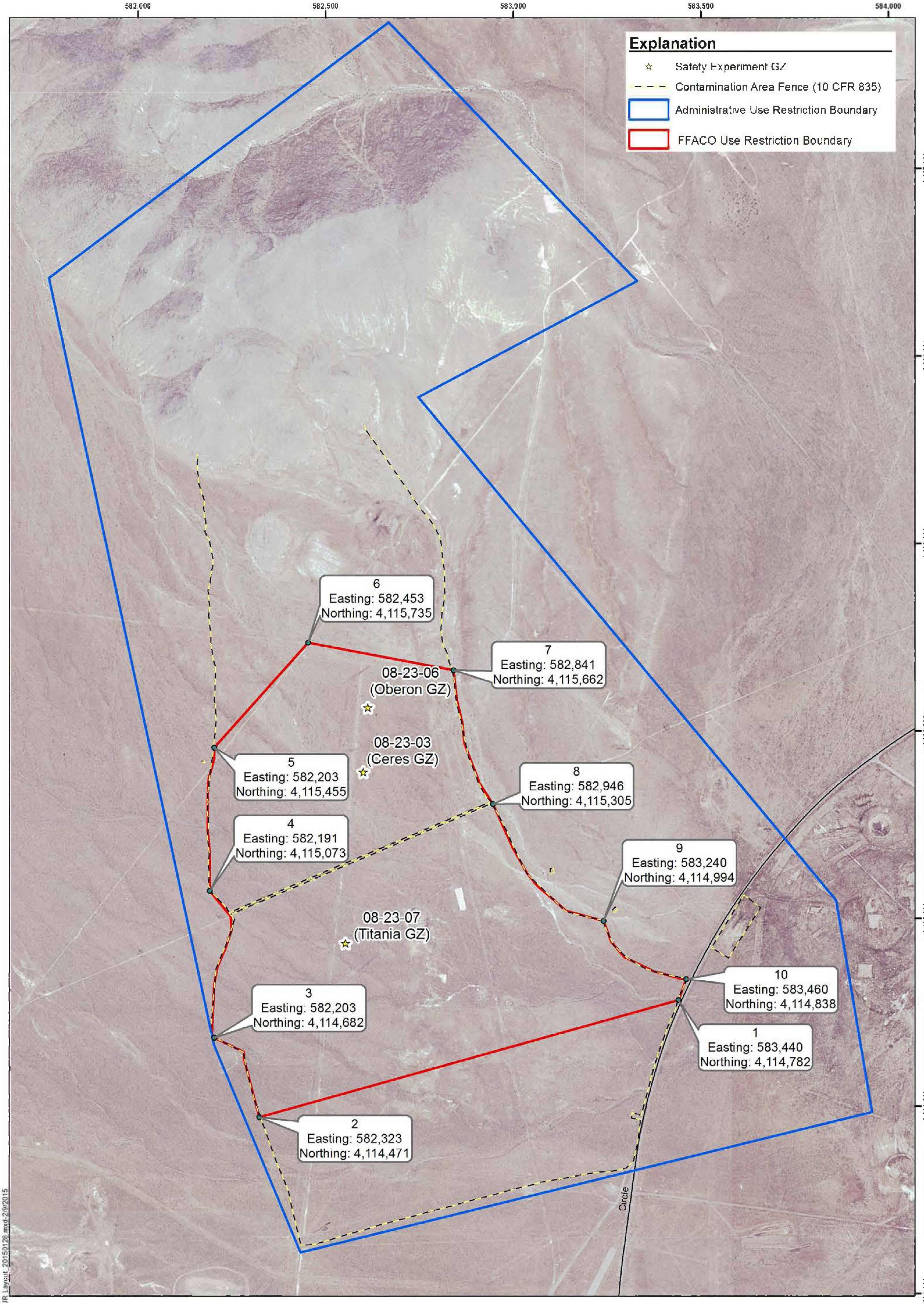
Description: N/A

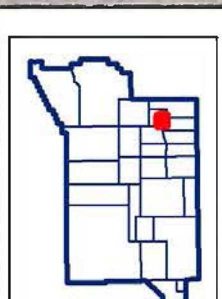
Inspection/Maintenance Frequency: N/A

The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments:
The **FFACO Use Restriction Physical Description** table includes ten UR points that represent the general shape of the FFACO UR boundary. The FFACO UR boundary follows the existing fenceline on the west and east sides of the boundary. Specifically, the UR follows the fenceline between UR Point #2 and UR point #5 along the western boundary and between UR point #1 and UR point #7 on the eastern boundary (see attached FFACO UR figure).

Submitted By: /S/ Tiffany A. Lantow **Date:** 2/9/2015





FFACO Use Restriction CAS 08-23-03, CAS 08-23-06, and CAS 08-23-07

0 200 400 600
Meters

0 500 1,000 2,000
Feet

N

UNCONTROLLED When Printed

Source: N-I GIS, 2015; NNSA/NV, 2002

Coordinate System: NAD 1983 UTM Zone 11N, Meters

H:\550\CADD_CR\GIS\CADD_CD_FINAL\UR_Layout_20150128.mxd-2/9/2015

Use Restriction Information

CAU Number/Description: CAU 550, Smoky Contamination Area
Applicable CAS Number/Description: CAS 08-26-01, Lead Bricks (200)
Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
1	4,116,006	582,667
2	4,115,989	582,637
3	4,116,028	582,611
4	4,116,043	582,647

Depth: 1 ft. bgs

Survey Source (GPS, GIS, etc): GPS

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure to lead contamination in surface and subsurface soil. This site consists of approximately 200 lead bricks. The lead bricks consist of metallic lead that if released, could cause the soil to exceed the risk-based action level for lead.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 550 CAS 08-26-01, Lead Bricks (200)			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Lead	Unknown	5,739	mg/kg

Site Controls: The use restricted area encompasses the area where lead is assumed to exceed risk-based action levels. The UR is established at the boundary identified by the coordinates listed above and depicted in the attached figure. This UR boundary is located within a fenced Contamination Area. Warning signs were placed on the Contamination Area fence, rather than at the UR coordinates. The FFACO UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files.

Administrative Use Restriction Physical Description*:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
NA		

Depth: NA

Survey Source (GPS, GIS, etc): NA

*Coordinates for the Administrative Use Restriction exclude the area defined by the FFACO Use Restriction coordinates.

Basis for Administrative UR(s):

Use Restriction Information

Summary Statement: NA

Contaminants Table:

Maximum Concentration of Contaminants			
Constituent	Maximum Concentration	Action Level	Units
NA			

Site Controls: NA

UR Maintenance Requirements (applies to both FFACO and Administrative UR(s) if Administrative UR exists):

Description: NA

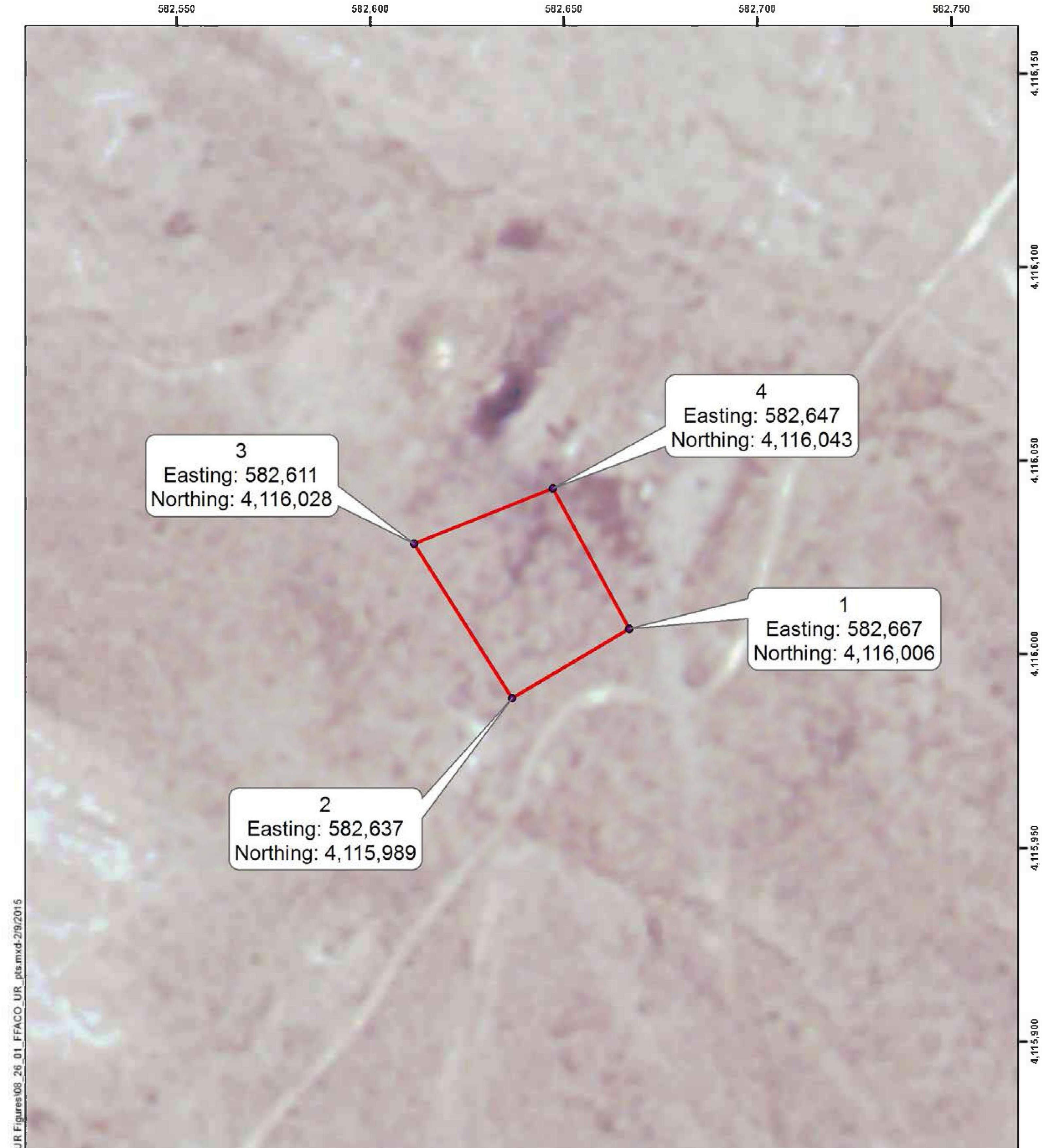
Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted of the FFACO UR to ensure postings are in place, intact, and legible.

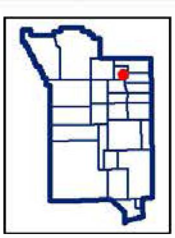
> The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Activities permitted under the current land use without prior NDEP approval include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas and fences, training exercises, and utility repair and maintenance.

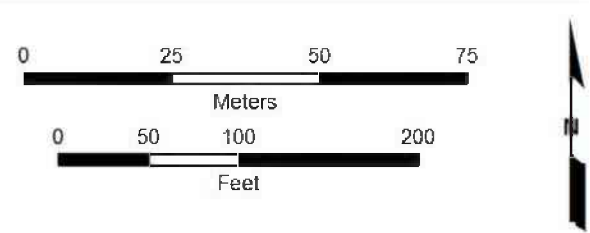
Submitted By: /s/ Tiffany A. Lantow **Date:** 2/9/2015

Note: Effective upon acceptance of closure documents by NDEP





FFACO Use Restriction CAS 08-26-01, (Lead Bricks [200])



UNCONTROLLED When Printed

Source: N-I GIS, 2015; NNSA/NV, 2002

Coordinate System: NAD 1983 UTM Zone 11N, Meters

Use Restriction Information

CAU Number/Description: CAU 550, Smoky Contamination Area
Applicable CAS Number/Description: 08-23-04, Atmospheric Test Site T-2C
Contact (DOE AL/Activity): NNSA Nevada Field Office Soils Activity Lead

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
NA		

Depth: __NA____

Survey Source (GPS, GIS, etc): __NA_____

Basis for FFACO UR(s):

Summary Statement:___NA______

Contaminants Table:

Maximum Concentration of Contaminants CAU 550 CAS 08-23-04, Atmospheric Test Site T-2C			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
NA			

Site Controls: ___NA______

Administrative Use Restriction Physical Description*:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
1	4,114,484	583,956
2	4,114,109	582,433
3	4,114,663	582,202
4	4,116,707	581,762
5	4,117,389	582,667
6	4,116,699	583,330
7	4,116,389	582,747
8	4,115,049	583,860

Depth: N/A

Survey Source (GPS, GIS, etc): GIS

*Coordinates for the Administrative Use Restriction exclude the area defined by the FFACO Use Restriction coordinates.

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction (UR) is to protect workers from receiving a dose exceeding 25 mrem/yr from contamination that is present at this site if current site usage were to increase in the future. Using the maximum calculated dose rate at this site, a worker could receive a 25 mrem dose in 521 hours of site exposure. The analytical results and locations of all samples are presented in the CADD/CR for CAU 550. As a best management practice, this administrative use restriction also protects workers from inadvertent exposure to removable contamination that exceeds the criteria for establishing a Contamination Area (CA).

Contaminants Table:

Maximum Concentration of Contaminants for CAU 550 CAS 08-23-04, Atmospheric Test Site T-2C			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED (Cesium-137)	96.0 (calculated)	25	mrem/IA-yr
Removable alpha radiological contaminants (e.g., plutonium, americium)	Unknown	20	dpm/100 cm^2

Site Controls: Activities that are not conducted under the provisions of 10 CFR Part 835 and would cause a site worker to be exposed to site radiological contamination for a period of more than 80 hours per year are restricted within the area defined by the coordinates listed above and depicted in the attached figure without prior notification and approval of NDEP. This administrative UR is recorded in the FFACO database, M&O Contractor GIS, and the NNSA Nevada Field Office CAU/CAS files. No physical site controls are required for this administrative UR.

UR Maintenance Requirements (applies to both FFACO and Administrative UR(s) if Administrative UR exists):

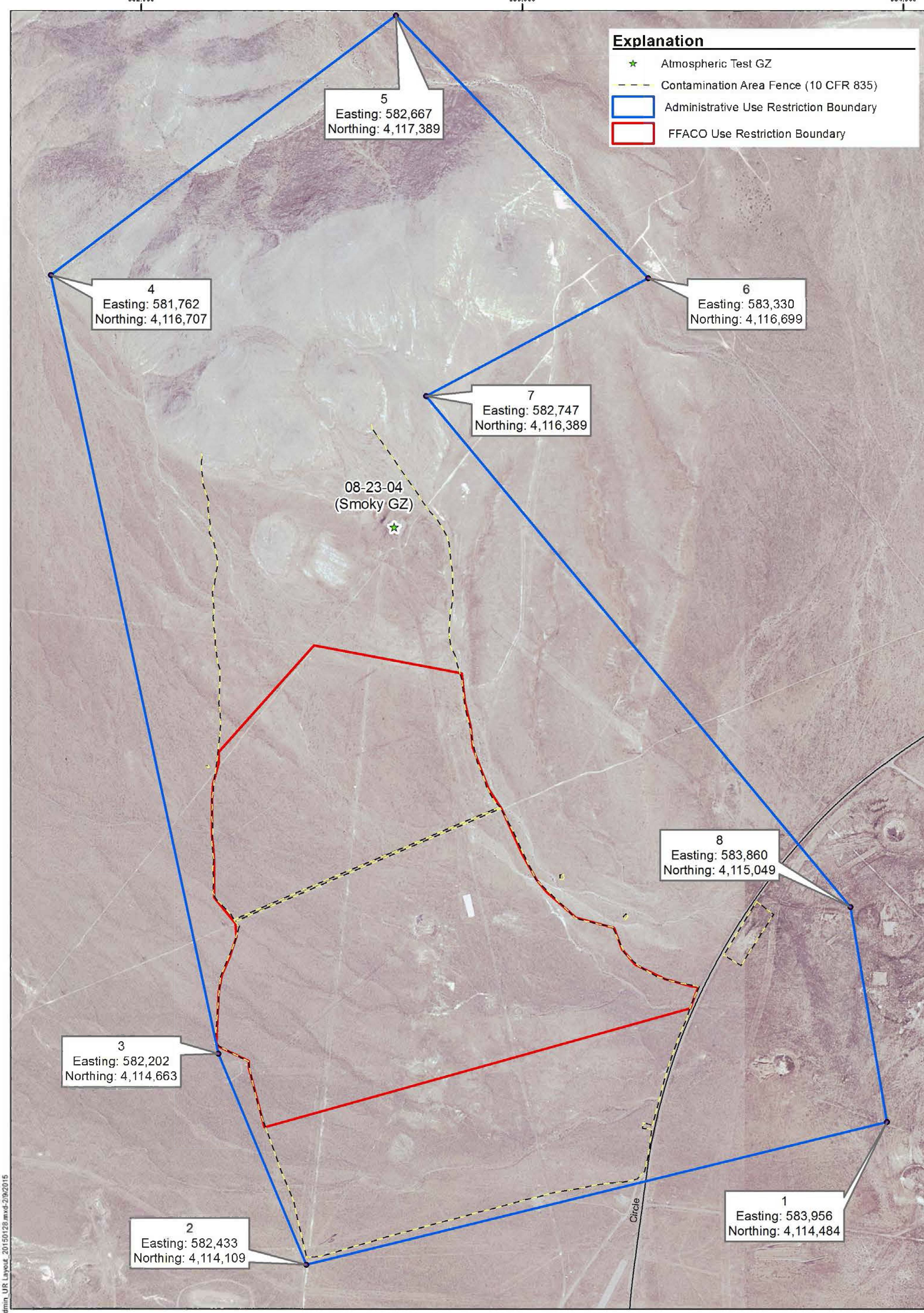
Description: N/A

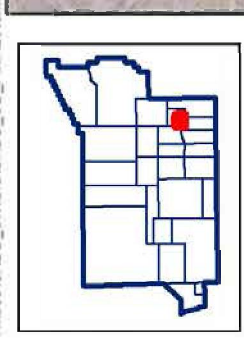
Inspection/Maintenance Frequency: NA

> The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments:

Submitted By: /s/ Tiffany A. Lantow **Date:** 2/9/2015





H:\550\CADD_CR\GIS\CADD_CD_FINAL\Admin_UR Layout_20150128.mxd-2/9/2015

Administrative Use Restriction
CAU 550, Smoky Contamination Area
CAS 08-23-04

0 200 400 600
Meters

0 500 1,000 2,000
Feet

N

UNCONTROLLED When Printed

Source: N-I GIS, 2015; NNSA/NV, 2002

Coordinate System: NAD 1983 UTM Zone 11N, Meters

Attachment D-2

Waste Disposal Documentation

(5 Pages)

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-0000006, Revision 15, shipment number ITL13002, with container numbers **153A01, 104A01, 104A02, 104A03, 104A04, 104A05, 104A06, 104A07, 104A08, 104A09, 104A10, 550A01, 550A02, 550A03, and 550A04**. was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Heser	NI	Waste Coordinator
Shipped by	Organization	Title
/s/ Mark Heser		10/10/12
Signature		Date
Ed Takahashi	NSTec	Scientist
Received by	Organization	Title
/s/ Signature on File		10-Oct-2012
Signature		Date

UNCONTROLLED When Printed

Certificate of Disposal

This is to certify that the Waste Stream No. LITN000000006, Revision 15, shipment number ITL14001, with container numbers 105A01, 550A05, 550A06, 550A07, and 550A08 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Nicole Nastanski	N-I	Waste Ops Lead
Shipped by	Organization	Title
/s/ Nicole Nastanski		11/14/13
Signature		Date
Ed Takahashi	NSTec	Sr Scientist
Received by	Organization	Title
/s/ Signature on File		14-NOV-2013
Signature		Date

Certificate of Disposal

This is to certify that the Waste Stream No. LITN000000006, Revision 15, shipment number ITL13013, with container numbers 550A09, 550A10, 550A11, and 550A12 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Nicole Nastanski	N-I	WO Lead
Shipped by	Organization	Title
/s/ Nicole Nastanski		8/28/13
Signature		Date

Chris Chalupka	H400	8/28/13
Received by	Organization	Title
/s/ Signature on File		Waste Spec
Signature		Date

NSTec Form FRM-0918

NNSS LANDFILL LOAD VERIFICATION

09/26/12
Rev. 03

SWO USE (Select One) AREA ☐ 23 ☐ 6 ☒ 9/10C **LANDFILL**

For waste characterization, approval, and/or assistance, contact Solid Waste Operation (SWO) at 5-7898.

REQUIRED: WASTE GERERATOR INFORMATION
(This form is for rolloffs, dump trucks, and other onsite disposal of materials.)

Waste Generator: Mark Heser Phone Number: 5-2124

Location / Origin: Building 23-153 - 20 yd3 roll-off (container # 153R12) of industrial waste for disposal at Area 9, U10c

Waste Category: (check one) ☐ Commercial ☒ Industrial

Waste Type: (check one) ☐ NNSS ☐ Non-Putrescible ☐ Putrescrible ☐ Asbestos Containing Material ☒ FFACO-onsite ☐ FFACO-offsite ☐ WAC Exception ☐ Historic DOE/NV

Pollution Prevention Category: (check one) ☒ Environmental management ☐ Defense Projects ☐ YMP

Pollution Prevention Category: (check one) ☐ Clean-Up ☒ Routine

Method of Characterization: (check one) ☐ Sampling & Analysis ☒ Process Knowledge ☒ Contents

Prohibited Waste at all three NNSS landfills: Radioactive waste; RCRA waste; Hazardous waste; Free liquids, PCBs above TSCA regulatory levels, and Medical wastes (needles, sharps, bloody clothing).

Additional Prohibited Waste at the Area 9 U10C Landfill: Sewage Sludge, Animal carcasses, Wet garbage (food waste); and Friable asbestos

REQUIRED: WASTE CONTENTS ALLOWABLE WASTES
Check all allowable wastes that are contained within this load:

NOTE: Waste disposal at the Area 6 Hydrocarbon Landfill must have come into contact with petroleum hydrocarbons or coolants, such as: gasoline (no benzene, lead); jet fuel; diesel fuel; lubricants and hydraulics; kerosene; asphaltic petroleum hydrocarbon; and ethylene glycol.

Acceptable waste at any NNSS landfill: ☒ Paper ☐ Rocks / unaltered geologic materials ☒ Empty containers
☐ Asphalt ☒ Metal ☒ Wood ☐ Soil ☐ Rubber (excluding tires) ☐ Demolition debris
☒ Plastic ☐ Wire ☐ Cable ☒ Cloth ☐ Insulation (non-Asbestosform) ☐ Cement & concrete
☒ Manufactured items: (swamp coolers, furniture, rugs, carpet, electronic components, PPE, etc.)

Additional waste accepted at the Area 23 Mercury Landfill: ☐ Office Waste ☐ Food Waste ☐ Animal Carcasses
☐ Asbestos ☐ Friable ☐ Non-Friable (contact SWO if regulated load) Quantity: ________

Additional waste accepted at the Area 9 U10c Landfill:
☐ Non-friable asbestos ☐ Drained automobiles and military vehicles ☐ Solid fractions from sand/oil/water separators
☐ Light ballasts (contact SWO) ☐ Drained fuel filters (gas & diesel) ☐ Deconned Underground and Above Ground Tanks
☒ Hydrocarbons (contact SWO) ☐ Other ________

Additional waste accepted at the Area 6 Hydrocarbon Landfill: ☐ ________
☐ Septic sludge ☐ Rags ☐ Drained fuel filters (gas & diesel) ☐ Crushed non-terne plated oil filters
☐ Plants ☐ Soil ☐ Sludge from sand/oil/water separators ☐ PCBs below 50 parts per million

REQUIRED: WASTE GENERATOR SIGNATURE

Initials: _____ **(if initialed, no radiological clearance is necessary.)**

The above mentioned waste was generated outside of a Controlled Waste Managen knowledge, does not contain radiological materials.

To the best of my knowledge, the waste described above contains only those mate site. I have verified this through the waste characterization method identified abov prohibited and allowable waste items. I have contacted Property Management and is approved for disposal in the landfill.

Print Name: Mark Heser //

Signature: /s/ Mark Heser Date: 5/13/13

Radiological Survey Release for Waste Disposal
RCT Initials
____ This container/load meets the criteria for no added man-made radioactive material
____ This container/load meets the criteria for Radcon Manual Table 4.2 release limits.
____ This container/load is exempt from survey due to process knowledge and origin.
SIGNATURE: /s/ Jeffrey J. Tappen DATE: 5-13-13
BN-0646 (10/05)

Note: "Food waste, office trash and animal carcasses do not require a radiological clearance. Freon-containing appliances must have signed removal certification statement with Load Verification."

SWO USE ONLY

Load Weight (net from scale or estimate): 4,980 Certifier: /s/ Signature on File
Printed Name & Signature

CERTFICATE OF RECYCLE

ISSUED TO: Navarro-Interra, LLC
COMPANY ADDRESS: Mercury NV 89023

Toxco Inc. certifies that the lead material noted in Contract No.NI13B0001A was received at the Toxco Material Management Center (TMMC) and title was assumed and the material will be reused as lead shielding within and in support of government or commercial nuclear industrial application as required by the Department of Energy Material Suspension.

Recycle and Disposition of Contaminated Lead from Navarro-Interra, LLC (N-I) c/o U.S. DOE NNSA/NFO Received in Shipment A13611.

/s/ Rick L. Low

Rick L. Low, TOXCO Materials Management Center Vice President/RSO 9/17/13

TOXCO, INC.
109 Flint Rd.
Oak Ridge TN 37830

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 550, describes the general standards and decision factors used to screen the various CAAs, and develops and evaluates a set of selected CAAs that will meet the corrective action objectives. This CAA evaluation is intended for use in making corrective action decisions for CAU 550 conditions at the conclusion of the CAI (after the completion of any corrective actions carried out during the CAI). For example, corrective actions that were able to be completed with little effort and expediently (e.g., removal of empty drums) were not subjected to a CAA evaluation. Corrective actions that may involve more complicated measures and/or considerations (e.g., worker health and safety) were assessed in a CAA evaluation.

The initial CAA meeting with NDEP was held on October 10, 2013 and included evaluation of the following three releases that required corrective action based on the CAI:

- CASs 08-23-03, 08-23-06, and 08-23-07 (three safety experiment sites)
- CAS 08-24-08 (Batteries [3])
- CAS 08-26-01 (Lead Bricks [200])

This meeting included a CAU 550 overview, a summary of the CAI results, the CAA evaluation results for the three releases, and the recommended corrective actions for each release location. At the request of NDEP, selection and approval of the corrective actions for CAU 550 was deferred pending additional discussion and a site visit. The NNSA/NFO conducted a site visit with NDEP on October 15, 2013. Following the visit, NDEP requested another CAA meeting for CAU 550 that incorporated a more interactive and collaborative discussion of each evaluation criteria. This CAA meeting was held on January 8, 2014, and included a revised meeting format to facilitate discussion. This new format included the consideration of the advantages and disadvantages of each evaluation criteria, which are detailed in the following sections.

E.1.1 Corrective Action Objectives

On May 1, 1996, EPA issued an Advance Notice of Proposed Rulemaking (ANPR) for corrective action for releases from solid waste management units at hazardous waste management facilities (EPA, 1996). EPA states that the ANPR should be considered the primary corrective action implementation guidance (Laws and Herman, 1997). The ANPR states that a basic operating principle for remedy selection is that corrective action decisions should be based on risk. It emphasizes that current and reasonably expected future land use should be considered when selecting corrective action remedies and encourages use of innovative site characterization techniques to expedite site investigations.

The ANPR provides the following EPA expectations for corrective action remedies (EPA, 1996):

- Treatment should be used to address principal threats wherever practicable and cost effective.
- Engineering controls, such as containment, should be used where wastes and contaminated media can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable.
- A combination of methods (e.g., treatment, engineering, and institutional controls) should be used, as appropriate, to protect human health and the environment.
- Institutional controls should be used primarily to supplement engineering controls as appropriate for short- or long-term management to prevent or limit exposure.
- Innovative technologies should be considered where such technologies offer potential for comparable or superior performance or implementability, less adverse impacts, or lower costs.
- Usable groundwater should be returned to maximum beneficial use wherever practicable.
- Contaminated soils should be remediated as necessary to prevent or limit direct exposure and to prevent the transfer of unacceptable concentrations of contaminants from soils to other media.

The corrective action objectives for CAU 550 are the FALs as defined in the Soils RBCA document (NNSA/NFO, 2014). The CAA evaluation process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012b). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012c) requires the use of ASTM Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

E.1.2 Screening Criteria

The screening criteria used to evaluate and select the preferred CAAs are identified in the *Guidance on RCRA Corrective Action Decision Documents* (EPA, 1991) and the *Final RCRA Corrective Action Plan* (EPA, 1994).

The evaluation of CAAs is a two-phased process. In the first phase, potential CAAs are evaluated against the four general corrective action standards. These standards represent the minimum requirements a CAA must meet in order to be considered a preferred remedy. The general corrective action standards are as follows:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control the source(s) of the release
- Comply with applicable federal, state, and local standards for waste management

If a CAA does not meet one or more of these standards, it is not considered a valid CAA and is not evaluated in the second phase. The second phase is the evaluation of each CAA against the five remedy selection decision factors to identify the CAA that provides the best relative combination of attributes. The remedy selection decision factors are as follows:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

E.1.3 Corrective Action Standards

The following subsections describe the corrective action standards used to evaluate the CAAs.

Protection of Human Health and the Environment

Protection of human health and the environment is a general mandate of the RCRA statute (EPA, 1994). This mandate requires that the corrective action include any necessary protective measures. These measures may or may not be directly related to media cleanup, source control, or management of wastes.

Compliance with Media Cleanup Standards

The CAAs are evaluated for the ability to meet the proposed media cleanup standards. The media cleanup standards are the FALs defined in Section 2.3.1.

Control the Source(s) of the Release

The CAAs are evaluated for the ability to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will involve a perpetual cleanup. Therefore, each CAA must provide effective source control to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

The CAAs are evaluated for the ability to be conducted in accordance with applicable federal and state regulations (e.g., 40 CFR 260 to 282, "Hazardous Waste Management" [CFR, 2013a]; 40 CFR 761 "Polychlorinated Biphenyls," [CFR, 2013b]; and NAC 444.842 to 444.980, "Facilities for Management of Hazardous Waste" [NAC, 2012a]).

E.1.3.1 Remedy Selection Decision Factors

The following text describes the remedy selection decision factors used to evaluate the CAAs.

Short-Term Reliability and Effectiveness

Each CAA must be evaluated with respect to its effects on human health and the environment during implementation of the selected corrective action. The following factors will be addressed for each alternative:

- Protection of the community from potential risks associated with implementation, such as fugitive dusts, transportation of hazardous materials, and explosion
- Protection of workers during implementation
- Environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

Each CAA must be evaluated for its ability to reduce the toxicity, mobility, and/or volume of the contaminated media. Reduction in toxicity, mobility, and/or volume refers to changes in one or more characteristics of the contaminated media by using corrective measures that decrease the inherent threats associated with that media.

Long-Term Reliability and Effectiveness

Each CAA must be evaluated in terms of risk remaining at the CAU after the CAA has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the control that may be required to manage the risk posed by treatment of residuals and/or untreated wastes.

Feasibility

The feasibility criterion addresses the technical and administrative feasibility of implementing a CAA and the availability of services and materials needed during implementation. Each CAA must be evaluated for the following criteria:

- **Construction and Operation.** The feasibility of implementing a CAA given the existing set of waste and site-specific conditions.
- **Administrative Feasibility.** The administrative activities needed to implement the CAA (e.g., permits, URs, public acceptance, rights of way, offsite approval).
- **Availability of Services and Materials.** The availability of adequate offsite and onsite treatment, storage capacity, disposal services, necessary technical services and materials, and prospective technologies for each CAA.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each CAA includes both capital, and operation and maintenance costs, as applicable. The following is a brief description of each component:

- **Capital Costs.** Costs that include direct costs that may consist of materials, labor, construction materials, equipment purchase and rental, excavation and backfilling, sampling and analysis, waste disposal, demobilization, and health and safety measures. Indirect costs are separate and not included in the estimates.

- **Operation and Maintenance Costs.** Separate costs that include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures. These costs are not included in the estimates.

E.1.4 Development of Corrective Action Alternatives

This section identifies and briefly describes the CAAs considered for the three releases that require corrective action at CAU 550. These locations consist of the three safety experiment sites (CASs 08-23-03, 08-23-06, and 08-23-07); CAS 08-24-08 (Batteries [3]); and CAS 08-26-01 (Lead Bricks [200]). CAS 08-24-08 consists of a debris pile that includes pieces of lead-acid batteries and other metal debris. CAS 08-26-01 consists of approximately 200 lead bricks near Smoky GZ.

The CAAs are based on the current nature of contamination at CAU 550. Based on the review of existing data, future use, and current operations at the NNSS, the following alternatives have been developed for consideration at CAU 550:

- **Alternative 1.** No further action
- **Alternative 2.** Clean closure
- **Alternative 3.** Closure in place

E.1.4.1 Alternative 1 – No Further Action

Under Alternative 1, no corrective action activities will be implemented. This alternative is a baseline case with which to compare and assess the other CAAs and their ability to meet the corrective action standards.

E.1.4.2 Alternative 2 – Clean Closure

Alternative 2 for the three safety experiment sites (CASs 08-23-03, 08-23-06, and 08-23-07) includes excavating and disposing of soil and debris within the DCB where HCA conditions for removable radioactive contamination are present. Soil would be removed to a depth of 6 in. (15 cm) bgs, based on the CSM assumption that the tests deposited removable contamination on the top 5 cm of the ground surface and the area has remained relatively undisturbed since the tests were conducted. Swipes would be collected and analyzed in accordance with established procedures, to verify that HCA conditions for removable radioactive contamination are no longer present. Contaminated materials removed would be disposed of at an appropriate disposal facility. Excavated areas would be returned to surface conditions compatible with the intended future use of the site.

Alternative 2 for CAS 08-24-08 (Batteries [3]) and CAS 08-26-01 (Lead Bricks [200]) includes removal of the debris and any impacted soil to a depth of 6 in. bgs. For estimating purposes, the extent of the impacted soil was assumed to be equal to the visual extent of the debris pile in CAS 08-24-08 and the lead bricks visible on the ground surface in CAS 08-26-01. Soil samples would be collected after debris removal and soil excavation to verify that lead concentrations in the remaining soil were below the FAL. Contaminated materials removed would be disposed of at an appropriate disposal facility. Excavated areas would be returned to surface conditions compatible with the intended future use of the site.

E.1.4.3 Alternative 3 – Closure in Place

Alternative 3 for the three safety experiment CASs includes the implementation of a UR surrounding the area where HCA conditions for removable radioactive contamination are present. This UR will restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to HCA conditions.

Alternative 3 for CAS 08-24-08 (Batteries [3]) and CAS 08-26-01 (Lead Bricks [200]) includes establishment of a UR at each location, where lead is assumed to be present at levels that exceed the FAL. This UR will restrict inadvertent contact with contaminated soil and/or debris by prohibiting any activity that would cause a site worker to be exposed to soil with lead contamination above the FAL.

E.1.5 Evaluation and Comparison of Alternatives

The three releases and associated CASs that required corrective action based on the results of the CAI are as followed:

- CASs 08-23-03, 08-23-06, and 08-23-07 (three safety experiment sites)
- CAS 08-24-08 (Batteries [3])
- CAS 08-26-01 (Lead Bricks [200])

The three CAAs of clean closure, closure in place with URs, and no further action were evaluated against the four general corrective action standards for each of the releases. The results of this evaluation area presented in Table E.1-1. For each release location, the CAAs of clean closure and closure in place with URs met the general corrective action standards. The no further action CAA did not meet the general standards and is not considered a viable CAA for the CAU 550 releases. Therefore, the no further action CAA was not considered when evaluating the remedy selection factors.

The two CAAs that met the general corrective action standards were further evaluated based on the remedy selection decision factors described in Section E.1.2. The results of this evaluation for each release location are presented in Tables E.1-2, E.1-3, and E.1-4. These tables also include parenthetical discussions from the January 2014 CAA meeting for completeness. With regard to the cost criterion, the tables contain the final cost estimate information, which was not available at the January 2014 CAA meeting. It was agreed to by DOE and NDEP that the numerical ranking of evaluation criteria completed as part of previous CAA evaluations, was of limited use. Instead, DOE and NDEP agreed to consider each remedy selection decision factor individually and select the CAA that best met the criterion or was the most desirable. The selected criteria are indicated by shaded cells in Tables E.1-2, E.1-3, and E.1-4. Once a CAA was selected for each criterion, the importance of the criteria were compared relative to each other, and the preferred CAA was selected considering all relevant factors.

Table E.1-1
Evaluation of General Corrective Action Standards
(CASs 08-23-03, 08-23-06, and 08-23-07; CAS 08-24-08; and CAS 08-26-01)

Clean Closure	Closure in Place with URs	No Further Action
Standard #1: Protection of Human Health and the Environment		
• The clean closure alternative is more protective than the other two alternatives because the contamination is removed, preventing future exposure. • Minimizes impact on future generations. • Future monitoring not required. • The clean closure alternative increases the potential for short-term environmental damage during cleanup activities.	• Considering the remoteness of the site, proximity to the public, and depth to groundwater, the closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure. • Minimizes exposure to workers. • The closure in place alternative preserves the historical landscape of the Smoky site. (*Only applies to CAS 08-26-01 [Lead Bricks (200)]*).	• The no further action alternative is not protective.
Standard #2: Compliance with Environmental Cleanup Standards and Standard #3: Compliance with Applicable Federal, State, and Local Standards for Waste Management		
• The clean closure alternative complies with cleanup standards established with the regulator through the FFACO process.	• The closure in place alternative complies with closure in place standards established in the FFACO process.	• The no further action alternative would not comply with environmental cleanup standards, but would comply with waste management standards because no waste would be generated.
Standard #4: Control the Source(s) of the Release		
• The clean closure alternative is more protective as the source of the release(s) is removed. • Minimizes risk to future generations.	• The closure in place alternative controls exposure by administrative controls and barriers, but does not remove the hazard.	• The no further action alternative would not control the release nor exposure to the release.

Table E.1-2
Evaluation of Remedy Selection Decision Factors
(CASs 08-23-03, 08-23-06, and 08-23-07)
(Page 1 of 3)

Clean Closure	Closure in Place with URs
Criterion #1: Long-Term Reliability and Effectiveness	
• The clean closure alternative is reliable and effective at protecting human health and the environment in the long term because removal of the contaminated media eliminates the future exposure of site workers and the environment. • Clean closure (removal) ensures no potential migration of contamination. • Clean closure does not eliminate the need for future institutional controls of contiguous areas (e.g., surrounding CA, Sedan site to east of Circle Road).	• The closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure of site workers and the public. • Contamination would not be prevented from airborne and surface migration; however, studies have shown that surface migration at these sites is minimal and does not contribute a dose exceeding the action level.
Criterion #2: Reduction of Toxicity, Mobility, and/or Volume	
• The clean closure alternative reduces the toxicity, mobility, and volume of the contamination because the contaminated media are removed.	• The closure in place alternative provides no reduction in the toxicity, mobility, or volume of the contamination. PSM remains in place and may be released to the soil.

Table E.1-2
Evaluation of Remedy Selection Decision Factors
(CASs 08-23-03, 08-23-06, and 08-23-07)
(Page 2 of 3)

Clean Closure	Closure in Place with URs
Criterion #3: Short-Term Reliability and Effectiveness	
• The clean closure alternative would present risk to site workers in the short term during implementation of the corrective action. This risk is based on the use of heavy equipment, exposure to contaminated soil and debris, and travel to/from the site. • Short-term risks to worker due to exposure to dust and safety/occupational risks during clean closure of site. • The clean closure alternative introduces short-term risks during waste management activities required for clean closure (e.g., ~19,000 truckloads of contaminated soil).	• The closure in place alternative would present minimal risk to site workers during installation of UR signs and maintenance of fencing, as required. This risk is based upon exposure to contaminated soil and debris, and travel to/from the site.
Criterion #4: Feasibility	
• The clean closure alternative is implementable. This alternative would require the most planning, resources, and time to implement, considering labor, equipment, transportation, waste management, and disposal. • Area 3/5 disposal capacity may not be adequate for the estimated volume of contaminated soil. • The estimated time frame to execute and complete the clean closure alternative would require multiple years of fieldwork and increased budgets. • The clean closure alternative would require extensive radiological controls.	• The closure in place alternative is implementable. This alternative is the most easily and quickly implemented, due to the limited actions involved (establishing the URs).

Table E.1-2
Evaluation of Remedy Selection Decision Factors
(CASs 08-23-03, 08-23-06, and 08-23-07)
(Page 3 of 3)

Clean Closure	Closure in Place with URs
Criterion #5: Cost	
• $46 million - Large volume of waste generated (4,972,000 cubic feet) - Large disposal costs (assumes disposal on NNSS of LLW) - Labor intensive • No maintenance costs	• $72,000 (first year) • $1,500 per year (post closure) - No waste, no disposal costs, not labor intensive • Requires long-term maintenance costs (UR only). • The estimated annual costs for post-closure monitoring do not include potential future costs for additional radiological surveys or road maintenance that may be required under the DOE Radiation Control program. • The closure in place alternative assumes that potential migration of contaminated soil will not affect the UR boundary.
Criterion #6: Other Considerations	
• Clean closure minimizes potential migration of contaminants. • Clean closure of the site would require historical assessment of the site before remediation. • Clean closure would require ecological/wildlife assessment of the site before remediation.	• The closure in place alternative allows for potential migration of contaminants. • Future mitigation/monitoring may be required to manage/control migration of contaminants.

Note: Shaded cells indicates the preferred corrective action.

Table E.1-3
Evaluation of Remedy Selection Decision Factors
(CAS 08-24-08, Batteries [3])
(Page 1 of 2)

Clean Closure	Closure in Place with URs
Criterion #1: Long-Term Reliability and Effectiveness	
• The clean closure alternative is reliable and effective at protecting human health and the environment in the long-term because removal of the contaminated media eliminates the future exposure of site workers and the environment.	• The closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure of site workers and the public.
Criterion #2: Reduction of Toxicity, Mobility, and/or Volume	
• The clean closure alternative reduces the toxicity, mobility, and volume of the contamination because the contaminated media are removed.	• The closure in place alternative provides no reduction in the toxicity, mobility, or volume of the contamination. PSM (lead) remains in place and may be released to the soil.
Criterion #3: Short-Term Reliability and Effectiveness	
• The clean closure alternative would present risk to site workers in the short term during implementation of the corrective action. This risk is based on the use of heavy equipment, exposure to contaminated soil and debris, and travel to/from the site. It also presents some risk to the public in the short term, because wastes may be transported on public roadways for offsite treatment/disposal. • The clean closure alternative exposes site workers to radiological contamination.	• The closure in place alternative would present minimal risk to site workers during installation of UR signs and maintenance of fencing, as required. This risk is based upon exposure to contaminated soil and debris, and travel to/from the site.
Criterion #4: Feasibility	
• The clean closure alternative is implementable. This alternative would require the most planning, resources, and time to implement, considering labor, equipment, transportation, waste management, and disposal. • The clean closure alternative would require ALARA consideration (e.g., due to work within an area with HCA conditions).	• The closure in place alternative is implementable. This alternative is the most easily and quickly implemented, due to the limited actions involved (establishing the URs).

Table E.1-3
Evaluation of Remedy Selection Decision Factors
(CAS 08-24-08, Batteries [3])
(Page 2 of 2)

Clean Closure	Closure in Place with URs
Criterion #5: Cost	
• $152,000 - Generation of low-level mixed waste - Treatment/disposal costs - Labor intensive No maintenance costs	• $2,000 (first year) • $1,500 per year (post closure) - No waste, no disposal costs, not labor intensive • Requires long-term maintenance costs (UR only). • The estimated annual costs for post-closure monitoring do not include potential future costs for additional radiological surveys or road maintenance that may be required under the DOE Radiation Control program.
Criterion #6: Other Considerations	
• The clean closure alternative would require ALARA consideration (e.g., due to work within an area with HCA conditions). • Surrounding area remains radiologically contaminated (i.e., remains an HCA) after cleanup of lead batteries.	• Contamination would still be subject to airborne and surface migration; however, studies have shown that surface migration at CAU 550 is minimal and does not contribute a dose exceeding the action level.

Note: Shaded cells indicates the preferred corrective action.

Table E.1-4
Evaluation of Remedy Selection Decision Factors
(CAS 08-26-01, Lead Bricks [200])
(Page 1 of 3)

Clean Closure	Closure in Place with URs
Criterion #1: Long-Term Reliability and Effectiveness	
• The clean closure alternative is reliable and effective at protecting human health and the environment in the long term because removal of the contaminated media eliminates the future exposure of site workers and the environment. • Impact to future generations is minimized.	• The closure in place alternative is protective as it establishes URs, and provides for periodic inspections and long-term maintenance to prevent future exposure of site workers and the public. • Contamination would not be prevented from airborne and surface migration; however, studies have shown that surface migration at CAU 550 is minimal and does not contribute a dose exceeding the action level.
Criterion #2: Reduction of Toxicity, Mobility, and/or Volume	
• The clean closure alternative reduces the toxicity, mobility, and volume of the contamination because the contaminated media are removed. • Removal of lead bricks could contribute to DOE pollution prevention goals if lead bricks are recyclable (dependent upon radiological contamination levels). • Removal of lead bricks would eliminate future releases of lead to the soil and/or sediment. • Removal of lead bricks would reduce the lead available for ingestion by biological organisms. • Removal of lead bricks would eliminate future surface transport of lead-contaminated soil and/or sediments.	• The closure in place alternative provides no reduction in the toxicity, mobility, or volume of the contamination. PSM (lead) remains in place and may be released to the soil.
Criterion #3: Short-Term Reliability and Effectiveness	
• The clean closure alternative would present risk to site workers in the short term during implementation of the corrective action. This risk is based on the use of heavy equipment, exposure to contaminated soil and debris, and travel to/from the site. It also presents some risk to the public in the short term, because wastes may be transported on public roadways for offsite treatment/disposal.	• The closure in place alternative would present minimal risk to site workers during installation of UR signs and maintenance of fencing, as required. This risk is based upon exposure to contaminated soil and debris, and travel to/from the site.

Table E.1-4
Evaluation of Remedy Selection Decision Factors
(CAS 08-26-01, Lead Bricks [200])
(Page 2 of 3)

Clean Closure	Closure in Place with URs
Criterion #4: Feasibility	
• The clean closure alternative is implementable. This alternative would require the most planning, resources, and time to implement, considering labor, equipment, transportation, waste management, and disposal.	• The closure in place alternative is implementable. This alternative is the most easily and quickly implemented, due to the limited actions involved (establishing the URs). • The closure in place alternative avoids mitigation measures that may be required by the *National Historic Preservation Act* (USC, 2012) if the bricks were removed.
Criterion #5: Cost	
• $2 million - Large volume of waste/potentially recyclable material - Large treatment/disposal/recycle costs - Labor intensive • No maintenance costs • Cost for mitigation of historical landscape not included in estimate	• $2,000 (first year) • $1,500 per year (post closure) - No waste - No treatment/recycle/disposal costs - Not labor intensive • Requires long-term maintenance costs (UR only). • No costs to preserve historical nature of site. • The estimated annual costs for post-closure monitoring do not include potential future costs for additional radiological surveys or road maintenance that may be required under the DOE Radiation Control program.

Table E.1-4
Evaluation of Remedy Selection Decision Factors
(CAS 08-26-01, Lead Bricks [200])
(Page 3 of 3)

Clean Closure	**Closure in Place with URs**
Criterion #6: Other Considerations	
• Surrounding area remains radiologically contaminated after cleanup of lead bricks. • The clean closure alternative would require mitigation measures under the *National Historic Preservation Act* (USC, 2012). • As of the date of this CADD/CR, the Smoky Atmospheric Test site, which encompasses CAS 08-26-01 (Lead Bricks [200]), has been determined eligible for the National Register of Historic Places by the Nevada State Historic Preservation Office (Ernstein, 2014).	• The closure in place alternative preserves the Smoky historical landscape. Note: The Closure in Place with URs corrective action was selected as the preferred alternative subsequent to the CAA meeting of January 8, 2014, and is based on a letter from NDEP to DOE dated October 7, 2014 (Andres, 2014).

Note: Shaded cells indicates the preferred corrective action.

E.2.0 Selected Alternative

Alternative 3, closure in place, is the selected alternative for the three safety experiment sites (CASs 08-23-03, 08-23-06, and 08-23-07) and CAS 08-26-01 (Lead Bricks [200]). The selected alternative for CAS 08-24-08 (Batteries [3]) is clean closure.

The three safety experiment CASs are within the DCB, which is an area where HCA conditions for removable contamination are present. Working in an HCA is a high-risk activity involving extensive radiological controls to protect workers from inhaling or ingesting airborne radioactive particles. A corrective action of clean closure at these three CASs would require extensive excavation and soil movement. The corrective action of closure in place would have minimal risk to site workers because onsite activity would be limited to installing and maintaining UR postings at the site.

CAS 08-26-01 is located within an area where removable contamination meets CA criteria. Excavation and removal of debris at this location would require similar radiological controls for site workers as in an HCA, as described above. In order to remove the surface and near surface lead bricks during a clean closure, excavation activities would be required. Another consideration for this CAS is the historical significance of the Smoky site. In June 2014, the Nevada State Historic Preservation Office concurred that the Smoky site is eligible for the National Register of Historic Places due to the relatively undisturbed condition of the site (Ernstein, 2014). Clean closure of this site would involve the use of heavy equipment in the area around Smoky GZ, which could cause irreversible damage to the other structures and features of the Smoky historical landscape. The lead bricks at CAS 08-26-01 have been determined an integral part of the historical landscape of the Smoky test site, and it is recommended that their removal or disturbance be avoided. The NDEP concurred with the recommended closure in place corrective action for this CAS in a letter dated October 7, 2014 (Andres, 2014).

The corrective actions for CAU 550 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer are valid, additional evaluation may be necessary.

All URs are recorded in the FFACO database; the M&O Contractor GIS; and the NNSA/NFO CAU/CAS files. The development of URs for CAU 550 are based on current land use. Any proposed activity within a use restricted area that would result in a more intensive use of the site would require NDEP approval.

E.3.0 Cost Estimates

The cost for clean closure of the three safety experiment CASs (CAS 08-23-03, CAS 08-23-06, and CAS 08-23-07) and the two releases in CASs 08-24-08 and 08-26-01 is estimated to exceed $46 million to conduct the following activities:

- Prepare and procure
- Excavate, load, and dispose of contaminated soil and debris
- Transport and dispose of debris
- Decontaminate equipment

The estimated cost for clean closure was based on removing contaminated soil and debris within the DCB and the extent of the two releases in CASs 08-24-08 and 08-26-01. This includes excavation, loading and processing, transportation, disposal, site restoration, and site support.

The costs for closure in place are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing UR signs. The closure in place estimate for CASs 08-23-03, 08-23-06, and 08-23-07 is $72,000 for the first year and $1,500 for each year thereafter. The closure in place estimate for each of the other two CASs (08-24-08 and 08-26-01) is $2,000 for the first year and $1,500 each year thereafter.

E.4.0 References

Andres, C.D., Nevada Division of Environmental Protection, Bureau of Federal Facilities. 2014. Letter to R.F. Boehlecke (NNSA/NFO) titled "RE: Smoky Atmospheric Test Location, Area 8, Nevada National Security Site, Nye County, Nevada, Corrective Action Unit (CAU) 550 Federal Facility Agreement and Consent Order (FFACO)," 7 October. Las Vegas, NV.

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United States Code. 2012. Title 16 USC 470 et seq., "National Historic Preservation Act of 1966," as amended. Washington, DC: U.S. Government Printing Office.

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U.S. Environmental Protection Agency. 1996. "Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities," 1 May. In *Federal Register*, Vol. 61, No. 85.

Appendix F

Sample Location Coordinates

F.1.0 Sample Location Coordinates

The center of each sample plot and the locations of individual (judgmental) sample locations for the CAU 550 CASs were surveyed using a GPS instrument. Survey coordinates for these locations are listed in Tables F.1-1 through F.1-4.

At soil sample plots, nine aliquot sample locations were established for each composite sample. Visual Sample Plan software (PNNL, 2007) was used to derive coordinates for a systematic triangular grid pattern based on a randomly generated origin or starting point. In some cases, aliquot locations were moved due to surface/subsurface obstructions or conditions (e.g., rocks, vegetation, and animal burrows). These offsets (distance and direction) of each aliquot location were recorded in the project files. It is important to note that if an offset was less than the nominal 4-in. width of core sampler, the original coordinate was not modified.

Table F.1-1
Sample Plot/Location Coordinates for Study Group 1
(Page 1 of 3)

Sample Location	Easting[a]	Northing[a]
A01	582709.1	4115822.6
A02	583626.2	4116314.5
A03	581255.6	4114966.8
A04	582209.4	4115921.9
A05	582207.2	4115723.9
A06	582209.7	4115527.1
A07	583007.4	4116323.7
A08	583109.8	4116221.9
A09	582906.9	4116221.7
A10	582707.6	4116223.1
A11	582708.3	4116124.1
A12	582808.0	4116121.4
A13	582907.0	4116124.8
A14	583007.1	4116123.2
A15	583110.8	4116023.0

Table F.1-1
Sample Plot/Location Coordinates for Study Group 1
(Page 2 of 3)

Sample Location	Easting[a]	Northing[a]
A16	582907.6	4116022.3
A17	582808.0	4116019.9
A18	582813.8	4115923.0
A19	582907.0	4115921.9
A20	583009.5	4115921.9
A21	582906.4	4115821.6
A22	583006.2	4115820.7
A23	583111.7	4115821.8
A24	583007.7	4115721.6
A25	582907.2	4115723.3
A26	582905.8	4115623.6
A27	583112.1	4115622.5
A28	583006.9	4115524.8
A29	582903.3	4115532.2
A30	581576.1	4116095.6
A31	582508.1	4116123.0
A32	582306.1	4116020.8
A33	582506.0	4116022.2
A34	582606.7	4116020.8
A35	582706.8	4116023.0
A36	582707.6	4115922.5
A37	582608.6	4115922.8
A38	582506.6	4115923.3
A39	582406.9	4115920.3
A40	582307.7	4115823.6
A41	582407.3	4115823.5
A42	582506.0	4115823.8
A43	582607.8	4115823.6
A44	582806.6	4115822.6

Table F.1-1
Sample Plot/Location Coordinates for Study Group 1
(Page 3 of 3)

Sample Location	Easting[a]	Northing[a]
A45	582808.2	4115722.9
A46	582709.2	4115720.3
A47	582608.1	4115721.2
A48	582507.7	4115722.2
A49	582407.1	4115723.4
A50	582305.2	4115626.2
A51	582507.9	4115622.4
A52	582608.6	4115622.5
A53	582707.5	4115622.6
A54	582806.2	4115623.9
A55	582805.5	4115526.2
A56	582709.0	4115524.6
A57	582607.7	4115528.2
A58	582508.0	4115526.2
A59	582408.0	4115525.3

[a]Universal Transverse Mercator (UTM) Zone 11, North American Datum (NAD) 1927 (U.S. Western) in meters.

Table F.1-2
Sample Plot Coordinates for Study Group 2

Sample Location	Easting[a]	Northing[a]
B01	582237.0	4114450.1
B02	582506.8	4115582.3

[a]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

Table F.1-3
Sample Location Coordinates for Study Group 3

Sample Location	Easting[a]	Northing[a]
C01	583499.2	4114573.0
C02	583496.7	4114542.4
C03	582965.7	4115319.5
C04	582991.9	4115249.4
C05	583144.7	4114918.2
C06	583487.6	4114744.4
C07	583601.2	4114756.3
C08	583655.0	4114843.6
C09	583120.6	4115261.7
C10	583174.3	4115108.0
C11	583687.6	4114769.8

[a]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

Table F.1-4
Sample Location Coordinates for Study Group 4
(Page 1 of 2)

Sample Location	Easting[a]	Northing[a]
D01	582704.7	4116015.9
E01	582735.0	4114855.2
F01	582583.4	4114716.6
G01	582652.7	4115145.4
H01	582882.3	4115314.3
I01	582527.1	4113906.7
J01	582527.1	4113906.7
K01	582804.3	4115561.2
N01	582830.3	4114456.7
P01	581678.2	4113668.4
Q01	582934.2	4114764.2
R01	582843.3	4114707.9
S1	582931.8	4113406.4

Table F.1-4
Sample Location Coordinates for Study Group 4
(Page 2 of 2)

Sample Location	Easting[a]	Northing[a]
S2	583046.9	4113624.9
T1	583117.4	4115634.9
U1	582920.5	4113468.9
W1	583734.0	4114442.3
X1	582629.9	4114989.3
Y1	582626.7	4115374.9

[a]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

F.2.0 References

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

Appendix G

Nevada Division of Environmental Protection Comments

(17 Pages)

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 550: Smoky Contamination Area, Nevada National Security Site, Nevada	**2. Document Date:**	11/19/2014
3. Revision Number:	0	**4. Originator/Organization:**	Navarro-INTERA
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	12/19/2014
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850, exts. 232/237	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
1.) Executive Summary, Page ES-3, 2nd Paragraph		Reference is made to catchment "basins" east and west of Circle Road, but there is only one basin apparent (east of Circle Road) in Figure 1-1 and related figures. Section A.5.1.1 implies basins only the east side. Clarify.	The sentence has been revised to read, “Surface water drains from northwest of CAU 550 across the atmospheric test and safety experiment sites and the majority of the debris CASs to washes on the eastern side of the site and ultimately to a large catchment area east of Circle Road.” The term “catchment area” has been defined in this document as the area on the east side of Circle Road that includes the U10a crater, the depositional area (defined as part of the Study Group 3 Washes),and areas of visible sediment accumulation. The catchment area is delineated on Figure A.5-1. The document has been revised throughout to incorporate this definition.	
2.) Figure 1-1, Page 2		Identify the drainage system and catchment basins as described in ES. Global comment for other figures as appropriate.	The primary purpose of Figure 1-1 is to present the CASs included in CAU 550. The drainage system and catchment area are not part of a CAS, but were investigated as a study group (SG3). Although the four CAU 550 study groups are briefly introduced in Section 1.0 (Table 1-1), they are not discussed in detail until Section 2.0. Specifically, Section 2.1.3 addresses Study Group 3 (Washes). This section references Figure A.5-1, which presents the drainage system and catchment area features (U10a crater, depositional area, sediment accumulation areas). No changes were made to Figure 1-1; however, Figure A.5-1 was revised to identify the catchment area on the east side of Circle Road.	

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5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	12/19/2014
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850, exts. 232/237	**9. Reviewer's Signature:**	

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3.) Section 2.1.1, Page 10, 1st Paragraph		Add brief assessment for removable contamination on these features.	The following was added to the Section 2.1.1, *Visual Surveys,* after the second sentence: "Removable contamination surveys were performed on debris identified outside the CA fence. These surveys did not indicate the presence of CA conditions. Debris items identified during the CAI that were located inside the CA fence (e.g., underground bunkers, airplane carcass) are assumed to present CA conditions."	
4.) Section 2.1.1, Page 10, 2nd Paragraph		1st Sentence: add reference.	Reference was added.	

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5.) Section 2.1.2, Page 13, 1st Paragraph		The section seems to imply the DCBs shown in Figure A.4-1 and elsewhere are also HCA boundaries. If so, should appropriate figures be labeled as such, and are these currently field posted as HCAs? Clarify.	At CAU 550, the DCB is not collocated with a posted HCA. The east and west boundaries of the DCB follow an existing fence line that is currently posted as a CA. The DCB was established during the CAI because HCA conditions were identified in the area. However, the responsibility for identifying, posting, and maintaining an HCA (or CA) rests with the DOE Occupational Radiation Protection program (governed by 10 CFR 835), which is independent of the FFACO process. Section 2.1.2 has been revised to clarify the applicability of relevant components of the DOE Occupational Radiation Protection program to the FFACO process. Section 2.1.2, second paragraph has been replaced with the following: "A default contamination boundary (DCB) surrounding the three safety experiments was established based on historical removable contamination survey data, which suggested the presence of high contamination area (HCA) conditions within the DCB (NNSA/NSO, 2012). The east and west boundaries of the DCB follow an existing fence line that is currently posted as a CA (see Figure A.4-1). However, the DCB does not coincide with a posted HCA. The responsibility for identifying, posting, and maintaining an HCA (or CA) rests with the DOE Occupational Radiation Protection program, which is governed by the requirements in 10 CFR 835, "Occupational Radiation Protection"(CFR, 2013). This program was established for worker health and safety, and is independent of the FFACO. However, the data collected in support of the program and the existing postings are relevant in determining the radiological conditions at a site."	

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			Section 2.3.1, *Final Action Levels*, seventh paragraph, after third sentence has been revised as follows: "A separate FAL for removable contamination has not been developed. Instead, the threshold criteria for posting HCAs and CAs found in 10 CFR 835 (CFR, 2013) have been adopted as guidelines at sites where removable contamination is present. The DOE Occupational Radiation Protection program requires that areas with removable alpha radioactive contamination at levels > 20 disintegrations per minute per 100 square centimeters (dpm/100 cm2) or > 2,000 dpm/100 cm2 be posted with CA and HCA signs, respectively. These are the numerical threshold criteria for posting HCA and CAs under 10 CFR 835. In order to ensure removable contamination is adequately considered in the FFACO process, these criteria are used to determine whether HCA or CA conditions are present at a site and whether corrective action is necessary to reduce the potential for the inadvertent offsite transfer of contamination. For CAU 550, it is assumed that releases which contain removable contamination at levels that meet HCA posting criteria (i.e., exhibit HCA conditions) require corrective action."	
6.) Section 3.0, Page 35, 4th Paragraph		2nd Sentence: define quantitatively what constitutes HCA conditions.	The 2nd sentence has been revised to read, "However, because HCA conditions for removable contamination (alpha > 2,000 dpm/100 cm2) are present within the DCB, corrective action is required."	

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7.) Section 3.0, Page 36, 3rd Paragraph		1st sentence: define quantitatively what constitutes CA conditions.	The 1st sentence has been revised to read, “In accordance with…a dose exceeding 25 mrem/yr (i.e., the PAL) and/or any area where removable radioactive contamination is present that exceeds CA criteria (alpha > 20 dpm/100 cm2, but < 2,000 dpm/100 cm2).	
8.) Section 3.0, Page 36, 3rd Paragraph		Suggest this section clarify the status of existing fencing/posting boundaries for CAs/HCAs at CAU 550, in light of the "no posting or inspection" requirement for establishing this administrative UR; e.g., is the "Contamination Area" shown on Figure A.4-3 is shown as fenced in the legend, but not on other figures.	A new figure (Plate 1) has been added. This figure includes all CASs, the two FFACO UR boundaries, the administrative UR boundary, existing fences under the DOE Occupational Radiation Protection program (10 CFR 835), and the locations of FFACO UR signs. Where appropriate, text revisions throughout the document were made to incorporate this new figure.	
9.) Section A.4.1, Page A-38, 2nd Paragraph		1st sentence: "within the boundary" - clarify if these means the DCB boundary is also an HCA boundary.	See response to comment #5. The sentence has been revised to read, “A DCB surrounding the three safety experiments was proposed in the CAIP (NNSA/NSO, 2012a) based on historical removable contamination survey data, which suggested the presence of HCA conditions within the DCB (Figure A.4-1).”	

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10.) Section A.4.1.1, Page A-38, 1st Paragraph		5th sentence: "...is not unexpected." Restate in the positive. 7th sentence: This sentence reaches a conclusion without any supporting information.	The 5th sentence has been revised to read, "Due to the nature of the three safety experiments and the location of the identified debris within the DCB, the presence of removable radioactive contamination was expected." The 7th sentence has been revised to read, "The radioactive contamination on the experiment debris consists primarily of alpha radiation, which is consistent with the type of material (e.g., plutonium) associated with the safety experiments."	
11.) Section A.4.5, Page A-45, 1st Paragraph		4th sentence: Figure A.4-3 appears to show 3 removable contamination sample locations exceeding CA criteria, contradicting this sentence. 4th sentence: change the phrase "confirming that CA conditions" to "suggesting that CA conditions..." Last sentence: convoluted, replace with "Due to the long half-lives of removable radioactive contaminants, including Pu-239 (24,000 years), the administrative UR is expected to remain in place indefinitely".	This discussion has been revised to read, "The fence line, however, is discontinuous across the northern portion of the site (Figure A.4-1), and it was uncertain as to the extent of CA conditions in this area of the CAU. According to a 2000 radiological survey report, the northern portion of the CA was not fenced due to the extremely steep terrain north of the site (DOE/NV, 2000a). In order to determine the northern extent of the area with CA conditions, removable contamination swipes were collected around the base of Smoky Hill. As shown in Figure A.4-3, three of the southernmost swipe locations exceed CA criteria. None of the other swipe locations around the base of the hill meet CA criteria. This suggests that CA conditions are present at the southern base of Smoky Hill and potentially extend to higher elevations on the southern side of the hill, but do not extend beyond the base of the hill in the west, north, and east directions." Last sentence was revised as requested.	

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12.) Section A.5.1.1, Pages A-47-49, 1st-3rd Paragraphs		3rd sentence: "...two small posted areas..." are difficult to discern in Figure A.5-1. Figure A.5-1: add basin boundary symbols to legend. Figure A.5-1: identify U10a crater.	An inset that is zoomed into the two posted areas has been placed on Figure A.5-1. Figure A.5-1 was revised to add the basin boundary symbol to the legend and identify the U10a crater.	
13.) Section A.5.1.1, Page A-49, 1st Paragraph		Describe how surface water flow in the wash crosses Circle Road and enters the catchment basin and depositional areas (i.e., culvert, etc.)	The second complete sentence on this page was revised to read, "The surface hydrologic survey suggests that the east side of Circle Road serves as a large catchment area for surface water flow across the paved surface of Circle Road from CAU 550. Currently, there are no engineered drainage features (e.g., culverts under Circle Road) that control the flow of surface water from the site."	
14.) Section A.5.5, Page A-59, 1st Paragraph		1st sentence: call out Figure where locations of sediment accumulation are shown.	The sentence was revised to read, "The extent of the administrative UR on the east side of Circle Road was determined visually and was based on the locations of sediment accumulation (Figure A.5-1)."	
15.) Section A.5.6, Page A-59, 1st Paragraph		Sentence beginning with, "This suggest..."; following "sediment" change "or" to "and/or".	The sentence was revised to read, "This suggests that the contaminants have been buried by sediment and/or redistributed laterally through the washes or into the large catchment area east of Circle Road."	

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16.) Section A.5.6, Page A-63, 2nd Paragraph		1st sentence: add "east" after "swipes".	The sentence was revised to read, "Additional swipes on the west shoulder and surface of Circle Road were collected by the NNSS M&O contractor as part of the DOE Occupational Radiation Protection program (CFR, 2013)."	
17.) Section A.5.6, Page A-63, Figure A.5-6		Suggest color code removable contamination sample locations to show samples meeting CA posting criteria IAW Figure A.4-3.	The symbol label for the green dots in the Figure A.5-6 legend has been changed to "Removable Contamination Sample Location < CA Criteria" to be consistent with the legend in Figure A.4-3.	
18.) Section A.5.6, Page A-63, 4th Paragraph		Last sentence: briefly add justification to last phrase, "...are not expected..."	The last sentence was revised to read, "However, current radiation dose and removable contamination levels do not require corrective action. Based on the physical properties of the contaminants and the expected decrease in contaminant concentrations over time with dispersion by stormwater and uncontaminated soil, the dose and removable contamination levels are not expected to exceed actions levels in the future."	
19.) Section B.1.1.2, Page B-10, 5th Paragraph		Second to last sentence: explain briefly here why lead bricks at CAS 08-26-01 were left in place.	The sentence was revised to read, "Based on the remoteness of the site, the proximity to the public, depth to groundwater, and recognition of the sites' historical value, the debris at CAS 08-26-01 (Lead Bricks [200]) was left in place."	

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20.) Section C.1.2, Page C-4, 2nd Paragraph		1st sentence: reference to catchment areas west of Circle Road - see comment 1.	No changes were made to the first sentence. The second sentence was changed to read, “Surface water drains from northwest of CAU 550 across the atmospheric test and safety experiment sites and the majority of the debris CASs to washes on the eastern side of the site and ultimately to a large catchment area east of Circle Road.”	
21.) Section C.1.3, Page C-5, 1st Paragraph		Add brief summary of Class 2 ASTM site definition.	The four site classifications are defined in the first paragraph of Section C.1.3. However, in order to make the terminology consistent, the first sentence has been revised to read, “The four major site classifications listed in Table 3 of the ASTM Standard are (1) Classification 1, immediate threat to human health, safety, and the environment; (2) Classification 2, short-term (0 to 2 years) threat to human health, safety, and the environment; (3) Classification 3, long-term (greater than 2 years) threat to human health, safety, and the environment; and (4) Classification 4, no demonstrated long-term threats.”	
22.) Section C.1.7, Page C-8, 1st Paragraph		2nd sentence: change, "...may be present..." to "...are expected to be present..."	The sentence has been revised to read, “A review of the current and projected use at all sites in CAU 550 determined that workers are expected to be present at these sites for a time period much less than 2,000 hr/yr (see Section C.1.10) (NNSA/NFO, 2014).”	
23.) Section D.1.1, Page D-1, 1st Paragraph		3rd sentence: implies fencing along most of the DCB boundary will have no UR signs. Clarify including the number and location of signs placed.	See response to comment #8.	

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24.) Appendix D		It would be very helpful if there was a map view of the entire CAU with the Use Restrictions depicted on it (i.e., a combination of Figure 1-1 and the two FFACO Use Restriction figures in Attachment D-1.	See response to comment #8.	
25.) Appendix D, Attachment D-1		Page 2 of 2 - UR Information sheet for CAS 08-26-01, under "Comments" add the following: "Should the site be altered in any way in the future, NDEP will be notified and a new determination regarding removal of lead bricks or any other associated material will be made at the time".	The entirety of Section 3.0 was reformatted to make the section clearer. The following text has been added to Section 3.1 that relates directly to this comment, "The corrective action decisions for CAU 550 are based on the current and future land use assumptions presented in Appendix C. Stakeholder concurrence, including NDEP, must be obtained in advance of an alteration or change in land use that results in a more intensive use of the site."	

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26.) Section D.1.4, Page D-2, 1st Paragraph		2nd sentence: implies only two signs were placed on the FFACO boundary even though the fence has 4 sides, clarify.	There is not an existing fence surrounding CAS 08-26-01; the FFACO UR figure for this CAS in Appendix D shows a rectangle designating the extent of the FFACO UR. The locations of UR signs are shown on Plate 1, which is the new figure described in the response to comment #8. To clarify, the second sentence in the first paragraph of Section D.1.4 has been revised to read, "In order to keep radiation exposure to site workers who will be inspecting and maintaining the UR ALARA, and due to the remoteness of the site, a total of 19 UR signs were placed on the existing fence at practical routes of ingress to the area containing the UR (see Plate 1). Ten of these UR signs were placed on the CA fence that parallels Circle Road because this is a heavily trafficked road and the primary route by which a pedestrian could reasonably access the site. "	

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27.) Section E.1.5, Page E-9, Table E.1-1		No preferred corrective actions are identified by shading, clarify.	To clarify, the following replaces Section E.1.2 after the first paragraph: "The evaluation of CAAs is a two-phased process. In the first phase, potential CAAs are evaluated against the four general corrective action standards. These standards represent the minimum requirements a CAA must meet in order to be considered a preferred remedy. The general corrective action standards are as follows: • Protection of human health and environment • Compliance with media cleanup standards • Control the source(s) of the release • Comply with applicable federal, state, and local standards for waste management If a CAA does not meet one or more of these standards, it is not considered a valid CAA and is not evaluated in the second phase. The second phase is the evaluation of each CAA against the five remedy selection decision factors to identify the CAA that provides the best relative combination of attributes. The remedy selection decision factors are as follows: • Short-term reliability and effectiveness • Reduction of toxicity, mobility, and/or volume • Long-term reliability and effectiveness • Feasibility • Cost The last bullet under the Clean Closure column under	

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			Standard #1 was removed. This bullet stated that mitigation measures would be necessary under the NHPA if the bricks were removed during clean closure. The bullet was removed because it does not relate directly to Standard #1, Protection of Human Health and the Environment.	

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28.) Section E.1.5, Page E-17, Table E.1-4		No preferred corrective actions are identified by shading, clarify. Clean Closure column, 1st bullet: Although NDEP has concurred with Closure in Place for 200 lead bricks, we nevertheless suggest developing a more balanced 'Other Consideration' for Clean Closure statement that at least mentions potential benefits of lead brick removal. We agree that soil radionuclides will continue to pose the greater environmental threat than metallic lead/lead in soil. However, the phrase "...only minimal environmental benefit is achieved..." fails to acknowledge any potential benefits associated with lead removal including: removing a large quantity of metallic lead and lead-contaminated soil exceeding risk-based action levels, and other regulatory limits; stopping lead leaching into soil; stopping potential surface transport of lead-contaminated sediments; reducing lead ingestion threat to biological organisms; and complying with regulatory and operational standards (FALs) for management of abandoned waste metallic lead (as has been routinely done at many other Soils Activity CAUs without historical significance). Clean Closure column, 2nd bullet: Suggest clarify that as of the date of this CADD/CR, this CAS has been determined eligible for inclusion for NRHP by NV SHPO, but was not federally (officially) designated as a historic place. If a timeframe for such designation is available, add it to discussion. Parenthetical Remarks: The "information" in parentheses	The Closure in Place with URs corrective action column has been shaded. A note was added to this column that reads, "The Closure in Place with URs corrective action was selected as the preferred alternative subsequent to the CAA meeting of January 8, 2014, and is based on a letter from NDEP to DOE dated October 7, 2014 (Andres, 2014)." Clean Closure column, 1st bullet: The benefits of clean closure of the lead bricks are noted in criteria #1 and #2 (e.g., reliable, effective, elimination of future exposure). The first bullet under Clean Closure for Criterion #6 has been changed to "Surrounding area remains radiologically contaminated after cleanup of lead bricks." The timeframe for formal listing on the NRHP is uncertain at this time. However, sites that have been determined eligible for the National Register of Historic Places are afforded the same protection under the law as those that are formally listed on the Register. In response to the comment on Clean Closure column, 2nd bullet (Criterion # 6), a third bullet has been added to this column which reads, "As of the date of this CADD/CR, the Smoky Atmospheric Test site, which encompasses CAS 08-26-01 (Lead Bricks [200]), has been determined eligible for the National Register of Historic Places by the Nevada State Historic Preservation Office (Ernstein, 2014)." Parenthetical comments have been removed from the tables, as requested. The following bullets were added under Criterion #2: Reduction of Toxicity, Mobility, and/or Volume in the Clean	

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		in these columns should be removed as it has no bearing on the **Evaluation of Remedy Selection Decision Factors**. Meeting minutes may be the appropriate document to capture such conversations, not the CADD/CR.	Closure column of Table E-1.4: • Removal of lead bricks would eliminate future releases of lead to the soil and/or sediment • Removal of lead bricks would reduce the lead available for ingestion by biological organisms • Removal of lead bricks would eliminate future surface transport of lead-contaminated soil and/or sediments	
29.) Section E.2.0, Page E-18, 2nd Paragraph		Last sentence: after, "...October 7, 2014...", add the following: "NDEP's approval and determination for closure in place was based on remoteness of the site from the public, depth to groundwater, and recognition of the site's historical value. However, NDEP's approval and determination is not precedent-setting for this CAU. Future alterations of the Smoky site will require a new NDEP determination regarding removal of lead bricks and associates material".	This statement cannot be added to the document because the DOE has not yet received approval for the CADD/CR from NDEP. This type of language is inappropriate for inclusion in a CADD/CR and may be more appropriate in correspondence.	

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 550: Smoky Contamination Area, Nevada National Security Site, Nevada	**2. Document Date:**	11/19/2014
3. Revision Number:	0	**4. Originator/Organization:**	Navarro-INTERA
5. Responsible NNSA/NFO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	12/19/2014
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Chris Andres and Scott Page, NDEP, (702) 486-2850, exts. 232/237	**9. Reviewer's Signature:**	

10. Comment Number/Location	**11. Type***	**12. Comment**	**13. Comment Response**	**14. Accept**
30.) Global		Throughout this document, CAS 08-23-04, the Smoky Atmospheric Test, and CAS 08-26-01, approximately 200 lead bricks, are described and written about as two, distinct, separate CASs, with no connection. It is understood that the Corrective Action Investigation Plan for CAU 550 established, "based on process knowledge of the releases associated with the nuclear tests and radiological survey information about the location and shape of the resulting contamination plumes" and the fact that "some of the CAS releases are co-located and will be investigated as study groups," four study groups. The Smoky Atmospheric Test, CAS 08-23-04, was designated Study Group 1. Study Group 4 included CAS 08-26-01, approximately 200 lead bricks. In an October 7, 2014 letter to NNSA/NFO regarding CAU 550, the NDEP stated that the removal of the lead bricks was not required at the time so as to not disturb the historical nature of the area. As such, the connection between Smoky test (CAS 08-23-04) and the 200 lead bricks (CAS 08-26-01) needs to be clearly stated THROUGHOUT the document, especially in the Executive Summary and the main body of the CADD/CR. It is not acceptable to have the first mention of the historical connection of these two CASs in the Appendices, namely Appendices A and E. The Corrective Action for CAS 08-26-01 needs to be tied to the significance it plays in CAS 08-23-04.	Page ES-3, third paragraph, the following language was substituted for the third and fourth sentences: "Although many of the debris CASs are proximate to the atmospheric or safety experiment CASs, only one has been definitively linked to a historical test. CAS 08-26-01, Lead Bricks (200), is located near the Smoky test ground zero and is considered an integral part of the relatively untouched, post-detonation environment. Based on the investigation data, corrective action was required at this CAS and at two other CASs: 08-24-07, (Batteries [3]; Battery; Lead Bricks [2]); and 08-24-08, (Batteries [3]). The corrective action implemented at CAS 08-26-01 was closure in place with URs; the corrective action implemented at CASs 08-24-07 and 08-24-08 was clean closure." The following was added to Section 2.1.1, *Visual Surveys*, second paragraph, following the second sentence: "The lead bricks identified at the Smoky site and shown in Figure 2-3 were investigated as a separate CAS in Study Group 4 (CAS 08-26-01, Lead Bricks [200]) due to the potential for lead contamination in the soil. Although the lead bricks were not investigated as part of Study Group 1 (CAS 08-23-04, Smoky Atmospheric Test), the lead bricks are directly related to the Smoky test and are considered an integral part of the Smoky historic landscape." The following was added to Section A.3.1.1, *Visual Surveys*, second paragraph, following the second	

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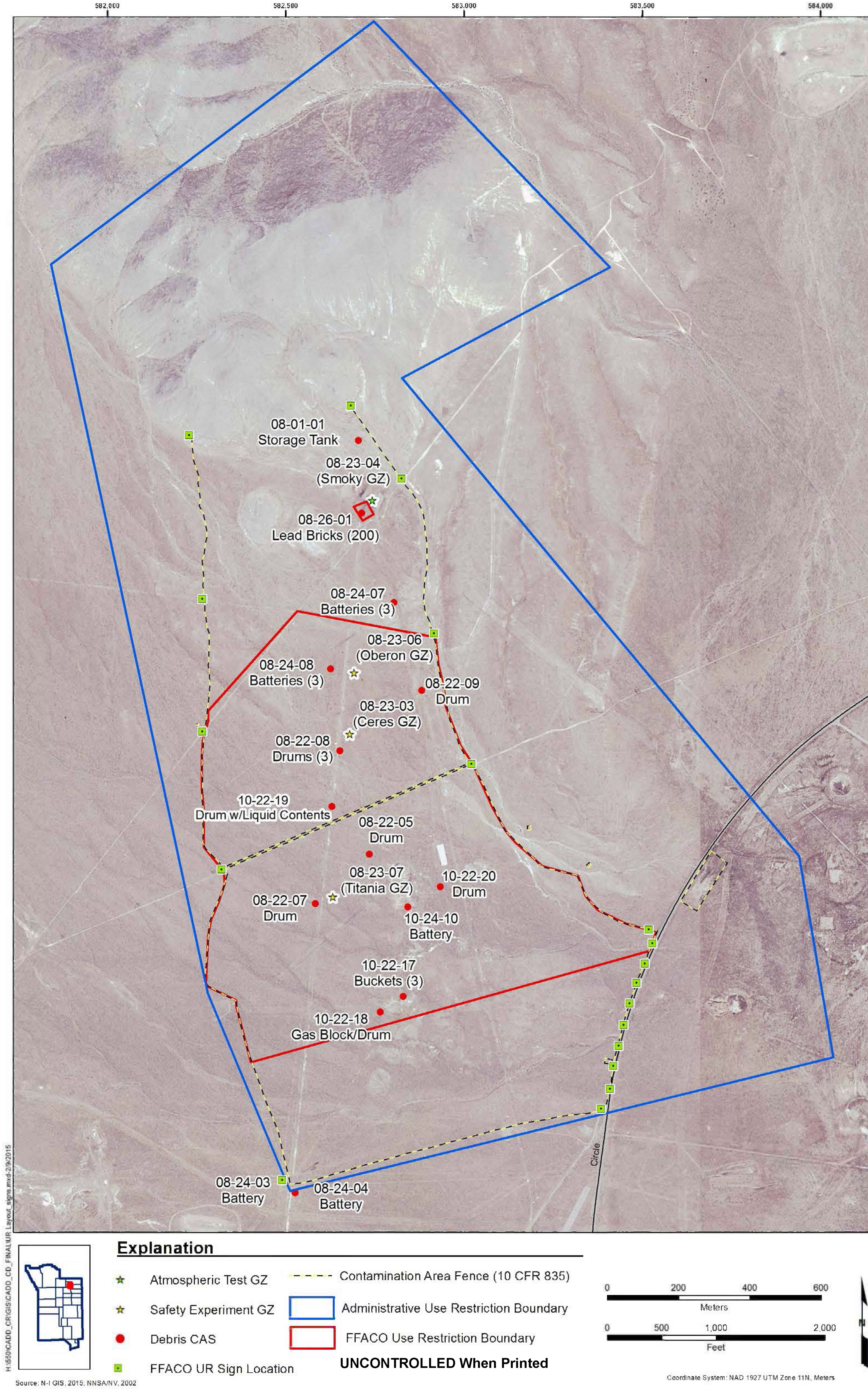
10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
			sentence: “The Smoky site encompasses CAS 08-26-01, Lead Bricks [200]. The lead bricks were investigated as a separate CAS in Study Group 4 (Debris) due to the potential for lead contamination in the soil. Although the lead bricks were not investigated as part of Study Group 1 (CAS 08-23-04, Smoky Atmospheric Test), the lead bricks are directly related to the Smoky test and are considered an integral part of the Smoky historic landscape.”	

Plate 1

Use Restriction Boundaries at CAU 550



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