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National Nuclear Security Administration

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 571: Area 9 Yucca Flat Plutonium Dispersion Sites Nevada National Security Site, Nevada

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/s/ Joseph P. Johnston	08/04/2014
Joseph P. Johnston, N-I CO	Date

U.S. Department of Energy
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CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 571: AREA 9 YUCCA FLAT PLUTONIUM DISPERSION SITES 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 571: AREA 9 YUCCA FLAT PLUTONIUM DISPERSION SITES NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/Tiffany A. Lantow Date: 8/5/2014

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List of Acronyms and Abbreviations

Ac	Actinium
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
COC	Contaminant of concern
COPC	Contaminant of potential concern
cpm	Counts per minute
cps	Counts per second
CR	Closure report
Cs	Cesium
CSM	Conceptual site model
day/yr	Days per year
DCB	Default contamination boundary

List of Acronyms and Abbreviations (Continued)

DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EPA	U.S. Environmental Protection Agency
Eu	Europium
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
GIS	Geographic Information Systems
GPS	Global Positioning System
GZ	Ground zero
HAZMAT	Hazardous materials
HCA	High contamination area
hr/day	Hours per day
hr/yr	Hours per year
in.	Inch
kg/cm^3	Kilograms per cubic centimeter
kt	Kiloton

List of Acronyms and Abbreviations (Continued)

lb	Pound
LCS	Laboratory control sample
LLW	Low-level radioactive waste
LVF	Load Verification Form
m	Meter
m^2	Square meter
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MLLW	Mixed low-level radioactive waste
M&O	Management and operating
MOB	Multiples of background
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
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
N-I	Navarro-Intera, LLC
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
NSTec	National Security Technologies, LLC

List of Acronyms and Abbreviations (Continued)

OU	Occasional Use
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
RadCon	Radiological control
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RSL	Regional Screening Level
RWMC	Radioactive waste management complex
SCL	Sample collection log
SG	Study group
Sr	Strontium
SVOC	Semivolatile organic compound
TBD	To be determined
Tc	Technetium
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose

List of Acronyms and Abbreviations *(Continued)*

TLD	Thermoluminescent dosimeter
TMMC	Toxco Materials Management Center
TPH	Total petroleum hydrocarbons
TRS	Terrestrial radiological survey
TSDF	Treatment, storage, and disposal facility
U	Uranium
UCL	Upper confidence limit
UGTA	Underground Test Area
UR	Use restriction
URMA	Underground radioactive material area
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
WCL	Waste container log
yd^3	Cubic yard

Executive Summary

This Corrective Action Decision Document/Closure Report presents information supporting the closure of Corrective Action Unit (CAU) 571: Area 9 Yucca Flat Plutonium Dispersion Sites, Nevada National Security Site, Nevada. This 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 571 comprises the five corrective action sites (CASs) listed in Table ES-1.

Table ES-1
CAU 571 CASs and Corrective Actions

CAS Number	FFACO CAS Description	Corrective Action
09-23-03	Atmospheric Test Site S-9F	Closure in Place
09-23-04	Atmospheric Test Site T9-C	Closure in Place
09-23-12	Atmospheric Test Site S-9E	Closure in Place
09-23-13	Atmospheric Test Site T-9D	Closure in Place
09-45-01	Windrows Crater	Closure in Place

The purpose of this Corrective Action Decision Document/Closure Report is to provide justification and documentation supporting the recommendation that no further corrective action is needed for CAU 571 based on the implementation of the corrective actions listed in Table ES-1.

Corrective action investigation (CAI) activities were performed from October 2013 through January 2014, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 571: Area 9 Yucca Flat Plutonium Dispersion Sites, Nevada National Security Site, Nevada*; and in accordance with the *Soils Activity Quality Assurance Plan*, which establishes requirements, technical planning, and general quality practices.

The approach for the CAI was to investigate and make data quality objective (DQO) decisions based on the types of releases present. To facilitate site investigation and DQO decisions, all identified releases (i.e., CAS components) were organized into study groups. The reporting of investigation results and the evaluation of DQO decisions are at the release level. The corrective action alternatives (CAAs) were evaluated and corrective actions applied at the FFACO CAS level.

The purpose of the CAI was to fulfill data needs as defined during the DQO process. The CAU 571 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 final action levels (FALs) established in this document. A radiological dose FAL of 25 millirem per year was established based on the Occasional Use Area exposure scenario (80 hours of annual exposure). Although radiological doses exceeding the FAL were not detected at any sample location, it is assumed that radiological dose exceeding the FAL is present within several high contamination areas and landfills that were not sampled due to worker protection. These areas require corrective action. Interim corrective actions of removal were completed during the CAI for several items of potential source material and one location where chemical soil contamination exceeded a FAL. After the interim corrective actions were implemented, it was determined that no further corrective actions are necessary for the potential source material and chemical soil contamination.

The corrective actions implemented at CAU 571 were developed based on an evaluation of analytical data from the CAI and the assumed presence of contaminants of concern at specific locations, a review of future and current operations in this portion of Area 9, and the detailed and comparative analysis of the CAAs. The CAAs were selected 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 571.
- The Nevada Division of Environmental Protection issue a Notice of Completion to the DOE National Nuclear Security Administration Nevada Field Office for closure of CAU 571.
- CAU 571 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) 571, Area 9 Yucca Flat Plutonium Dispersion Sites, located at the Nevada National Security Site (NNSS), Nevada. CAU 571 comprises the five corrective action sites (CASs) listed in Table 1-1 and shown on Figure 1-1.

Table 1-1
CAU 571 CAS Information

CAS Number	FFACO CAS Description	Associated Test	Site Name
09-23-03	Atmospheric Test Site S-9F	Juno	Juno
09-23-04	Atmospheric Test Site T9-C	Post	Post
09-23-12	Atmospheric Test Site S-9E	Vesta	Vesta
09-23-13	Atmospheric Test Site T-9D	Mazama	Mazama
09-45-01	Windrows Crater	Juno, Vesta, Mazama	Windrows

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 571: Area 9 Yucca Flat Plutonium Dispersion Sites, Nevada National Security Site, Nevada* (NNSA/NFO, 2013).

The release sources specific to CAU 571 are listed in Table 1-2. 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 for different releases were organized into study groups. The study groups and the CASs associated with each release are described in Table 1-2. The need for corrective action and corrective action alternatives (CAAs) are evaluated separately for each release.

The following identifies the release sources specific to CAU 571:

- Post was a weapons-related test conducted on April 9, 1955, as part of Operation Teapot. The test consisted of a primarily plutonium and uranium device that was detonated atop a 300-foot (ft) tower. The resulting yield was 2 kilotons (kt) (DOE/NV, 2000).

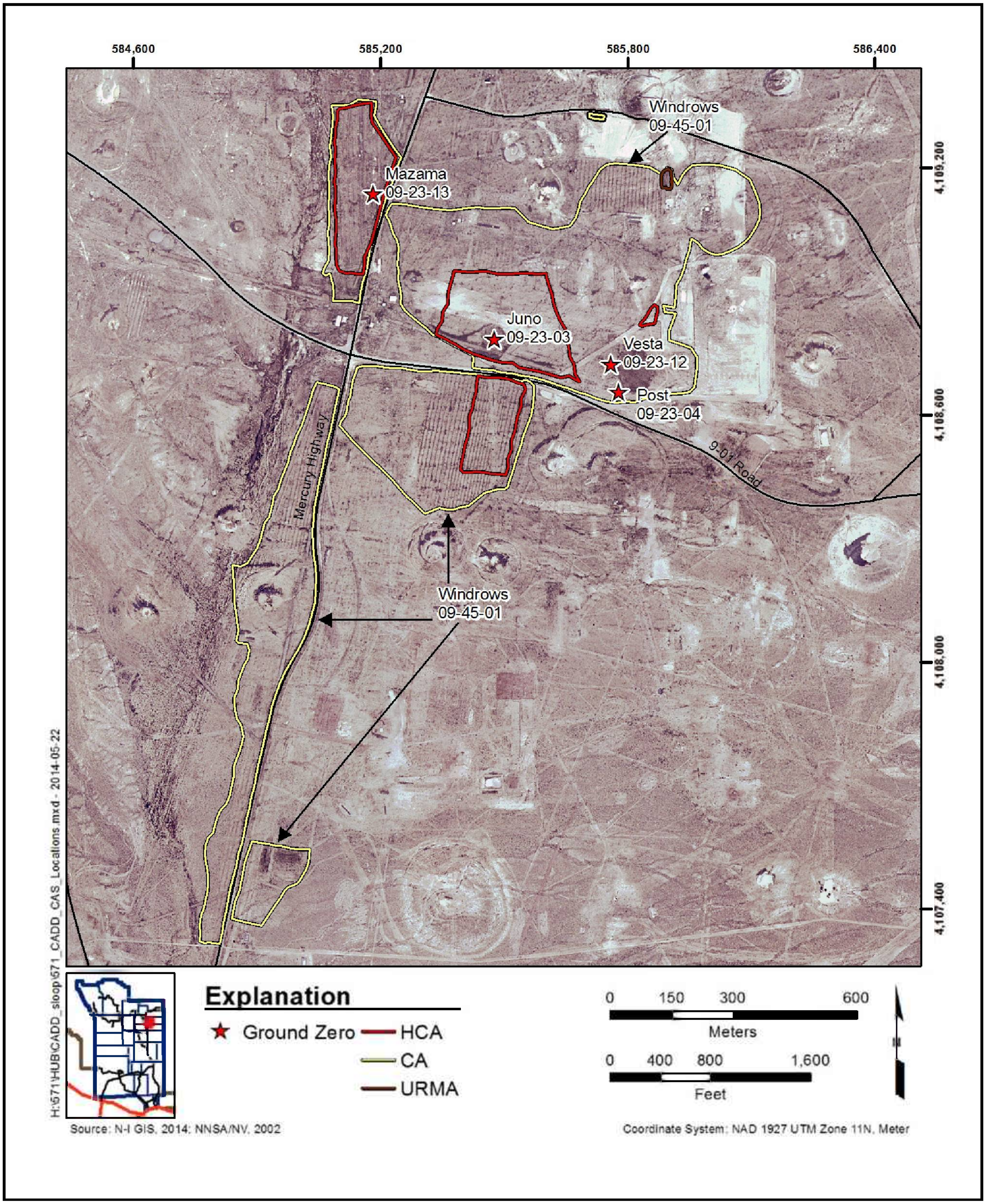

Figure 1-1
CAU 571 CAS Location Map

Table 1-2
CAU 571 Study Groups

Study Group	Description	FFACO CASs	Release
N/A	Default Contamination Boundaries (DCBs)	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), 09-23-13 (Mazama), and 09-45-01 (Windrows)	The DCBs were established based on the assumed presence of removable contamination at levels exceeding HCA criteria (Juno, Mazama, and Windrows) and the impracticality of characterizing a heterogenous landfill (Juno, Vesta, and an URMA Pile).
Study Group 1	Atmospheric Release	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), and 09-23-13 (Mazama)	This study group consists of the areas of relatively undisturbed atmospheric deposition of radionuclides from weapons-related tests and safety experiments.
Study Group 2	Subsurface Contamination	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), and 09-23-13 (Mazama)	This study group consists of the areas of atmospheric deposition of radionuclides from weapons-related tests and safety experiments that have subsequently been disturbed or covered.
Study Group 3	Windrows	09-45-01 (Windrows)	This study group consists of areas where the initial surface release of radionuclides from weapons-related tests and safety experiments were placed in rows (i.e., windrows). The windrows were then sprayed with road oil.
Study Group 4	Drainage	09-23-03 (Juno), 09-23-04 (Post), and 09-23-12 (Vesta)	This study group consists of a drainage where the initial surface release of radionuclides from weapons-related tests and safety experiments was subsequently displaced through erosion.
Study Group 5	Other	09-23-03 (Juno) and 09-23-12 (Vesta)	This study group consists of all other radiological and chemical releases identified that do not fall into any other study groups. This includes potentially contaminated debris, stained soil, and other radiologically contaminated areas.

HCA = High contamination area
N/A = Not applicable
URMA = Underground radioactive material area

- Vesta was a safety experiment conducted on October 17, 1958, as part of Operation Hardtack II. The test consisted of a primarily plutonium and uranium device that was detonated in a gravel gertie. The resulting yield was 24 tons (DOE/NV, 2000).

- Juno was a safety experiment conducted in October 24, 1958, as part of Operation Hardtack II. The test consisted of a primarily plutonium device that was detonated in a gravel gertie. The resulting yield was 1.7 tons (DOE/NV, 2000).

- Mazama was a weapons-related test conducted on October 29, 1958, as part of Operation Hardtack II. The test consisted of a primarily plutonium device that was detonated atop a 50-ft tower. There was no yield (DOE/NV, 2000).

- During a decontamination effort, contaminated soil was scraped into 2-ft-high-by-3-ft-wide windrows and then sprayed with road oil.
- Migration of contaminants through erosion from the test releases may have occurred at the site.
- Other potential releases—such as potential source material (PSM), a radiologically posted contamination area (CA), and stained soil—are present at CAU 571.

Potential releases that are also included and evaluated in the closure of CAU 571 are underground tests throughout the area with a documented release (referred to as Underground Test Area [UGTA] Releases in this document), which include U9g (Codsaw), U9ay (Oconto), U9ar (Driver), and U9w (Kootanai).

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 571 based on the implementation of corrective actions. This includes a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed. The CAIP (NNSA/NFO, 2013) provides information relating to the scope and planning of the investigation. Therefore, that information will not be repeated in this document.

1.2 Scope

The corrective action investigation (CAI) for CAU 571 was completed by demonstrating through environmental soil and thermoluminescent dosimeter (TLD) sample analytical results the nature and extent of contaminants of concern (COCs) at any 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 presence of a COC requires a corrective action. A corrective action is also required if a waste present within a release site contains a contaminant that, if released to the soil, would cause the soil to contain a COC. Such a waste is considered to be PSM as defined in the Soils Risk-Based Corrective Action (RBCA) document (NNSA/NFO, 2014).

The activities used to identify, evaluate, and recommend preferred CAAs for CAU 571 included the following:

- Performed visual surveys to identify biasing factors for selecting soil and PSM sample locations.
- Performed radiological surveys to identify biasing factors for selecting soil and PSM sample locations.
- Established sample plots and biased sample locations.
- Collected soil samples at sample plots and biased sampling locations.
- Submitted soil samples for analysis.
- Staged TLDs at soil sample and background locations.
- Collected and submitted TLDs for analysis.
- Collected Global Positioning System (GPS) coordinates of sample locations, TLD locations, and points of interest.
- Conducted interim corrective actions (i.e., PSM and soil removal).
- Conducted waste management activities (e.g., sampling, disposal).
- Evaluated corrective action objectives based on the results of the CAI and the CAA screening criteria.
- Implemented and justified CAAs.

The CAI activities were completed in accordance with the CAIP (NNSA/NFO, 2013) except as noted in Appendix A and in accordance with the *Soils Activity Quality Assurance Plan* (QAP) (NNSA/NSO, 2012), 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 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, "Recommendation," 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 571 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 571.

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 recommended alternative.

Appendix F, *Sample Location Coordinates*, presents the CAI sample location coordinates.

Appendix G, *Nevada Division of Environmental Protection Comments*, contains responses to Nevada Division of Environmental Protection (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 571, Area 9 Yucca Flat Plutonium Dispersion Sites Nevada National Security Site, Nevada (NNSA/NFO, 2013)
- Soils QAP (NNSA/NSO, 2012)
- Soils RBCA document (NNSA/NFO, 2014)
- FFACO (1996, as amended)

1.3.2 Data Quality Assessment Summary

The CAIP (NNSA/NFO, 2013) 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 571 have been adequately identified to implement the corrective actions. Information generated during the investigation supports the conceptual site model (CSM) assumptions, and the data collected met 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 571. Detailed investigation activities and results for individual CAU 571 study groups are presented in Appendix A of this document.

2.1 Investigation Activities

CAI activities were conducted from October 2013 through January 2014. The purpose of the CAU 571 CAI was to provide the additional information needed to resolve the following CAU 571-specific DQOs:

- Determine whether COCs are present in the soils associated with CAU 571.
- Determine the extent of identified COCs.
- Ensure adequate data have been collected to evaluate closure alternatives under the FFACO.

The field investigation was completed as specified in the CAIP as described in Sections A.2.1 through A.2.5, which provide the general investigation and evaluation methodologies.

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

The DQO Decision I (the presence of a COC) is resolved for the locations that exceed HCA criteria or contain PSM (e.g., lead items). DQO Decision II (the extent of COC contamination) was resolved for the locations that exceed HCA criteria by the currently established HCA boundaries and for the PSM by collecting soil samples in the area potentially impacted by the PSM.

For DQO Decision I at other potential release sites, sample locations were established judgmentally based on the presence of biasing factors (e.g., staining and 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 in 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).

Sample locations for DQO Decision II (the extent of COC contamination) for chemical COCs were selected judgmentally at locations surrounding the estimated extent of COC contamination.

The TED 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, 2014) 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 industrial workers to contaminants in soil:

- **Industrial Area.** Assumes continuous industrial use of a site. This scenario assumes that this 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], 250 days per year [day/yr] for 25 years). The TED values calculated using this exposure scenario are the TED an industrial area 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 this 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 on 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 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 addresses industrial workers who are not assigned to the area as a regular worksite but may occasionally use the site. This scenario assumes that this 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 QAP (NNSA/NSO, 2012), the dataset quality 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 FALs are based on the Occasional Use Area site-specific exposure scenario, and chemical FALs are based on the Industrial Area exposure scenario.

The RBCA dose evaluation does not address the potential for removable contamination to be transported to other areas. A discussion on the risks associated with removable radioactive contamination is presented in the Soils RBCA document (NNSA/NFO, 2014). 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.

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 the CAU 571 investigation activities. Additional detail regarding the investigation is presented in Appendix A.

2.1.1 Default Contamination Boundaries

DCBs were established during the DQOs and agreed to by decision makers in the CAIP (NNSA/NFO, 2013). The DCBs were not a part of the CAI, as these areas were assumed to contain contamination levels that exceed the FAL, thus requiring corrective action. The extents of the DCBs were determined by visual inspection and were established based on an existing radiologically posted fence line or, in the case of the Vesta Landfill, the surface expression of the mounded landfill. Because a portion of the area impacted by the Post weapons-related test falls within the Vesta Landfill DCB, Post (CAS 09-23-04) will be captured within the Vesta Landfill DCB (CAS 09-23-12). The DCBs are shown in Figure A.3-1.

2.1.2 Study Group 1

Investigation activities at Study Group 1 included performing visual inspections, conducting GPS-assisted terrestrial radiological surveys (TRSs), staging TLDs, and collecting soil samples. The TRSs were conducted within Study Group 1 (i.e., the relatively undisturbed areas outside the Study Group 2 area) to identify locations of elevated radiological readings. The TRS results were very near background levels. Three separate areas within Study Group 1 that could potentially be impacted by the plume were selected for investigation. The highest radiological reading from the TRSs biased the exact location of each sample plot within each of the preselected areas. Therefore, one 100-square-meter (m^2) sample plot was established in each of three selected areas, with each plot being established at the highest TRS readings in that preselected area (see Figure A.4-2).

TLDs were installed at the three sample plot locations within Study Group 1 to measure external radiological doses. Sampling activities to determine internal dose at the three sample plots consisted of collecting composite surface soil samples from nine unbiased locations within each sample plot.

See Section A.4.1 for additional information on investigation activities at Study Group 1. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2013). The contamination pattern of the radionuclides at Study Group 1 is consistent with the CSM in that the radiological contamination decreases with distance from the release points. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.3 Study Group 2

Investigation activities at Study Group 2 included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, field screening at depth, and collecting soil samples. The TRSs were conducted within the atmospheric release area that had previously been disturbed as a result of decontamination activities and underground testing to identify locations of elevated radiological readings. The TRS results showed that the highest radiation readings were generally located in between the Juno HCA and the Vesta Landfill. One 100-m^2 sample plot was established at the two locations (B01 and B02) with the highest TRS readings (see Figure A.5-2). An additional 14 sample plots were established at intervals along the Juno and Vesta Landfill DCBs.

TLDs were installed at all 16 sample plot locations within Study Group 2 to measure external radiological doses. Sampling activities to determine internal dose at sample plots consisted of collecting composite surface soil samples at each of the 16 sample plots. The CSM includes the potential for contamination to have been mixed into the subsurface or covered with fill material. Therefore, the soil from the center of all 16 sample plots was screened in 5-centimeter (cm)-depth intervals until native soil was reached to determine whether buried contamination may be present (see Section A.2.2.2). As a result of this screening, two subsurface soil grab samples were collected from the center of two sample plot locations (B04 and B13). See Section A.5.1 for additional information on investigation activities at Study Group 2. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2013). The contamination pattern of the radionuclides at Study Group 2 is consistent with the CSM in that the radiological contamination decreases with distance from the release points. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.4 Study Group 3

Investigation activities at Study Group 3 included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, and collecting surface and subsurface soil samples. The TRSs were conducted within the five defined windrow zones to identify locations of elevated radiological readings. Figure A.6-1 depicts the five windrow zones, while Figure A.6-2 shows the results of the TRSs. The TRS results showed that the highest radiological readings were located within windrows zones 1 and 2. However, a minimum of two sample locations were selected within each of the five windrow zones. Within each zone, the first sample location was established at the location with the highest radiological reading as detected during the TRSs, while the second (or third) sample was selected in the location with the subsequent highest readings (see Figure A.6-2).

TLDs were installed at 12 grab sample locations within Study Group 3 to measure external radiological doses. Sampling activities to determine internal dose at grab sample locations consisted of collecting soil from the surface to the base of the windrow at each of the 12 sample locations. Three sample locations were selected in each of windrow zones 1 and 2, while two sample locations were selected in each of the remaining windrow zones 3, 4, and 5. The sample locations were visually surveyed to determine whether there was evidence of road oil application to further bias the analysis for these locations. See Section A.6.1 for additional information on investigation activities at Study Group 3. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2013). The contamination pattern of the radionuclides at Study Group 3 is consistent with the CSM in that the radiological contamination decreases with distance from the release points. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.5 Study Group 4

Investigation activities at Study Group 4 included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, field screening at depth, and collecting soil samples. Minor sedimentation areas were identified within the only drainage in the CAU 571 investigation area. The drainage is located north of the windrow zone 2. The TRSs were conducted within the drainage, including the sedimentation areas, to identify locations of elevated radiological readings for sample location selection (see Figure A.7-1). The TRS results indicated that the radiological readings were very near background and did not influence the selection of sample locations within the sedimentation areas.

TLDs were installed at the two grab sample locations identified within the sedimentation areas to measure external radiological doses. Sampling activities to determine internal dose at grab sample locations consisted of collecting surface soil samples at two sedimentation locations (see Figure A.7-1). The CSM includes the potential for contamination to be present at depth due to migration. Therefore, sample locations were screened in 10-cm-depth intervals until native soil was reached to determine whether buried contamination may be present (see Section A.2.2.2). As buried contamination was not identified at any location, subsurface samples were not submitted for this study group. See Section A.7.1 for additional information on investigation activities at Study Group 4. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2013). Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.6 Study Group 5

Investigation activities at Study Group 5 included performing visual inspections, conducting GPS-assisted TRSs, staging TLDs, field screening at depth as applicable, and collecting soil samples. During the investigation, PSM, stained soil, and an area with removable contamination that exceeds the criteria for a CA was identified. Several debris items (three drums and an oil filter) were identified but determined to not be PSM. The TRS was conducted within this CA to identify the location with the most elevated radiological readings.

A TLD was installed at one sample plot within the CA in the area with the most elevated radiological readings (as determined by the TRS) to measure external radiological doses. Sampling activities to determine internal dose at sample plots consisted of collecting composite surface soil samples at this sample plot. The CSM includes the potential for contamination to have been mixed into the subsurface. Therefore, soil from the center of the sample plot was screened in 5-cm-depth intervals to determine whether buried contamination may be present (see Section A.2.2.2). As buried contamination was not identified, no subsurface samples were collected.

Additional sampling activities in Study Group 5 consisted of collecting samples at PSM and stained soil locations. Sample plots were established at PSM locations to evaluate the presence of COCs within an area that could conceivably be impacted by the PSM. The size of the sample plot was determined by the extent of the PSM. There were 18 sample plots established at lead and battery locations. Three grab sample locations were selected based on the presence of stained soil, while two samples were collected to investigate the asphalt pile. As these locations were being evaluated for chemical COCs, no TLDs were placed at PSM or stained soil sample locations (see Figure A.8-1).

See Section A.8.1 for additional information on investigation activities at Study Group 5. Results of the sampling effort are reported in Section 2.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2013). Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.2 Results

The data summary provided in Section 2.2.1 discusses the COCs identified at CAU 571. Section 2.2.2 summarizes the assessment made 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 571 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/NFO, 2013) 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 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 8 hr/day for 10 day/yr). To be comparable to these action levels, the CAU 571 investigation results are presented in terms of the dose a receptor would receive from site contamination under the Industrial Area (mrem/IA-yr), Remote Work Area (mrem/RW-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 *Resource Conservation and Recovery Act* (RCRA) metal exceed the screening level (e.g., arsenic on the NNSS). 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 5. All sampling and analyses were conducted as specified in the CAIP (NNSA/NFO, 2013).

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 comparable to the dose-based FAL of 25 mrem/OU-yr as established in Appendix C. Calculation of the TED for each sample was accomplished through summation of internal and external dose as described in Section A.2.3.

Judgmental sample results are reported as individual analytical results. Probabilistic sample results are reported as the average and the 95 percent UCL of the average results.

2.2.1.1 Default Contamination Boundaries

Several DCBs were established in the CAIP (NNSA/NFO, 2013). The DCBs were assumed to have contamination at levels that exceeds the FAL for the radiological dose (25 mrem/OU-yr). Therefore, the DCBs, as shown in Figure A.3-1, require corrective action.

2.2.1.2 Study Groups 1, 2, 3, and 4

Based on the results of TLD and soil samples collected at Study Groups 1, 2, 3, and 4, radiological contamination did not exceed the FAL for the radiological dose (25 mrem/OU-yr) outside the DCBs, and no chemical COCs were identified. Therefore, a corrective action is not required for these study groups. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations as well as any sample results for chemical analyses are reported in Sections A.4.0 through A.7.0.

2.2.1.3 Study Group 5

Based on the TLD and soil sample result at the CA in Study Group 5, radiological contamination did not exceed the FAL for the radiological dose (25 mrem/OU-yr). Therefore, a corrective action is not required based on the results of samples collected for potential radiological contamination. The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios as well as any sample results for grab samples with chemical and radiological analyses are reported in Section A.8.0.

There were 26 items of PSM in the form of lead and batteries as well as one soil location (E08) with contamination that exceeded the FAL for lead. An interim corrective action of removing all of the PSM as well at the lead-contaminated soil was completed. A verification sample was collected and it was determined that lead in the remaining soil was below FALs and no additional corrective action is required. Sample location E08 is shown in Figure A.8-1. The analytical results of the soil sample collected after corrective action are presented in Table A.8-10. Soil samples collected at the stained soil and asphalt pile did not exceed chemical FALs.

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 some of the data were qualified in the areas of accuracy and precision. However, these deficiencies do not affect the decision-making process.

The results of the DQI evaluation in Appendix B show that all DQI criteria were met and that the CAU 571 dataset supports their intended use in the decision-making process. Based on the results of the DQA, the nature and extent of COCs at CAU 571 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 571 based on the absence of contamination exceeding risk-based levels (presented in Section 2.3.1) or the implementation of the corrective actions based on an evaluation of risk, feasibility, and cost effectiveness (presented in Appendix E). The need for corrective action is evaluated for each release through the resolution of the DQO decisions as presented in Section 2.3.2. The implementation of corrective actions at CAU 571 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). 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 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 a quick regulatory closure or warrant a more site-specific assessment. For chemical contaminants, this was accomplished by comparing individual source area contaminant concentration results to the Tier 1 action levels (the PALs established in the CAIP). 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.

The FALs for all non-radiological contaminants were established as the Tier I action levels. The FALs for radiological contaminants were passed on to a Tier 2 evaluation.

The Tier 2 evaluation was conducted in accordance with the Soils RBCA document (NNSA/NFO, 2014). This evaluation (presented in Appendix C) was based on risk to receptors. The risk to receptors from contaminants at CAU 571 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 571 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 571 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 571, current and anticipated future site activities were evaluated in Appendix C. This evaluation concluded that the most exposed worker under current land usage is an Inspection and Maintenance worker, who has the potential to be present at the site for up to 10 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 exposure scenario (80 hr/yr). Therefore, the Tier 2 action level and the TEDs at each location were calculated using a more conservative exposure time of 80 hr/yr. For Decision I, the 95 percent UCL of the TED measured at each location was used to compare to the FAL. Additional details of the Tier 2 evaluation for radionuclides are provided in Appendix C.

The FALs for all CAU 571 contaminants of potential concern (COPCs) are shown in Table 2-1.

Table 2-1
Definition of FALs for CAU 571 COPCs

COPCs	Tier 1 Based FALs	Tier 2 Based FALs	Tier 3 Based FALs
VOCs	EPA Region 9 RSLs	None	N/A
SVOCs	EPA Region 9 RSLs	None	N/A
Dioxins	EPA Region 9 RSLs	None	N/A
PCBs	EPA Region 9 RSLs	None	N/A
RCRA metals	EPA Region 9 RSLs	None	N/A
Radionuclides	None	25 mrem/OU-yr	N/A

PCB = Polychlorinated biphenyl
SVOC = Semivolatile organic compound
VOC = Volatile organic compound

A corrective action may also be required if a waste present within a CAS 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 is made that any physical waste containment will fail at some point and the contaminants will be released to the surrounding media. The criteria to be 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 presented in Section 2.3.1 for the resolution of DQO decisions and the need for corrective action.

2.3.2.1 DCB Resolution of DQO Decisions

The DCBs established in the CAIP define areas where it is assumed that contamination is present that exceeds FALs. Because a COC is assumed to be present, the resolution of Decision I is that corrective action is required for each DCB (see Figure A.3-1) and that Decision II must be resolved. Decision II (i.e., the extent of COC contamination and the volume of potential corrective action wastes) for the DCBs is resolved based on the defined areas (i.e., boundaries) of the DCBs as presented in Section 2.1.1 and the resulting volumes listed in Table E.2-1.

2.3.2.2 Study Groups 1 through 4 Resolution of DQO Decisions

Based on analytical results for TLDs and/or soil samples collected during the investigation of Study Groups 1 through 4, no COCs were identified. Additionally, based on the results of the TRSs, there was no indication of the potential for COCs originating from the UGTA Releases. Therefore, the resolution of Decision I is that no corrective action is needed and that Decision II does not need to be resolved.

2.3.2.3 Study Group 5 Resolution of DQO Decisions

PSM in the form of 13 lead items and 13 lead-acid batteries was identified at Study Group 5 during the CAI. Based on analytical results for TLDs and/or soil samples collected from the CA, the stained soil locations, and beneath the PSM items, a COC (lead) was only identified in the soil beneath one broken lead-acid battery location. Based on the identification of PSM (assumed to have the potential to release contamination to soil at levels that exceed a FAL) and the presence of a COC beneath a PSM item, the resolution of Decision I is that corrective action is required for each PSM item and the

COC-contaminated soil. An interim corrective action was completed by removing all of the PSM and lead-impacted soil at one location. After the interim corrective action, additional sampling was conducted to reevaluate Decision I for the remaining soil at that location. No remaining COCs were detected. Therefore, the final resolution of Decision I for Study Group 5 is that no corrective action is needed and that Decision II does not need to be resolved.

3.0 Recommendation

Corrective actions for each CAS were based on an evaluation of analytical data from the CAI, the assumed presence of COCs in select areas (DCBs), a review of current and future operations at CAU 571, the risk assessment presented in Appendix C, and the detailed and comparative analysis of the CAAs presented in Appendix E. The CAI results and actions implemented are summarized in Section A.11.0 and Table A.11-1.

It was assumed that radioactivity within the DCBs exceeds FALs and requires corrective action. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for each DCB is closure in place with an FFACO use restriction (UR). The FFACO URs implemented at each release site will protect site workers from inadvertent exposure. The FFACO URs are defined and shown in Attachment D-1. Based on the implementation of these corrective actions, no further corrective action is required for the DCBs.

PSM in the form of 13 lead items and 13 lead-acid batteries was identified at Study Group 5 during the CAI. A COC (lead) was identified in the soil beneath one broken lead-acid battery location. An interim corrective action was completed by removing all of the PSM and the lead-impacted soil. As no remaining PSM or COCs were present after the interim corrective action, no further corrective action is required for PSM or PSM-impacted soil.

Based on the CAU 571 CAI results for TLDs and/or soil samples collected after the interim corrective action, no COCs were identified and no corrective action is required.

Therefore, no further corrective action is required based upon implementation of corrective actions at the CAU 571 CASs. The corrective actions 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.

In accordance with the Soils RBCA document (NNSA/NFO, 2014) and Section 3.3 of the CAIP (NNSA/NFO, 2013), an administrative UR was implemented as a best management practice (BMP) for areas where (1) an industrial land use of the area could cause a future site worker to receive an annual dose exceeding 25 mrem/IA-yr or (2) removable radioactive contamination exceeds CA criteria. This assumes the worker would be exposed to site contamination for a period of 2,000 hr/yr. This administrative UR (implemented as a BMP) is not part of any FFACO corrective action.

In Study Group 2, the TED from surface soils exceeds a dose of 25 mrem/IA-yr under the Industrial Area scenario at sample locations B01, B02, and B03 (see Table A.5-6). To determine the extent of the area of the administrative UR, a correlation of radiation survey values to the average industrial area TED values was conducted for each radiation survey (see Table A.5-7). The radiation survey that exhibited the best correlation is the TRS. Based on these correlations, the radiation survey values that correspond to the 25-mrem/IA-yr PAL is 12.8 multiples of background (see Figure A.5-4). The second criterion for an administrative UR is the presence of removable contamination that meets CA criteria. Because the area in Study Group 2 that exceeds CA criteria encompasses the area that exceeds 25 mrem/IA-yr, the administrative UR boundary was based on the CA criteria and was established at the outer CA fence line. Additional BMPs include establishing an administrative UR for windrow zones 2, 3, and 4 in Study Group 3 as well as the CA in Study Group 5 because these areas have removable contamination that exceeds the criteria for a CA. The administrative URs are presented and shown in Attachment D-1.

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 571 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 approval from NDEP.

The NNSA/NFO requests that NDEP issue a Notice of Completion for this CAU 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).

4.0 References

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N-I GIS, see Navarro-Intera Geographic Information Systems.

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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 571. CAU 571 consists of the releases associated with the CASs listed in Table A.1-1 and shown on Figure A.1-1. All of the CAU 571 CASs are located in Area 9 of the NNSS.

Table A.1-1
CAU 571 CAS Information

CAS Number	FFACO CAS Description	Associated Test	Site Name
09-23-03	Atmospheric Test Site S-9F	Juno	Juno
09-23-04	Atmospheric Test Site T9-C	Post	Post
09-23-12	Atmospheric Test Site S-9E	Vesta	Vesta
09-23-13	Atmospheric Test Site T-9D	Mazama	Mazama
09-45-01	Windrows Crater	Juno, Vesta, Mazama	Windrows

To facilitate site investigation and the evaluation of DQO decisions for different releases, the reporting of investigation results and the evaluation of DQO decisions for different releases were organized into study groups. The study groups and the CASs or CAS components associated with each study group are described in Table A.1-2. Although the need for corrective action is evaluated separately for each release, CAAs are applied to each FFACO CAS.

The following identifies the release sources specific to CAU 571:

- Post was a weapons-related test conducted on April 9, 1955, as part of Operation Teapot. The test consisted of a primarily plutonium and uranium device that was detonated atop a 300-ft tower. The resulting yield was 2 kt (DOE/NV, 2000).
- Vesta was a safety experiment conducted on October 17, 1958, as part of Operation Hardtack II. The test consisted of a primarily plutonium and uranium device that was detonated in a gravel gertie. The resulting yield was 24 tons (DOE/NV, 2000).
- Juno was a safety experiment conducted in October 24, 1958, as part of Operation Hardtack II. The test consisted of a primarily plutonium device that was detonated in a gravel gertie. The resulting yield was 1.7 tons (DOE/NV, 2000).

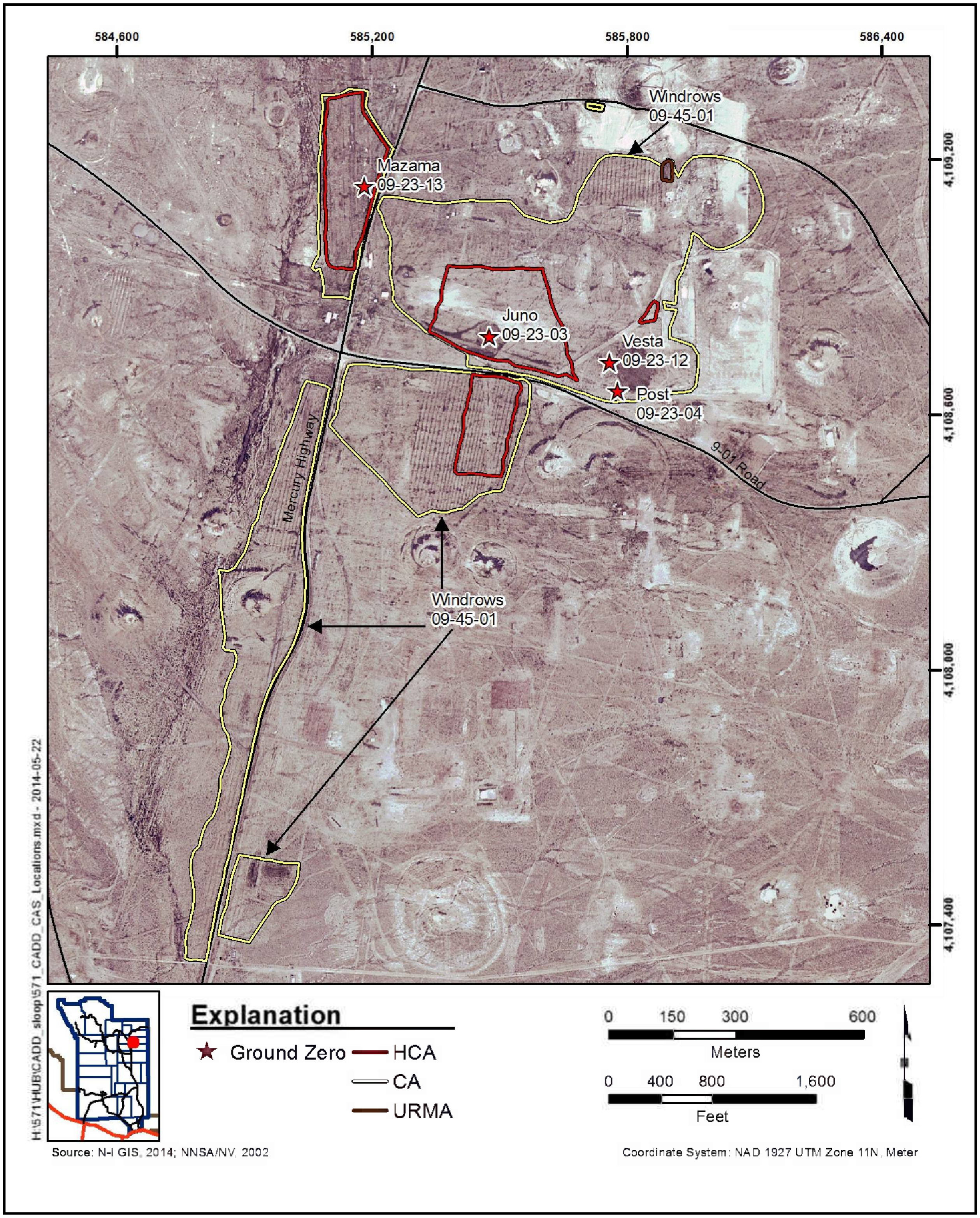

Figure A.1-1
CAU 571 CAS Location Map

Table A.1-2
CAU 571 Study Groups

Study Group	Description	FFACO CASs	Release
N/A	DCBs	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), 09-23-13 (Mazama), and 09-45-01 (Windrows)	The DCBs were established based on the assumed presence of removable contamination at levels exceeding HCA criteria (Juno, Mazama, and Windrows) and the impracticality of characterizing a heterogenous landfill (Juno, Vesta, and an URMA Pile).
Study Group 1	Atmospheric Release	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), and 09-23-13 (Mazama)	This study group consists of the areas of relatively undisturbed atmospheric deposition of radionuclides from weapons-related tests and safety experiments.
Study Group 2	Subsurface Contamination	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), and 09-23-13 (Mazama)	This study group consists of the areas of atmospheric deposition of radionuclides from weapons-related tests and safety experiments that have subsequently been disturbed or covered.
Study Group 3	Windrows	09-45-01 (Windrows)	This study group consists of areas where the initial surface release of radionuclides from weapons-related tests and safety experiments were placed in rows (i.e., windrows). The windrows were then sprayed with road oil.
Study Group 4	Drainage	09-23-03 (Juno), 09-23-04 (Post), and 09-23-12 (Vesta)	This study group consists of a drainage where the initial surface release of radionuclides from weapons-related tests and safety experiments was subsequently displaced through erosion.
Study Group 5	Other	09-23-03 (Juno) and 09-23-12 (Vesta)	This study group consists of all other radiological and chemical releases identified that do not fall into any other study groups. This includes potentially contaminated debris, stained soil, and other radiologically contaminated areas.

- Mazama was a weapons-related test conducted on October 29, 1958, as part of Operation Hardtack II. The test consisted of a primarily plutonium device that was detonated atop a 50-ft tower. There was no yield (DOE/NV, 2000).

- During a decontamination effort, contaminated soil was scraped into 2-ft-high-by-3-ft-wide windrows and then sprayed with road oil.

- Migration of contaminants through erosion from the test releases may have occurred at the site.

- Other releases such as lead items (including batteries), drums, an asphalt pile and a radiologically posted CA are present at CAU 571. There is the potential to find additional spills or debris that could provide a source for the release of contamination to the surface soils.

Potential releases that are also included and evaluated in the closure of CAU 571 are underground tests throughout the area with a documented release (referred to as UGTA Releases in this document), which include U9g (Codsaw), U9ay (Oconto), U9ar (Driver), and U9w (Kootanai).

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 571 CAIP (NNSA/NFO, 2013a).

A.1.1 Investigation Objectives

The objective of the investigation was to provide sufficient information to complete corrective actions and support the recommendation for closure of each CAS in CAU 571. This objective was achieved by identifying the nature and extent of COCs; and by evaluating, selecting, and implementing acceptable CAAs.

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 other types of contamination, a COC is defined as the presence of a contaminant at a concentration exceeding its corresponding FAL concentration (see Section A.2.4).

A.1.2 Contents

This appendix describes the investigation and presents the results. The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and the contents of this document.
- Section A.2.0 provides an investigation overview.
- Sections A.3.0 through A.8.0 provide specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.9.0 summarizes waste management activities.
- Section A.10.0 discusses the QA and quality control (QC) processes followed and the results of QA/QC activities.

- Section A.11.0 provides a summary of the investigation results.
- Section A.12.0 lists the cited references.

The complete field documentation and laboratory data—including field activity daily logs, sample collection logs (SCLs), analysis request/chain-of-custody forms, laboratory certificates of analyses, and analytical results are retained in CAU 571 files as hard copy documents or electronic media.

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 571 CAI were conducted between October 2013 and January 2014. 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/NFO, 2013a) (except any deviations described herein) and in accordance with the Soils 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 RBCA document (NNSA/NFO, 2014).

In accordance with the graded approach described in the Soils 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. The radiological and chemical FALs are presented in Appendix C.

The study groups were investigated by collecting TLD samples for external radiological dose calculations and collecting soil samples for the calculation of internal radiological dose and in some case, the presence of chemical COCs. The field investigation was completed as specified in the CAIP (NNSA/NFO, 2013a) and as described in Sections A.2.1 through A.2.4, which provide the general investigation and evaluation methodologies.

A.2.1 Sample Locations

All sample locations for CAU 571 were selected judgmentally, using biasing factors such as radiological survey results and/or the presence of debris. At locations 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 for each sample were identified using a predetermined random-start, triangular grid pattern.

Judgmental sample locations were selected based on visual biasing factors, such as sedimentation areas in washes or 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/NFO, 2013a) and the study-group-specific sections (Sections A.3.0 through A.8.0). Except as noted in the following subsections, CAU 571 sampling locations were accessible and sampling activities at planned locations were not restricted.

A.2.2 Investigation Activities

The investigation activities as listed in Section A.2.0 performed at CAU 571 were consistent with the field investigation activities specified in the CAIP (NNSA/NFO, 2013a). The investigation strategy provided the necessary information to establish the nature and extent of contamination associated with each study group. The following subsections describe the specific investigation activities that took place at CAU 571.

A.2.2.1 Radiological Surveys

Aerial surveys and TRSs were conducted at the CAU 571 CASs. An aerial survey was performed in the testing area in 2012 at an altitude of 50 ft with 75-ft flight-line spacing (NSTec, 2012). Ground-based radiological surveys (referred to in this document as TRSs) were performed to refine and verify the aerial radiological data and to identify specific locations for sample plots and biased sample locations. Count-rate data were collected with a TSA Systems PRM-470 model plastic scintillator as well as a field instrument for the detection of low-energy radiation (FIDLER). Count-rate and position data were collected and recorded at 1-second intervals, via a Trimble Systems GeoXT GPS unit. The travel speed was approximately 1 to 2 meters per second with the radiation detector held at a height of approximately 18 inches (in.) above the ground surface.

The PRM-470 did not show any areas of significantly elevated gamma activity that was not previously identified by the FIDLER because the tests resulted in mainly americium and plutonium contamination. Therefore, the FIDLER TRS results and the americium (Am)-241 aerial surveys best represent the contamination at this site. The FIDLER results were used to aid in selecting biasing locations, as discussed in the CAIP (NNSA/NFO, 2013a). Although the FIDLER survey results are collected in units of counts per minute (cpm), for the purpose of comparability, they are presented and evaluated in units of multiples of background. Figures A.2-1 and A.2-2 show the Am-241 aerial radiological survey and the FIDLER survey, respectively, for the entire area addressed in CAU 571.

A.2.2.2 Radiological Field Screening

The study-group-specific sections of this document identify the locations where field screening was conducted and how the field-screening levels (FSLs) were used to aid in the selection of samples submitted for analysis. Field-screening results (FSRs) are recorded on SCLs that are retained in project files.

Site-specific FSLs were determined each day before investigational soil sampling began. A location 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 cm of soil, were collected at random locations within the selected area. The aliquots were then mixed, and 10 one-minute static counts were 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.

Field screening was conducted at Study Groups 2, 4, and 5 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.

As part of the Study Groups 2 and 5 investigation, soil from a location selected at the center of each sample plot was removed and screened for radioactivity in 5-cm-depth increments to a total depth of 30 cm below ground surface (bgs). At Study Group 4, soil was screened in 10-cm intervals from a location established in each of two sedimentation areas. These 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 reading exceeded the FSL, and there was a greater than 20 percent difference between the depth interval reading and the surface soil

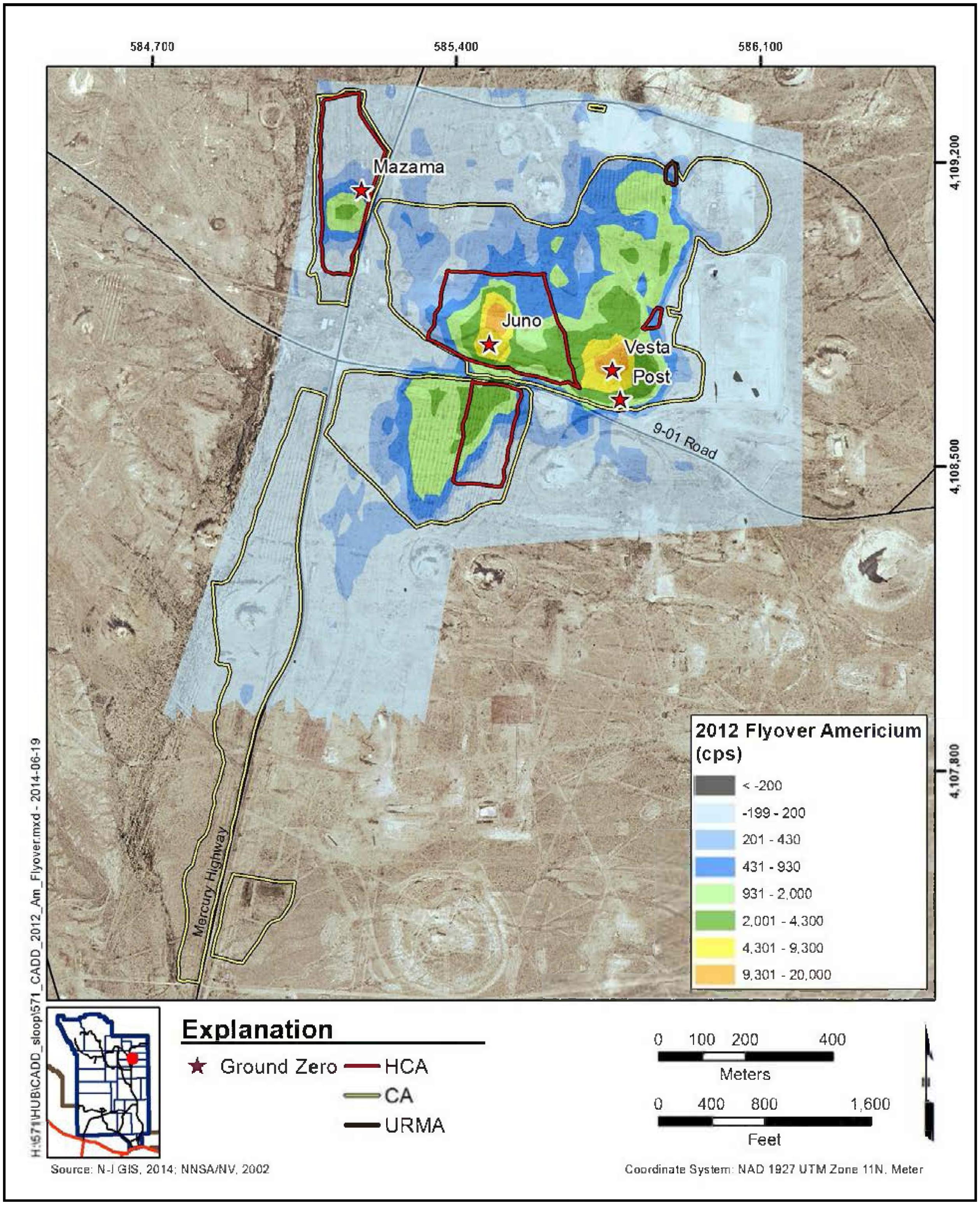

Figure A.2-1
CAU 571 Am-241 Aerial Data

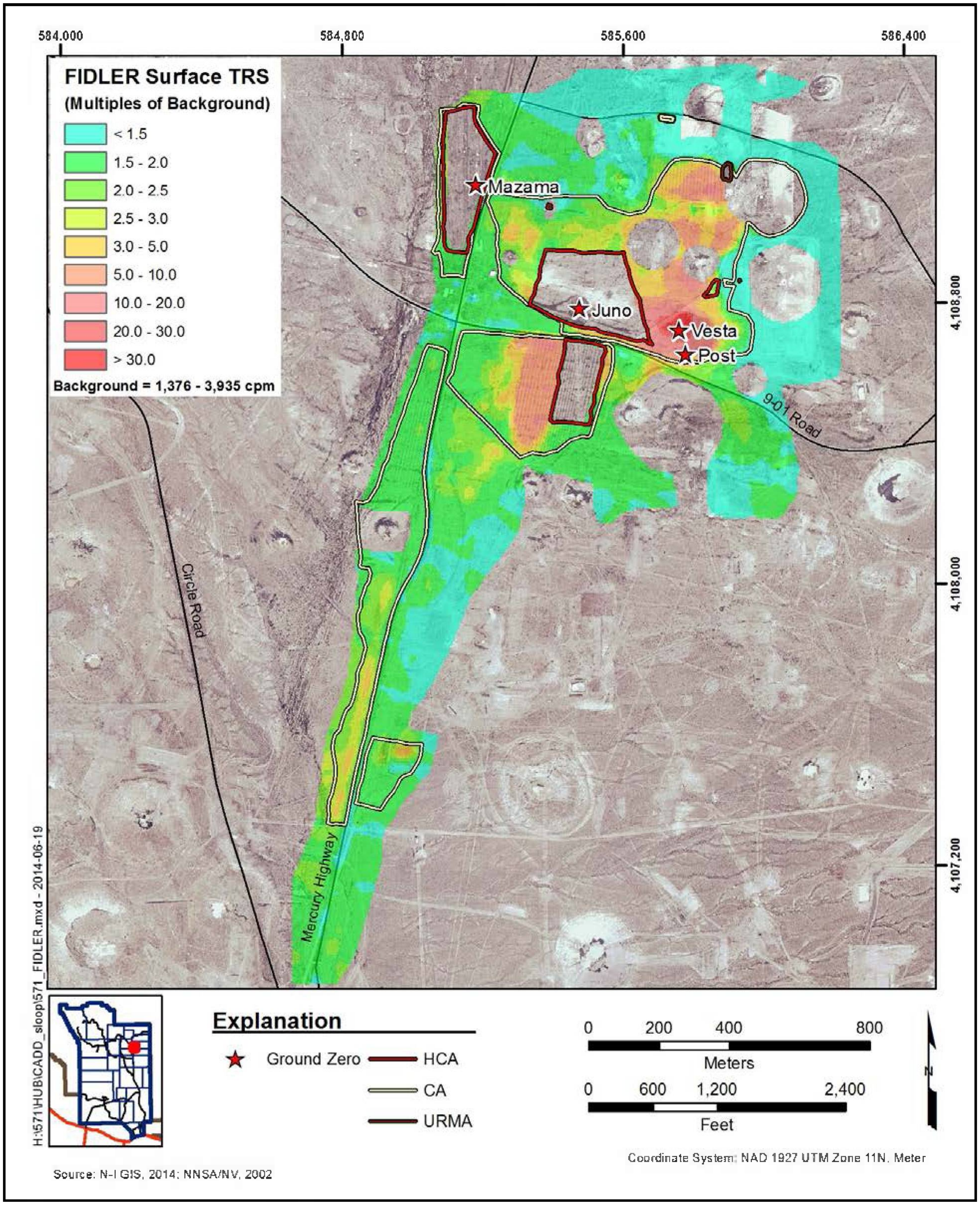

Figure A.2-2
CAU 571 FIDLER Survey Results

reading. For locations where it was determined that buried contamination was present, the subsurface depth interval with the highest reading was sent for offsite laboratory analyses.

A.2.2.3 TLD Sampling

TLDs (Panasonic UD-814) were staged at CAU 571 with the objective of collecting *in situ* measurements to determine the external radiological dose. TLDs were placed at select locations within each study group. TLDs were placed at both sample plot and grab sample locations where radiological constituents were evaluated.

TLDs were also placed at three background locations outside the influence of any identified release 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 the CAU-related releases during field deployment. The locations for the three background TLDs were selected using the 1994 background gamma aerial radiation survey (BN, 1999). 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 571. The background dose was determined to be the average of the background TLD results from H01, H02, and H03 (23.1 mrem/IA-yr).

Table A.2-1
Background TLD Samples

TLD Location	TLD Number	Date Placed	Date Removed	Purpose
H01	5296	07/22/2013	11/04/2013	Background
H02	4698			
H03	5147			

Each TLD was placed at a height of 1 meter (m) 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.10.0. All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location.

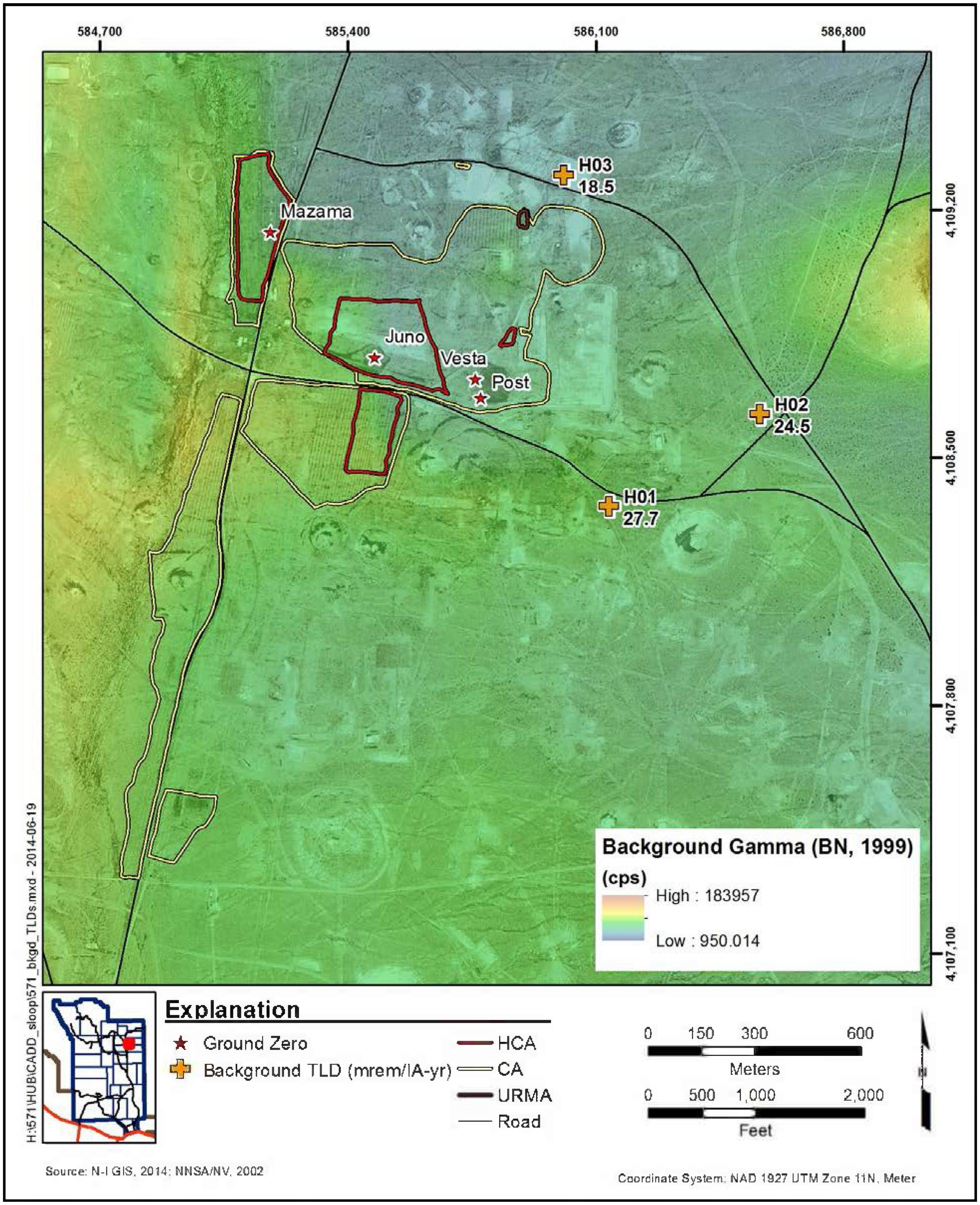

Figure A.2-3
CAU 571 Background TLD Locations and Results

A.2.2.4 Soil Sampling

Soil sampling at CAU 571 included the collection of surface and subsurface soil samples within sample plot and grab sample locations.

Within each sample plot, 4 composite surface samples were collected. Each composite sample was composed of 9 randomly located aliquots, resulting in a total of 36 aliquots collected from each plot. Each aliquot was collected using a "vertical-slice cylinder and bottom-trowel" method. This required the insertion of the 3.5-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 captured a cylindrical-shaped section of the soil from 0 to 5 cm bgs.

At subsurface locations, samples were collected using a disposal scoop from predetermined depth intervals based on the field screening process as described in Section A.2.2.2.

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 (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 RRMG (NNSA/NFO, 2014) 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. Soil concentrations of plutonium isotopes are inferred from gamma spectroscopy results as described in the representativeness discussion of 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 the internal dose.

For TLD locations where 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:

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

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

External dose was calculated using TLDs. The TLDs used at CAU 571 contain four individual elements. External dose at each TLD location is determined using the readings from TLD elements 2, 3, and 4. Each of these elements is considered to be a separate independent measurement of external dose. A 95 percent UCL of the average of these measurements was calculated for each TLD location.

Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose for the purpose of this investigation.

For subsurface sample locations where external dose measurements were not available, 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:

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

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 571 sites are presented as net values (i.e., background radiation dose has been subtracted from the raw result). The background dose at CAU 571 was determined to be the average of the background TLD results from locations H01, H02, and H03.

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 locations where a TLD was not placed, TED was calculated directly from the soil sample analytical results. This was accomplished using the same method described in Section A.2.3.1 for internal dose, except the RRMGs for TED was used instead of the RRMG for internal dose.

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 calculated 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/NFO, 2013a) conservatively prescribes using the 95 percent UCL of the TED for DQO decisions. The

95 percent UCL of the TED is also used for determining the presence or absence of COCs (DQO Decision I). For sample locations where a TLD and multiple soil samples are collected (i.e., sample plots), this 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, this 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, 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 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 571 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NFO, 2013a) 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).

Results for each of the study groups are presented in Sections A.4.3, A.5.3, A.6.3, A.7.3, and A.8.3. Radiological results are reported as doses that are comparable to the dose-based FAL as established in Appendix C. Chemical results are reported as individual concentrations that are comparable to the individual chemical FALs as established in Appendix C.

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 study group.

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 any physical containment and release of contaminants into soil) would be equal to the mass of the contaminant 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 any physical containment 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 RRMGs for TED as described in Section A.2.3.3. If the 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)

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 following the process described in the Soils RBCA document (NNSA/NFO, 2014) if it can be shown that a sufficient correlation exists between TED and radiation survey values. A continuous spatial distribution (i.e., interpolated surface) was estimated from each of the listed radiation surveys using an inverse distance weighted interpolation technique. The average Industrial Area TED value for each study group was then matched with a radiation survey value from the interpolated surface at the corresponding geographic location. A correlation was then calculated between data pairs for each radiation survey. Correlation statistics are 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, or r^2). The minimum strength of the relationship for a valid correlation was defined in the DQOs as an r^2 of 0.8.

The TED values used in the correlation were the average 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.

A.3.0 Default Contamination Boundaries

The DCBs for CAU 571 were established during the DQO process and presented in the CAIP (NNSA/NFO, 2013a). The DCBs are shown in Figure A.3-1. Table A.3-1 provides a summary for establishing DCBs at this CAU:

Table A.3-1
CAU 571 DCB Summary

DCB Description	Associated CAS	DCB Justification
Juno HCA and Landfill	09-23-03	The CAU 571 investigation will not include areas that contain removable radioactivity that exceeds the criteria for establishing an HCA (defined in the Soils RBCA document [NNSA/NFO, 2014]), as contamination exceeding FALs is assumed to be present within these areas. This assumption is based on the potential for a receptor to inhale, ingest, and transport this removable contamination. The extent of the DCBs was determined by the presence of radiological postings associated with Juno, the Small HCA north of Vesta, Mazama, and the central windrows.
Small HCA north of Vesta	09-23-12	
Mazama HCA	09-23-13	
Windrows HCA	09-45-01	
Vesta Landfill (Note: Because of proximity, the Vesta Landfill includes the area impacted by the Post test.)	09-23-12 (includes 09-23-04)	These features are assumed to contain contamination exceeding FALs based on available process knowledge that they were used to dispose of contaminated material and the impracticality of characterizing a heterogeneous landfill. The extent of the DCBs was determined by the mounded feature associated with Vesta and the radiological posting associated with the URMA Pile.
URMA Pile	09-23-12	

GZ = Ground zero

A.3.1 Corrective Actions

As it was assumed that contamination within the DCBs exceeded FALs, these areas require corrective action. The corrective action areas will be established as the DCBs, as described in Table A.3-1 and shown in Figure A.3-1. The alternatives of clean closure and closure in place will be evaluated for each DCB.

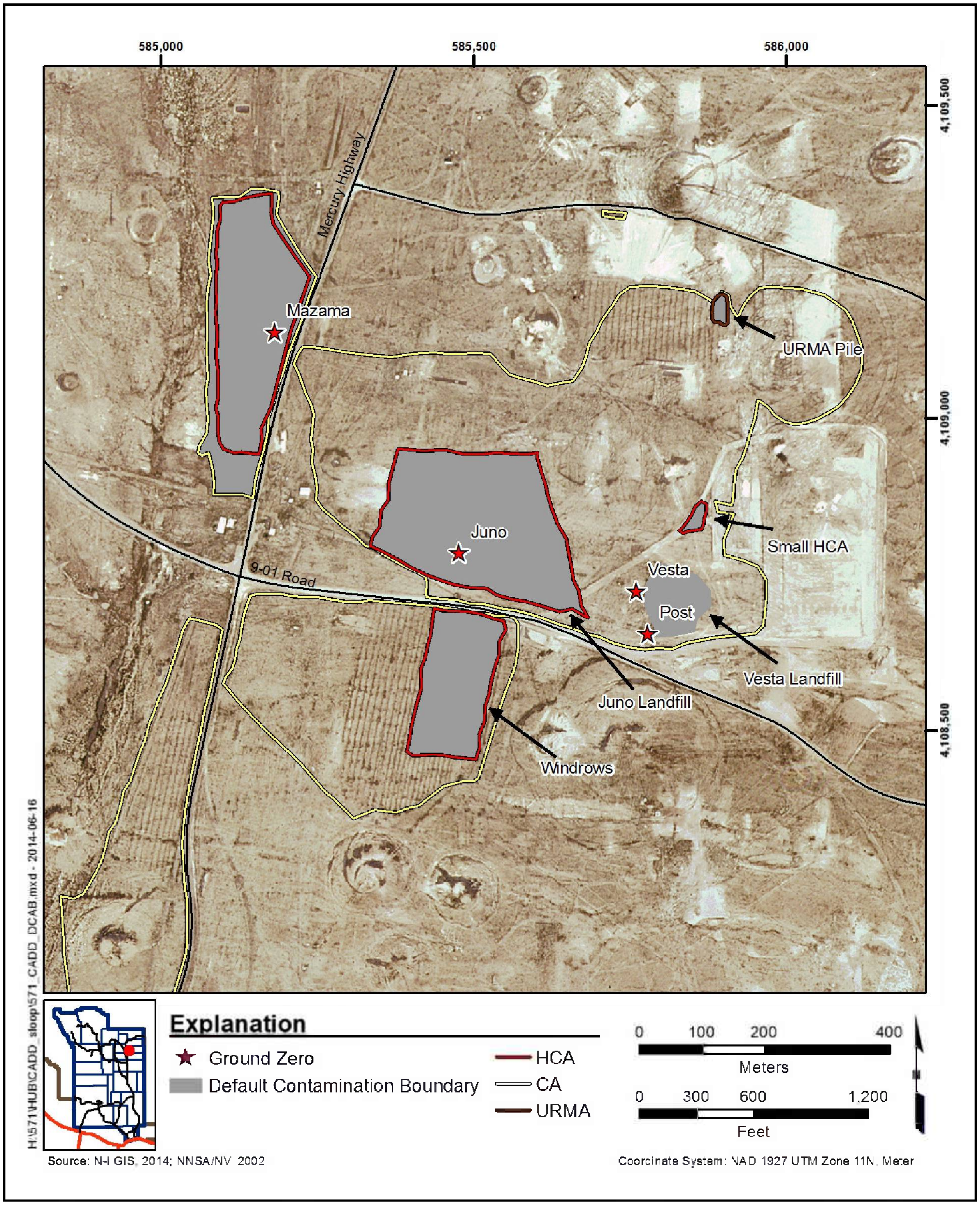

Figure A.3-1
CAU 571 DCBs

A.4.0 Study Group 1, Atmospheric Release

This study group consists of the areas of relatively undisturbed atmospheric depositions of radionuclides from weapons-related tests and safety experiments. Additional detail on the history of Study Group 1 is provided in the CAIP (NNSA/NFO, 2013a).

A.4.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections (NNSA/NFO, 2013a).

A.4.1.1 Visual Surveys

Visual survey of Study Group 1 was conducted. Because much of the original atmospheric release area was disturbed due to subsequent decontamination and underground testing activities, visual inspection of the area aided in establishing a boundary between the relatively undisturbed area (Study Group 1) and the highly disturbed areas. The determination of this boundary was essential to aiding in the selection of Study Group 1 sample locations (see Section A.4.1.3 for additional detail regarding sample location selection). It was determined that the PSM located within Study Group 1 would be addressed in Study Group 5, Other. See Section A.8.0 for additional information regarding Study Group 5. No other features or potential releases associated with Study Group 1 were identified. The Study Group 1 boundary is depicted on Figure A.4-1.

A.4.1.2 Radiological Surveys

Aerial surveys and TRSs were performed at Study Group 1. The aerial surveys are described in Section A.2.2.1. The aerial surveys and the TRSs were conducted at the site to identify spatial distribution of radiological readings and to identify the location of the highest radiological readings within the Study Group 1 boundary. The radiological levels identified in this study group minimally exceeded background. However, the biasing factor in determining the sample plot locations was the highest radiological readings from the TRSs in each of three selected areas (see Section A.4.1.3.1). Figure A.4-2 presents a graphic representation of the data from the TRS.

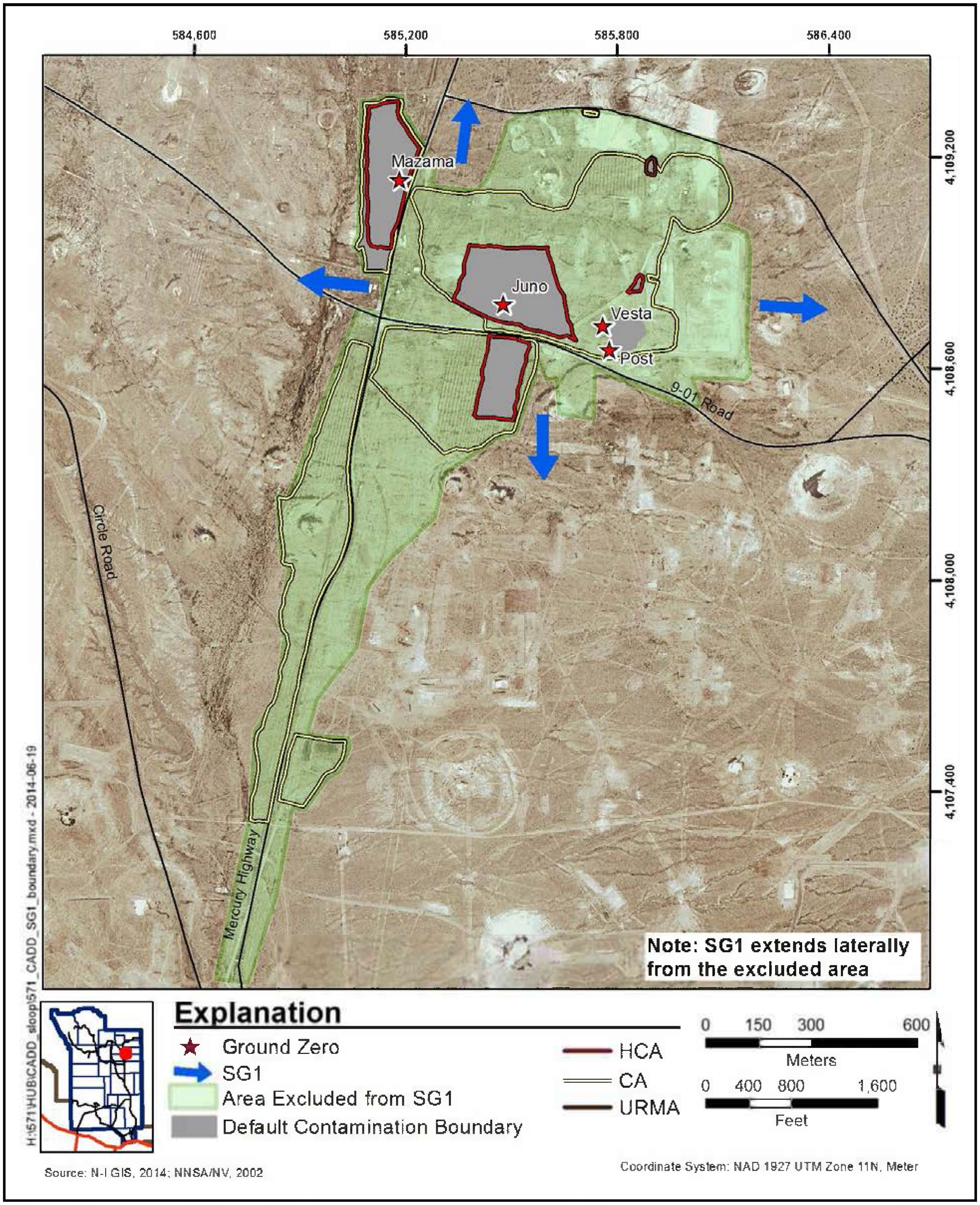

Figure A.4-1
Site Boundary for Study Group 1

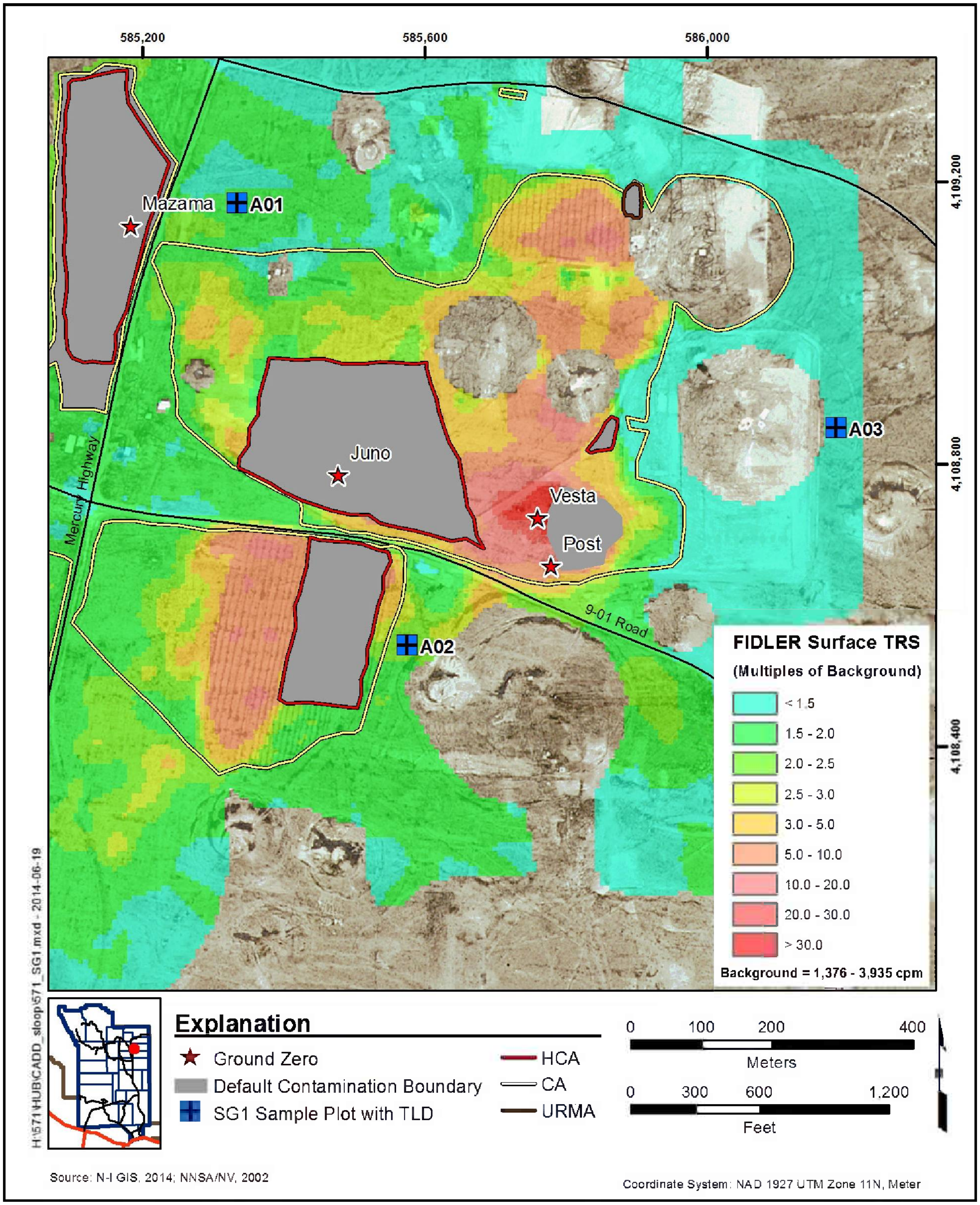

Figure A.4-2
Study Group 1 Sample and TLD Locations

A.4.1.3 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013a) at Study Group 1. The specific CAI activities conducted for this study group are described in the following subsections.

A.4.1.3.1 TLD Samples

One TLD was placed in the center of each of three sample plot locations (A01 through A03). Three separate areas within Study Group 1 that could potentially be impacted by the plume were selected for investigation. The highest radiological reading from the TRSs biased the exact location of each sample plot within each of the preselected areas. The sample locations are shown in Figure A.4-2.

Three TLDs (locations H01 through H03) were placed at background field locations. These locations were selected based on regional geology and the natural radiological distribution map (Section A.2.2.3). All TLDs were placed to measure external doses. Table A.4-1 provides details regarding the TLDs placed in Study Group 1.

Table A.4-1
TLDs at Study Group 1

Location	TLD No.	Date Placed	Date Removed	Purpose
A01	4516	07/22/2013	11/04/2013	Sample plot
A02	4420	07/22/2013	11/04/2013	
A03	4428	07/22/2013	11/04/2013	
H01	5296	07/22/2013	11/04/2013	Background TLD location
H02	4698	07/22/2013	11/04/2013	
H03	5147	07/22/2013	11/04/2013	

A.4.1.3.2 Soil Samples

Soil sampling consisted of collecting four composite soil samples from each of three plot locations. Soil sample plot locations were established at the TLD locations as described in Section A.4.1.3.1. All of the samples were analyzed for gamma spectroscopy; and isotopic uranium (U), plutonium (Pu), and Am. One sample plot from the location with the highest radiological survey value (A01) was analyzed for strontium (Sr)-90 and technetium (Tc)-99 because these were identified as possible but not suspected COCs. Additional information including depth and purpose for each soil sample collected for Study Group 1 is provided in Table A.4-2. Sample locations are shown on Figure A.4-2.

Table A.4-2
Samples Collected at Study Group 1

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
A01	A601	0.0 - 5.0	Soil	Environmental
	A602			
	A603			
	A604			
A02	A605	0.0 - 5.0	Soil	Environmental
	A606			
	A607			
	A608			
A03	A609	0.0 -5.0	Soil	Environmental
	A610			
	A611			
	A612			

A.4.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013a) 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/NFO, 2013a). 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 as described in Section A.2.3. External doses for TLD locations are summarized in Section A.4.3.1. Internal doses for each sample plot are summarized in Section A.4.3.2. The TEDs for each sampled location are summarized in Section A.4.3.3.

A.4.3.1 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 elements, minimum sample size, 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 all TLD samples.

Table A.4-3
Study Group 1, 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
A01	0.03	3	3	5.0	0.8	0.3
A02	0.03	3	3	5.3	0.9	0.3
A03	0.03	3	3	3.7	0.6	0.2

OU = Occasional Use

A.4.3.2 Internal Radiological Dose Estimations

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 each exposure scenario are presented in Table A.4-4. The minimum sample size criterion was met for all soil samples.

Table A.4-4
Study Group 1, 95% UCL Internal Dose for Each Exposure Scenario

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	0.0	4	3	0.4	0.1	0.0
A02	0.0	4	3	0.5	0.1	0.0
A03	0.0	4	3	0.1	0.0	0.0

A.4.3.3 Total Effective Dose

The TED for each sample plot 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 95 percent UCL of the TED at the Study Group 1 location with the maximum dose is less than 1 mrem/OU-yr. Therefore, none of the Study Group 1 sample locations exceeded 25 mrem/OU-yr (Figure A.4-3).

Table A.4-5
Study Group 1, TED at Sample Locations (mrem/yr)

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	4.1	5.4	0.7	0.9	0.2	0.3
A02	4.7	5.8	0.8	1.0	0.2	0.3
A03	2.8	3.8	0.5	0.6	0.1	0.2

A.4.4 Nature and Extent of COCs

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.

A.4.5 Corrective Actions

As there were no COCs identified, no corrective actions are required for Study Group 1.

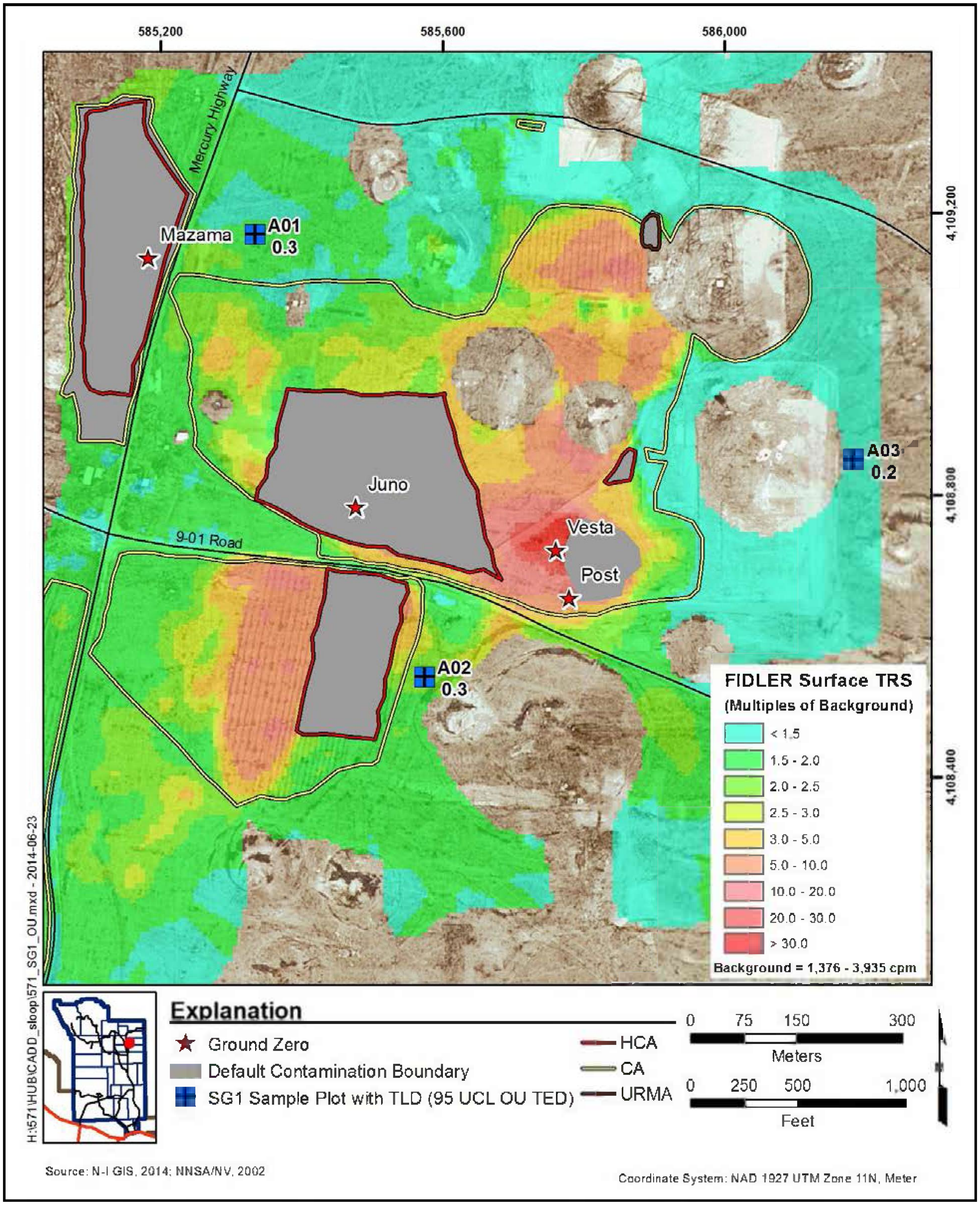

Figure A.4-3
95% UCL of the TED at Study Group 1

A.5.0 Study Group 2, Subsurface Contamination

This study group consists of the areas of relatively undisturbed atmospheric depositions of radionuclides from two weapons-related tests and two safety experiments. Additional detail on the history of Study Group 2 is provided in the CAIP (NNSA/NFO, 2013a).

A.5.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections (NNSA/NFO, 2013a).

A.5.1.1 Visual Surveys

Visual survey of Study Group 2 was conducted. Because much of the original atmospheric release area was subsequently disturbed due to decontamination and underground testing activities, visual survey of the area aided in establishing a boundary between the relatively undisturbed area (Study Group 1) and the highly disturbed areas. Once the disturbed area (excluding windrows [see Section A.6.0]) boundary was established, a visual inspection was completed to determine the DCBs and identify any other features of interest. The majority of Study Group 2 falls within a CA, with some portions being posted as HCAs. The determination of the Study Group 2 boundary as well as the DCBs was essential to aiding in the selection of Study Group 2 sample locations (see Section A.5.1.4 for additional detail regarding sample location selection). The following DCBs are located within the Study Group 2 boundary:

- Juno HCA and Landfill
- Vesta Landfill
- Small HCA north of Vesta
- URMA Pile

Figure A.5-1 depicts the Study Group 2 boundary as well as the locations of the DCBs. See Section A.3.0 for additional information regarding the DCBs. It was determined that PSM, stained soil, and a small radiologically posted CA located on the northern edge of the Study Group 2 boundary would be investigated as part of Study Group 5, Other. See Section A.8.0 for additional information regarding Study Group 5.

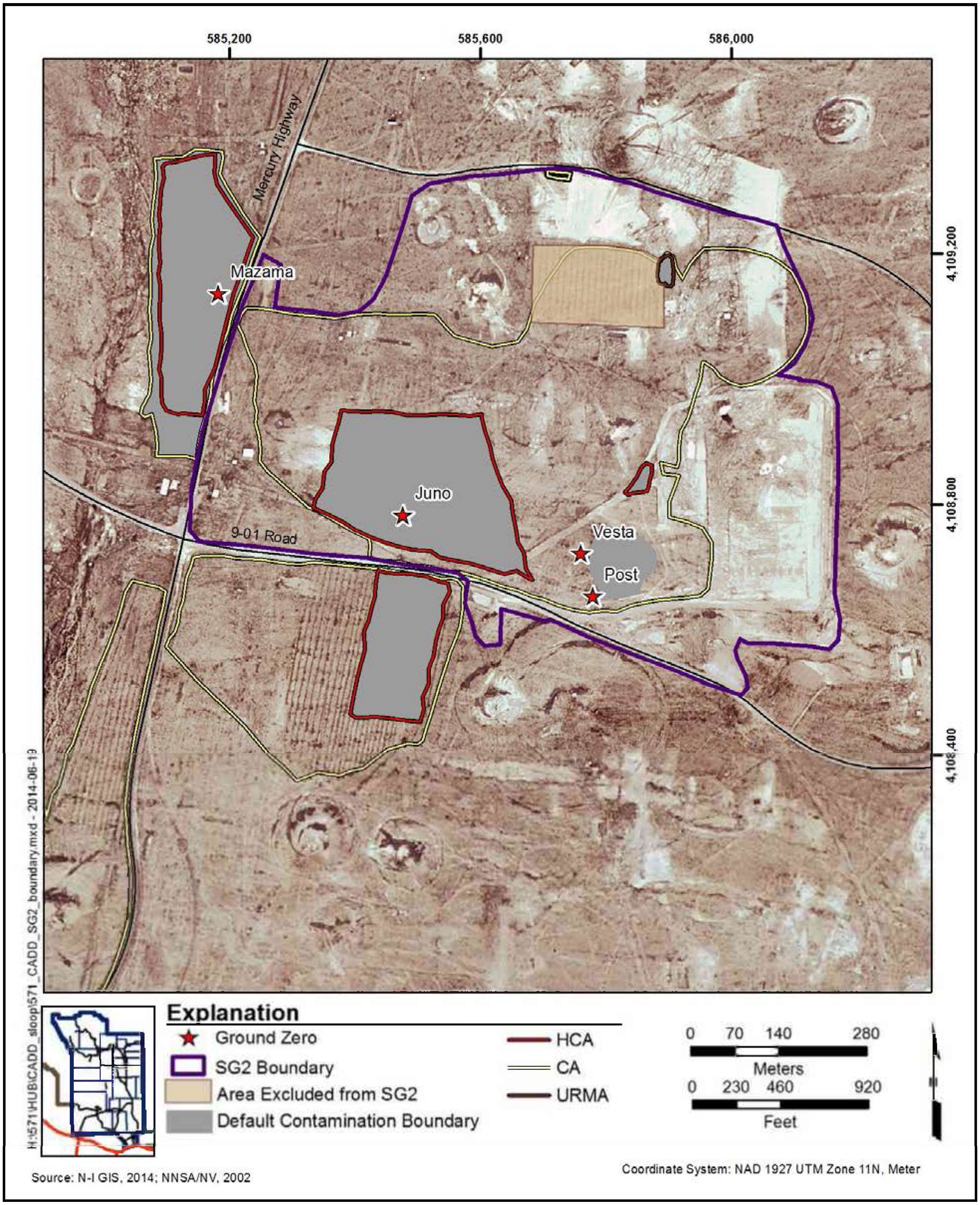

Figure A.5-1
Site Boundary for Study Group 2

A.5.1.2 Radiological Field Screening

Radiological screening (as described in Section A.2.2.2) was performed at all Study Group 2 sample plot locations to determine whether contamination was present below the surface. Screening results were used to justify the analysis of two subsurface soil samples (B001 and B002) collected from two subsurface sample locations (B04a and B13a).

A.5.1.3 Radiological Surveys

Aerial surveys and TRSs were performed at Study Group 2. The aerial surveys are described in Section A.2.2.1. The radiological surveys were conducted at the site to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings within the Study Group 2 boundary. The results of the surveys were used to bias the selection of two sample locations (see Section A.5.1.4.1). The radiological levels identified in this study group were most elevated between the Juno HCA and the Vesta Landfill. Figure A.5-2 presents a graphic representation of the data from the TRS.

A.5.1.4 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013a) at Study Group 2. The specific CAI activities conducted at this study group are described in the following subsections.

A.5.1.4.1 TLD Samples

Sixteen TLDs were placed at sample plot locations B01 through B16. The sample locations were selected primarily based on their location within Study Group 2. Secondarily, 2 locations (B01 and B02) were selected based on the highest radiological readings from the TRS, while 14 locations (B03 through B16) were biased based on their proximity to the Juno and Vesta GZs (the sources of contamination). These locations were selected at intervals along the boundaries of the Juno and Vesta DCBs. The TLD sample locations are shown on Figure A.5-2. Table A.5-1 provides details regarding the TLDs placed in Study Group 2.

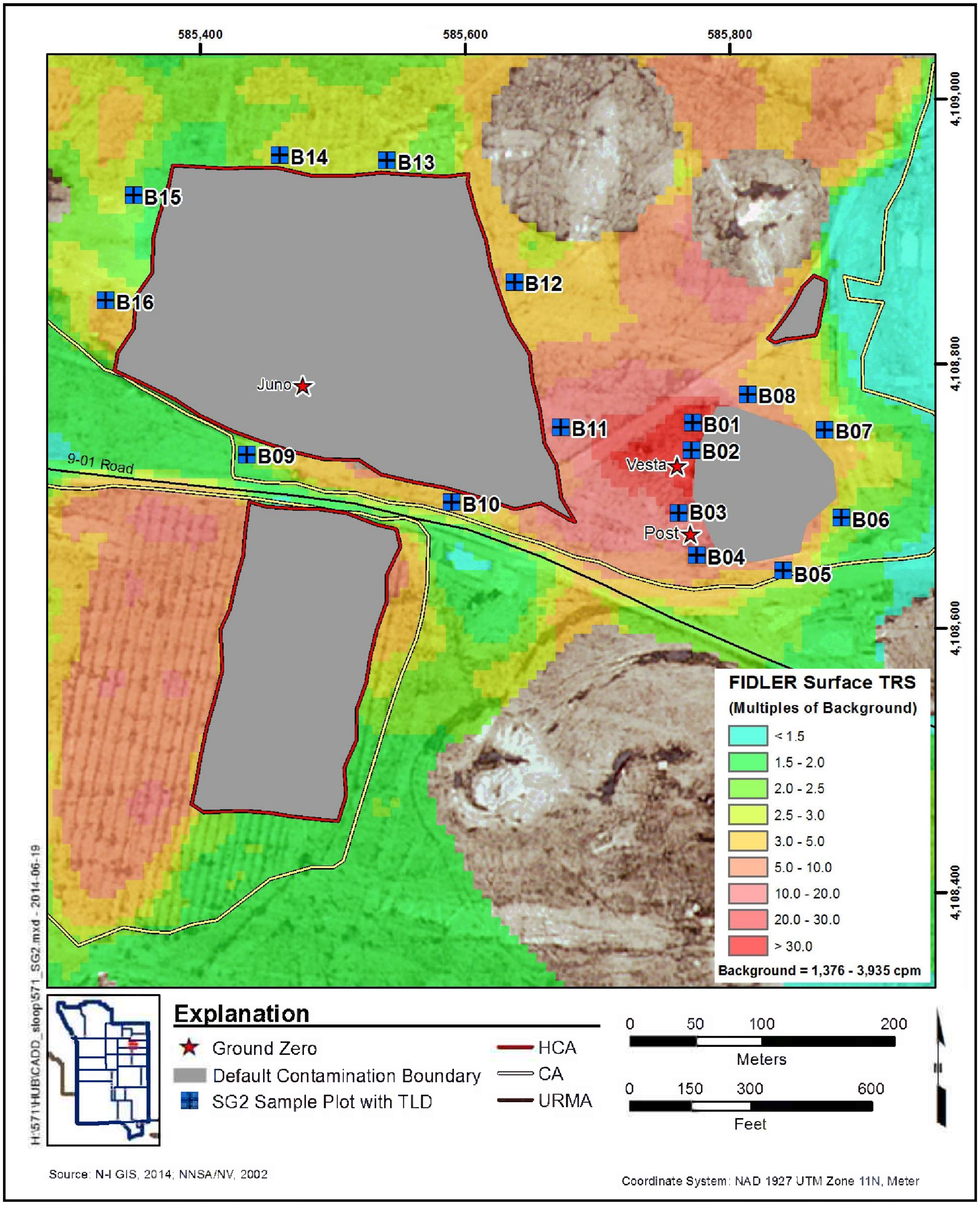

Figure A.5-2
Study Group 2 Sample and TLD Locations

Table A.5-1
TLDs at Study Group 2

Location	TLD No.	Date Placed	Date Removed	Purpose
B01	5181	07/23/2013	11/05/2013	Sample plot (subsurface grab sample, as applicable)
B02	6396	07/23/2013	11/05/2013	
B03	5100	07/23/2013	11/05/2013	
B04	5197	07/23/2013	11/05/2013	
B05	4672	07/23/2013	11/05/2013	
B06	3818	07/23/2013	11/05/2013	
B07	4539	07/23/2013	11/05/2013	
B08	5131	07/23/2013	11/05/2013	
B09	4857	07/23/2013	11/05/2013	
B10	4762	07/23/2013	11/05/2013	
B11	5255	07/23/2013	11/05/2013	
B12	5098	07/23/2013	11/05/2013	
B13	4514	07/23/2013	11/05/2013	
B14	4927	07/23/2013	11/05/2013	
B15	4330	07/23/2013	11/05/2013	
B16	5046	07/23/2013	11/05/2013	

A.5.1.4.2 Soil Samples

Soil sample locations were selected at the TLD locations as described in Section A.5.1.4.1. Soil sampling consisted of collecting four composite soil samples from each of 16 sample plots. Additionally, subsurface soil from the center of each sample plot was screened to determine whether buried contamination is present as described in Section A.2.2.2. Subsurface soil at sample plots B04 and B13 met the criteria for buried contamination and were submitted for analysis. The sample locations for these grab samples are referred to as B04a and B13a. All of the samples were analyzed for gamma spectroscopy; and isotopic U, Pu, and Am. One sample location (B01) with the highest radiological survey value was analyzed for Sr-90 and Tc-99 because these were identified as possible but not suspected COCs. Additional information including depth and purpose for each soil sample collected for Study Group 2 is provided in Table A.5-2. Sample locations are shown on Figure A.5-2.

Table A.5-2
Samples Collected at Study Group 2
(Page 1 of 3)

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
B01	B601	0.0 - 5.0	Soil	Environmental
	B602			
	B603			
	B604			
B02	B605	0.0 - 5.0	Soil	Environmental
	B606			
	B607			
	B608			
B03	B609	0.0 - 5.0	Soil	Environmental
	B610			
	B611			
	B612			
B04	B613	0.0 - 5.0	Soil	Environmental
	B614			
	B615			
	B616			
B04a	B001	10.0 - 15.0		
B05	B617	0.0 - 5.0	Soil	Environmental
	B618			
	B619			
	B620			
B06	B621	0.0 - 5.0	Soil	Environmental
	B622			
	B623			
	B624			
B07	B625	0.0 - 5.0	Soil	Environmental
	B626			
	B627			
	B628			

Table A.5-2
Samples Collected at Study Group 2
(Page 2 of 3)

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
B08	B629	0.0 - 5.0	Soil	Environmental
	B630			
	B631			
	B632			
B09	B633	0.0 - 5.0	Soil	Environmental
	B634			
	B635			
	B636			
B10	B637	0.0 - 5.0	Soil	Environmental
	B638			
	B639			
	B640			
B11	B641	0.0 - 5.0	Soil	Environmental
	B642			
	B643			
	B644			
B12	B645	0.0 - 5.0	Soil	Environmental
	B646			
	B647			
	B648			
B13	B649	0.0 - 5.0	Soil	Environmental
	B650			
	B651			
	B652			
B13a	B002	5.0 - 10.0		
B14	B653	0.0 - 5.0	Soil	Environmental
	B654			
	B655			
	B656			

Table A.5-2
Samples Collected at Study Group 2
(Page 3 of 3)

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
B15	B657	0.0 - 5.0	Soil	Environmental
	B658			
	B659			
	B660			
B16	B661	0.0 - 5.0	Soil	Environmental
	B662			
	B663			
	B664			

A.5.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013a) 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.5.3 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/NFO, 2013a). 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.5.3.1. Internal doses for each sample plot are summarized in Section A.5.3.2. The TEDs for each sampled location are summarized in Section A.5.3.3.

A.5.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each Study Group 2 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 elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.5-3. The minimum sample size criterion was met for all TLD samples

Table A.5-3
Study Group 2, 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B01	0.47	3	3	**55.9**	9.4	2.8
B02	0.25	3	3	**35.2**	5.9	1.8
B03	0.08	3	3	18.3	3.1	0.9
B04	0.04	3	3	11.3	1.9	0.6
B05	0.04	3	3	9.6	1.6	0.5
B06	0.03	3	3	6.1	1.0	0.3
B07	0.09	3	3	9.9	1.7	0.5
B08	0.00	3	3	4.8	0.8	0.2
B09	0.02	3	3	4.0	0.7	0.2
B10	0.01	3	3	6.2	1.0	0.3
B11	0.06	3	3	10.5	1.8	0.5
B12	0.06	3	3	6.8	1.2	0.3
B13	0.03	3	3	5.3	0.9	0.3
B14	0.03	3	3	4.5	0.8	0.2
B15	0.03	3	3	5.0	0.8	0.2
B16	0.02	3	3	4.8	0.8	0.2

Bold indicates the values exceeding 25 mrem/yr.

A.5.3.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each Study Group 2 sample location were determined as described in Section A.2.3. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose for each exposure scenario are presented in Table A.5-4. Although the data in Table A.5-5 demonstrates that the internal dose at Study Group 2 comprises a large portion of the TED (indicating the presence of unfissioned nuclear fuel), there is the variability of internal and external doses indicating multiple sources. These sources include both weapons-related tests and safety experiments conducted in this area.

Table A.5-4
Study Group 2, 95% UCL Internal Dose for Each Exposure Scenario
(Page 1 of 2)

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)
B01	1.5	4	3	**99.6**	16.8	6.0
B02	0.3	4	3	**38.3**	6.4	2.3
B03	0.3	4	3	17.6	3.0	1.1
B04	0.0	4	3	1.9	0.3	0.1
B04a (subsurface)[a]	N/A	1	N/A	5.8	1.0	0.4
B05	0.0	4	3	1.4	0.2	0.1
B06	0.0	4	3	1.6	0.3	0.1
B07	0.0	4	3	2.1	0.3	0.1
B08	0.0	4	3	0.7	0.1	0.0
B09	0.0	4	3	0.8	0.1	0.0
B10	0.0	4	3	1.1	0.2	0.1
B11	0.1	4	3	5.4	0.9	0.3
B12	0.1	4	3	5.8	1.0	0.3
B13	0.1	5	3	5.8	1.0	0.4
B13a (subsurface)[a]	N/A	1	N/A	2.4	0.4	0.1
B14	0.0	4	3	1.2	0.2	0.1

Table A.5-4
Study Group 2, 95% UCL Internal Dose for Each Exposure Scenario
(Page 2 of 2)

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)
B15	0.0	4	3	1.0	0.2	0.1
B16	0.0	4	3	0.4	0.1	0.0

[a]Statistics were not completed as these are subsurface grab samples with one sample

Bold indicates the values exceeding 25 mrem/yr.

Table A.5-5
Study Group 2, Contribution of Internal Dose to TED

Location	Average Internal Dose (mrem/OU-yr)	Average Total Dose (mrem/OU-yr)	Percent Internal Dose
B01	4.0	6.0	67
B02	1.9	3.2	59
B03	0.7	1.5	47

A.5.3.3 Total Effective Dose

The TED for each sample plot or grab 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.5-6. The 95 percent UCL of the TED for Study Group 2 location with the maximum dose is 8.8 mrem/OU-yr. Therefore, none of the Study Group 2 sample locations exceeded 25 mrem/OU-yr (Figure A.5-3).

A.5.4 Nature and Extent of COCs

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.

Table A.5-6
Study Group 2, TED at Sample Locations (mrem/yr)

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	**107.1**	**155.5**	18.0	**26.2**	6.0	8.8
B02	**58.4**	**73.4**	9.8	12.4	3.2	4.1
B03	**27.1**	**35.9**	4.6	6.0	1.5	2.0
B04	11.7	13.2	2.0	2.2	0.6	0.7
B04a (subsurface)	12.2	13.0	2.0	2.2	0.7	0.7
B05	9.3	11.0	1.6	1.9	0.5	0.6
B06	6.0	7.7	1.0	1.3	0.3	0.4
B07	8.2	12.0	1.4	2.0	0.4	0.6
B08	5.1	5.4	0.9	0.9	0.3	0.3
B09	3.9	4.8	0.7	0.8	0.2	0.2
B10	6.8	7.3	1.1	1.2	0.4	0.4
B11	12.7	15.9	2.1	2.7	0.7	0.8
B12	9.0	12.6	1.5	2.1	0.5	0.7
B13	7.3	11.1	1.2	1.9	0.4	0.6
B13a (subsurface)	10.0	11.6	1.7	2.0	0.5	0.6
B14	4.7	5.7	0.8	1.0	0.2	0.3
B15	4.6	5.9	0.8	1.0	0.2	0.3
B16	4.3	5.2	0.7	0.9	0.2	0.3

Bold indicates the values exceeding 25 mrem/yr.

A.5.5 Corrective Actions

As there were no COCs identified, no corrective actions are required for Study Group 2.

A.5.6 Best Management Practices

As a BMP, an administrative UR was established to include 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. To

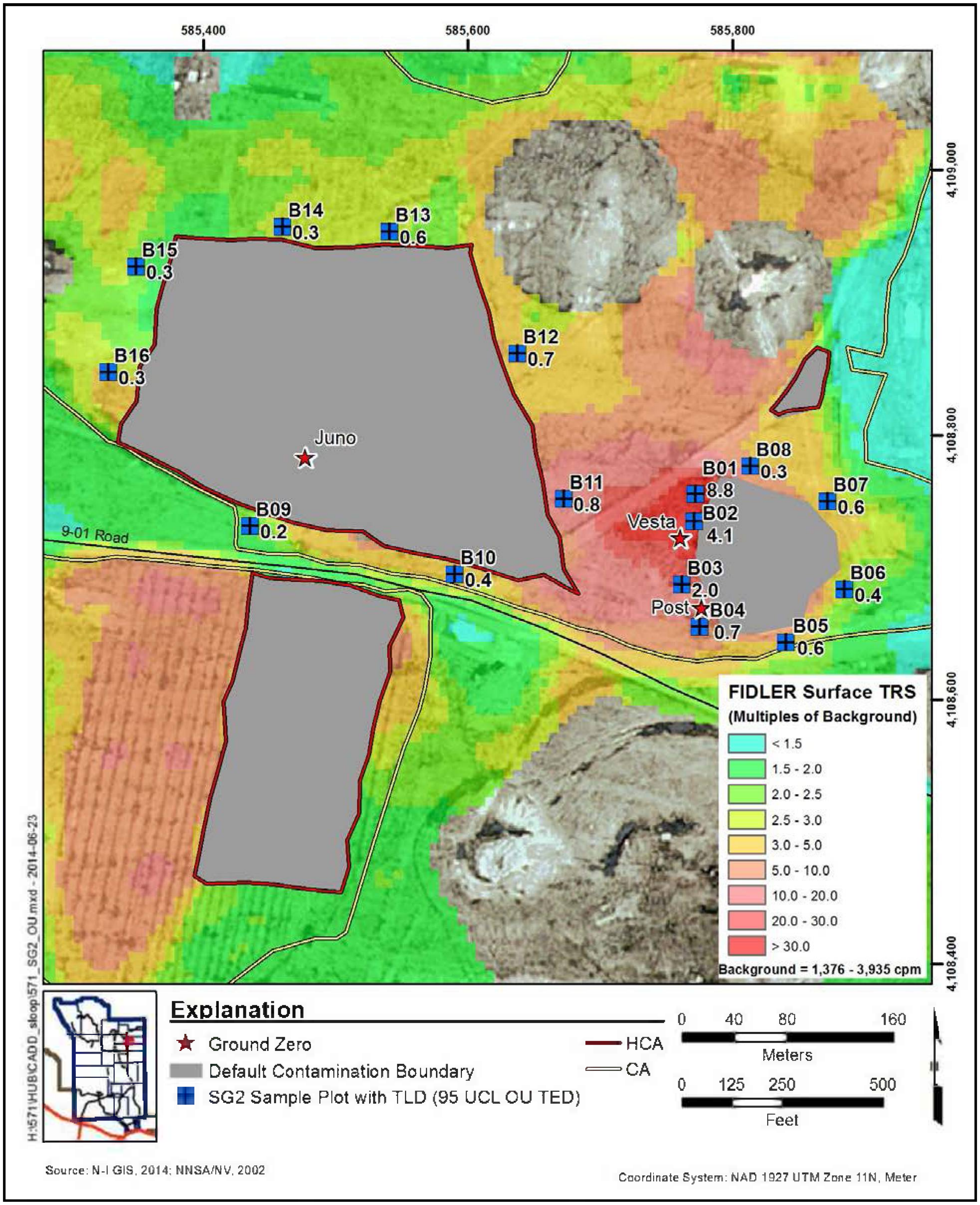

Figure A.5-3
95% UCL of the TED at Study Group 2

determine the extent of the area where TED exceeds the PAL (Industrial Area scenario), 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:

- 2012 Am-241 aerial radiation survey (NSTec, 2012)
- Site-specific TRS (FIDLER survey)

The quality of these correlations is indicated by the r^2 as shown in Table A.5-7. The radiation survey that exhibited the best correlation is the FIDLER TRS with an r^2 of 0.85, which exceeds the minimum criteria of 0.80 as set in the Soils RBCA document (NNSA/NFO, 2014). Based on the FIDLER TRS correlation, the radiation survey value that corresponds to the 25 mrem/IA-yr PAL is 12.8 multiples of background. The second criterion for an administrative UR is the presence of removable contamination that meets CA criteria. Because the area in Study Group 2 that exceeds CA criteria encompasses the area that exceeds the 25 mrem/IA-yr PAL, the administrative UR boundary was based on CA criteria and was established at the outer CA fence line. These areas are shown on Figure A.5-4. The administrative URs are presented in Attachment D-1.

Table A.5-7
Coefficients of Determination of TED with Radiological Surveys

Dataset	Coefficient of Determination (r^2)
N-I FIDLER TRS	0.85
2012 Americium Aerial Radiation Survey	0.76

N-I = Navarro-Intera, LLC

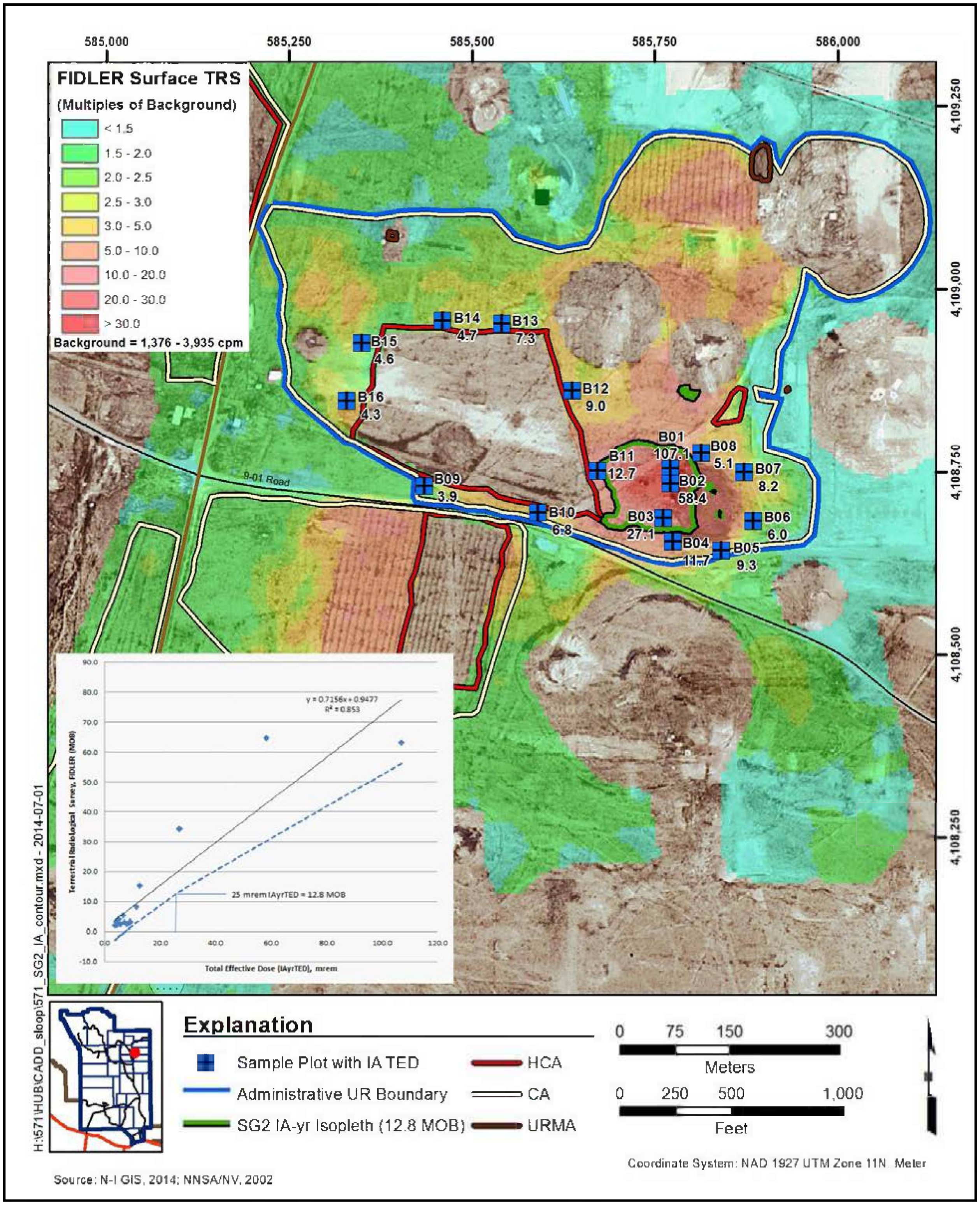

Figure A.5-4
Administrative UR Boundary for Study Group 2

A.6.0 Study Group 3, Windrows

This study group consists of areas where the initial surface release of radionuclides from weapons-related tests and safety experiments were placed in rows (i.e., windrows). The windrows were then sprayed with road oil. Additional detail on the history of Study Group 3 is provided in the CAIP (NNSA/NFO, 2013a).

A.6.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections (NNSA/NFO, 2013a).

A.6.1.1 Visual Surveys

There were five different windrow zones established based on the visual survey (see the CAIP for discussion regarding the creation of windrow zones [NNSA/NFO, 2013a]). The determination of these windrow zones was essential in selecting sample locations (see Section A.6.1.3.1 for additional detail regarding sample location selection). All windrows associated with CAU 571 that were identified during the historical research were included in the field investigation. The visual surveys aided in identifying the areas impacted by windrows. Several locations of intact windrows were identified as a result of the visual surveys, while it was noted that other previously windrowed areas had been disturbed due to the subsequent underground testing in the area. A portion of the windrows are radiologically posted as HCA and/or CA. The remaining intact windrows and former windrowed areas are not posted. It was determined that the PSM located within Study Group 3 would be addressed in Study Group 5, Other. See Section A.8.0 for additional information regarding Study Group 5. The Study Group 3 boundary is depicted on Figure A.6-1.

A.6.1.2 Radiological Surveys

Aerial surveys and TRSs were performed at Study Group 3. The aerial surveys are described in Section A.2.2.1. The aerial surveys and TRSs were conducted at the site to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings within the Study Group 3 windrow zones. See Figure A.6-1 for the Study Group 3 windrow zone

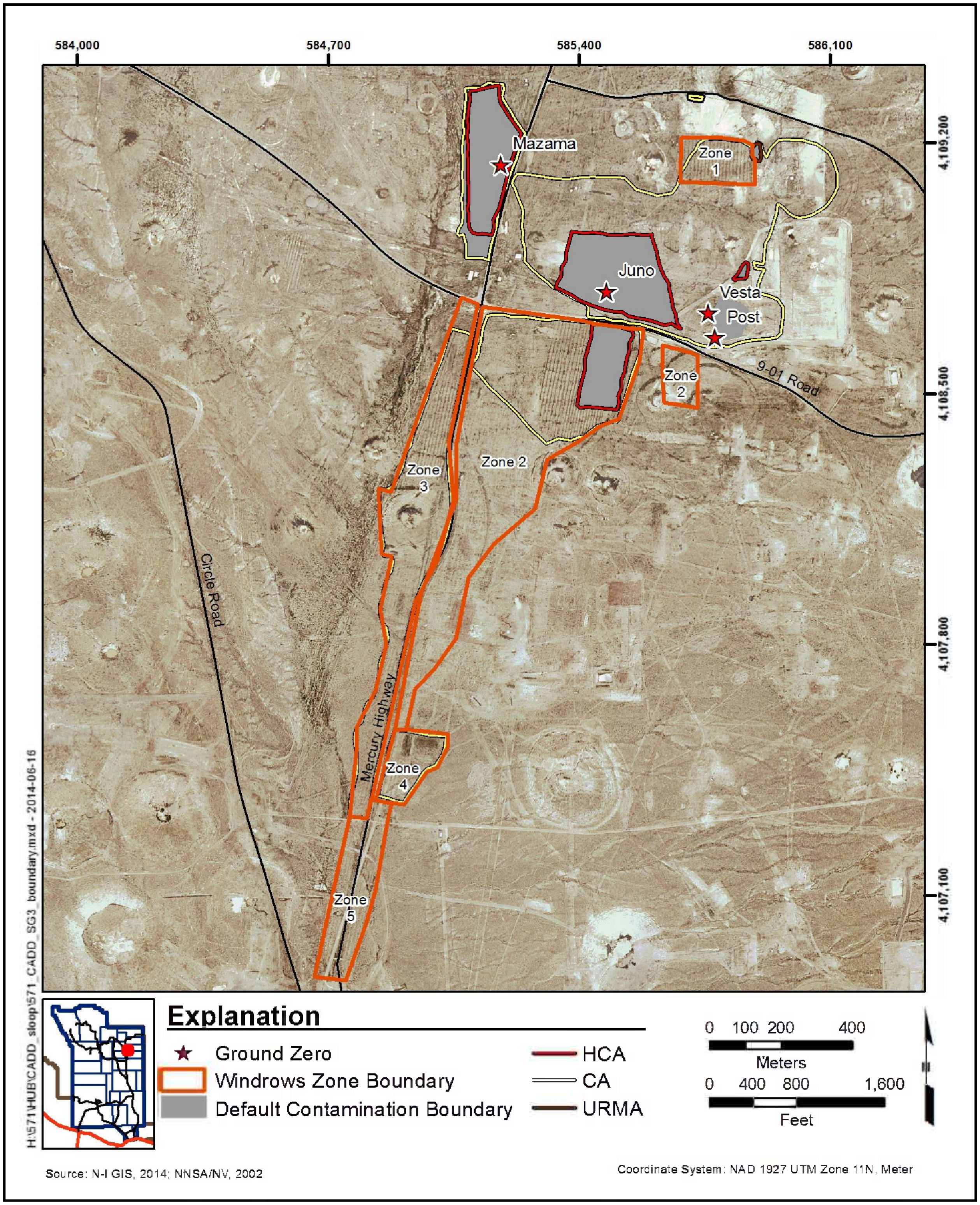

Figure A.6-1
Site Boundary for Study Group 3

boundaries. The TRS results showed that the highest radiological readings were located within windrows zones 1 and 2. The results of the surveys were used to bias the selection of 12 sample locations (see Section A.6.1.3.1). Figure A.6-2 presents a graphic representation of the data from the TRS.

A.6.1.3 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013a) at Study Group 3. The specific CAI activities conducted at this study group are described in the following subsections.

A.6.1.3.1 TLD Samples

Twelve TLDs were placed at grab sample locations C01 through C12. The sample locations were primarily selected by their location within Study Group 3 and, secondarily, based on the TRS results within each of five windrow zones. The TRS results showed that the highest radiological readings were located within windrows zones 1 and 2. However, a minimum of two sample locations were selected within each of the five windrow zones. Within each zone, the first sample location was established at the location with the highest radiological reading as detected during the TRSs, while the second (or third) sample was selected in the isopleth with the subsequent highest readings. Three sample locations were selected in each of windrow zones 1 and 2, while two sample locations were selected in each of the remaining windrow zones 3, 4, and 5. The TLD locations are shown on Figure A.6-2. Table A.6-1 provides details regarding the TLDs placed in Study Group 3.

A.6.1.3.2 Soil Samples

Soil sampling consisted of collecting 13 grab samples (1 field duplicate [FD]) collected from the surface to the base of the windrow at each of the 12 TLD sample locations. Soil sample locations were selected as described in Section A.6.1.3.1. All of the samples were analyzed for VOCs; SVOCs; PCBs; gamma spectroscopy; and isotopic U, Pu, and Am. Five sample locations (one location from each windrow zone) were analyzed for dioxins. There were no biasing factors, such as soil texture changes or staining, to help determine which location was selected for dioxin analysis. Additional information including depth and purpose for each soil sample collected for Study Group 3 is provided in Table A.6-2. Sample locations are shown on Figure A.6-2.

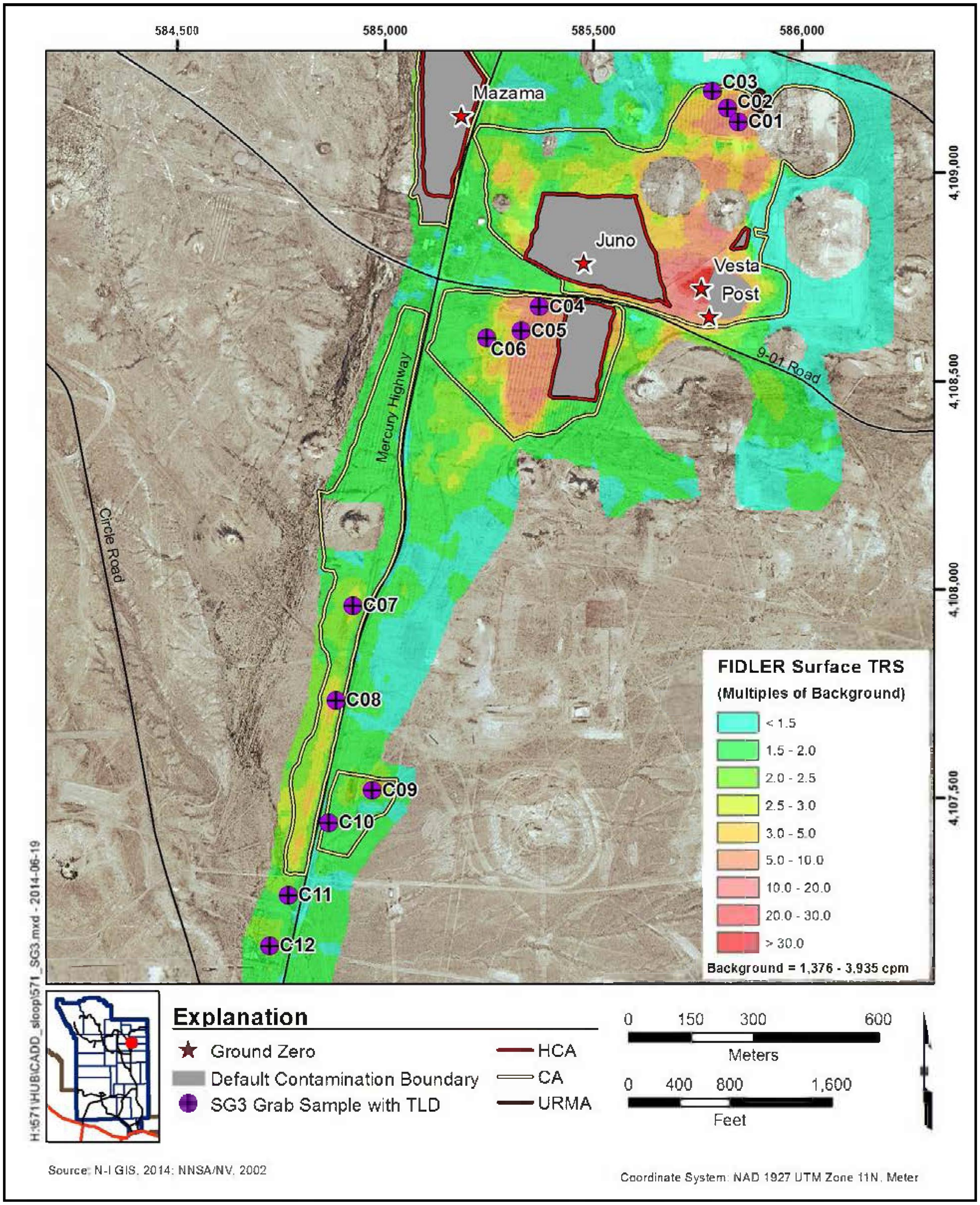

Figure A.6-2
Study Group 3 Sample and TLD Locations

Table A.6-1
TLDs at Study Group 3

Location	TLD No.	Date Placed	Date Removed	Purpose
C01	5111	07/23/2013	11/04/2013	Grab Sample
C02	4775	07/23/2013	11/04/2013	
C03	4962	07/23/2013	11/04/2013	
C04	4603	07/24/2013	11/04/2013	
C05	5089	07/24/2013	11/04/2013	
C06	4623	07/24/2013	11/04/2013	
C07	4707	07/25/2013	11/04/2013	
C08	1775	07/25/2013	11/04/2013	
C09	5065	07/25/2013	11/04/2013	
C10	4840	07/25/2013	11/04/2013	
C11	4651	07/22/2013	11/04/2013	
C12	4496	07/22/2013	11/04/2013	

Table A.6-2
Samples Collected at Study Group 3

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
C01	C006	0.0 - 30.0	Soil	Environmental
C02	C007	0.0 - 30.0		
C03	C008	0.0 - 30.0		
C04	C011	0.0 - 30.0		
C05	C012	0.0 - 30.0		
C06	C013	0.0 - 30.0		
C07	C001	0.0 - 30.0		
	C002			FD
C08	C003	0.0 - 30.0		Environmental
C09	C009	0.0 - 15.0		
C10	C010	0.0 - 30.0		
C11	C004	0.0 - 20.0		
C12	C005	0.0 - 20.0		

A.6.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013a) 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.6.3 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/NFO, 2013a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. For chemical contaminants, the results are reported as individual concentrations that are comparable to their corresponding FALs. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

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.6.3.1. Internal doses for each sample plot are summarized in Section A.6.3.2. The TEDs for each sampled location are summarized in Section A.6.3.3. Chemical contaminant results for Study Group 3 are summarized in Section A.6.3.4.

A.6.3.1 External Radiological Dose Calculations

Estimates for 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. 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 elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.6-3. The minimum sample size criterion was met for all TLD samples.

Table A.6-3
Study Group 3, 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C01	0.04	3	3	3.6	0.6	0.2
C02	0.02	3	3	3.5	0.6	0.2
C03	0.03	3	3	1.3	0.2	0.1
C04	0.04	3	3	7.8	1.3	0.4
C05	0.04	3	3	7.5	1.3	0.4
C06	0.01	3	3	4.9	0.8	0.2
C07	0.03	3	3	5.1	0.9	0.3
C08	0.01	3	3	4.4	0.7	0.2
C09	0.01	3	3	5.6	0.9	0.3
C10	0.06	3	3	6.0	1.0	0.3
C11	0.04	3	3	6.3	1.1	0.3
C12	0.04	3	3	6.1	1.0	0.3

A.6.3.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each Study Group 3 sample location were determined as described in Section A.2.3.1. The internal dose for each exposure scenario are presented in Table A.6-4.

Table A.6-4
Study Group 3, Internal Dose for Each Exposure Scenario
(Page 1 of 2)

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C01	1.9	0.3	0.1
C02	3.0	0.5	0.2
C03	0.3	0.1	0.0
C04	3.9	0.7	0.2
C05	1.7	0.3	0.1
C06	1.3	0.2	0.1

Table A.6-4
Study Group 3, Internal Dose for Each Exposure Scenario
(Page 2 of 2)

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C07	0.1	0.0	0.0
	0.1	0.0	0.0
C08	0.5	0.1	0.0
C09	1.5	0.3	0.1
C10	0.1	0.0	0.0
C11	0.3	0.0	0.0
C12	0.1	0.0	0.0

A.6.3.3 Total Effective Dose

The TED for each grab 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.6-5. The 95 percent UCL of the TED at the Study Group 3 location with the maximum dose is less than 1 mrem/OU-yr. Therefor, none of the Study Group 3 sample locations exceeded 25 mrem/OU-yr (Figure A.6-3).

Table A.6-5
Study Group 3, TED at Sample Locations (mrem/yr)
(Page 1 of 2)

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	4.2	5.5	0.7	0.9	0.2	0.3
C02	5.7	6.4	1.0	1.1	0.3	0.4
C03	0.8	1.6	0.1	0.3	0.0	0.1
C04	10.5	11.7	1.8	2.0	0.6	0.6
C05	8.0	9.2	1.4	1.6	0.4	0.5
C06	5.9	6.3	1.0	1.1	0.3	0.3
C07	4.2	5.2	0.7	0.9	0.2	0.3

Table A.6-5
Study Group 3, TED at Sample Locations (mrem/yr)
(Page 2 of 2)

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
C08	4.3	4.8	0.7	0.8	0.2	0.2
C09	7.0	7.2	1.2	1.2	0.4	0.4
C10	4.0	6.1	0.7	1.0	0.2	0.3
C11	5.1	6.5	0.9	1.1	0.3	0.3
C12	4.8	6.2	0.8	1.0	0.2	0.3

A.6.3.4 Chemical Contaminants

All samples collected in Study Group 3 were analyzed for VOCs, SVOCs, and PCBs, while one sample from each windrow zone was analyzed for dioxins (Section A.6.1.3.2). Analytical results exceeding minimum detectable concentrations (MDCs) from the samples are presented in the following subsections.

A.6.3.4.1 VOCs

There were no VOCs detected above MDCs. Therefore, no sample results exceeded FALs.

A.6.3.4.2 SVOCs

The analytical results for SVOCs in samples that exceeded the MDCs are shown in Table A.6-6. No results exceeded the FAL.

A.6.3.4.3 PCBs

The analytical results for PCBs in samples that exceeded the MDCs are shown in Table A.6-7. No results exceeded the FAL.

A.6.3.4.4 Dioxins

There were no dioxins detected above MDCs. Therefore, no sample results exceeded FALs.

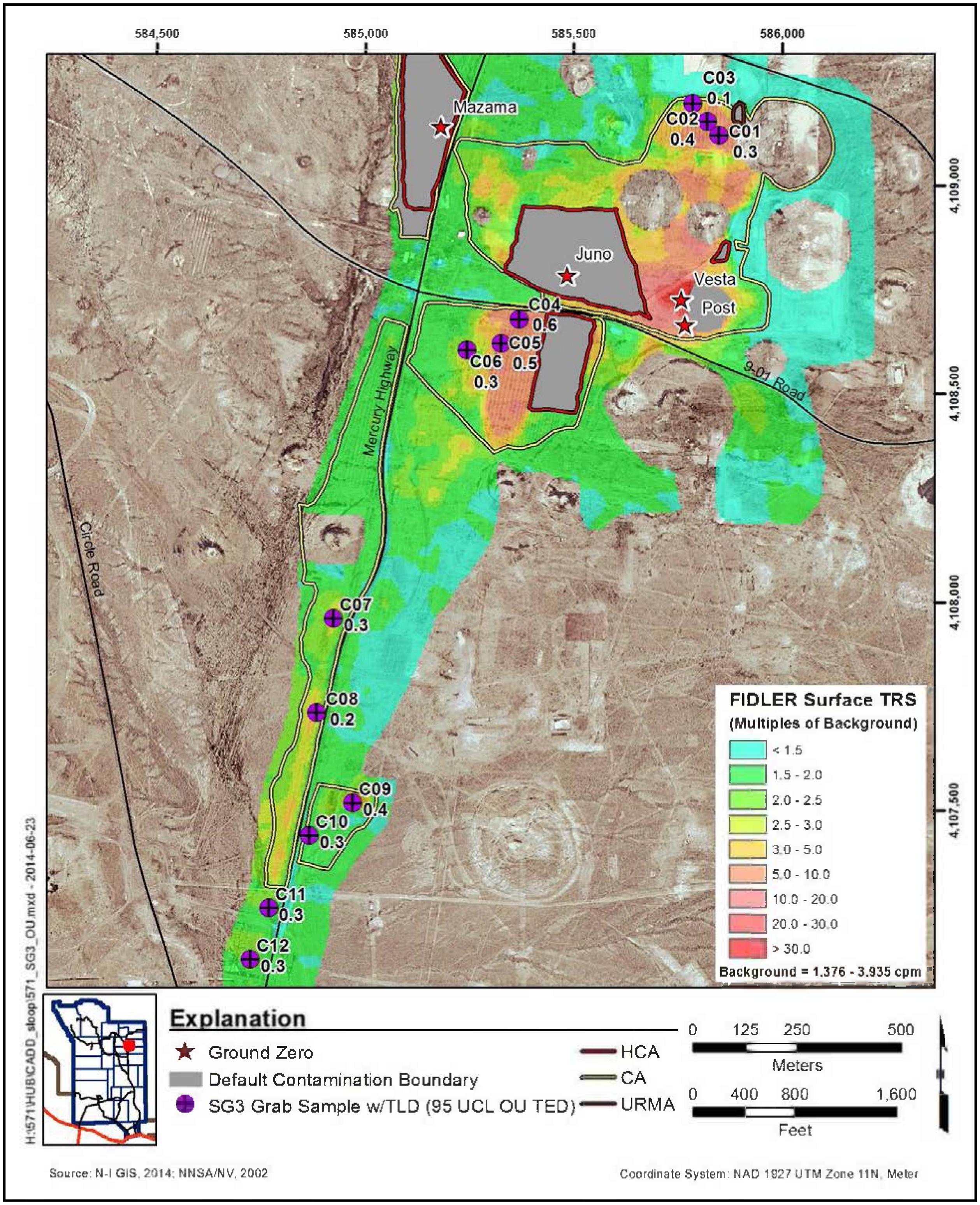

Figure A.6-3
95% UCL of the TED at Study Group 3

Table A.6-6
Study Group 3, Sample Results for SVOCs

Location	Sample Number	COPC (mg/kg)
		Di-n-Butyl Phthalate
FAL		62,000
C06	C013	0.124

Table A.6-7
Study Group 3, Sample Results for PCBs

Location	Sample Number	COPC (mg/kg)
		Aroclor 260
FAL		0.74
C04	C011	0.00206
C09	C009	0.00145
C11	C004	0.00125

A.6.4 Nature and Extent of COCs

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.

A.6.5 Corrective Actions

As there were no COCs identified, no corrective actions are required for Study Group 3.

A.7.0 Study Group 4, Drainage

This study group consists of a drainage where the initial surface release of radionuclides from weapons-related tests and safety experiments was subsequently displaced through erosion. Additional detail on the history of Study Group 4 is provided in the CAIP (NNSA/NFO, 2013a).

A.7.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections (NNSA/NFO, 2013a).

A.7.1.1 Visual Surveys

Visual survey of the CAU 571 investigation area was conducted. A small drainage was identified along the south side of and parallel to the 9-01 Road and a mud pit and elevated windrows area. Obvious sedimentation areas along the drainage were minimal and did not consist of much accumulation of soil.

A.7.1.2 Radiological Surveys

Aerial surveys and TRSs were performed at Study Group 4. The aerial surveys area described in Section A.2.2.1. The aerial surveys and TRSs were conducted at the site to identify the location of the highest radiological readings within the drainage. The radiological levels identified in the drainage minimally exceeded background and, therefore, were not used to bias sample locations. Figure A.7-1 presents a graphic representation of the data from the TRS.

A.7.1.3 Radiological Field Screening

Radiological screening (as described in Section A.2.2.2) was performed at all Study Group 4 grab sample locations to determine whether buried contamination was present below the surface. Screening results were used to determine that buried contamination did not exist within the drainage. Therefore, only surface samples were collected in this study group.

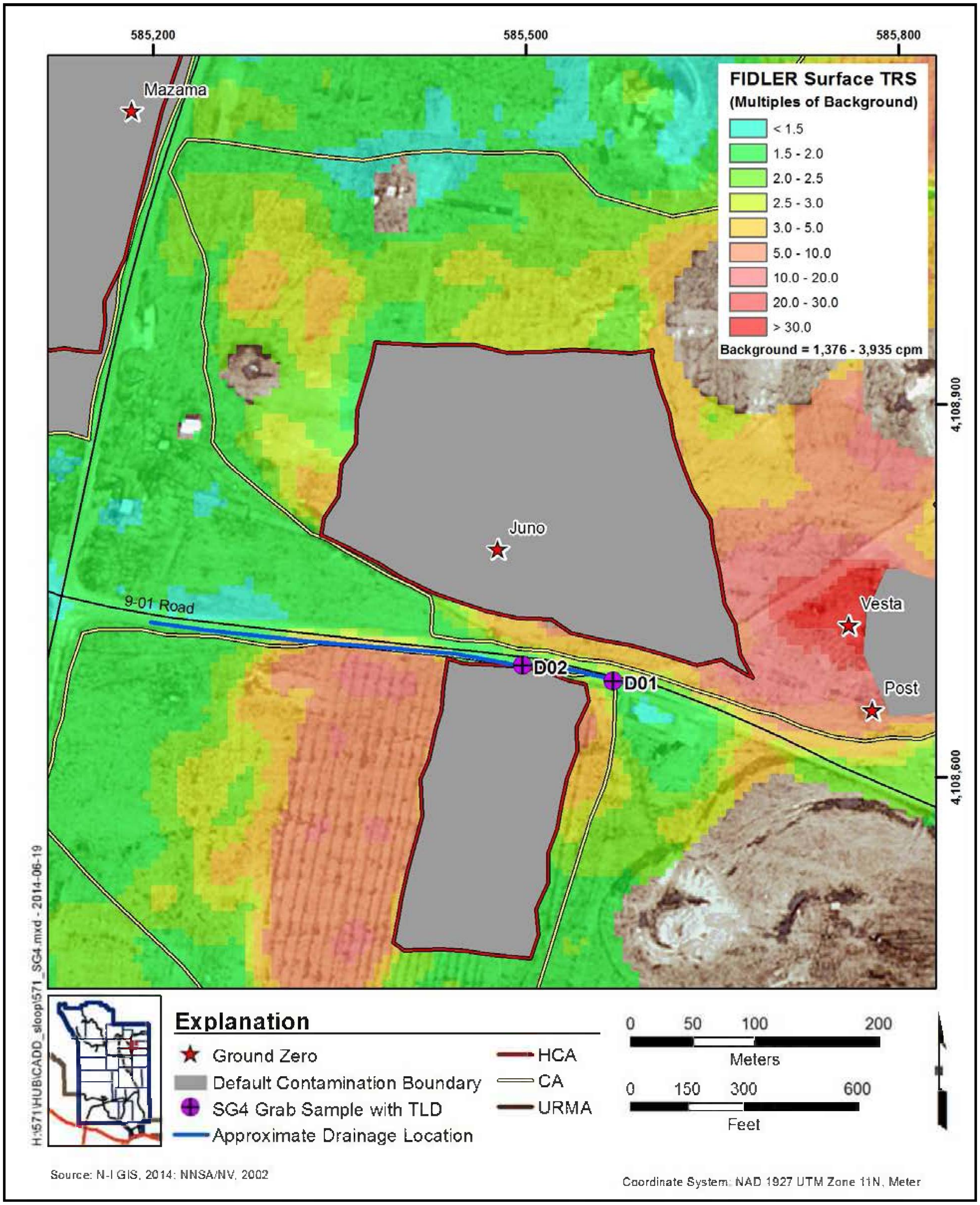

Figure A.7-1
Study Group 4 Sample and TLD Locations

A.7.1.4 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013a) at Study Group 4. The specific CAI activities conducted at this study group are described in the following subsections.

A.7.1.4.1 TLD Samples

One TLD sample location was selected within the first sedimentation accumulation area (D01) identified within the drainage with another TLD location (D02) selected in the subsequent sedimentation accumulation area identified downstream. The TLD locations are shown on Figure A.7-1. Table A.7-1 provides details regarding the TLDs placed in Study Group 4.

Table A.7-1
TLDs at Study Group 4

Location	TLD No.	Date Placed	Date Removed	Purpose
D01	5036	07/29/2013	11/04/2013	Grab
D02	4636	07/29/2013	11/04/2013	Grab

A.7.1.4.2 Soil Samples

Soil sampling consisted of collecting two surface soil samples from each of the TLD sample locations as described in Section A.7.1.4.1. The samples were analyzed for PCBs; gamma spectroscopy; and isotopic U, Pu, and Am. Additional information including depth and purpose for each soil sample collected for Study Group 4 is provided in Table A.7-2. Sample locations are shown on Figure A.7-1.

Table A.7-2
Samples Collected at Study Group 4

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
D01	D002	0.0 - 10.0	Soil	Environmental
D02	D001	0.0 - 10.0	Soil	Environmental

A.7.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013a) 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.7.3 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/NFO, 2013a). 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 as described in Section A.2.3.1. External doses for TLD locations are summarized in Section A.4.3.1. Internal doses for each sample plot are summarized in Section A.4.3.2. The TEDs for each sampled location are summarized in Section A.4.3.3.

A.7.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each Study Group 4 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 elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.7-3. The minimum sample size criterion was met for all TLD samples.

Table A.7-3
Study Group 4, 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
D01	0.01	3	3	2.8	0.5	0.1
D02	0.04	3	3	5.7	1.0	0.3

A.7.3.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each Study Group 4 sample location were determined as described in Section A.2.3. The internal dose for each exposure scenario are presented in Table A.7-4.

Table A.7-4
Study Group 4, Internal Dose for Each Exposure Scenario

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
D01	0.0	0.0	0.0
D02	0.0	0.0	0.0

A.7.3.3 Total Effective Dose

The TED for each grab 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.7-5. The 95 percent UCL of the TED at the Study Group 4 with the maximum dose is less than 1 mrem/OU-yr. Therefore, none of the Study Group 4 sample locations exceeded 25 mrem/OU-yr (Figure A.7-2).

Table A.7-5
Study Group 4, TED at Sample Locations (mrem/yr)

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
D01	2.4	2.9	0.4	0.5	0.1	0.1
D02	4.3	5.7	0.7	1.0	0.2	0.3

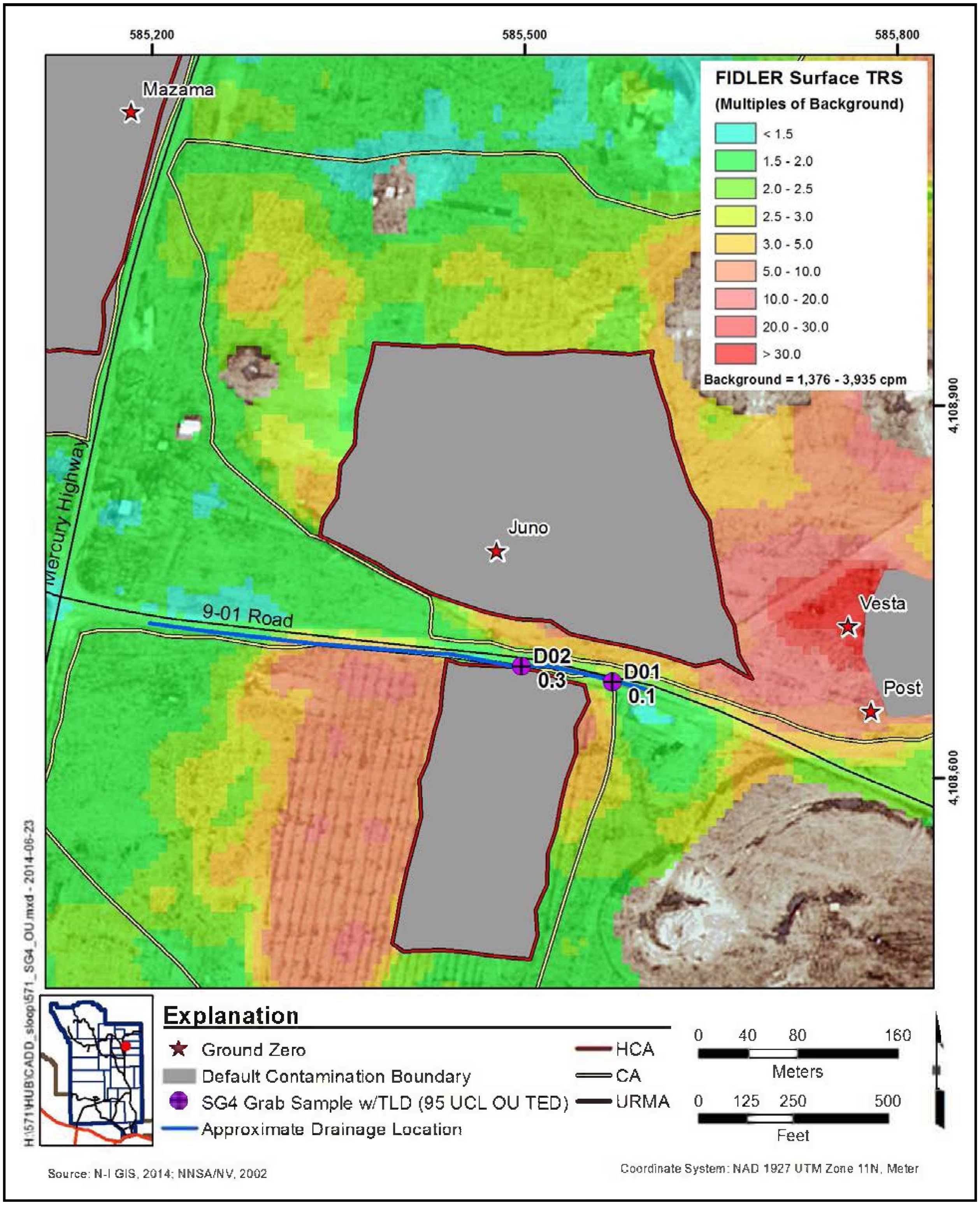

Figure A.7-2
95% UCL of the TED at Study Group 4

A.7.4 Nature and Extent of COCs

Based on the data evaluation, no sample location exceeded the FAL of 25 mrem/OU-yr; therefore, no COCs were identified at Study Group 4.

A.7.5 Corrective Actions

As there were no COCs identified, no corrective actions are required for Study Group 4.

A.8.0 Study Group 5, Other

This study group consists of all other radiological and chemical releases identified that do not fall into any other study groups. The identified potential releases were potentially contaminated debris, stained soil, and a radiologically contaminated area. Additional detail on the history of Study Group 5 is provided in the CAIP (NNSA/NFO, 2013a).

A.8.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this study group are described in the following subsections (NNSA/NFO, 2013a).

A.8.1.1 Visual Surveys

Visual survey of the entire investigation area was conducted to identify potential releases not captured in any of the other study groups. Potential releases identified during the visual survey were a radiologically contaminated area, 13 lead items, 13 lead-acid batteries, stained soil, and an asphalt pile. Debris (3 drums and a filter) was also identified. Two of the drums were empty, while the third—which was partially buried in mud at the bottom of a crater—was partially filled with the mud it was buried in.

A.8.1.2 Radiological Surveys

During the preliminary investigation of the test area, an area of elevated removable contamination was identified, and the area was posted as a CA. A TRS was performed at the CA to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings within the CA. Figure A.8-1 presents a graphic representation of the data from the TRS. The TRS results did not result in any other biased sample locations for Study Group 5 components.

A.8.1.3 Radiological Field Screening

Radiological screening (as described in Section A.2.2.2) was performed at the sample plot within the CA to determine whether buried contamination was present below the surface. Screening results were

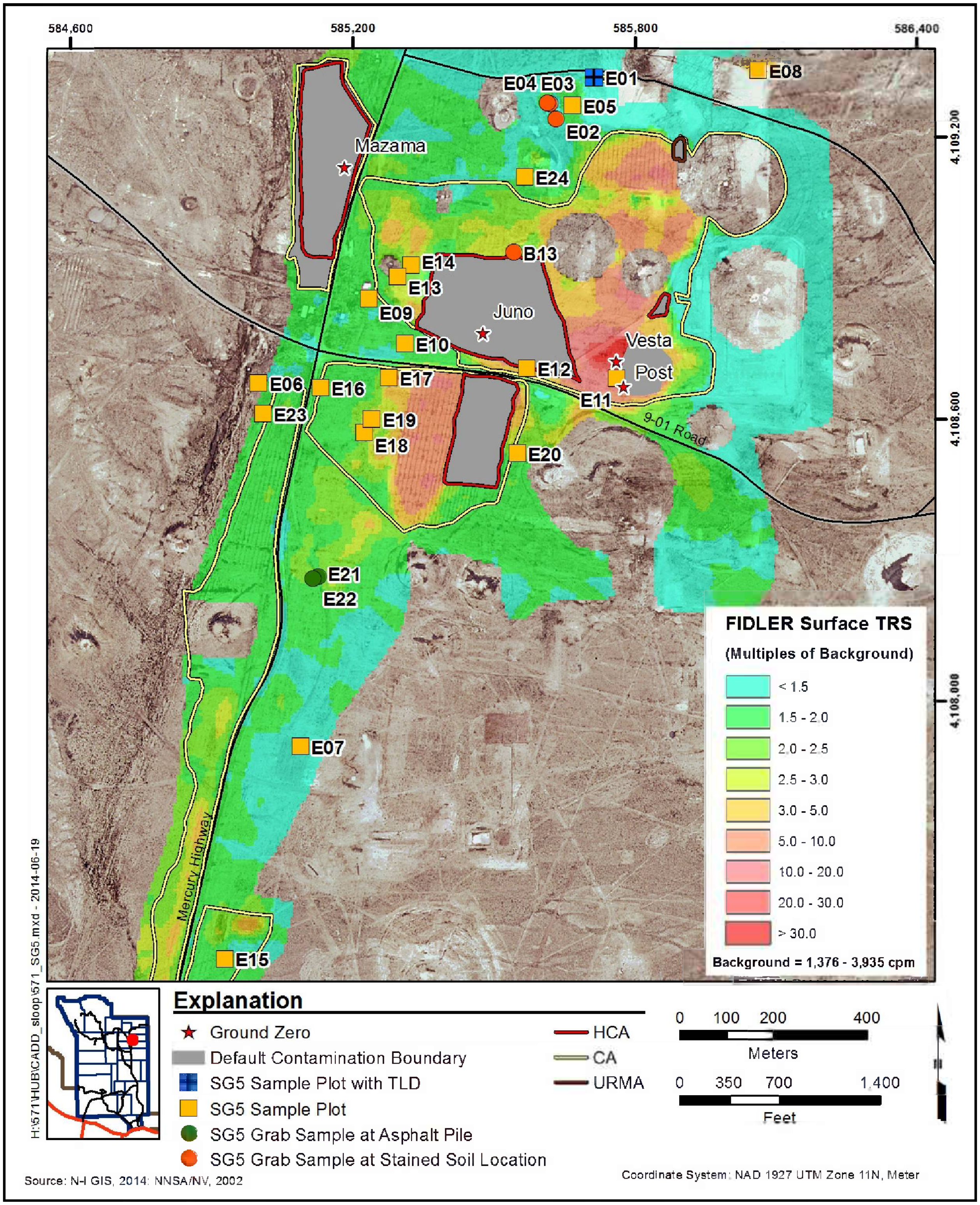

Figure A.8-1
Study Group 5 Sample and TLD Locations

used to determine that buried contamination did not exist within the CA. Therefore, only surface samples were collected at this sample plot.

A.8.1.4 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NFO, 2013a) at Study Group 5. The specific CAI activities conducted at this study group are described in the following subsections.

A.8.1.4.1 TLD Samples

One TLD sample plot location was selected based on its location within the CA and to include the highest radiological value from the TRS. Because the remaining potential releases within Study Group 5 were identified as chemical in nature and did not have a radiological component, no other TLDs samples were collected. The TLD sample location is shown on Figure A.8-1. Table A.8-1 provides details regarding the TLD placed in Study Group 5.

Table A.8-1
TLDs at Study Group 5

Location	TLD No.	Date Placed	Date Removed	Purpose
E01	4696	07/29/2013	11/04/2013	Environmental

A.8.1.4.2 Soil Samples

Soil sampling consisted of collecting 4 composite samples from 1 sample plot located within the CA. There were 18 sample plots established at lead and battery locations. Sample plots were established in the location that could conceivably be impacted by the PSM determined to potentially result in soil contamination. The size of the sample plot was determined by the extent of the PSM. One sample, consisting of 9 aliquots, was collected from each PSM sample plot. Four grab soil samples were collected based on the presence of stained soil, while 2 soil samples were collected to investigate the impact of the asphalt pile on the underlying soil. Table A.8-2 shows the number of soil samples collected by type and details the analyses. Additional information regarding depth and purpose for each soil sample collected for Study Group 5 is provided in Table A.8-3. Sample locations are shown on Figure A.8-1.

Table A.8-2
Study Group 5 Soil Sample Summary

Sample Type	Number of Locations	Number of Soil Samples	Analyses (Method)
Plot	1	4	Gamma Spectroscopy, Isotopic U, Isotopic Pu, Isotopic Am
Grab	1	1	VOCs, SVOCs, RCRA Metals, PCBs
	3	4 (1 FD)	Gamma Spectroscopy, Isotopic U, Isotopic Pu, Isotopic Am, VOCs, SVOCs, RCRA Metals, PCBs, Hexavalent Chromium
	18	20 (1 FD, 1 verification sample)	RCRA Metals
	2	2	Gamma Spectroscopy, Isotopic U, Isotopic Pu, Isotopic Am, VOCs, SVOCs, RCRA Metals, PCBs, Hexavalent Chromium
Total	**25**	**31**	

A.8.2 Deviations/Revised Conceptual Site Model

The CAIP requirements (NNSA/NFO, 2013a) 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.8.3 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/NFO, 2013a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. For chemical contaminants, the results are reported as individual concentrations that are comparable to their corresponding FALs. The analytical parameters and laboratory methods used during this investigation were discussed in CAIP.

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.8.3.1. Internal doses for each sample plot are summarized in Section A.8.3.2. The TEDs for each sampled location are summarized in Section A.8.3.3. Chemical contaminant results for Study Group 3 are summarized in Section A.8.3.4.

Table A.8-3
Samples Collected at Study Group 5
(Page 1 of 2)

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
E01	E601	0.0 - 5.0	Soil	Environmental
	E602			
	E603			
	E604			
E02	E002	0.0 - 15.0		
E03	E003	0.0 - 15.0		
E04	E004	0.0 - 15.0		
	E005	0.0 - 15.0		FD
E05	E006	0.0 - 5.0		Environmental
E06	E007	0.0 - 5.0		
E07	E008	0.0 - 5.0		
E08	E009	0.0 - 5.0		
	E027	0.0 - 15.0		
E09	E010	0.0 - 5.0		
E10	E011	0.0 - 5.0		
E11	E012	0.0 - 5.0		
E12	E013	0.0 - 5.0		
E13	E014	0.0 - 5.0		
E14	E015	0.0 - 5.0		
E15	E016	0.0 - 5.0		
E16	E017	0.0 - 5.0		
E17	E018	0.0 - 5.0		
E18	E019	0.0 - 5.0		
E19	E020	0.0 - 5.0		
E20	E021	0.0 - 5.0		
E21	E022	0.0 - 15.0		
E22	E023	0.0 - 15.0		

Table A.8-3
Samples Collected at Study Group 5
(Page 2 of 2)

Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
E23	E024	0.0 - 5.0	Soil	Environmental
E24	E025	0.0 - 5.0		
	E026	0.0 - 5.0		FD
B13	E001	8.0 -12.0	Soil	Environmental

A.8.3.1 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each Study Group 5 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 elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.8-4. The minimum sample size criterion was met for all TLD samples.

Table A.8-4
Study Group 5, 95% UCL External Dose for Each Exposure Scenario

Location	Standard Deviation (OU Scenario)	Number of Elements	Minimum Sample Size (OU Scenario)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
E01	0.02	3	3	2.6	0.4	0.1

A.8.3.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each Study Group 3 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 each exposure scenario are presented in Table A.8-5.

Table A.8-5
Study Group 5, 95% UCL Internal Dose for Each Exposure Scenario

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)
E01	0.0	4	3	3.3	0.6	0.2

A.8.3.3 Total Effective Dose

The TED for each grab 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.8-6. The 95 percent UCL of the TED at the Study Group 5 with the maximum dose is less than 1 mrem/OU-yr. Therefore, the Study Group 5 sample location did not exceed 25 mrem/OU-yr (Figure A.8-2).

Table A.8-6
Study Group 5, TED at Sample Locations (mrem/yr)

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
E01	4.3	5.9	0.7	1.0	0.2	0.3

A.8.3.4 Chemical and Radiological Contaminants

Several grab samples in Study Group 5 were analyzed for chemical COCs, depending on the release being evaluated. The CSM for these components of Study Group 5 do not include a radiological source; however, radionuclides were analyzed and reported for completeness. Analytical results exceeding MDCs from the samples are presented in the following subsections.

A.8.3.4.1 VOCs

The analytical results for VOCs in samples that exceeded the MDCs are shown in Table A.8-7. No results exceeded the FAL.

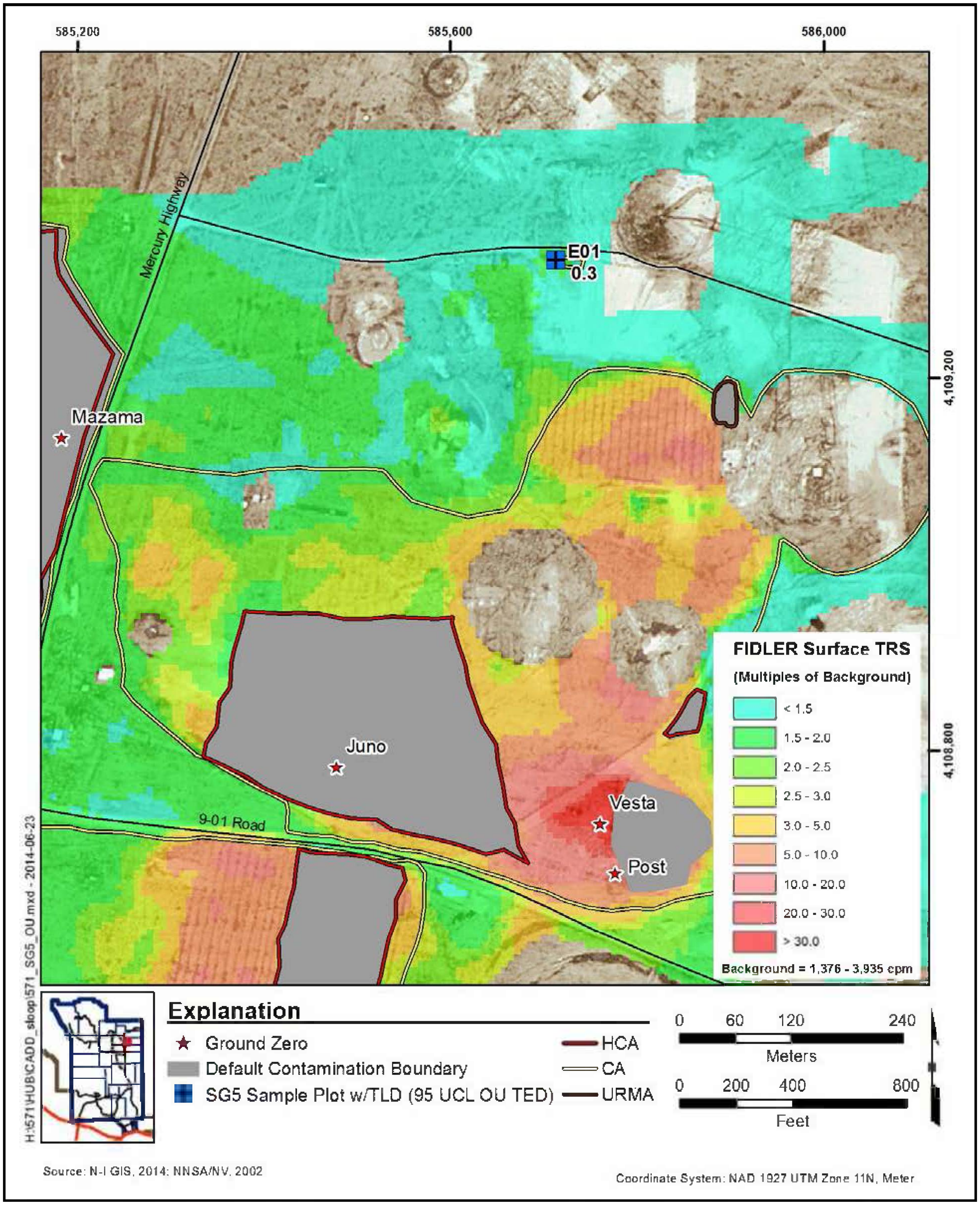

Figure A.8-2
95% UCL of the TED at Study Group 5

Table A.8-7
Study Group 5, Sample Result for VOCs

Location	Sample Number	COPC (mg/kg)
		Toluene
FAL		45,000
E22	E023	0.000364 (J)

J = Estimated value.

A.8.3.4.2 SVOCs

The analytical results for SVOCs in samples that exceeded the MDCs are shown in Table A.8-8. No results exceeded the FAL.

Table A.8-8
Study Group 5, Sample Results for SVOCs

Location	Sample Number	COPCs (mg/kg)	
		Bis(2-ethylhexyl)phthalate	Phenanthrene
FALs		120	170,000
E03	E003	--	0.0338 (J)
E04	E005	0.595	--

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

A.8.3.4.3 PCBs

The analytical results for PCBs in samples that exceeded the MDCs are shown in Table A.8-9. No results exceeded the FAL.

Table A.8-9
Study Group 5, Sample Results for PCBs

Location	Sample Number	COPCs (mg/kg)	
		Aroclor 1254	Aroclor 1260
FALs		0.74	0.74
E03	E003	0.0117	0.00423
E04	E004	--	0.00145 (J)
	E005	--	0.0017 (J)

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

A.8.3.4.4 RCRA Metals

The analytical results for RCRA metals in samples that exceeded the MDCs are shown in Table A.8-10. One sample plot (E08) exceeded the FAL for lead. An interim corrective action of soil removal was conducted. After soil removal, a verification sample (E027) was collected from the impacted area. The verification sample (E027) indicated that the extent of the COC was established and that the COC was removed to below the FAL.

Table A.8-10
Study Group 5, Sample Results for Metals
(Page 1 of 2)

Location	Sample Number	COPCs (mg/kg)						
		Arsenic	Barium	Cadmium	Hexavalent Chromium	Lead	Mercury	Silver
FALs		23	190,000	9,300	5.6	800	43	5,100
B13	E001	2.4	116 (J)	0.191 (J)	--	8.4 (J)	0.016	--
E02	E002	3.95	140	0.265 (J)	--	8.96	0.021 (J-)	--
E03	E003	4.06	131	0.218 (J)	--	22.1	0.0231 (J-)	--
E04	E004	3.33	70.6	0.115 (J)	--	13.5	0.0243 (J-)	--
	E005	3.3	101	0.106 (J)	--	19	0.0263 (J-)	--
E05	E006	3.29	173	0.47 (J)	--	65.8	0.0274 (J-)	--

Table A.8-10
Study Group 5, Sample Results for Metals
(Page 2 of 2)

Location	Sample Number	COPCs (mg/kg)						
		Arsenic	Barium	Cadmium	Hexavalent Chromium	Lead	Mercury	Silver
FALs		23	190,000	9,300	5.6	800	43	5,100
E06	E007	2.02	173	0.368 (J)	--	114	0.0167 (J-)	--
E07	E008	1.05	133	0.277 (J)	--	17	0.017 (J-)	--
E08	E009	4.1	134	0.426 (J)	--	**34,300**	0.0325 (J-)	--
	E027	2.48	115	0.644	--	505	0.0256	0.562 (J)
E09	E010	2.27	115	0.363 (J)	--	28.2	0.0207 (J-)	--
E10	E011	1.95	122	0.319 (J)	--	427	0.0206 (J-)	--
E11	E012	2.33	142	0.125 (J)	--	87.5 (J)	0.0134	--
E12	E013	2.69	116	--	--	20.4 (J)	0.0146	--
E13	E014	2.26	115	4.71	--	19 (J)	0.0178	--
E14	E015	1.97	119	0.205 (J)	--	47 (J)	0.0187	0.511 (J)
E15	E016	3.32	186	--	--	40.2 (J)	0.0167	--
E16	E017	2.15	233	0.209 (J)	--	36.9 (J)	0.00429 (J)	--
E17	E018	1.99	165	0.169 (J)	--	57.4 (J)	0.0154	--
E18	E019	2.48	311	0.121 (J)	--	50.1 (J)	0.00428 (J)	--
E19	E020	2.03	132	--	--	174 (J)	0.0101 (J)	--
E20	E021	2.7	128	0.102 (J)	--	13.4 (J)	0.0191	--
E21	E022	1.77	126	--	0.232 (J-)	8.2 (J)	0.00866 (J)	--
E22	E023	1.92	155	--	--	16.3 (J)	0.0141	--
E23	E024	1.59	169 (J)	0.198 (J)	--	76.6	0.0235	--
E24	E025	1.74	113 (J)	--	--	73.4	0.0167	--
	E026	2.3	101 (J)	2.23	--	85.6	0.0176	0.679 (J)

J = Estimated value.
J- = The result is an estimated value, but is biased low.
-- = Not detected above MDCs.

Bold indicates the values exceeding the FALs.

A.8.3.4.5 Gamma-Emitting Radionuclides

The analytical results for gamma-emitting radionuclides in samples that exceeded the MDCs are shown in Table A.8-11. No results exceeded the FAL.

Table A.8-11
Study Group 5, Sample Results for Gamma-Emitting Radionuclides

Location	Sample Number	COPCs (pCi/g)			
		Ac-228	Am-241	Cs-137	Eu-152
FALs		1.18E+04	3.90E+04	1.63E+03	8.54E+02
E02	E002	1.57	--	0.244	0.402
E03	E003	2.26	2.59	0.343	--
E04	E004	1.44	2.92 (J)	0.355	0.435 (J)
	E005	1.56	3.84 (J)	0.339	0.36 (J)
E21	E022	1.81	--	--	--
E22	E023	1.59	3.63 (J)	0.128	--

Ac = Actinium
Cs = Cesium
Eu = Europium

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

A.8.3.4.6 Isotopic Radionuclides

The analytical results for isotopic radionuclides in samples that exceeded the MDCs are shown in Table A.8-12. No results exceeded the FAL.

A.8.4 Nature and Extent of COCs

Based on the data evaluation, no sample location exceeded the FAL of 25 mrem/OU-yr. However, one sample location (E08) exceeded the FAL for lead. As there was a COC present in the soil below a former broken battery location, an interim corrective action of soil removal was conducted. The area was sampled after the corrective action to confirm the extent of the COC had been determined and the COC removed to levels below the FAL. The verification sample (E027) indicated that the extent of

Table A.8-12
Study Group 5, Sample Results for Isotopes

Location	Sample Number	COPCs (pCi/g)					
		Am-241	Pu-238	Pu-239/240	Pu-241	U-234	U-238
FALs		3.90E+04	7.49E+04	6.86E+04	3.36E+06	3.70E+05	3.12E+04
E02	E002	--	--	0.608	--	1.01	0.928
E03	E003	0.835	--	7.8	--	1.95	1.88
E04	E004	1.18	0.205	14.1	--	0.8	0.715
	E005	0.766 (J)	0.171	10.9	--	0.812	0.753
E21	E022	--	--	--	--	0.613	0.723
E22	E023	0.582	0.115	3.88	--	0.554	0.632

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

the COC was established and that the COC was removed to below the FAL. Therefore, no COCs remain at Study Group 5.

A.8.5 Corrective Actions

A COC (lead) was identified at one sample location (E08), and an interim corrective action of soil removal was performed at the COC location. A verification sample (E027) was collected to verify that the COC had been removed to levels below the FAL for that COC. Therefore, no further corrective action is required for Study Group 5.

A.9.0 Waste Management

This section addresses the characterization and management of investigation and remediation wastes. Waste management activities were conducted as specified in the CAIP (NNSA/NFO, 2013a).

A.9.1 Generated Wastes

The wastes listed in Table A.9-1 were generated during the field investigation activities of CAU 571. The amount, type, and source of waste placed into each container were recorded in waste management logbooks that are maintained in the CAU 571 file.

Wastes were 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. Wastes generated during the CAI were segregated into the following waste streams:

- Disposable personal protective equipment (PPE) and sampling equipment
- Mixed low-level radioactive waste (MLLW) soil
- Debris (e.g., empty drum and housing filter)
- Recyclable waste (i.e., lead-acid batteries and lead debris)

A.9.2 Waste Characterization and Disposal

The waste streams at CAU 571 were characterized using analytical results, process knowledge, and radiological surveys. The characterization of the waste and recommended disposition were determined based on a review of the analytical results and compared to federal and state regulations, permit requirements, and disposal or recycle facility acceptance criteria. Waste characterization documentation is maintained in the CAU 571 project file. Analytical results and comparisons to regulatory criteria are presented in Table A.9-2. Sample E501 was collected from an asphalt pile, while samples E502 and E503 were collected from drilling mud/soil that had migrated into two discarded drums lying in a crater. These three samples were collected to support potential waste disposal. However, as no waste was generated in association with these samples, the data were not used but are reported in Table A.9-2 for completeness. Sample E504 was collected from the waste

Table A.9-1
Waste Summary Table
(Page 1 of 2)

Container Number	Waste Description	Waste Characterization	Waste Disposition			
			Disposal Facility	Waste Volume	Disposal Date	Disposal Doc[a]
Solid Industrial Waste						
571D02	Empty 55-gal steel drum	Solid Industrial Waste	Area 9, U10c Industrial Landfill	47 lb	04/01/2014	LVF
571D05	Metal filter canister	Solid Industrial Waste	Area 9, U10c Industrial Landfill	25 lb	04/01/2014	LVF
Low-Level Radioactive Waste (LLW)						
571A01 to 571A08	Debris - PPE	Low-Level Radioactive Waste	Area 5 - RWMC	Eight 55-gal drums	Projected (September 2014)	CD (pending)
Mixed Low-Level Radioactive Waste (MLLW)						
571D06	Soil	Mixed Low-Level Radioactive Waste	Offsite TSDF	50 gal	Transferred to M&O Contractor (April 2014)	Onsite HAZMAT transfer paperwork
Recycled Materials						
571D01	Spent Lead-Acid Batteries	Recycle Material	NSTec Fleet Services	7 batteries (~750 lb)	03/12/2014	WCL
571D07	Elemental Lead (bricks, plates)	Recycle Material	Offsite Recycle Facility - TBD	110 lb	TBD	Certificate of Recycle (pending)
571D08	Elemental Lead (brick, wool)	Recycle Material	Offsite Recycle Facility - TBD	90 lb	TBD	Certificate of Recycle (pending)
571D09	Elemental Lead (brick, sheet)	Recycle Material	Offsite Recycle Facility - TBD	30 lb	TBD	Certificate of Recycle (pending)

Table A.9-1
Waste Summary Table
(Page 2 of 2)

Container Number	Waste Description	Waste Characterization	Waste Disposition			
			Disposal Facility	Waste Volume	Disposal Date	Disposal Doc[a]
571D10	Elemental Lead (broken lead-acid battery pieces)	Recycle Material	Offsite Recycle Facility - TBD	10-gal steel drum	TBD	Certificate of Recycle (pending)
571D11	Elemental Lead (broken lead-acid battery pieces)	Recycle Material	Offsite Recycle Facility - TBD	5-gal poly bucket	TBD	Certificate of Recycle (pending)
571D12	Elemental Lead (broken lead-acid battery pieces)	Recycle Material	Offsite Recycle Facility - TBD	5-gal poly bucket	TBD	Certificate of Recycle (pending)

CD = Certificate of Disposal
gal = Gallon
HAZMAT = Hazardous materials
lb = Pound
LVF = Load Verification Form
NSTec = National Security Technologies, LLC
RWMC = Radioactive waste management complex
TBD = To be determined
TSDF = Treatment, storage, and disposal facility
WCL = Waste container log

Table A.9-2
Waste Management Results Detected above MDCs at CAU 571
(Page 1 of 2)

Sample Location	Sample Number	Sample Matrix	Parameter	Result	Criteria	Units
E21	E501	Solid	Barium	0.469	100[a]	mg/L
			TPH-DRO	103 (J)	N/A	mg/kg
			Motor Oil	2070	N/A	mg/kg
			Am-241	0.886	10[b]	pCi/g
			Am-241	4.64 (J)	10[b]	pCi/g
			Cs-137	0.476	100[b]	pCi/g
			Pu-238	0.116	10[b]	pCi/g
			Pu-239/240	7.55	10[b]	pCi/g
			U-234	0.492	100[b]	pCi/g
			U-238	0.525	100[b]	pCi/g
Container #571D04	E502	Soil	Barium	0.803	100[a]	mg/L
			TPH-DRO	36 (J)	N/A	mg/kg
			Motor Oil	107 (J)	N/A	mg/kg
			Am-241	0.921	10[b]	pCi/g
			Am-241	3.18	10[b]	pCi/g
			Cs-137	0.246	100[b]	pCi/g
			Pu-239/240	8.76	10[b]	pCi/g
			U-234	1.25	100[b]	pCi/g
			U-235/236	0.0777	100[b]	pCi/g
			U-238	1.23	100[b]	pCi/g
Container #571D03	E503	Soil	Barium	0.69	100[a]	mg/L
			Motor Oil	35.3 (J)	N/A	mg/kg
			Am-241	**11**	10[b]	pCi/g
			Am-241	**11.1**	10[b]	pCi/g
			Cs-137	1.06	100[b]	pCi/g
			Pu-238	1.3	10[b]	pCi/g
			Pu-239/240	**78.7**	10[b]	pCi/g
			U-234	1.13	100[b]	pCi/g
			U-238	0.835	100[b]	pCi/g

Table A.9-2
Waste Management Results Detected above MDCs at CAU 571
(Page 2 of 2)

Sample Location	Sample Number	Sample Matrix	Parameter	Result	Criteria	Units
E08/Drum #571D06	E504	Soil	Barium	0.0829 (J)	100[a]	mg/L
			Cadmium	0.28	1[a]	mg/L
			Lead	**530**	5[a]	mg/L
			Silver	0.0161 (J)	5[a]	mg/L
			Am-241	1.94	10[b]	pCi/g
			Am-241	4.48 (J)	10[b]	pCi/g
			Cs-137	1.87	100[b]	pCi/g
			Eu-152	0.456	100[b]	pCi/g
			Pu-238	0.158	10[b]	pCi/g
			Pu-239/240	**13.8**	10[b]	pCi/g
			U-234	0.797	100[b]	pCi/g
			U-238	0.653	100[b]	pCi/g

[a]TCLP limit (CFR, 2014)
[b]Radionuclide limits in NNSS U10c landfill permit (NNSA/NSO, 2010)

DRO = Diesel-range organics
mg/kg = Milligrams per kilogram
mg/L = Milligrams per liter
TCLP = Toxicity Characteristic Leaching Procedure
TPH = Total petroleum hydrocarbons

Bold indicates the values exceeding the regulatory limit.

soil generated at location E08 and containerized in drum 571D06 for disposition characterization; results are discussed further in Section A.9.2.3.

The generated waste streams were characterized as Industrial Solid Waste, LLW, MLLW, and Recyclable Materials. The waste shipping and/or disposal documentation is provided in Attachment D-2.

A.9.2.1 Industrial Solid Waste

Approximately 0.5 cubic yards (yd^3) of debris consisting of an empty metal drum and an abandoned equipment housing filter was generated and characterized as industrial solid waste that meets the chemical and radiological waste acceptance criteria of the Area 9 U10c solid waste landfill. The empty drum and housing filter were issued unique container identification numbers (571D02 and 571D05, respectively) for tracking purposes. The debris was disposed at the Area 9, U10c solid waste landfill with other industrial solid wastes from CAU 567.

Approximately 1 yd^3 of PPE and disposable sampling equipment was generated during CAI activities. The PPE and disposable sampling equipment generated were field screened, as generated, to meet the unrestricted release of materials screening limits of Table 4.2 of the *Nevada National Security Site Radiological Control* (RadCon) *Manual* (NNSA/NSO, 2012a). 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 (NNSA/NFO, 2013b). The solid waste was bagged, marked, and placed in a roll-off container located at Building 23-310 for final disposal at the Area 9, U10c landfill.

A.9.2.2 LLW

Eight 55-gal drums were generated during the CAU 571 CAI. The drums (571A01 through 571A08) contained PPE and disposable sampling equipment that was generated during sampling activities within a posted radiological CA and were characterized as LLW. The waste in containers 571A01 through 571A08 meets the NNSS Waste Acceptance Criteria for disposal at the Area 5 RWMC (NNSA/NFO, 2013b).

A.9.2.3 MLLW

One 55-gal drum (571D06) containing soil removed from beneath an abandoned and broken lead-acid battery was generated and characterized as MLLW. The waste was transferred on April 22, 2014, to NSTec Waste Generator Services for treatment and disposal at an offsite TSDF. Before the contaminated soil was removed, battery lead plates from inside the battery casing were removed as a BMP for recycling. Analytical data reported in Table A.9-2 for soil sample E504 were evaluated to support the hazardous and radiological characterization of the waste soil. The composite sample was collected during the removal and placement of soil into drum #571D06. Based on the analytical results, lead exceeded the TCLP limit of 5.0 mg/L with cadmium as an underlying hazardous constituent; therefore, the soil is RCRA regulated. Based on the analytical results, the maximum activity concentrations of Pu-239/240 in the waste container exceed the *Nevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995); therefore, the waste is characterized as MLLW.

A.9.2.4 Recyclable Materials

Recycled materials generated during the CAI at CAU 571 included lead-acid batteries and elemental lead debris items comprising lead bricks, lead plates, and lead pieces that were packaged in containers 571D01 and 571D07 through 571D12.

The lead materials in containers 571D10, 571D11, and 571D12 were radiologically field screened as generated to meet the unrestricted release of materials screening limits of Table 4.2 of the RadCon Manual (NNSA/NSO, 2012a). The lead materials in containers 571D07, 571D08, and 571D09 were determined to have radiological contamination but meet the Toxco Materials Management Center (TMMC) recycling criteria. All recyclable lead materials in containers 571D07 through 571D12 are pending transfer offsite to TMMC for recycling.

Six partially intact lead-acid batteries and one intact lead-acid battery (container 571D01) were identified during the CAI. The batteries were radiologically field screened and met the unrestricted release limits of Table 4.2 of the RadCon Manual (NNSA/NSO, 2012a). The batteries were transferred to NSTec Fleet Services for offsite recycling.

A.10.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 571 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 QAP (NNSA/NSO, 2012b).

A.10.1 Data Validation

Data validation was performed in accordance with the Soils QAP (NNSA/NSO, 2012b) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 571 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 571 files as a hard copy and electronic media.

All laboratory data were subjected to a Tier I evaluation, while a Tier II evaluation was performed on a subset of reported data for all samples. A Tier III evaluation was performed on the analytical results for samples which represent 5 percent of the samples collected for site characterization.

A.10.1.1 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.10.1.2 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.10.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation and the laboratory reported data. A Tier III review of 5 percent of the samples collected had Tier III validation performed by TLI Solutions, Inc. in Golden, Colorado. The Tier II and Tier III evaluations were in agreement and evaluated data was used. 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,
  - 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,
  - 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,
  - 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.10.2 Field QC Samples

Laboratory QC samples used to measure accuracy and precision were analyzed by the laboratory with each batch of samples submitted for analysis. Discussion can be found in Sections A.4.0 through A.8.0 (see Appendix B for further discussion). Initial and continuing calibrations were also performed for each sample delivery group. When QC criteria was exceeded, qualifying flags were added to sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in CAU 571 files as both hard copy and electronic media.

During the CAI, three FDs were also sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in the CAIP (NNSA/NFO, 2013a). For these samples, the duplicate results precision (i.e., relative percent differences [RPDs] between the environmental sample results and their corresponding FD sample results) were evaluated.

A.10.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.10.4 Laboratory Nonconformances

N-I issued no laboratory nonconformance reports during the course of the CAI.

A.10.5 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 NSTec RadCon 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, 2014) 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.11.0 Summary

It was assumed that radioactivity within the DCBs exceeds FALs and requires corrective action. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for each DCB is closure in place with an FFACO UR. The FFACO URs implemented at each release site will protect site workers from inadvertent exposure. The FFACO URs are defined and shown in Attachment D-1. Based on the implementation of the following corrective actions, no further corrective action is required for the following DCBs:

- ***The Juno HCA and Landfill***, where surface and subsurface soil is assumed to exceed the radiological FAL. A corrective action of closure in place was implemented for CAS 09-23-03, consisting of an FFACO UR for the radiological contamination.
- ***The Vesta Landfill***, where surface and subsurface soil is assumed to exceed the radiological FAL. A corrective action of closure in place was implemented for CAS 09-23-12 (including CAS 09-23-04), consisting of an FFACO UR for the radiological contamination.
- ***The Small HCA north of Vesta***, where surface soil is assumed to exceed the radiological FAL. A corrective action of closure in place was implemented as a part of CAS 09-23-12, consisting of an FFACO UR for the radiological contamination.
- ***The URMA Pile,*** where subsurface soil is assumed to exceed the radiological FAL. A corrective action of closure in place was implemented as a part of CAS 09-23-12, consisting of an FFACO UR for the radiological contamination.
- ***The Mazama HCA***, where surface soil is assumed to exceed the radiological FAL. A corrective action of closure in place was implemented for CAS 09-23-13, consisting of an FFACO UR for the radiological contamination.
- ***The Windrows HCA***, where surface and subsurface soil is assumed to exceed the radiological FAL. A corrective action of closure in place was implemented for CAS 09-45-01, consisting of an FFACO UR for the radiological contamination.

PSM in the form of 13 lead items and 13 lead-acid batteries was identified at Study Group 5 during the CAI. A COC (lead) was identified in the soil beneath one broken lead-acid battery location. An interim corrective action was completed by removing all of the PSM and the lead-impacted soil. As no remaining PSM or COCs were present after the interim corrective action, no further corrective action is required for PSM or PSM-impacted soil.

Based on the CAU 571 CAI results for TLDs and/or soil samples collected after the interim corrective action, no COCs were identified and no corrective action is required.

In addition, a BMP was implemented 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/IA-yr and at areas where removable contamination is present at levels exceeding CA criteria. Because the area in Study Group 2 that exceeds CA criteria encompasses the area that exceeds 25 mrem/IA-yr, the administrative UR boundary for Study Group 2 was based on the CA criteria and was established at the outer CA fence line. Additional BMPs include establishing an administrative UR for windrow zones 2, 3, and 4 in Study Group 3 as well as the CA in Study Group 5 because these areas have removable contamination that exceeds the criteria for a CA. The administrative URs are presented and shown in Attachment D-1.

A summary of CAI results and actions implemented are presented in Table A.11-1 for each CAU 571 release.

Table A.11-1
Summary of Investigation Results at CAU 571

Study Group	CAS	Release	COC	Corrective Action	BMP
DCB	09-23-03	Juno HCA and Landfill	Assumed radiological COCs that exceed the FAL	Closure in place with FFACO URs	None
	09-23-12 (includes 09-23-04)	Vesta Landfill (includes Post)			
	09-23-12	Small HCA north of Vesta			
	09-23-12	URMA Pile			
	09-23-13	Mazama HCA			
	09-45-01	Windrows HCA			
Study Group 1, Atmospheric Release	N/A[a]	Relatively undisturbed atmospheric deposition of radionuclides from weapons-related tests and safety experiments.	None	None	None
Study Group 2, Subsurface Contamination	09-23-12	Atmospheric deposition of radionuclides that have subsequently been disturbed or covered.	None	None	Administrative UR based on exceedances of 25 mrem/IA-yr
Study Group 3, Windrows	09-45-01	Atmospheric deposition of radionuclides that were placed in rows (i.e., windrows) and then sprayed with road oil.	None	None	Administrative UR for the CA boundaries at windrows zones 2, 3, and 4
Study Group 4, Drainage	N/A[a]	Initial surface release of radionuclides was subsequently displaced through erosion.	None	None	None
Study Group 5, Other	09-45-01	Radiological release associated with features or items that do not fall into any other study group. This includes a radiologically posted CA.	None	None	Administrative UR for the CA boundary
	N/A[a]	Chemical release associated with features or items that do fall into any other study group. This includes PSM (e.g., lead items).	Lead	Clean Closure	Removal of debris

[a]A CAS was not assigned to these releases as there is no corrective action or BMP for this release.

A.12.0 References

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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 571 CAIP (NNSA/NFO, 2013) 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.* Review QA reports and inspect 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/NFO, 2013). 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/NFO, 2013) is as follows: "Is any COC associated with the CAU 571 release present in environmental media?" Any contaminant that is present (or is assumed to be present) at concentrations exceeding its corresponding FAL will be defined as a COC. 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 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 study group (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 Judgmental Sample Locations Identify COCs)

Decision I (as stipulated in the DQOs) was already resolved for the areas within the DCBs because those areas were already identified as requiring corrective action. Therefore, Decision I sampling only applied to those areas outside the DCBs. 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.
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

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

Study Group 1, Atmospheric Release

Sample plot locations were primarily selected by their location within Study Group 1 (in a relatively undisturbed area that would have potentially been impacted by an atmospheric release) and secondarily, by the TRS results. One sample plot was established in each of three separate areas within the Study Group 1 boundary, with each plot being established at the highest anomalous readings in each area as detected during the TRS.

Study Group 2, Subsurface Contamination

Sample plot locations were selected primarily based on their location within Study Group 2 (the area that would have been impacted by atmospheric releases and then subsequently disturbed). Secondarily, 16 locations were selected based on results of the TRS. The highest radiological readings were identified between the Juno HCA and the Vesta Landfill. One sample plot was established at the 2 locations with the highest anomalous readings. An additional 14 sample plots were established based on their proximity to the Juno and Vesta GZs. Due to the potential for subsurface contamination to be present, the soil from the center of all 16 sample plots were screened to determine the need for analysis.

Study Group 3, Windrows

Sample locations were primarily selected by their location within the Study Group 3 boundary and secondarily, based on the TRS results within each of five windrow zones. The TRS results showed that the highest radiation readings were located within windrow zones 1 and 2. However, a minimum of two sample locations were selected within each of the windrow zones. Within each zone, the first sample location was established at the location with the highest radiological reading as detected during the TRSs, while the second (or third) sample was selected in the location with the subsequent highest readings.

Study Group 4, Drainage

Sample locations were selected based on their location within sedimentation areas within the drainage. TRSs were conducted within the drainage, including the sedimentation areas, to identify locations of elevated radiological readings for sample location selection. The radiological readings were very near background and did not influence the selection of sample locations within the drainage. Due to the potential for subsurface contamination to be present, the soil at the sample locations were screened to determine the need for analysis.

Study Group 5, Other

Sample locations were selected based on the presence of PSM, stained soil, radiologically contaminated soil, and an asphalt pile. The analytical method for each release was chosen based on the COPCs that could reasonably be expected at that release 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 (NNSA/NFO, 2013) with the following exceptions:

- Sr-90 and Tc-99 were included in the analysis request for Study Group 1 and Study Group 2 due to their historical presence as fission product radionuclides and because there were two weapons-related tests conducted in the investigation area. The locations with the highest TRS readings (sample locations A01, B01, and B02) were selected for these additional analyses.

- In addition to the radiological analyses, samples collected in Study Group 3 were also analyzed for VOCs, SVOCs, and PCBs because road oil was sprayed on the windrows. A dioxin sample was collected from one location within each of the windrow zones.

- In addition to the radiological analyses, samples collected in Study Group 4 were also analyzed for PCBs because road oil was sprayed on the windrows and the drainage is adjacent to the windrows.

- In Study Group 5, samples were collected from soil potentially impacted by PSM, a stained area, and a radiologically contaminated area. In addition to the radiological analyses, samples were analyzed for VOCs, SVOCs, PCBs, RCRA metals, and/or hexavalent chromium, depending on the nature of the release.

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

Control of the false-negative decision error for the 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 a sample plot was accomplished using a random start, systematic triangular grid pattern for sample placement. This permitted that all given locations within the boundaries of the sample plot would have an equal probability of being 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 for each probabilistic sample location was calculated for both the internal (soil samples) and external (TLD elements) dose samples. 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 are presented in Table B.1-1. As shown in this table, the minimum number of sample plot and TLD samples was met or exceeded. The minimum sample size calculations were conducted for probabilistic sample locations as stipulated in the CAIP (NNSA/NFO, 2013) 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 QAP (NNSA/NSO, 2012). The sensitivity acceptance criterion is that analytical detection limits will be less than the corresponding FAL (NNSA/NFO, 2013). For radionuclides, the criterion is that all detection limits are less than their corresponding Occasional Use Area internal dose RRMGs. All of the chemical and radiological analyses met this criterion. Therefore, the DQI for sensitivity has been met for all contaminants, and no 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, representativeness, comparability, and completeness, as defined in the Soils QAP (NNSA/NSO, 2012). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NFO, 2013). The individual DQI results are presented in the following subsections.

Precision

Precision was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NFO, 2013) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012). Table B.1-2 provides the results for all

Table B.1-1
Input Values and Determined Minimum Number of Samples for Sample Plots
(Page 1 of 2)

Source	Plot	Standard Deviation (OU Scenario)	Minimum Sample Size	Samples Collected
Soil Samples				
Study Group 1, Atmospheric Release	A01	0.0	3	4
	A02	0.0	3	4
	A03	0.0	3	4
Study Group 2, Subsurface Contamination	B01	1.7	3	4
	B02	0.3	3	4
	B03	0.3	3	4
	B04	0.0	3	4
	B05	0.0	3	4
	B06	0.0	3	4
	B07	0.0	3	4
	B08	0.0	3	4
	B09	0.0	3	4
	B10	0.0	3	4
	B11	0.1	3	4
	B12	0.1	3	4
	B13	0.1	3	4
	B14	0.0	3	4
	B15	0.0	3	4
	B16	0.0	3	4
Study Group 5, Other	E01	0.0	3	4

Table B.1-1
Input Values and Determined Minimum Number of Samples for Sample Plots
(Page 2 of 2)

Source	Plot	Standard Deviation (OU Scenario)	Minimum Sample Size	Samples Collected
TLD Samples				
Study Group 1, Atmospheric Release	A01	0.0	3	3
	A02	0.0	3	3
	A03	0.0	3	3
Study Group 2, Subsurface Contamination	B01	0.5	3	3
	B02	0.3	3	3
	B03	0.1	3	3
	B04	0.0	3	3
	B05	0.0	3	3
	B06	0.0	3	3
	B07	0.1	3	3
	B08	0.0	3	3
	B09	0.0	3	3
	B10	0.0	3	3
	B11	0.1	3	3
	B12	0.1	3	3
	B13	0.0	3	3
	B14	0.0	3	3
	B15	0.0	3	3
	B16	0.0	3	3
Study Group 5, Other	E01	0.0	3	3

Note: The actual required minimum number of samples calculated by the one-sample t-test (EPA, 2006; PNNL, 2007) was less than 3. The minimum number of samples required to calculate statistics is 3.

constituents that were qualified for precision. The precision rate for U-234 and Sr-90 met the CAIP criterion of 80 percent. As stipulated in Section 4.3 of the Soils 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.

Table B.1-2
Precision Measurements

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
U-234	Uranium	12	103	88.3
Sr-90	Strontium	1	8	87.5
Lead	Metals	12	27	55.6

No lead results qualified for precision 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.

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NFO, 2013) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012). No hexavalent chromium results qualified for accuracy 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. As stipulated in Section 4.3 of the Soils 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.

Table B.1-3 provides the results for all constituents that were qualified for accuracy. The accuracy for 4-nitrophenol, pentachlorophenol, selenium, and barium met the CAIP criterion of 80 percent.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NFO, 2013) was used to address sampling and analytical requirements for CAU 571. 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

Table B.1-3
Accuracy Measurements

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
4-Nitrophenol	SVOCs	1	20	95
Pentachlorophenol		1	20	95
Selenium	Metals	3	27	88.9
Barium		4	27	85.2
Chromium VI	Hexavalent Chromium	2	6	66.7

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 571 CAI are considered to adequately represent contaminant concentrations of the sampled population.

Comparability

Field sampling, as described in the CAIP (NNSA/NFO, 2013), 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 571 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/NFO, 2013) 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. As there was no rejected data for CAU 571, the completeness quality objective for decision making was met.

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/NFO, 2013) is as follows: "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.

An interim corrective action of removal was completed for PSM and COC-contaminated soil beneath one broken lead-acid battery that were identified during the CAI for Study Group 5. The locations where the interim corrective action was completed were reevaluated for the presence of PSM or COCs. As PSM or COCs were not present at these or any other Study Group location outside the DCBs, corrective action and the resolution of Decision II is not needed for any Study Group. However, because the DCBs are assumed to contain COCs, they require corrective action and the resolution of Decision II.

The information needed to resolve the lateral and vertical extent of COC contamination (i.e., potential waste volumes) for the DCBs is resolved based on the defined areas (i.e., boundaries) of the DCBs as presented in Section 2.1.1 and the resulting volumes listed in Table E.2-1.

The information needed to predict potential remediation waste types was provided by the analytical results from soil samples. This determined that the potential waste type for the DCBs was at least LLW with the potential to contain MLLW.

The information needed to evaluate the feasibility of remediation alternatives was provided by the potential waste volumes and the potential waste types.

B.1.1.3 Sampling Design

The CAIP (NNSA/NFO, 2013) 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 the 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 within the windrows, at the drainage, and at hazardous debris locations.

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 QAP (NNSA/NSO, 2012). 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 for radiological contamination was the comparison of the TED to the FAL of 25 mrem/OU-yr. For other types of contamination, the test for making DQO decisions was the comparison of the maximum analyte result from each release to the corresponding FAL. 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.1-4.

Table B.1-4
Key Assumptions

Exposure Scenario	Occasional Use Area
Affected Media	Surface, shallow, and subsurface soil; drainage sediments
Location of Contamination/Release Points	Surface, shallow subsurface, and subsurface soil; drainage sediments
Transport Mechanisms	Percolation of precipitation through subsurface media serves as the major driving force for migration of contaminants. Surface water runoff may provide for the transportation of some contaminants within or outside the footprints of the study groups (i.e., drainages).
Preferential Pathways	Vertical transport is expected to dominate over lateral transport due to small surface gradients. However, the CASs are located on an alluvial fan that drains to Yucca Flat, so there is some potential for lateral transport.
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 and depth from the source. Lateral and vertical extent of contamination exceeding FALs is assumed to be within the spatial boundaries.
Groundwater Impacts	None
Future Land Use	Nuclear Test Zone
Other DQO Assumptions	Subsurface contamination is present at the Juno and Vesta Landfills as well as the URMA Pile due to the buried contaminated soil and debris. Surface contamination is present at the Juno HCA, Small HCA north of Vesta, Mazama HCA, and Windrows HCA due to the testing conducted in this area. The CSM includes the potential for contamination associated with areas outside the HCAs, landfills, drainage, and PSM. The DQIs were satisfactorily met as discussed in Section B.1.1.1.1. The data collected during the CAI are considered to support the CSM and the DQO decision; therefore, no revisions to the CSM were necessary.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 571 DQOs and Table B.1-4. 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/NFO, 2013) made the following commitments:

1. ***Study Group 1, Atmospheric Release***

   Decision I will be evaluated by calculating TED in three sample plots within the Study Group 1 boundary. The sample plots will be established within each of three selected areas that could potentially be impacted by the plume. Within each area, the highest value as determined by the results of a TRS will bias the location of the sample plot within each of these preselected areas.

   Result: Decision I was resolved by the placement of TLDs and collection of environmental samples in three sample plots as required in the CAIP.

2. ***Study Group 2, Subsurface Contamination***

   Decision I outside the DCBs will be evaluated by calculating TED in 16 sample plots established within the Study Group 2 boundary. Two plots locations will be selected based on the highest values as determined by the results of a TRS, while 14 plot locations will be selected based on the proximity to the Juno and Vesta GZs.

   Result: Decision I was resolved by the placement of TLDs and collection of environmental samples in 16 sample plots as required in the CAIP.

3. ***Study Group 3, Windrows***

   Decision I will be evaluated by calculating TED from a minimum of 10 grab samples collected throughout the 5 windrow zones. The locations will be selected based on the highest values as determined by the results of a TRS.

   Result: Decision I was resolved by the placement of TLDs and collection of environmental samples at 12 sample locations as required in the CAIP.

4. ***Study Group 4, Drainage***

   Decision I will be evaluated by calculating TED from samples collected in two sediment accumulation areas present within the drainage.

   Result: Decision I was resolved by the placement of TLDs and collection of environmental samples at two sample locations as required in the CAIP.

5. *Study Group 5, Other*

Determine whether a potential release is present based on biasing factors such as elevated radiological readings, PSM, or stains.

Result. A radiologically posted CA, PSM, and a stained area were evaluated. Analyses and sample method (plot vs. grab) was determined based on the type of potential release. It was determined that one battery location contained COCs. The impacted soil was removed, and a verification sample was collected. No COCs above the FAL remain in the soil. Decision I was resolved as required by the CAIP.

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 571 study groups.

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 Section A.5.2 of the CAIP (NNSA/NFO, 2013), 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 did 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 DCBs, corrective action and the resolution of Decision II is required for the DCBs.

- **Result.** A COC was found at a PSM location and was removed as an interim corrective action. There were no COCs identified at any CAU 571 location after the interim corrective action was completed. Therefore, no additional corrective actions nor the resolution of Decision II were required based on CAI results.

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

- **Result.** Hazardous debris was identified as PSM and an interim corrective action of PSM removal was completed. After the interim corrective action was completed, PSM is not present at CAU 571. Therefore, no additional corrective actions nor the resolution of Decision II were required based on the presence of PSM.

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.** Decision II was resolved for the DCBs based on the defined areas (i.e., boundaries) of the DCBs as presented in Section 2.1.1, the depth assumptions presented in Section E.1.3.2, and the potential waste types described in Section A.9.0. Therefore, no additional information is needed to complete the Decision II evaluation.

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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U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

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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.

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 571 CAIP [NNSA/NFO, 2013]). 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 following DCBs:

- Juno HCA and Landfill
- Vesta Landfill
- Small HCA north of Vesta
- URMA Pile

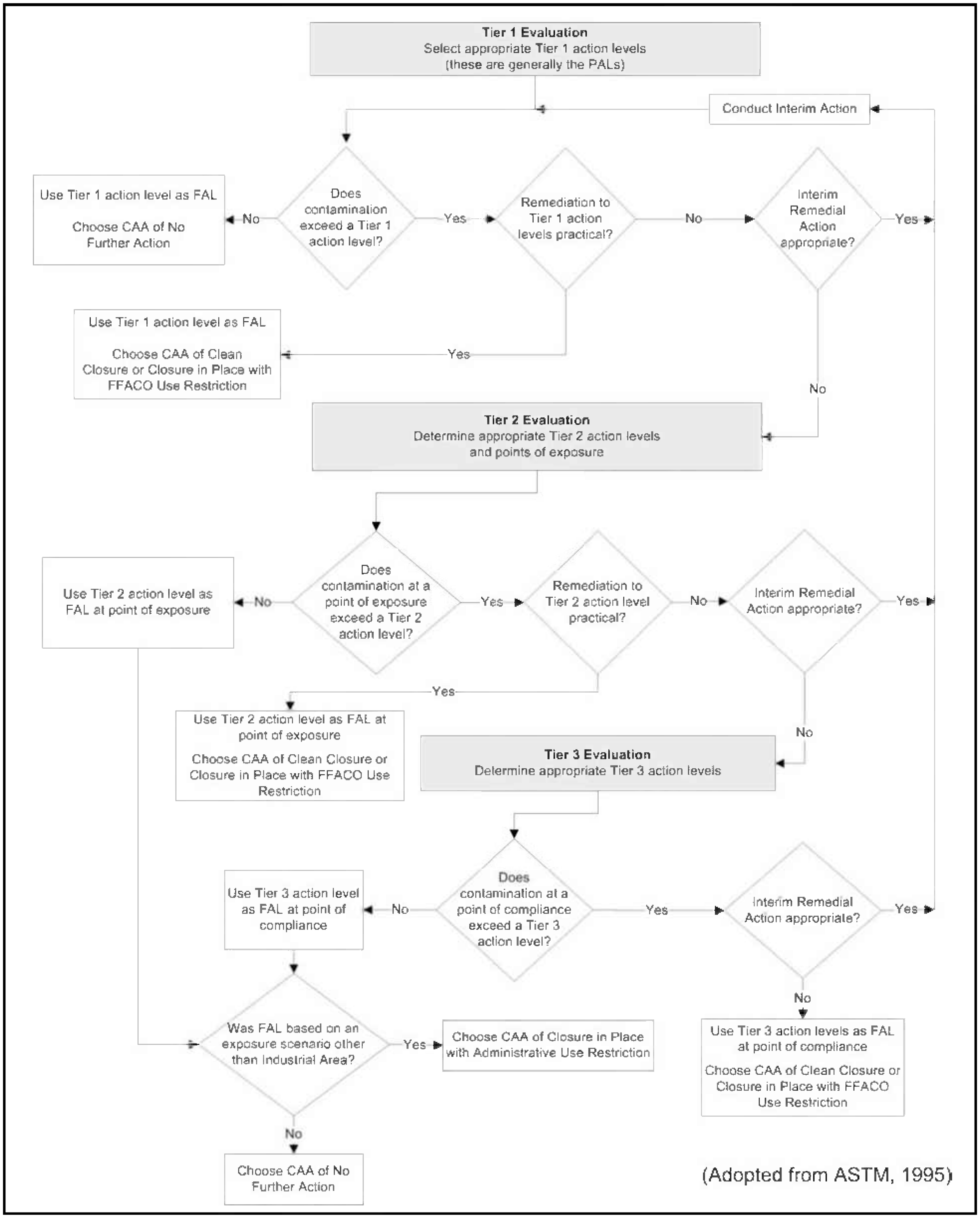

Figure C.1-1
RBCA Decision Process

- Mazama HCA
- Windrows HCA

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.

In addition, PSM (lead items and lead-acid batteries) and soil exceeding the FAL for lead at a location of a broken battery was removed under an interim corrective action during the CAI. However, this risk evaluation is intended for use in making corrective action decisions for CAU 571 conditions at the conclusion of the CAI (after the completion of any interim corrective actions).

C.1.1 Scenario

CAU 571, Area 9 Yucca Flat Plutonium Dispersion Sites, comprises the five CASs listed in Table C.1-1:

Table C.1-1
CAU 571 CAS Information

CAS Number	FFACO CAS Description	Associated Test	Site Name
09-23-03	Atmospheric Test Site S-9F	Juno	Juno
09-23-04	Atmospheric Test Site T9-C	Post	Post
09-23-12	Atmospheric Test Site S-9E	Vesta	Vesta
09-23-13	Atmospheric Test Site T-9D	Mazama	Mazama
09-45-01	Windrows Crater	Juno, Vesta, Mazama	Windrows

The following identifies the release sources specific to CAU 571:

- Post was a weapons-related test conducted on April 9, 1955, as part of Operation Teapot. The test consisted of a primarily plutonium and uranium device that was detonated atop a 300-ft tower. The resulting yield was 2 kt (DOE/NV, 2000).

- Vesta was a safety experiment conducted on October 17, 1958 as part of Operation Hardtack II. The test consisted of a primarily plutonium and uranium device that was detonated in a gravel gertie. The resulting yield was 24 tons (DOE/NV, 2000).

- Juno was a safety experiment conducted in October 24, 1958 as part of Operation Hardtack II. The test consisted of a primarily plutonium device that was detonated in a gravel gertie. the resulting yield was 1.7 tons (DOE/NV, 2000).

- Mazama was a weapons-related test conducted on October 29, 1958 as part of Operation Hardtack II. The test consisted of a primarily plutonium device that was detonated atop a 50-ft tower. There was no yield (DOE/NV, 2000).

- During a decontamination effort, contaminated soil was scraped into 2-ft-high-by-3-ft-wide windrows and then sprayed with road oil.

- Migration of contaminants through erosion from the test releases may have occurred at the site.

- Other potential releases such as lead items (including batteries), drums, an asphalt pile and a radiologically posted CA are present at CAU 571. There is the potential to find additional spills or debris that could provide a source for the release of contamination to the surface soils.

The study groups and the CASs associated with each release are described in Table C.1-2 as well as the results of the investigation. The need for corrective action and CAAs are evaluated separately for each release.

C.1.2 Site Assessment

Investigation activities at all study groups included an evaluation of radiological and chemical contamination resulting from atmospheric testing and associated support activities. Soil samples and TLDs were used to calculate the TED to workers. Refer to Section A.2.2.3 for details on the calculation of TED. Soil samples were collected to determine the presence of chemical COCs. The investigation results are summarized in Table C.1-2. It is assumed that contamination exceeds the FAL of 25 mrem/OU-yr within the DCBs. The maximum calculated TED (based on the Occasional Use scenario) does not exceed the FAL at any other locations within the investigation area of CAU 571. However, if the site usage were to change in the future to a continuous industrial work site, an industrial worker could potentially receive a TED in excess of 25 mrem/yr within the Study Group 2 investigation area as the maximum calculated TED was 145.8 mrem/IA-yr (Table C.1-2).

Table C.1-2
CAU 571 Study Groups

Study Group	Description	FFACO CASs	Release	Results
N/A	DCBs	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), 09-23-13 (Mazama), and 09-45-01 (Windrows)	The DCBs were established based on the assumed presence of removable contamination at levels exceeding HCA criteria (Juno, Mazama, and Windrows) and the impracticality of characterizing a heterogenous landfill (Juno, Vesta, and an URMA Pile).	Assumed to exceed 25 mrem/OU-yr
Study Group 1	Atmospheric Release	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), and 09-23-13 (Mazama)	This study group consists of the areas of relatively undisturbed atmospheric deposition of radionuclides from weapons-related tests and safety experiments.	Maximum TED: 0.3 mrem/OU-yr 5.8 mrem/IA-yr
Study Group 2	Subsurface Contamination	09-23-03 (Juno), 09-23-04 (Post), 09-23-12 (Vesta), and 09-23-13 (Mazama)	This study group consists of the areas of atmospheric deposition of radionuclides from weapons-related tests and safety experiments that have subsequently been disturbed or covered.	Maximum TED: 8.8 mrem/OU-yr 155.5 mrem/IA-yr
Study Group 3	Windrows	09-45-01 (Windrows)	This study group consists of areas where the initial surface release of radionuclides from weapons-related tests and safety experiments were placed in rows (i.e., windrows). The windrows were then sprayed with road oil.	Maximum TED: 0.6 mrem/OU-yr 11.7 mrem/IA-yr
Study Group 4	Drainage	09-23-03 (Juno), 09-23-04 (Post), and 09-23-12 (Vesta)	This study group consists of a drainage where the initial surface release of radionuclides from weapons-related tests and safety experiments was subsequently displaced through erosion.	Maximum TED: 0.3 mrem/OU-yr 5.7 mrem/IA-yr
Study Group 5	Other	09-23-03 (Juno) and 09-23-12 (Vesta)	This study group consists of all other radiological and chemical releases identified that do not fall into any other study groups. This includes potentially contaminated debris, stained soil, and other radiologically contaminated areas.	Maximum TED: 0.3 mrem/OU-yr 5.9 mrem/IA-yr Lead results at one location exceeded the FAL

C.1.3 Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are (1) immediate threat to human health, safety, and the environment; (2) short-term (0 to 2 years) threat to human health, safety, and the environment; (3) long-term (greater than 2 years) threat to human health, safety, or the environment; and (4) no demonstrated long-term threats.

Based on the CAI and the completion of interim corrective actions, the area (outside the DCBs) no longer contains contaminants that present an immediate threat to human health, safety, and the environment; therefore, no additional interim response actions are necessary at these sites. However, contamination is present within the DCBs that, could pose a threat to human health, safety, and/or the environment. Therefore, CAU 571 has been determined to be a Classification 2 site 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/NFO, 2013) 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 is 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, 2013).
- 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 this site and there are no assigned work stations in the surrounding area. Therefore, the use of an industrial scenario is 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

An exposure time based on the Industrial Area scenario (2,000 hr/yr) was used to calculate the Tier 1 action levels (i.e., PALs). For radiological contaminants, dose values were calculated for comparison to the Tier 1 action level based on an exposure time of 2,000 hr/yr. Individual chemical analytical results were directly compared to chemical PALs.

All sampled locations at each CAU 571 release that exceed a Tier 1 action level (i.e., PAL) are listed in Table C.1-3. No chemical contamination was detected at any sample location that exceeded the Tier 1 action level. Based on the unrealistic but conservative assumption that a site worker would be exposed to the maximum dose calculated at any sampled location outside the DCBs, this site worker would receive a 25-millirem (mrem) dose at location B01 (the sample location with the maximum TED of 155.5 mrem/IA-yr) in 321 hours of exposure.

Table C.1-3
Locations Where TED Exceeds the Tier 1 Action Level at CAU 571 (mrem/IA-yr)

Study Group	Sample Location	Average TED	95% UCL TED
Study Group 2, Subsurface Contamination	B01	**107.1**	**155.5**
	B02	**58.4**	**73.4**
	B03	**27.1**	**35.9**

Bold indicates the values exceeding 25 mrem/yr.

C.1.7 Evaluation of Tier 1 Results

For the release sites listed in Table C.1-3, NNSA/NFO determined that remediation to the Tier 1 action level is not appropriate. The risk to receptors from contaminants at CAU 571 is due to chronic exposure to radionuclides (i.e., 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 at all sites in CAU 571 determined that workers may be present at these sites for only a few hours per year (see Section C.1.10), and it is not reasonable to assume that any worker would be present at this site for 2,000 hr/yr (DOE/NV, 1996). Therefore, it was determined to conduct a Tier 2 evaluation.

For the chemical contamination assumed to require corrective action (i.e., the PSM), it was determined that remediation to the Tier 1 action levels was feasible and appropriate. Therefore, the FALs for chemical contaminants at CAU 571 were established at the Tier 1 action levels.

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 radiological Tier 2 action levels, the annual dose limit for a site worker is 25 mrem/yr (the same as was used for the Tier 1 evaluation). 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 571 release 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 571 identified the general types of work activities that are currently conducted at the site, to include fencing/posting inspection and maintenance workers, and military trainees. 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 571 releases, 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 UR areas. The URs require a periodic inspection to ensure that any required access controls are intact and legible. This may require two people to spend up to 10 hr/yr at each UR.

- **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).

Under the current land use at each of the CAU 571 releases, the most exposed worker would be the Inspection and Maintenance Worker, who would not be exposed to site contamination for more than 10 hr/yr. Based on the conservative assumption that the most exposed worker would be exposed to the maximum dose calculated at any sampled location outside any DCB for the entire 10 hours, this worker would receive a maximum potential dose at the release listed in Table C.1-4.

Table C.1-4
Maximum Potential Dose to Most Exposed Worker at CAU 571

Study Group	Most Exposed Worker	Exposure Time	Maximum Potential Dose
Study Group 2, Subsurface Contamination	Inspection and Maintenance Worker	10 hr/yr	0.88 mrem/yr

In the CAU 571 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAIP [NNSA/NFO, 2013]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 571 releases. 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. As the use of this scenario provides a more conservative (longer) exposure to site contaminants than the most exposed worker (based on current and projected future land use), the development and evaluation of Tier 2 action levels were based on the Occasional Use Area exposure scenario.

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

For the locations with contamination that exceeded Tier I actions levels, the TEDs calculated using the Occasional Use Area exposure scenario were then compared to the 25-mrem/OU-yr Tier 2 action level. As shown in Table C.1-5, none of the 95 percent UCL TED values exceeded the 25-mrem/OU-yr Tier 2 action level.

Table C.1-5
Occasional Use Area Scenario TED (mrem/OU-yr)

Study Group	Sample Location	Average TED	95% UCL TED
Study Group 2, Subsurface Contamination	B01	6.0	8.8
	B02	3.2	4.1
	B03	1.5	2.0

C.1.12 Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation, soil contamination at CAU 572, beyond that assumed to be present within DCBs, is not present at levels that exceed the Tier 2 action level. As corrective actions are not required for these locations, the Tier 2 action level is established as the FAL, and corrective actions are proposed based only on the remaining contamination within the DCBs.

As the FALs for all contaminants that were passed on to a Tier 2 evaluation were established as the Tier 2 action levels, a Tier 3 evaluation is not necessary.

C.2.0 Recommendations

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. For CAU 571, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from single point locations.

Because all of the TED values, beyond those assumed to be present within DCBs, are below FALs (using the Occasional Use Area exposure scenario), it was determined that corrective action is not required. However, within the DCBs it is assumed that radiological contamination exceeds the Tier 2 based 25 mrem/OU-yr FAL and corrective action is necessary. A corrective action of closure in place with UR is recommended for the Juno HCA and Landfill, Vesta Landfill, Small HCA north of Vesta, URMA Pile, Mazama HCA, and Windrows HCA.

The FAL was based on an exposure time of 80 hr/yr of site worker exposure. If the land use within Study Group 2 changed to a more intensive use of the site, a site worker could be potentially exposed to site contamination for longer exposure times and receive an unacceptable level of risk. Therefore, an administrative boundary was established as a BMP that would restrict a more intensive use of this site without NDEP notification. The area in Study Group 2 that could potentially provide sufficient dose to cause a full-time industrial worker to receive an annual dose exceeding 25 mrem was conservatively bounded as described in Section D.1.3. Therefore, an administrative UR was established for this area of Study Group 2.

The corrective actions for CAU 571 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.

C.3.0 References

ASTM, see ASTM International.

ASTM International. 1995 (reapproved 2010). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739 - 95(2010)e1. West Conshohocken, PA.

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NAC, see *Nevada Administrative Code*

NBMG, see Nevada Bureau of Mines and Geology.

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

Nevada Administrative Code. 2012a. NAC 445A.227, "Contamination of Soil: Order by Director for Corrective Action; Factors To Be Considered in Determining Whether Corrective Action Required." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 12 April 2013.

Nevada Administrative Code. 2012b. NAC 445A.22705, "Contamination of Soil: Evaluation of Site by Owner or Operator; Review of Evaluation by Division." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 12 April 2013.

Nevada Bureau of Mines and Geology. 1998. *Mineral and Energy Resource Assessment of the Nellis Air Force Range*, Open-File Report 98-1. Reno, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2013. *Corrective Action Investigation Plan for Corrective Action Unit 571: Area 9 Yucca Flat Plutonium Dispersion Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1505. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS-0243. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 2000. *United States Nuclear Tests, July 1945 through September 1992,* DOE/NV--209-Rev 15. Las Vegas, NV.

U.S. Environmental Protection Agency. 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A),* EPA/540/1-89/002. Washington, DC: Office of Emergency and Remedial Response.

U.S. Environmental Protection Agency. 2013. *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants.* As accessed at http://www.epa.gov/region9/superfund/prg/ on 12 April. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

Appendix D

Closure Activity Summary

D.1.0 Closure Activity Summary

The following subsections document closure activities completed for CAU 571.

D.1.1 DCB Closure Activities

Six DCBs are assumed to exceed the radiological FAL of 25 mrem/OU-yr. Therefore, a corrective action of closure in place with a UR was implemented for each of the DCBs listed in Table D.1-1. Each DCB has an associated CAS and is defined by the coordinates listed in the FFACO UR forms as presented in Attachment D-1. The URs are recorded in the FFACO database, M&O Contractor GIS, and 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.

Table D.1-1
UR Summary

DCB	CAS	FFACO UR	Administrative UR
Juno HCA and Landfill	09-23-03	X	--
Vesta Landfill (includes Post), Small HCA north of Vesta, URMA Pile	09-23-12 (includes 09-23-04)	X	X
Mazama HCA	09-23-13	X	--
Windrows HCA	09-45-01	X	X

The FFACO UR signs for all of the FFACO URs in CAU 571 read as follows:

WARNING

RADIOLOGICAL CONTAMINATION

FFACO Site CAU 571,

Area 9 Yucca Flat Plutonium Dispersion Sites

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.1.2 Lead Soil Closure Activities

As an interim corrective action, PSM in the form of 13 lead items and 13 lead-acid batteries was removed from the site because the debris had the potential to release COCs. As a result of the verification sampling associated with the PSM, lead-impacted soil was identified at the location of one broken lead-acid battery (location E08). The interim corrective action included removing approximately 50 gal of lead-impacted soil. Once the soil was removed, verification sampling (sample E027) was completed to confirm that no COCs above action levels remained in the soil. As the samples verified that no COCs remained in soil and all PSM was removed, no further corrective action is required.

D.1.3 Administrative UR Closure Activities

Administrative URs will be implemented for one area that exceeds the FAL of 25 mrem/IA-yr and three areas that exceed the criteria for a CA (Table D.1-1). The administrative URs were implemented (as presented in Attachment D-1) to prevent a future site worker from inadvertently receiving a dose exceeding 25 mrem/IA-yr if a more intensive use of the site were to occur or from being exposed to removable contamination at levels that exceed the CA criteria.

Attachment D-1

Use Restrictions

(16 Pages)

Use Restriction Information

CAU Number/Description: CAU 571, Area 9 Yucca Flat Plutonium Dispersion Sites
Applicable CAS Number/Description: CAS 09-23-03, Atmospheric Test Site S-9F

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	4108871	585614
2	4108913	585402
3	4108986	585250
4	4109149	585296
5	4109144	585527

Depth: 6 inches bgs

Survey Source (GPS, GIS, etc): GPS

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 the site. This is based on the current land use which is an assumed maximum exposure period of 80 hours. Dose was not calculated for HCA and landfill but is assumed to exceed the action level of 25 mrem/yr. The analytical results and locations of all samples are presented in the CADD/CR for CAU 571.

Contaminants Table:

Maximum Concentration of Contaminants			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	Unknown	25	mrem/yr

Site Controls: The area defined by the coordinates listed above for the FFACO UR and depicted in the attached figure is restricted for any activities that would cause site workers to be exposed to site radiological contamination without an approved radiological permit. Any activities that do not meet this criterion would require 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.

Use Restriction Information

Administrative Use Restriction Physical Description*: N/A

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

UR Points	Northing	Easting
N/A	N/A	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 UR(s):

Summary Statement: N/A

Contaminants Table:

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

Site Controls: N/A

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

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.

Inspection/Maintenance Frequency: Inspections will be conducted of the FFACO UR annually.

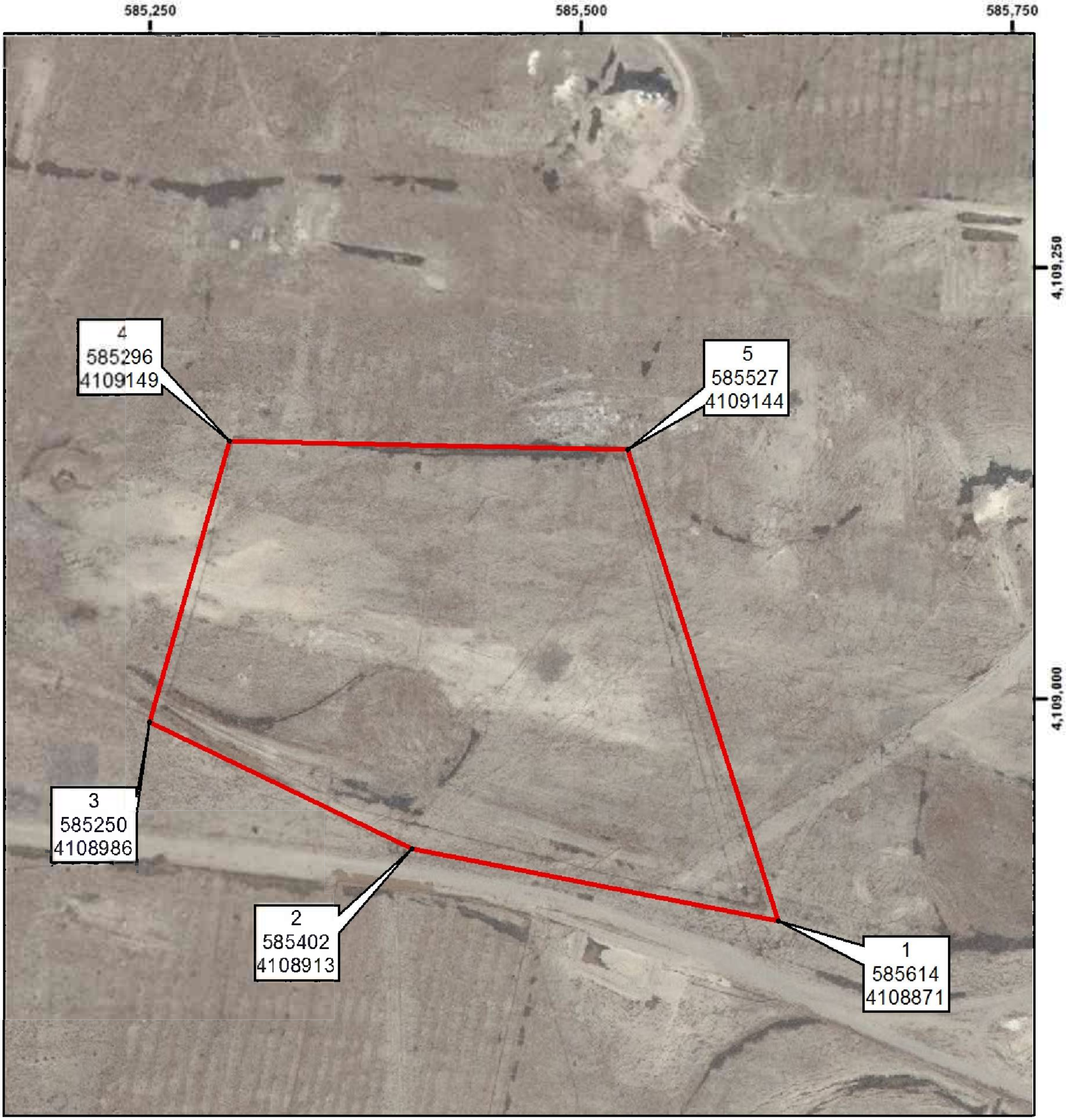
The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless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

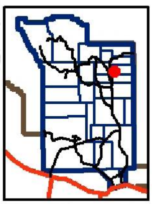
Comments: None

Submitted By: /s/ Tiffany A. Lantow **Date:** 8/5/2014

Note: Effective upon acceptance of closure documents by NDEP

UNCONTROLLED When Printed





CAU 571, CAS 09-23-03
Atmospheric Test - Juno
FFACO UR

0 25 50 100
Meters

0 100 200 400
Feet

N

Source: N-I GIS, 2014; ESRI, 2014

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

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Use Restriction Information

CAU Number/Description: CAU 571, Area 9 Yucca Flat Plutonium Dispersion Sites
Applicable CAS Number/Description: CAS 09-23-12, Atmospheric Test Site S-9E (includes CAS 09-23-04, Atmospheric Test Site T9-C)

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
Vesta Landfill (includes Post)		
1	4108881	585794
2	4108850	585761
3	4108849	585714
4	4108882	585681
5	4108929	585680
6	4108963	585713
7	4108963	585761
8	4108930	585794
Small HCA		
9	4109016	585790
10	4109010	585750
11	4109016	585745
12	4109067	585782
13	4109063	585797
URMA Pile		
14	4109342	585831
15	4109342	585799
16	4109399	585799
17	4109399	585831

Depth: 6 inches bgs

Survey Source (GPS, GIS, etc.): GPS

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 the site. This is based on the current land use which is an assumed maximum exposure period of 80 hours. Dose was not calculated for the landfill, HCA, and URMA but is assumed to exceed the action level of 25 mrem/yr. The analytical results and locations of all samples are presented in the CADD/CR for CAU 571.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 571			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	Unknown	25	mrem/yr

Use Restriction Information

Site Controls: The area defined by the coordinates listed above for the FFACO UR and depicted in the attached figure is restricted for any activities that would cause site workers to be exposed to site radiological contamination without an approved radiological permit. Any activities that do not meet this criterion would require 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.

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
1	4108849	585903
2	4108820	585689
3	4108887	585485
4	4108909	585345
5	4109060	585161
6	4109283	585131
7	4109312	585144
8	4109306	585447
9	4109374	585447
10	4109415	585496
11	4109404	585978
12	4109348	586040
13	4109239	586042
14	4109122	585863

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc.): GPS

*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 UR is to protect site workers from receiving a dose exceeding 25 mrem/yr from contamination that is present at this site if the site were to be used for industrial type activities in the future. This is based on a potential future land use in which a worker would be assigned a full time work station (i.e., 2,000 hours per year) at the location of the maximum dose. Using the maximum calculated dose rate at this site, a worker could receive a 25 mrem dose in 321 hours of site exposure. The maximum concentration of any radionuclide detected in soil samples that could contribute more than 10 percent of the action level is presented in the contaminants table below. The analytical results and locations of all sample are presented in the CADD/CR for CAU 571.

Contaminants Table:

Maximum Concentration of Contaminants			
Constituent	**Maximum Concentration**	**Action Level (Industrial Area)**	**Units**
Americium-241	1,700	2,110	pCi/g
Cesium-137	16	81	pCi/g
Plutonium-239/240	15,605	4,120	pCi/g

Use Restriction Information

Site Controls: The area defined by the coordinates listed above for the Administrative UR and depicted in the attached figure is restricted for any activities that would cause site workers to be exposed to site radiological contamination without an approved radiological control permit. Any activities that do not meet this criterion would require prior notification and approval of NDEP. The FFACO and Administrative URs are 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):

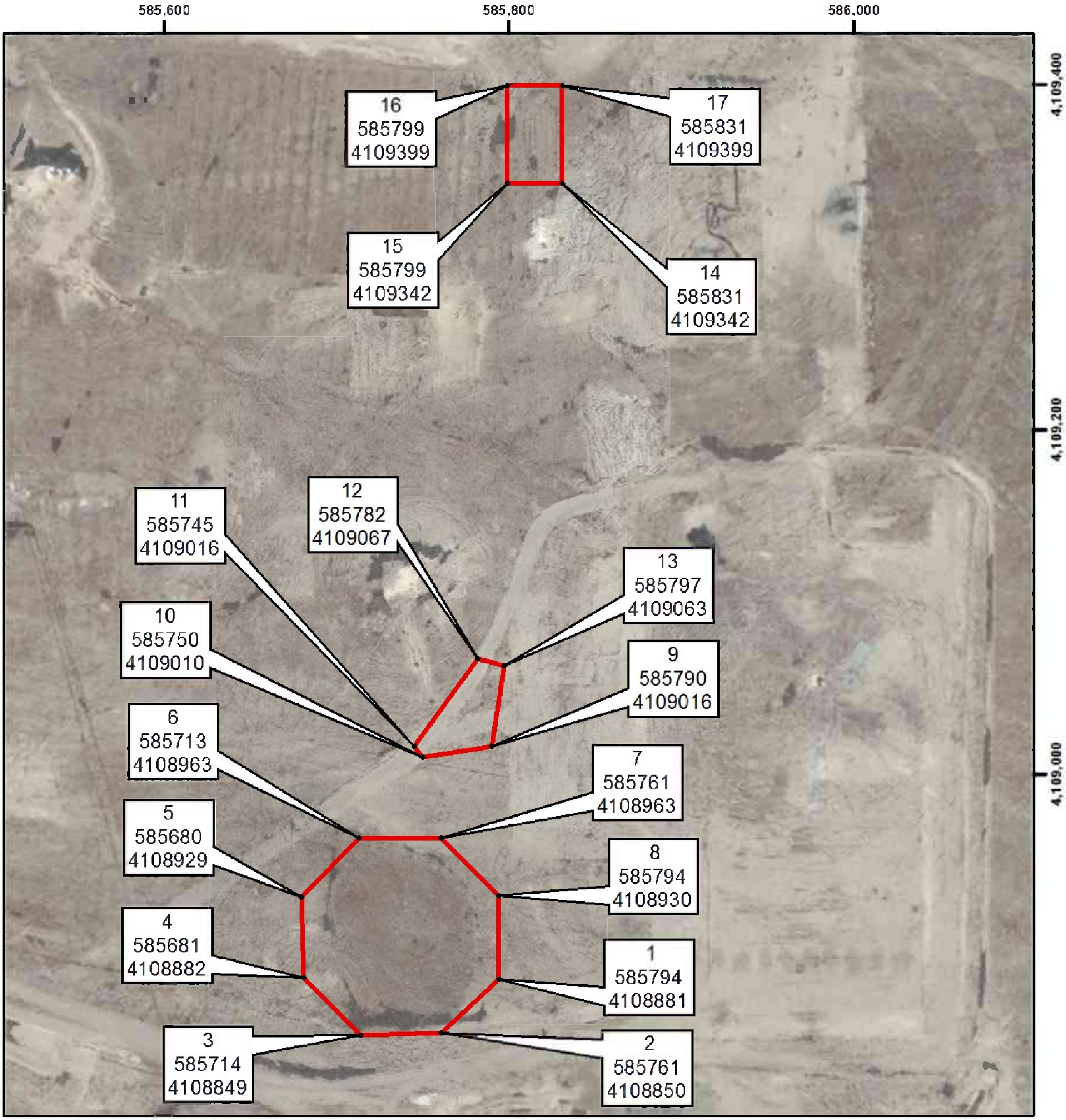
Description: Warning signs for the FFACO UR will be inspected to ensure postings are in place, intact, and legible. Signs will be repaired or replaced as needed.

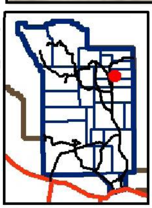
Inspection/Maintenance Frequency: Inspections will be conducted of the FFACO UR annually.

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: None

Submitted By: /s/ Tiffany A. Lantow **Date:** 8/5/2014





CAU 571, CAS 09-23-12
Atmospheric Test - Vesta
FFACO UR

0 25 50 100 Meters

0 100 200 400 Feet

UNCONTROLLED When Printed

Source: N-I GIS, 2014; ESRI, 2014

Coordinate System: NAD 1983 UTM Zone 11N, Meter

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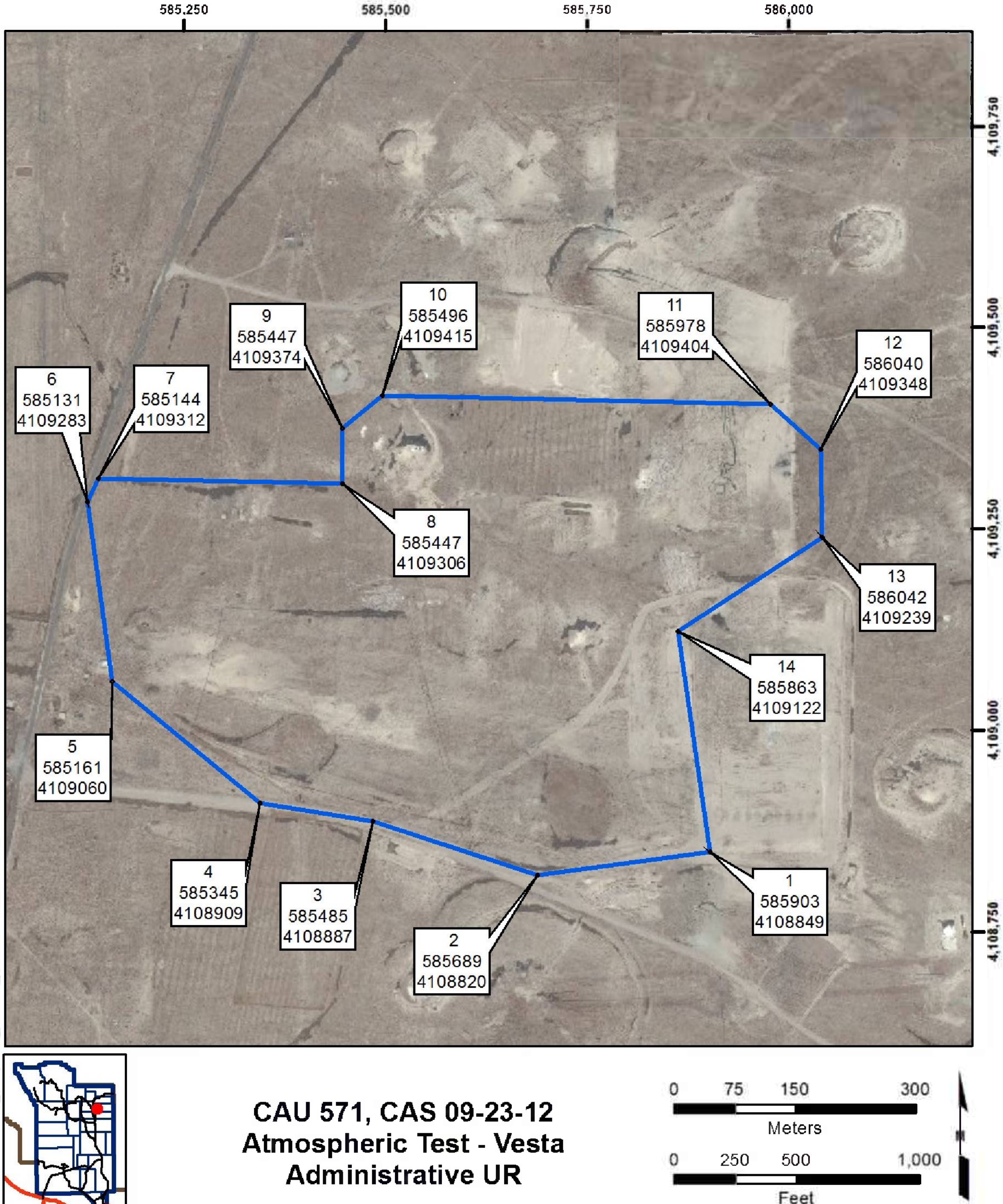

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CAU 571, CAS 09-23-12
Atmospheric Test - Vesta
Administrative UR

Source: N-I GIS, 2014; ESRI, 2014

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Use Restriction Information

CAU Number/Description: CAU 571, Area 9 Yucca Flat Plutonium Dispersion Sites
Applicable CAS Number/Description: CAS 09-23-13, Atmospheric Test Site T-9D

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	4109069	585069
2	4109072	585002
3	4109142	584978
4	4109552	584999
5	4109573	585106
6	4109426	585171
7	4109324	585133
8	4109240	585105

Depth: 6 inches bgs

Survey Source (GPS, GIS, etc): GPS

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 the site. This is based on the current land use which is an assumed maximum exposure period of 80 hours. Dose was not calculated for the HCA and CA but is assumed to exceed the action level of 25 mrem/yr. The analytical results and locations of all samples are presented in the CADD/CR for CAU 571.

Contaminants Table:

Maximum Concentration of Contaminants			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	Unknown	25	mrem/yr

Site Controls: The area defined by the coordinates listed above for the FFACO UR and depicted in the attached figure is restricted for any activities that would cause site workers to be exposed to site radiological contamination without an approved radiological permit. Any activities that do not meet this criterion would require 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.

Use Restriction Information

Administrative Use Restriction Physical Description*: N/A

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

UR Points	Northing	Easting
N/A	N/A	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 UR(s):

Summary Statement: N/A

Contaminants Table:

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

Site Controls: N/A

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

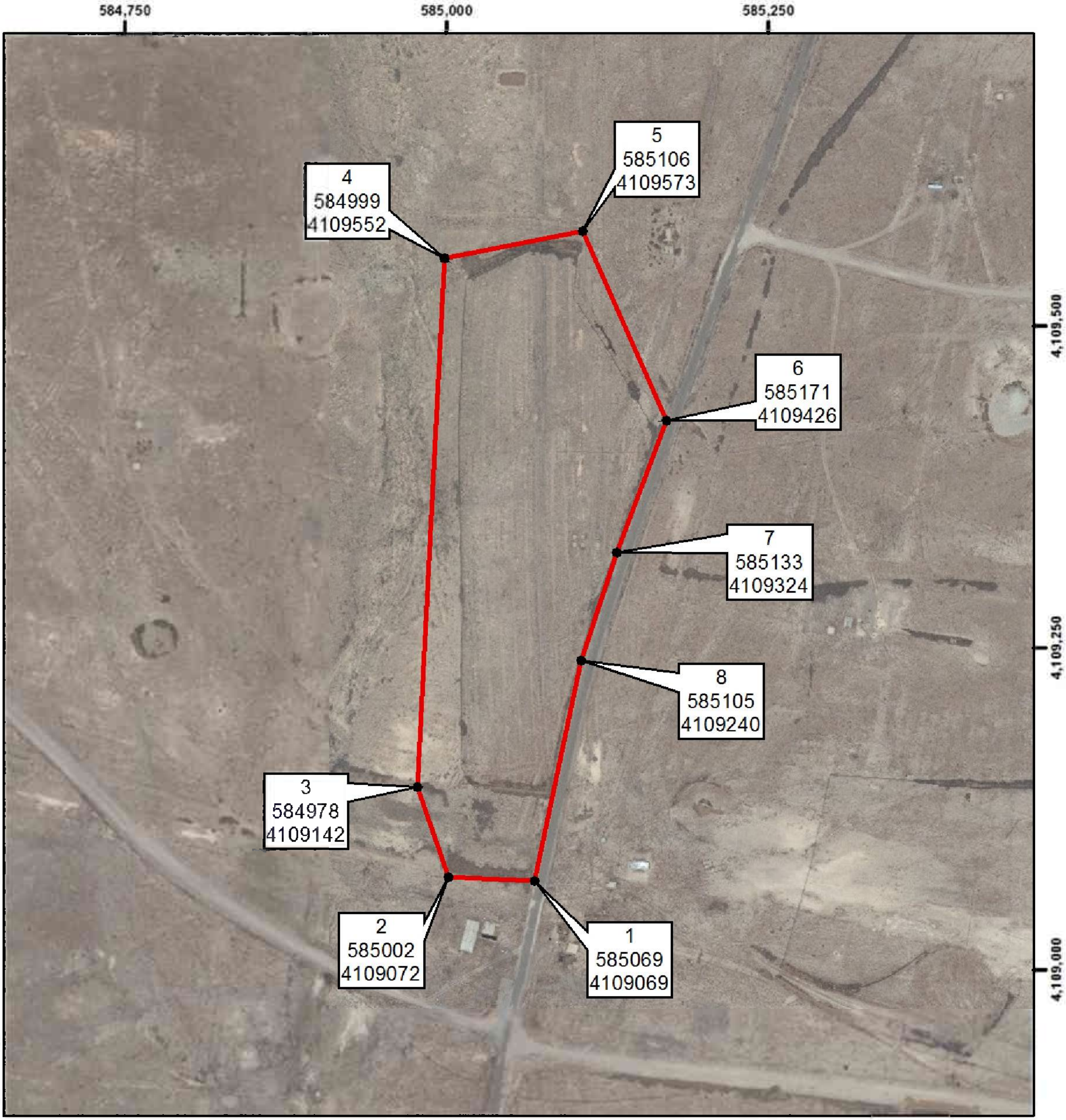
Description: Warning signs for the FFACO UR will be inspected to ensure postings are in place, intact, and legible. Signs will be repaired or replaced as needed.

Inspection/Maintenance Frequency: Inspections will be conducted of the FFACO UR annually.

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: None

Submitted By: /s/ Tiffany A. Lantow **Date:** 8/5/2014



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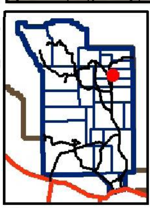


CAU 571, CAS 09-23-13
Atmospheric Test - Mazama
FFACO UR

0 50 100 200
Meters

0 150 300 600
Feet

Source: N-I GIS, 2014; ESRI, 2014

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Use Restriction Information

CAU Number/Description: CAU 571, Area 9 Yucca Flat Plutonium Dispersion Sites
Applicable CAS Number/Description: CAS 09-45-01, Windrows Crater

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	4108645	585427
2	4108655	585309
3	4108895	585353
4	4108875	585477

Depth: 6 inches bgs

Survey Source (GPS, GIS, etc): GPS

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 the site. This is based on the current land use which is an assumed maximum exposure period of 80 hours. Dose was not calculated for the HCA but is assumed to exceed the action level of 25 mrem/yr. The analytical results and locations of all samples are presented in the CADD/CR for CAU 571.

Contaminants Table:

Maximum Concentration of Contaminants			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	Unknown	25	mrem/yr

Site Controls: The area defined by the coordinates listed above for the FFACO UR and depicted in the attached figure is restricted for any activities that would cause site workers to be exposed to site radiological contamination without an approved radiological permit. Any activities that do not meet this criterion would require 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.

Use Restriction Information

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
Northern CA		
1	4109511	585665
2	4109517	585622
3	4109532	585624
4	4109527	585667
Central CA		
5	4108613	585431
6	4108539	585241
7	4108766	585018
8	4108926	585060
9	4108896	585353
10	4108872	585496
11	4108803	585494
Southeastern CA		
12	4107546	584835
13	4107568	584754
14	4107768	584800
15	4107749	584958
16	4107675	584948
Western CA		
17	4107509	584728
18	4107512	584671
19	4107755	584690
20	4108159	584770
21	4108433	584756
22	4108486	584817
23	4108881	584961
24	4108863	585023
25	4108555	584959
26	4108356	584966
27	4108264	584941
28	4108116	584866

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): GPS

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

Use Restriction Information

Basis for Administrative UR(s):

Summary Statement: This Administrative use restriction is to protect workers from inadvertent exposure to removable contamination that exceeds the criteria for establishing a radiologically posted Contamination Area (CA). As a best management, practice this Administrative use restriction will prevent a future (more intensive) use of the area.

Contaminants Table:

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

Site Controls: The area defined by the coordinates listed above for the Administrative UR and depicted in the attached figure is restricted for any activities that would cause site workers to be exposed to site radiological contamination without an approved radiological permit. Any activities that do not meet this criterion would require prior notification and approval of NDEP. The FFACO and Administrative URs are 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):

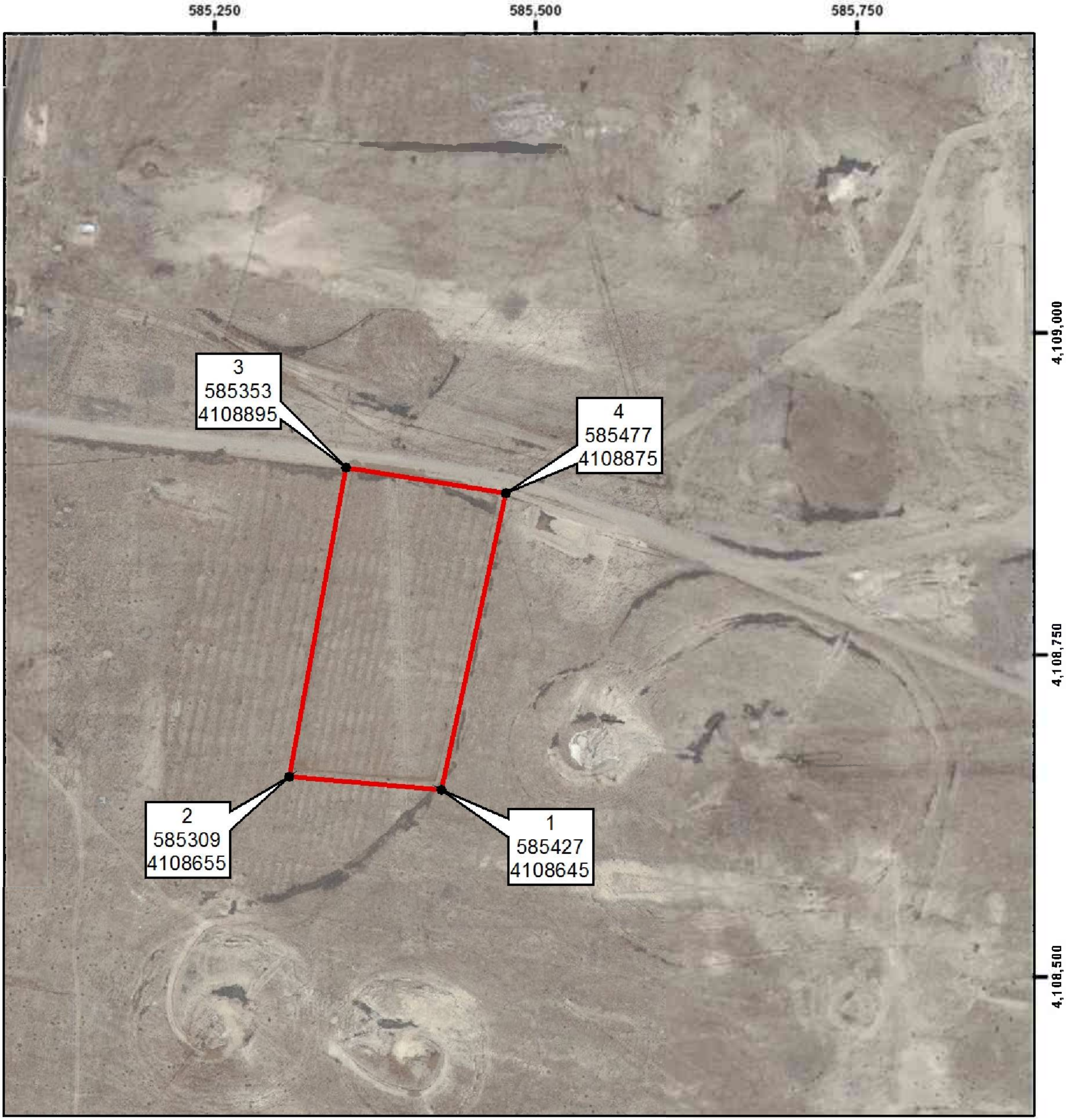
Description: Warning signs for the FFACO UR will be inspected to ensure postings are in place, intact, and legible. Signs will be repaired or replaced as needed.

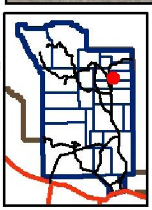
Inspection/Maintenance Frequency: Inspections will be conducted of the FFACO UR annually.

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: None

Submitted By: /s/ Tiffany A. Lantow **Date:** 8/5/2014





CAU 571, CAS 09-45-01
Atmospheric Test - Windrows
FFACO UR

0 50 100 200
Meters
0 150 300 600
Feet

Source: N-I GIS, 2014; ESRI, 2014

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

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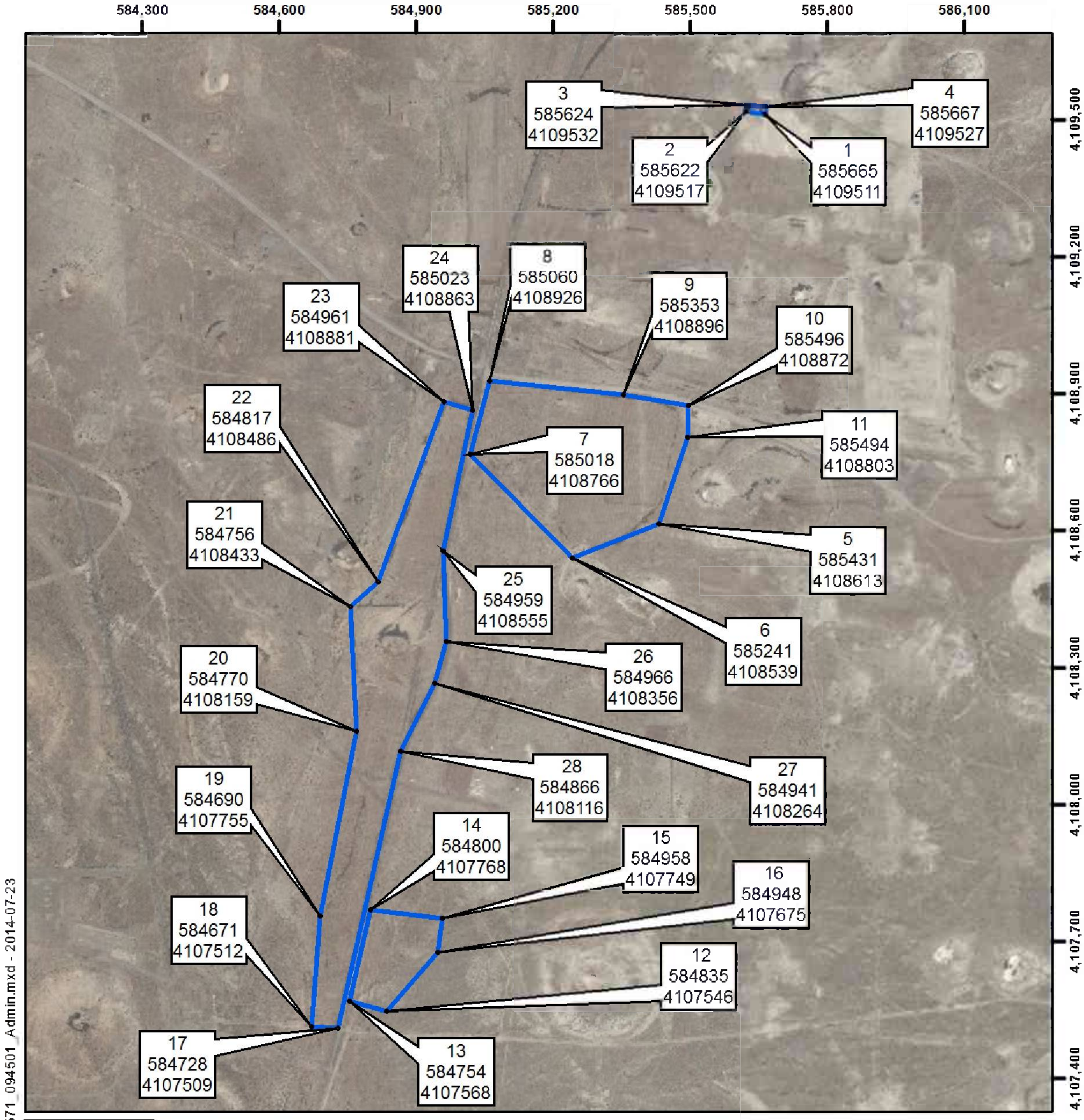

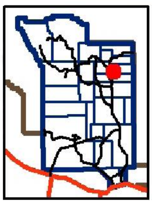

CAU 571, CAS 09-45-01
Atmospheric Test - Windrows
Administrative UR

0 100 200 400
Meters

0 250 500 1,000
Feet

Source: N-I GIS, 2014; ESRI, 2014

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Attachment D-2

Waste Disposal Documentation

(3 Pages)

NTS On-Site HazMat Transfer - Published

Tracking No: DPM14T04 **Mesa Number:**
Carrier: NSTEC ON BEHALF OF NNSA
Vehicle: G631905L
Driver: RUSSELL CROZIER

Depart: 22-APR-2014 Arrival: 22-APR-2014

From:	To:
ROBERT ZION	CHRISTOPHER CHALUPKA
NSTEC	NSTEC
BASE CAMP	BASE CAMP
AREA 9	TRU PAD
MERCURY, NV 89023	MERCURY, NV 89023
Area: 09	Area: 05
Bldg: CAU-571	Bldg: 024
Phone: 702/295-4594	Phone: 702-295-6348
Mobile: 702/466-4231	Mobile:

Entered By: ROBERT ZION Date Entered: 08-APR-2014
Modified By: ROBERT ZION Date Modified: 21-APR-2014

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
RQ, UN/NA 2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, LIMITED QUANTITY OF MATERIAL, 7 WASTE (D008), UHC CADMIUM. RADIONUCLIDES: AM-241; CO-60; NB-94; CS-137; EU-152; EU-154; EU-155; PU-238; PU-239; PU-240; PU-241; SR-90; U-234; U-235; U-238. PHYSICAL FORM: SOLID. CHEMICAL FORM: OXIDE. PACKAGE ACTIVITY: PACKAGE# 571D06: 3.53 E+06 BQ. CATEGORY: EXCEPTED PACKAGING, FISSILE EXCEPTED, EXCLUSIVE USE SHIPMENT.	1 DRUM, METAL	580.00 POUND(S) (GROSS)	161

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
MIKE MCKINNON @ 702/417-0537

In the event of an emergency on the Novada National Security Site, immediately contact the Operations Coordination Center (OCC) Duty Manager at 702/295-0311 for assistance.

EMERGENCY RESPONSE

By Phone
702-295-0311

By Radio
'MAYDAY - MAYDAY - MAYDAY'

In the event of an incident involving Hazardous Material:

1. Gather HazMat shipping papers and NAER Guidebook
2. Isolate the immediate area
3. Assess the situation:
   a. Fire, Spill, or Leak?
   b. People, Property, or the Environment at risk?
4. Contact On-site Emergency Response Personnel
5. Reference On-Site HazMat Transfer Tracking Number

This is to certify that the above-named materials are properly classified, described, packaged, marked, placarded, and labeled and are in proper condition for transportation according to the applicable regulations of the U.S Department of Transportation. As a signatory I certify that I have been trained and tested to the requirements of 49 CFR, Part 172-700 and is compliant with the NTS OTSD.

Authorized Signature: /s/ Signature on File Date: 4/22/14 Time: 0950

Received by: /s/ Signature on File Date: 4/22/2014 Time: 1032

UNCONTROLLED When Printed

Package Shipment and Disposal Request

Shipment Number: DPM14T04

Date: 09-Apr-2014

Prepared By: /s/ Signature on File

Manifest Number: 000000014N18

Package No:	571D06	Contact (mSv/h):	0.0001	Completed Date:	03-Feb-2014
Container Code:	102	1 Meter (mSv/h):	0.0001	Total Activity (bq):	3.528E+06
External Volume (m^3)	2.265E-01	Gross Weight (kg):	2.630E+02	Activity Date:	19-Mar-2014
Waste Volume (m^3):	1.610E-01	Net Weight (kg):	2.420E+02	Accountable Material?	N

Comment: D008 (UHC: CD)

Waste Stream /Profile	Rev. No.	Revision Date	Nuclide	Qty (Bq)
LRY500STORAGE	00	05-Oct-2011	AM-241	2.110E+04
LRY500STORAGE	00	05-Oct-2011	CO-60	5.810E+02
LRY500STORAGE	00	05-Oct-2011	CS-137	1.850E+04
LRY500STORAGE	00	05-Oct-2011	EU-152	5.460E+03
LRY500STORAGE	00	05-Oct-2011	EU-154	1.720E+03
LRY500STORAGE	00	05-Oct-2011	EU-155	1.280E+03
LRY500STORAGE	00	05-Oct-2011	NB-94	5.310E+02
LRY500STORAGE	00	05-Oct-2011	PU-238	2.140E+03
LRY500STORAGE	00	05-Oct-2011	PU-239	1.420E+05
LRY500STORAGE	00	05-Oct-2011	PU-240	1.500E+05
LRY500STORAGE	00	05-Oct-2011	PU-241	3.150E+06
LRY500STORAGE	00	05-Oct-2011	SR-90	1.850E+04
LRY500STORAGE	00	05-Oct-2011	U-234	8.720E+03
LRY500STORAGE	00	05-Oct-2011	U-235	5.720E+02
LRY500STORAGE	00	05-Oct-2011	U-238	7.230E+03

Waste Stream /Profile	Rev. No.	Revision Date	EPA Code
LRY500STORAGE	00	05-Oct-2011	D008

Reviewed By: /s/ Signature on File 4/21/14

UNCONTROLLED When Printed

ONSITE WASTE TRANSPORT MANIFEST

Manifest Document No.: 14N118

Page 1 of 1

Generation/Out-of-Service Date: 4/22/2014

1. Generator's Name, Organization, and Location: (Please Print)
Alissa Silvas Environmental Restoration
Area-9, CAU-571, Mercury NV, 89023
Generator's Phone: (702) 295-7186

2. Receiving Facility, Organization, Location: (Please Print)
National Security Technologies, LLC (NSTec)
For the United States Department of Energy.
Waste Management, Nevada National Security Site
Zone-2, Mercury NV, 89023
Contact Phone: (702) 295-6348

3a. Transporter Name: (Please Print) Russ Crozier
Transport Date: 4/22/2014

3b. Vehicle I.D. Number: G63 1905L

	HM	4. U.S. D.O.T. Description. Include: EPA Waste Code and Package Tracking Numbers.	5. Containers No.	Type	6. Total Quantity	7. Unit Wt./Vol (P or K)
a	RQ	UN2910, Waste radioactive material, excepted package, limited quantity of material, 7, (D008), UHC cadmium	1	Dm	1	580 P
b						
c						
d						
e						
f						
g						

Use continuation pages for additional items, as necessary.

8. Special Handling Instructions/Additional Information: 24-Hour emergency contact: 702-295-0311 / Secondary: McKinnon 702/417-0537 (Name & phone no.)

One 55 gallon MLLW drum of lead contaminated soil (UHC cadmium) to be transferred from Area-9-CAU-571 to Area-5-024 for storage until offsite shipment for treatment/disposal. Pkg# 571D06. (NI-SAA-048; NI container barcode "LVEC-120036")

8a. This is to certify that the above named materials are properly classified, described, packaged, marked, labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Robert H. Zion /s/ Signature on File — 4/22/2014
Printed Name / Signature — Date

9. Released by: Alissa Silvas (Printed Name) /s/ Alissa Silvas (Signature) Date: 4/22/2014

10. Received for Transport by: Russ Crozier (Printed Name) /s/ Russ Crozier (Signature) Date: 4/22/2014

11. Discrepancy Indication: None.

12. Disposal/Accumulation Site Signature: (Acknowledges acceptance of waste)
Chris Chalupka (Printed Name) /s/ Chris Chalupka (Signature) Date: 4/22/2014

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 571, 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 571 conditions at the conclusion of the CAI (after the completion of any interim corrective actions).

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). The 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.

E.1.1 Corrective Action Objectives

The corrective action objectives are the FALs as defined in the Soils RBCA document (NNSA/NFO, 2014). 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 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).

CAAs are evaluated based on four general corrective action standards and five remedy selection decision factors. All CAAs must meet the four general standards to be selected for evaluation using the remedy selection decision factors.

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

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.1.2.1 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, 2014a]; 40 CFR 761 "Polychlorinated Biphenyls," [CFR, 2014b]; and NAC 444.842 to 444.980, "Facilities for Management of Hazardous Waste" [NAC, 2012a]).

E.1.2.2 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.1.3 Development of Corrective Action Alternatives

This section identifies and briefly describes the viable corrective action technologies and the CAAs considered for each CAU 571 CAS. The CAAs are based on the current nature of contamination at CAU 571, which does not include contamination removed as part of the corrective actions completed during the CAI (Section 2.2.1). 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 571:

- **Alternative 1.** No Further Action
- **Alternative 2.** Clean Closure
- **Alternative 3.** Closure in Place

E.1.3.1 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.1.3.2 Alternative 2 – Clean Closure

Clean closure for the site includes excavating and disposing of soil and debris in the areas assumed to exceed the dose of 25 mrem/OU-yr. These areas include the Juno HCA and Landfill, Vesta Landfill, Small HCA north of Vesta, URMA Pile, Mazama HCA, and Windrows HCA. Closure activities include removing approximately 238,500 yd^3 of soil and debris from the six areas. Surface soil will be excavated to a depth of 6 in., while the depth of the landfills may vary (potentially to a depth greater than 50 ft). The soil and debris volumes for each DCB are presented in Table E.2-1. Verification soil samples will be collected and analyzed for the presence of radiological contamination exceeding the FAL after soil and debris are removed.

Contaminated materials removed will be disposed of at an appropriate disposal facility. Excavated areas will be returned to surface conditions compatible with the intended future use of the site.

E.1.3.3 Alternative 3 – Closure in Place

Closure in place for the DCBs includes the implementation of a UR where contamination is present at levels that exceed a FAL. This UR will restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to COCs exceeding the risk evaluation basis as presented in Appendix C.

E.1.4 Evaluation and Comparison of CAAs

The evaluation of CAAs does not include corrective actions that have been completed during the CAI. The removal of PSM and lead-impacted soil from one location in Study Group 5 is considered to be complete and do not require any further corrective action.

Each CAA presented in Section E.1.3 was evaluated by stakeholders in the CAA meeting conducted on May 14, 2014 for the CASs that require corrective action (i.e., the DCBs) based on the general corrective action standards listed in Section E.1.2. This evaluation is presented in Table E.1-1. It was agreed that CAA evaluation criteria 1, 2, 3, and 4 would not be ranked because these are threshold criteria and if a CAA does not meet these criteria, that CAA will not be considered further. The CAAs of clean closure and closure in place with UR met the general corrective action standards.

Table E.1-1
Evaluation of General Corrective Action Standards

Clean Closure	Close in Place with UR
Standard #1: Protection of Human Health and the Environment	
• The clean closure alternative is more protective as 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.
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.
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 hazard.

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. This evaluation is presented in Table E.1-2. The stakeholders determined a preferred CAA for each remedy selection decision factor.

During the stakeholder meeting, it was agreed to adopt the Close in Place with Use Restrictions alternative as a "blanket" alternative for all DCBs as a group rather than analyzing decision factors for each individual DCB. This agreement applied to the Juno HCA and Landfill, Vesta Landfill, Small HCA north of Vesta, URMA Pile, Mazama HCA, and Windrows HCA.

This agreement was conditioned upon the CADD/CR presenting sufficient information about the nature and extent of contamination at each unit to justify group the DCB Closure in Place correction action alternative. The agreement stipulated documenting predicted and known contaminants, anticipated distribution among units, and assessing the likelihood of any unique or unexpected contaminants that might pose environmental or safety risks that would warrant development of unit-by-unit closure alternatives.

It was agreed to by stakeholders in the DQO meeting on March 6, 2013, that the Juno HCA and Landfill, Vesta Landfill, Small HCA north of Vesta, URMA Pile, Mazama HCA, and Windrows HCA areas would be assumed to contain contamination at levels exceeding the FAL and the decision that corrective action is required was resolved without the need for investigation. The CSM was that the contamination present at each of these sites originated from the low-yield weapons related tests or safety experiments that produced significant amounts of plutonium contamination in combination with fission products. The nature and extent of the contamination based on CAI results from locations surrounding the DCBs (as presented in Appendix A) support this CSM element and the decision by stakeholders in the CAA meeting to evaluate these DCB sites as a group. These results show no significant differences in contamination at these sites, or any unique or unexpected contaminants that would warrant development of unit-by-unit closure alternatives.

Due to the proximity of the sites and the common contaminants, it was agreed during the CAA meeting that a CAA decision for any DCB would likely also apply to the other DCB sites. It was also agreed that if a CAA of clean closure were selected for any site that it would be appropriate to clean close all of the DCB sites due to the significant mobilization of heavy excavation and transportation

Table E.1-2
Evaluation of Remedy Selection Decision Factors
(Page 1 of 3)

Clean Closure	Close in Place with UR
Decision Factor #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., CAU 570 sites are across the 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.
Decision Factor #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 is released to the soil.
Decision Factor #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 or similar hazards, 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 (large volumes of contaminated soil and debris being removed).	• 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.1-2
Evaluation of Remedy Selection Decision Factors
(Page 2 of 3)

Clean Closure	Close in Place with UR
Decision Factor #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 3.3 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).
Decision Factor #5: Cost	
• $30.75 million - large volume of waste generated (238,500 yd^3) - large disposal costs (assumes disposal on NNSS of at least LLW) - labor intensive • No maintenance costs • The estimated cost for clean closure does not include potential additional disposal costs due to the volume of the waste.	• $213,000 (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 close in place alternative would require long-term monitoring-radiological/demarcation and posting. • The close in place alternative assumes that potential migration of contaminated soil will not affect the UR boundary.

Table E.1-2
Evaluation of Remedy Selection Decision Factors
(Page 3 of 3)

Clean Closure	Close in Place with UR
Decision Factor #6: Other Considerations[a]	
• Clean closure minimizes potential migration of contaminants. • Clean closure of the site would require historical assessment of the site prior to remediation. • Clean closure would require ecological/wildlife assessment of the site prior to remediation	• The closure in place alternative allows for potential migration of contaminants. • Future mitigation/monitoring may be required to manage/control migration of contaminants.
Notes	
• It was decided that the decision factors could be reviewed for all DCBs as a group rather than individually. • There was a consensus that general corrective action standards #1 through #4 did not need to be discussed.	

[a] e.g., environmental setting, radiological status of site, proximity to other releases, site specific considerations

Note: Shaded cells indicates the preferred corrective action.

equipment required for clean closure. Therefore, it was proposed and accepted by stakeholders in the May 14, 2014, CAA meeting that CAAs for the DCBs would be evaluated as a group and that the selected CAA would be applied to all sites in the group.

E.2.0 Recommended Alternative

The corrective actions that were completed during the CAU 571 field investigation were as follows:

- Thirteen lead items (e.g., bricks, plates) and 13 lead-acid batteries were removed as PSM. Confirmation soil samples were collected and analyzed to verify that no COCs were present in the soil. Lead exceeded the FAL at 1 broken battery location.
- Lead-contaminated soil was removed at a broken battery location in Study Group 5, Other. This corrective action involved the removal of 50 gal of MLLW contaminated soil. Confirmation soil samples were collected and analyzed to verify the removal of lead soil to below FALs.

Verification of the completion of these corrective actions are documented in this report. Therefore, additional corrective actions were not required nor included in the evaluation of CAAs.

The CAAs for the sites that require additional corrective actions were evaluated based on technical merits focusing on reduction of toxicity, mobility and/or volume; reliability; short- and long-term feasibility; and cost. The corrective action recommendations for CAU 571 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.

The following DCBs require corrective action:

- The Juno HCA, Small HCA north of Vesta, Mazama HCA, and Windrows HCA contain the assumed presence of surface contamination exceeding the radiological FAL.
- The Juno Landfill, Vesta Landfill (including Post), and URMA Pile contain the assumed presence of subsurface contamination exceeding the radiological FAL.

The three CAAs of no further action (CAA 1), clean closure (CAA 2), and closure in place (CAA 3) were evaluated for the DCBs. Only CAA 2 and CAA 3 met all requirements for general corrective action standards (Section E.1.2). Further evaluation of the two CAAs was based on the five EPA remedy selection decision factors.

Alternative 3, closure in place, is selected as the preferred correction action (Table E.1-2) for the DCBs in CAU 571, which have high levels of removable contamination. Working in areas of high removable contamination (such as removing soil under a corrective action of clean closure) requires extensive radiological controls to protect workers from inhaling or ingesting airborne radioactive particles. A corrective action of clean closure at these CASs would require extensive excavations (the corrective action areas and volumes for each DCB are presented in Table E.2-1). Based on the extent of the corrective action boundaries and the infeasibility of removing large quantities of soils and debris containing high levels of removable contamination, the corrective action of closure in place with URs was selected for the DCBs.

Table E.2-1
Corrective Action Boundary Areas and Volumes for the DCBs at CAU 571

DCB	Area (ft^2)	Volume (yd^3)
Juno (CAS 09-23-03) HCA and Landfill	666,250	63,215
Vesta (CAS 09-23-12) Landfill (includes Post [CAS 09-23-04])	115,920	145,641
Small HCA north of Vesta (included in CAS 09-23-12)	17,900	331
URMA Pile (included in CAS 09-23-12)	10,800	6,782
Mazama (CAS 09-23-13) HCA	661,725	12,254
Windrows (CAS 09-45-01) HCA	279,624	10,356

ft^2 = Square foot

In addition to the corrective actions previously identified, a BMP will be implemented. In accordance with the Soils RBCA document (NNSA/NFO, 2014) and Section 3.3 of the CAIP (NNSA/NFO, 2013), an administrative UR was identified as a BMP for areas where a future site worker could receive an annual dose exceeding 25 mrem/yr if the land use were to change and a more intensive use of the area (up to a full-time industrial use) was implemented. This conservative assumption is that a worker would be exposed to site contamination for a period of 2,000 hr/yr. This administrative UR (implemented as a BMP) is not part of any FFACO corrective action. To determine the extent of this area, a correlation of radiation survey values to the 95 percent UCL of Industrial Area TED values was conducted as discussed in Section A.2.5 for the area where dose is present at a level exceeding 25 mrem/IA-yr (as is the case in Study Group 2). To be conservative, the administrative UR was expanded to the CA fence line that encompasses the isopleth. The administrative UR will be recorded and controlled in the same manner as the FFACO URs, but will not require posting or inspections. The administrative UR is presented in Attachment D-1.

All URs are recorded in the FFACO database, M&O Contractor GIS, and NNSA/NFO CAU/CAS files. The development of URs for CAU 571 is based on current land use. Any proposed activity within a use restricted area that would result in higher risk to the most exposed site worker than that presented in the risk evaluation (Appendix C) would require NDEP approval.

E.3.0 Cost Estimates

The cost estimate for clean closure is estimated to be approximately $30.75 million to conduct the following activities:

- Preparation and procurement
- Grub surface contamination
- Excavate, load, and dispose contaminated soil (approximately 238,500 yd^3)
- Dispose of debris
- Equipment decontamination

The estimated costs for clean closure of CAU 571 are based on removing contaminated material within the 25-mrem/yr boundary. Specifically, soil (as well as debris in the landfills and URMA Pile) within the DCBs at the Juno HCA and Landfill, Vesta Landfill, Small HCA north of Vesta, URMA Pile, Mazama HCA, and Windrows HCA would be removed. This includes excavation, loading and processing, transportation, disposal, site restoration, and site support.

The costs for closure in place, however, are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing, UR signs, and are estimated to be approximately $213,000 for the first year and $1,500 for each year thereafter.

E.4.0 References

ASTM, see ASTM International.

ASTM International. 1995 (reapproved 2010). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739 - 95(2010)e1. West Conshohocken, PA.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2014a. Title 40 CFR, Parts 260 to 282, "Hazardous Waste Management." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2014b. Title 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." Washington, DC: U.S. Government Printing Office.

EPA, see U.S. Environmental Protection Agency.

Laws, E.P., and S.A. Herman, U.S. Environmental Protection Agency. 1997. Memorandum to RCRA/CERCLA Senior Policy Managers Region I–X titled "Use of the Corrective Action Advance Notice of Proposed Rulemaking as Guidance," 17 January. Washington, DC: Offices of Solid Waste and Emergency Response, and Enforcement and Compliance Assurance.

NAC, see *Nevada Administrative Code*.

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

Nevada Administrative Code. 2012a. NAC 444.842 to 444.980, "Facilities for Management of Hazardous Waste." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 12 April 2013.

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Nevada Administrative Code. 2012c. NAC 445A.22705, "Contamination of Soil: Evaluation of Site by Owner or Operator; Review of Evaluation by Division." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 12 April 2013.

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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 were surveyed using a GPS instrument. Survey coordinates for these locations are listed in Table F.1-1.

Table F.1-1
Sample Plot/Location Coordinates for CAU 571
(Page 1 of 3)

Sample Plot/Location	Easting[a]	Northing[a]
Study Group 1, Atmospheric Release		
A01	585334.6	4109168.8
A02	585575.3	4108542.1
A03	586183.5	4108850.7
Study Group 2, Subsurface Contamination		
B01	585772.2	4108755.0
B02	585771.4	4108734.4
B03	585761.8	4108686.9
B04	585775.5	4108654.8
B05	585840.8	4108643.2
B06	585884.7	4108683.0
B07	585872.2	4108749.7
B08	585813.9	4108776.5
B09	585435.2	4108730.8
B10	585590.3	4108694.7
B11	585672.5	4108751.7
B12	585637.4	4108861.5
B13	585541.1	4108953.6
B14	585460.0	4108957.5
B15	585349.4	4108927.1
B16	585328.5	4108847.6
Study Group 3, Windrows		
C01	585848.8	4109120.1
C02	585821.5	4109152.5
C03	585786.0	4109195.7
C04	585370.1	4108677.0
C05	585327.0	4108619.3
C06	585243.7	4108603.2

Table F.1-1
Sample Plot/Location Coordinates for CAU 571
(Page 2 of 3)

Sample Plot/Location	Easting[a]	Northing[a]
Study Group 3, Windrows (continued)		
C07	584923.2	4107960.0
C08	584882.6	4107733.0
C09	584969.4	4107516.8
C10	584864.9	4107439.3
C11	584768.7	4107264.9
C12	584723.5	4107143.2
Study Group 4, Drainage		
D01	585570.6	4108676.9
D02	585497.5	4108689.6
Study Group 5, Other		
E01	585713.4	4109325.8
E02	585632.1	4109237.0
E03	585618.3	4109269.3
E04	585613.5	4109270.2
E05	585667.1	4109266.1
E06	584999.9	4108675.4
E07	585089.5	4107903.1
E08	586062.2	4109341.5
E09	585233.8	4108855.5
E10	585310.5	4108759.2
E11	585761.1	4108686.0
E12	585569.9	4108707.1
E13	585295.4	4108902.4
E14	585323.6	4108926.0
E15	584927.8	4107450.8
E16	585131.6	4108665.9
E17	585276.8	4108686.8
E18	585223.9	4108570.8
E19	585240.6	4108598.3
E20	585550.1	4108526.4
E21	585125.6	4108263.0
E22	585115.1	4108259.0

Table F.1-1
Sample Plot/Location Coordinates for CAU 571
(Page 3 of 3)

Sample Plot/Location	Easting[a]	Northing[a]
Study Group 5, Other		
E23	585566.1	4108609.9
E24	585566.1	4109114.6

[a]Universal Transverse Mercator (UTM) Zone 11, North American Datum (NAD) 1927 (U.S. Western) in meters.

Nine aliquot sample locations were established at each plot for each composite sample (4 composite samples, 36 aliquot sample locations). 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.

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

(2 Pages)

NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1. Document Title/Number: CAU 571 Area 9 Yucca Flat Plutonium Dispersion Sites Draft CADD/CR	2. Document Date: June 2014
3. Revision Number: 0	4. Originator/Organization: N-I
5. Responsible DOE NNSA/NFO Activity Lead: Tiffany Lantow	6. Date Comments Due: July 24, 2014
7. Review Criteria: Complete Document	
8. Reviewer/Organization Phone No.: Chris Andres/Scott Page/NDEP/702-486-2850	9. Reviewer's Signature:

10. Comment Number/Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept/ Reject
1. Section E.1.4, page E-8, paragraph 3	M	At the end of the paragraph, insert the following: "During the stakeholder meeting it was agreed to adopt the Close in Place with Use Restrictions alternative as a 'blanket' alternative for all DCBs as group rather than individually analyzing decision factors. This agreement applied to Mazama Windrows, June, Central Windrows, Vesta Landfill, Small HCA, and URMA Pile." "This agreement was conditioned upon the CADD/CR presenting sufficient information about the nature and extent of contamination at each unit to justify group DCB Closure in Place correction action alternative. The agreement stipulated documenting predicted and known contaminants, anticipated distribution among units, and assessing the likelihood of any unique or unexpected contaminants that might pose environmental or safety risks that would warrant development of unit-by-unit closure alternatives."	The following text was added as requested, with minor edits made for consistency with the titles used throughout the CADD/CR: During the stakeholder meeting, it was agreed to adopt the Close in Place with Use Restrictions alternative as a "blanket" alternative for all DCBs as a group rather than analyzing decision factors for each individual DCB. This agreement applied to the Juno HCA and Landfill, Vesta Landfill, Small HCA north of Vesta, URMA Pile, Mazama HCA, and Windrows HCA. This agreement was conditioned upon the CADD/CR presenting sufficient information about the nature and extent of contamination at each unit to justify group the DCB Closure in Place correction action alternative. The agreement stipulated documenting predicted and known contaminants, anticipated distribution among units, and assessing the likelihood of any unique or unexpected contaminants that might pose environmental or safety risks that would warrant development of unit-by-unit closure alternatives.	Accept, BB

[a]Comment Types: M = Mandatory, S = Suggested.
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10. Comment Number/Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept/ Reject
2. Section E.1.4, page E-8, paragraph 3	M	Summarize briefly and concisely how the CAI results presented in Appendix A generally fulfill the conditions outline in the 2nd paragraph (Comment 1); i.e., why Appendix A demonstrates that: 1) decision factors could be properly reviewed for all DCBs as a group rather than individually and, 2. Why general corrective action standards #1 through #4 did not need to be analyzed in detail (see 2nd bullet, last row, Table E.1-2, p. E-11).	The following text was added: 1) It was agreed to by stakeholders in the DQO meeting on March 6, 2013, that the Juno HCA and Landfill, Vesta Landfill, Small HCA north of Vesta, URMA Pile, Mazama HCA, and Windrows HCA areas would be assumed to contain contamination at levels exceeding the FAL and the decision that corrective action is required was resolved without the need for investigation. The CSM was that the contamination present at each of these sites originated from the low-yield weapons-related tests or safety experiments that produced significant amounts of plutonium contamination in combination with fission products. The nature and extent of the contamination based on CAI results from locations surrounding the DCBs (as presented in Appendix A) support this CSM element and the decision by stakeholders in the CAA meeting to evaluate these DCB sites as a group. These results show no significant differences in contamination at these sites, or any unique or unexpected contaminants that would warrant development of unit-by-unit closure alternatives. Due to the proximity of the sites and the common contaminants, it was agreed during the CAA meeting that a CAA decision for any DCB would likely also apply to the other DCB sites. It was also agreed that if a CAA of clean closure were selected for any site that it would be appropriate to clean close all of the DCB sites due to the significant mobilization of heavy excavation and transportation equipment required for clean closure. Therefore, it was proposed and accepted by stakeholders in the May 14, 2014, CAA meeting that CAAs for the DCBs would be evaluated as a group and that the selected CAA would be applied to all sites in the group. 2) The following text was added to Section E.1.4: It was agreed that CAA evaluation criteria 1, 2, 3, and 4 would not be ranked because these are threshold criteria and if a CAA does not meet these criteria, that CAA will not be considered further.	Accept, BB

[a]Comment Types: M = Mandatory, S = Suggested.
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