Nevada
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DOE/NV--1508

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites
Nevada National Security Site, Nevada

Controlled Copy No.: ___
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September 2013

UNCLASSIFIED

/s/ Joseph P. Johnston, N-I CO 09/10/2013

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CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 105: AREA 2 YUCCA FLAT ATMOSPHERIC TEST 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 105:
AREA 2 YUCCA FLAT ATMOSPHERIC TEST SITES
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Tiffany A. Lantow Date: 9/10/2013

Tiffany A. Lantow
Soils Activity Lead

Approved by: /s/ Robert F. Boehlecke Date: 9/10/2013

Robert F. Boehlecke
Environmental Management Operations Manager

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List of Acronyms and Abbreviations

Ac	Actinium
ALM	Adult Lead Methodology
Am	Americium
ANPR	Advance Notice of Proposed Rulemaking
ASTM	ASTM International
BEEF	Big Explosive Experimental Facility
bgs	Below ground surface
BMP	Best management practice
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
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
CR	Closure report
Cs	Cesium
CSM	Conceptual site model
day/yr	Days per year

List of Acronyms and Abbreviations *(Continued)*

DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
gal	Gallon
g/day	Grams per day
GIS	Geographical Information Systems
GPS	Global Positioning System
GZ	Ground zero
HASL	Health and Safety Laboratory
HCA	High contamination area
hr/day	Hours per day
hr/yr	Hours per year
IA	Industrial Area
ID	Identification
IDW	Investigation-derived waste
in.	Inch
kt	Kiloton

List of Acronyms and Abbreviations *(Continued)*

LCS	Laboratory control sample
LLW	Low-level waste
LVF	Landfill verification form
m	Meter
m^2	Square meter
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mi	Mile
MLLW	Mixed low-level waste
M&O	Management and operating
mrem	Millirem
mrem/IA-yr	Millirem per Industrial Area year
mrem/OU-yr	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
m/s	Meters per second
mV	Millivolt
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
NIST	National Institute of Standards and Technology
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NSTec	National Security Technologies, LLC
OU	Occasional Use Area

List of Acronyms and Abbreviations (Continued)

PAL	Preliminary action level
pCi/g	Picocuries per gram
POC	Performance Objective for Certification
PPE	Personal protective equipment
ppt	Parts per thousand
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
r^2	Coefficient of determination
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
RfD	Reference dose
RIDP	Radionuclide Inventory and Distribution Program
RMA	Radioactive material area
RRMG	Residual radioactive material guideline
RSL	Regional Screening Level
RW	Remote Work Area
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SVOC	Semivolatile organic compound
Tc	Technetium

List of Acronyms and Abbreviations *(Continued)*

TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
TLD	Thermoluminescent dosimeter
TRS	Terrestrial radiological survey
TSDF	Treatment, storage, and disposal facility
U	Uranium
UCL	Upper confidence limit
UR	Use restriction
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
yd^3	Cubic yard
μR/hr	Microroentgens per hour

Executive Summary

This Corrective Action Decision Document/Closure Report presents information supporting the closure of Corrective Action Unit (CAU) 105: Area 2 Yucca Flat Atmospheric Test 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 105 comprises the following five corrective action sites (CASs):

Table ES-1
CAU 105 CASs

CAS Number	CAS Name	Recommended Corrective Action
02-23-04	Atmospheric Test Site - Whitney	Closure In Place
02-23-05	Atmospheric Test Site T-2A	Closure In Place
02-23-06	Atmospheric Test Site T-2B	Clean Closure
02-23-08	Atmospheric Test Site T-2	Closure In Place
02-23-09	Atmospheric Test Site - Turk	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 105 based on the implementation of the corrective actions. Corrective action investigation (CAI) activities were performed from October 22, 2012, through May 23, 2013, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites*; 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 study group level. The corrective action alternatives (CAAs) were evaluated and applied at the FFACO CAS level.

The purpose of the CAI was to fulfill data needs as defined during the DQO process. The CAU 105 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 CAI measurements did not result in radiological doses exceeding the FAL, some areas could not be sampled and were assumed to exceed FALs and require corrective action. These corrective actions are listed in Table ES-2. This table lists the CASs where potential source material (PSM) was identified and the corrective actions that were completed during the CAI. The final FFACO corrective actions and the rationale for those corrective action decisions are also listed in Table ES-2.

Table ES-2
CAU 105 Corrective Actions

CAS Number and Name	Corrective Action Required?	Rationale	Corrective Action
02-23-05, Atmospheric Test Site T-2A	Yes	Lead contamination assumed to exceed the FAL at 225-foot radius from ground zero. No radiological contamination present that exceeds FALs.	Closure in Place with FFACO Use Restriction
02-23-06, Atmospheric Test Site T-2B	Yes	Removed PSM (2 lead bricks). No other contamination present that exceeds FALs.	Clean Closure
02-23-04, Atmospheric Test Site - Whitney 02-23-08, Atmospheric Test Site T-2 02-23-09, Atmospheric Test Site - Turk	Yes	Removed PSM (67 lead bricks and 3 lead-acid batteries). Radiological and chemical contamination assumed to exceed FALs at previously unidentified waste trenches.	Closure in Place with FFACO Use Restriction

Recommended corrective actions were developed based on an evaluation of analytical data from the CAI, the assumed presence of contaminants of concern at specific locations, a review of future and current operations in this area, and the detailed and comparative analysis of the potential CAAs. The preferred CAAs were evaluated on technical merit focusing on performance, reliability, feasibility, safety, and cost. The CAAs were judged to meet all requirements for the technical components evaluated, and all applicable federal and state regulations for closure of the site.

Therefore, the DOE, National Nuclear Security Administration Nevada Field Office provides the following recommendations:

- No further corrective actions are necessary for CAU 105.
- A Notice of Completion to the DOE, National Nuclear Security Administration Nevada Field Office is requested from the Nevada Division of Environmental Protection for closure of CAU 105.
- CAU 105 should 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) 105, Area 2 Yucca Flat Atmospheric Test Sites, located at the Nevada National Security Site (NNSS), Nevada. 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. The NNSS is located approximately 65 miles (mi) northwest of Las Vegas, Nevada.

CAU 105 comprises the five corrective action sites (CASs) shown on Figure 1-1 and listed below:

- 02-23-04, Atmospheric Test Site - Whitney
- 02-23-05, Atmospheric Test Site T-2A
- 02-23-06, Atmospheric Test Site T-2B
- 02-23-08, Atmospheric Test Site T-2
- 02-23-09, Atmospheric Test Site - Turk

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites* (NNSA/NSO, 2012a).

1.1 Purpose

This CADD/CR provides documentation and justification for the closure of CAU 105. This includes a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed. Information relating to the scope and planning of the investigation is found in the CAIP and will not be repeated in this document.

CAU 105 consists of five CASs at three inactive sites located in Area 2 of the NNSS. The CAU 105 sites were used to support atmospheric nuclear testing conducted at the Yucca Flat area between 1952 and 1957. The five CASs within CAU 105 were grouped into three sites based on geographic proximity and similarity of release as shown on Figure 1-1 and in Table 1-1.

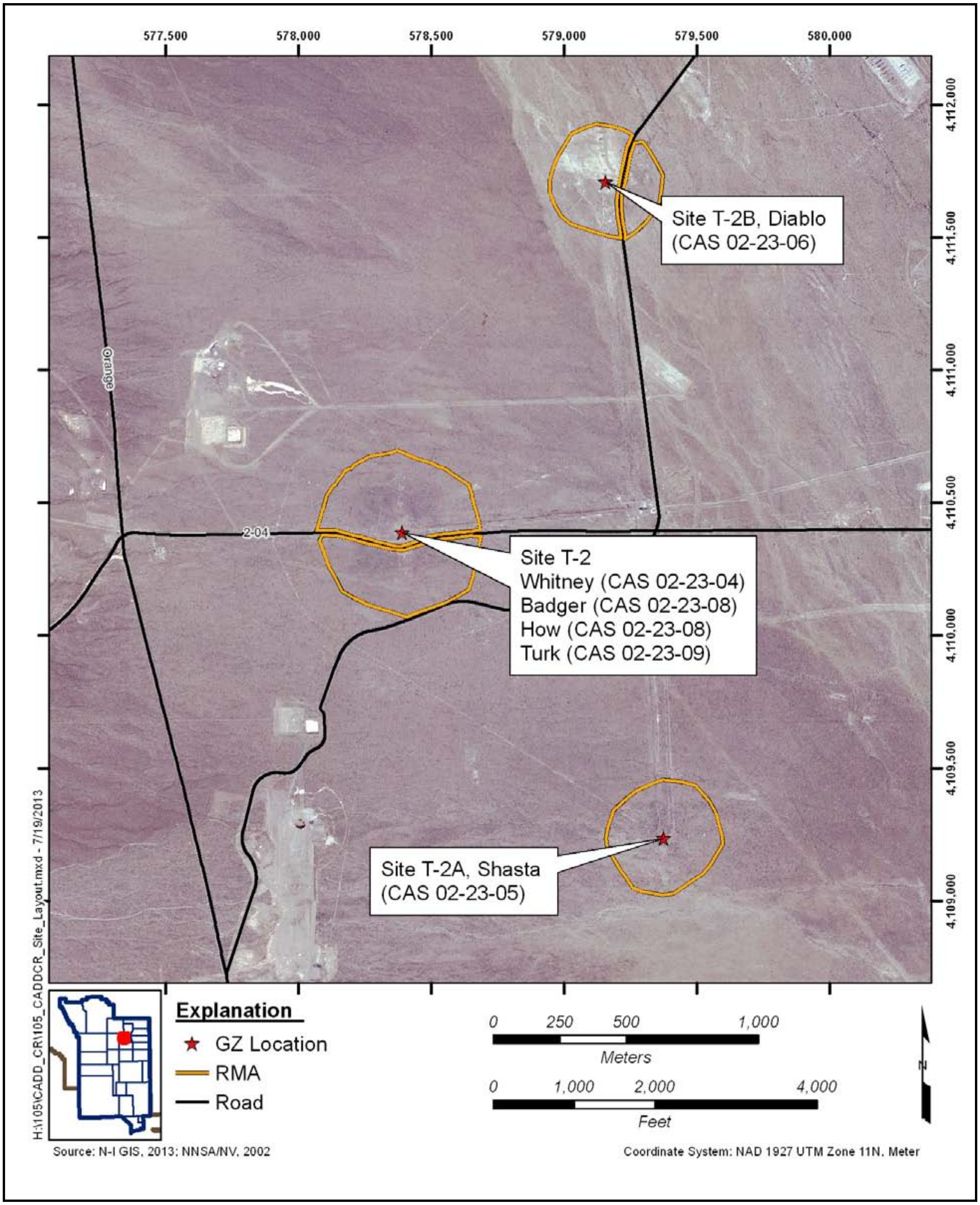


Figure 1-1
CAU 105, CAS Location Map

Table 1-1
Study Sites

CAS Number	CAS Name	Associated Tests	Site	Site Name
02-23-04	Atmospheric Test Site - Whitney	Whitney	T-2	Site T-2
02-23-08	Atmospheric Test Site T-2	Badger, How	T-2	Site T-2
02-23-09	Atmospheric Test Site - Turk	Turk	T-2	Site T-2
02-23-05	Atmospheric Test Site T-2A	Shasta	T-2A	Site T-2A, Shasta
02-23-06	Atmospheric Test Site T-2B	Diablo	T-2B	Site T-2B, Diablo

The releases of contamination at the CAU 105 sites are directly or indirectly associated with atmospheric testing. Releases of radioactive contamination to the surface soil were observed at all sites. Releases include fallout of fission products and the neutron activation of soils and debris to include trinitite. Releases may also be attributed to the historical use of radionuclides as tracers and/or surrogates. Different mixtures of radionuclides may be present at these release sites based on the varying composition of the nuclear source material used in the test devices that did not fission. The fission and activation products released were distributed in a roughly annular pattern around ground zero (GZ). Debris items identified at these sites include miscellaneous debris such as metal pieces, batteries, and lead bricks/piping.

1.1.1 Site T-2A, Shasta: CAS 02-23-05, Atmospheric Test Site T-2A

This CAS is defined as a release of contaminants associated with the atmospheric test of one nuclear weapon at Site T-2A, Shasta. This weapons-related test was performed on August 18, 1957, from a 500-foot (ft) tower with a yield of 17 kilotons (kt) (DOE/NV, 2000).

1.1.2 Site T-2B, Diablo: CAS 02-23-06, Atmospheric Test Site T-2B

This CAS is defined as the release of contaminants associated with the atmospheric test of one nuclear weapon at Site T-2B, Diablo. This weapons-related test was performed on July 15, 1957, from a 500-ft tower with a yield of 17 kt (DOE/NV, 2000).

A 1989 Radioactive Waste Consolidation Project was reported to have removed more than 600 shipments of soil from the north and northwest section of Site T-2B, Diablo to the Area 3 Radioactive

Waste Management Site (RWMS) (REECo, 1988; Johnston, 2012). This project was initiated to determine the feasibility of the remediation of contaminated surface soils and debris. In the northern area of this site, soil and debris have been mounded in preparation for shipment; however, they were not removed because the project was discontinued. These soil and debris mounds are currently visible at the site. Steel tower debris, some lead debris, and concrete tower anchors were also removed during consolidation project efforts. Concrete tower anchor foundations were removed from Site T-2B, Diablo during consolidation project activities. The concrete foundations measured 8 ft deep, 20 ft long, and 8 ft across and were removed using explosives. The former locations of the foundation are currently expressed as depressions in the ground with some steel reinforcement bars remaining. Debris containing concrete, soil, and reinforcement bars is presently mounded around the depressions (Johnston, 2012).

1.1.3 Site T-2: CAS 02-23-04, Atmospheric Test Site - Whitney; CAS 02-23-08; Atmospheric Test Site T-2; and CAS 02-23-09, Atmospheric Test Site - Turk

The three CASs within this site are defined as the release of contaminants associated with atmospheric testing of nuclear weapons at Site T-2. The four weapons-related tests conducted at this site shared a common GZ area, are similar in nature, and are the reason the three CASs are grouped into one site. The following discusses the specifics of each CAS (DOE/NV, 2000):

- CAS 02-23-04, Atmospheric Test Site - Whitney, was performed on September 23, 1957, from a 500-ft tower with a yield of 19 kt. Whitney was the last of four tests performed at this site.
- CAS 02-23-08, Atmospheric Test Site T-2, consists of two tests, Badger and How. Badger was performed on April 18, 1953, from a 300-ft tower with a yield of 23 kt. How was performed on June 5, 1952, from a 300-ft tower with a yield of 14 kt.
- CAS 02-23-09, Atmospheric Test Site - Turk, was performed on March 7, 1955, from a 500-ft tower with a yield of 43 kt. The yield for Turk was the largest observed for CAU 105.

In addition to the five CASs at the three locations, a previously unidentified waste trench was identified approximately 0.7 mi east of Site T-2 that is assumed to be associated with testing performed at this site. An open trench measuring approximately 160 by 40 ft contains metal, wood debris, and some lead from an unknown source. Aerial photographs and visual surveys reveal linear areas south of the open trench that suggest potential buried landfills.

1.2 Scope

The corrective action investigation (CAI) for CAU 105 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 (defined in Section 2.1). For radiological releases, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding a final action level (FAL) of 25 millirem per year (mrem/yr). For chemical releases, a COC is defined as the presence of a contaminant above its corresponding FAL.

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

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. As presented in Appendix C, the radiological and chemical FALs are based on the appropriate site-specific exposure scenario (Occasional Use Area).

The scope of activities used to identify, evaluate, and recommend preferred corrective action alternatives (CAAs) for CAU 105 included the following:

- Performed visual surveys.
- Performed terrestrial radiological surveys (TRSs).
- Performed geophysical surveys.
- Performed field screening.
- Measured *in situ* external dose rates using TLDs.
- Collected and submitted environmental samples for laboratory analysis.
- Evaluated analytical results to determine the presence of COCs.
- Determined the nature and extent of COCs.
- Collected samples of waste material to determine the potential for a release exceeding FALs.

- Collected samples of potential remediation wastes.
- Collected quality control (QC) samples.

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 105 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 data quality objective (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 105.

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, *Data Tables*, provides tabular compilations of validated analytical results that provide a basis for the internal radiological dose estimates, and the tabular compilations of TLD sample data that provide a basis for the external radiological dose estimates.

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

Appendix H, *Nevada Division of Environmental Protection* (NDEP) *Comments*, contains NDEP comments on the draft version of this document.

1.3.1 Applicable Programmatic Plans and Documents

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

- CAIP for CAU 105, Area 2 Yucca Flat Atmospheric Test Sites (NNSA/NSO, 2012a)
- Soils QAP (NNSA/NSO, 2012b)
- Soils RBCA document (NNSA/NSO, 2012c)
- FFACO (1996, as amended)

1.3.2 Data Quality Assessment Summary

The CAIP (NNSA/NSO, 2012a) 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 105 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 105. Detailed investigation activities and results for individual CAU 105 study groups are presented in Appendix A of this document.

2.1 Investigation Activities

CAI activities were conducted as set forth in the CAIP (NNSA/NSO, 2012a) from October 22, 2012, through May 23, 2013. The purpose of the CAU 105 CAI was to provide the additional information needed to resolve the following CAU 105-specific DQOs:

- Determine whether COCs are present in the soils associated with CAU 105.
- Determine the extent of identified COCs.
- Ensure adequate data have been collected to evaluate closure alternatives under the FFACO.

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the reporting of investigation results and the evaluation of DQO decisions for different CSM components were organized into study groups.

The sites, associated CASs, and applicable study groups are described in Table 2-1. Descriptions of the study groups and study sites to which they are applicable are provided in Table 2-2. Although the need for corrective action is evaluated separately for each study group, CAAs are evaluated for each FFACO CAS.

Table 2-1
CAU 105 Sites and Applicable Study Groups

Site	CAS	Applicable Study Groups
T-2A, Shasta	02-23-05	1, 3, 4
T-2B, Diablo	02-23-06	1, 2, 3, 4
T-2 Whitney; Badger, How; Turk	02-23-04, 02-23-08, 02-23-09	1, 3, 4, 5

Table 2-2
Study Group Descriptions

Study Group	Description	Applicable Site
1	Atmospheric Tests	All Sites (T-2A, Shasta; T-2B, Badger; T-2)
2	Excavations	T-2B, Badger
3	Debris/Spills	All Sites (T-2A, Shasta; T-2B, Badger; T-2)
4	Migration	All Sites (T-2A, Shasta; T-2B, Badger; T-2)
5	Landfills	T-2

The study groups were generally investigated by collecting TLD samples for external radiological dose measurements and collecting soil samples for the calculation of internal radiological dose. The field investigation was completed as specified in the CAIP with minor deviations as described in Sections A.2.1 through A.2.6, which provide the general investigation and evaluation methodologies.

For Study Group 1, sample locations were established judgmentally based on aerial radiation surveys and the results of the TRSs. For Study Groups 2, 3, 4, and 5, judgmental sample locations were determined based on biasing criteria such as elevated radiological readings, stained soil, potential source material (PSM), and sediment accumulation areas.

Confidence in judgmental sampling scheme decisions was established qualitatively through validation of the CSM and verification that the selected locations meet the DQO criteria (see Sections A.3.5, A.4.4, A.5.4, A.6.5, and A.7.4, and Appendix B).

Samples within the sample plots were collected and evaluated based on a probabilistic sampling scheme. Confidence in probabilistic sampling scheme decisions was established by validating the CSM, justifying that sampling locations are representative of the plot area, and demonstrating that a sufficient number of samples were collected to justify statistical inferences (e.g., averages and 95 percent upper confidence limits [UCLs]).

The potential internal dose at each soil sample location was determined based on the laboratory analytical results of soil samples and residual radioactivity material guidelines (RRMGs) that were calculated using the RESRAD computer code, version 6.5 (Yu et al., 2001; NNSA/NSO, 2012c). The RRMGs are the activity concentrations of individual radionuclides in surface soil that would cause a receptor to receive an internal dose equal to the radiological FAL. The internal doses from each of the radionuclides are summed to produce the total potential internal dose.

The potential internal dose at each TLD location where soil samples were not collected was conservatively estimated using the potential external dose from the TLD and the ratio of internal dose to external dose from the sample location with the maximum internal dose. This was done under the conservative assumption that the internal dose at any location would constitute the same percentage of the total dose as at the location where the maximum internal dose was observed. Therefore, the ratio of the internal to external dose was determined at the location with the highest internal dose by dividing the internal dose by the external dose. This release-site-specific ratio was then multiplied by the external dose measured at each TLD location where soil samples were not collected to estimate the internal dose at these locations.

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

Because a calculated TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the calculated TED were significantly different than the true TED, a decision based on the calculated TED could result in a decision error. To reduce the probability of making a false negative decision error at probabilistic sample locations, a conservative estimate of the true TED is used to compare to the FAL instead of the calculated TED. This conservative estimate (overestimation) of the true TED was calculated as the 95 percent UCL of the average TED. 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 potential external dose at each TLD location was determined from the results of a TLD placed at a height of 1 meter (m) above the soil surface. The net external dose (the gross TLD dose reading minus the background dose) was then divided by the number of hours the TLD was exposed to site contamination, resulting in an hourly dose rate. That hourly dose rate was then multiplied by the number of hours per year (hr/yr) that a site worker would be present at the site (i.e., the annual exposure duration) to establish the potential annual external dose a site worker could receive. The appropriate annual exposure duration in hours is based on the exposure scenario used.

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:

- **Industrial Area.** Assumes continuous industrial use of a site. This scenario addresses exposure to industrial workers exposed daily to contaminants in soil during an average workday. This scenario assumes that this is the regular assigned work area for the worker who will be on the site for an entire career (250 days per year [day/yr], 8 hours per day [hr/day] for 25 years). The TED values calculated using this exposure scenario are the TED an industrial worker receives during 2,000 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Industrial Area year (mrem/IA-yr).

- **Remote Work Area.** Assumes non-continuous work activities at a site. This scenario addresses exposure to industrial workers exposed to contaminants in soil during a portion of an average workday. 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 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 exposure to 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). This scenario has been determined to be applicable to CAU 105.

The following subsections describe specific investigation activities conducted at each study group. Additional information regarding the investigation is presented in Appendix A.

2.1.1 Study Group 1, Atmospheric Tests

Investigation activities for Study Group 1 at all sites included conducting TRSs, staging TLDs, and collecting surface soil samples. Study Group 1 was evaluated by measuring the TED at sample locations established in selected patterns for each site as presented in Figures A.3-6 through A.3-8. This was accomplished by measuring the internal and external dose at each of the three sites.

A total of 207 TLDs were installed in a vector or grid pattern at each site to measure external dose. One 100-square-meter (m^2) judgmental sample plot was established at each of the three study sites to measure internal dose. Sample plot locations were selected based on areas where the highest readings from the TRSs were observed. A TLD was placed in the approximate center of each sample plot to determine the external dose.

The investigation activities specific to TRSs at Site T-2A, Shasta showed that the highest radiation readings from the TRSs were detected near GZ and confirmed that the fallout plume was positioned consistent with the 1994 aerial radiological surveys (BN, 1999) used in the CAIP to select sampling locations. A total of 59 TLDs were installed in a vector pattern (see Figure A.3-3) as proposed in the CAIP (NNSA/NSO, 2012a) to measure external radiological doses. A vector pattern was proposed at Site T-2A, Shasta because isotopes released from the tests consist of fission and activation products distributed in a roughly annular pattern around GZ. Sample vectors provide greater sample density closer to GZ. A 100-m^2 judgmental sample plot was placed in the area of most elevated readings (location A01) as determined from the TRSs (see Figure A.3-3).

The investigation activities specific to Site T-2B, Diablo showed that the highest radiation readings from the TRSs were detected adjacent to and outside the southwestern corner of the radioactive material area (RMA) and confirmed that the fallout plume was positioned as expected from previously performed radiological surveys (BN, 1999). A total of 71 TLDs were installed in a grid pattern (see Figure A.3-4) as proposed in the CAIP (NNSA/NSO, 2012a) to measure external radiological doses. A grid pattern was established at Site T-2B, Diablo because the annular pattern of fallout had been affected by past consolidation efforts. Excavation performed in the northern section of the site as part of the consolidation efforts in 1989 resulted in a discontinuous and not readily discernible pattern of remaining radiological contamination. As a result, a sample grid was selected to provide more uniform coverage. A 100-m^2 probabilistic sample plot was placed in the area of most elevated readings (location B01) as determined from TRSs (see Figure A.3-4).

The investigation activities specific to Site T-2 showed that the highest radiation readings from the TRSs were detected south of GZ to the south of Road 2-04 and confirmed that the fallout plume was consistent with the 1994 aerial radiological surveys (BN, 1999) used in the CAIP to select sampling locations. A total of 65 TLDs were installed in a vector pattern (see Figure A.3-5) as proposed in the CAIP (NNSA/NSO, 2012a) to measure external radiological doses. A vector pattern was proposed at Site T-2 because isotopes released from the four tests consisted of fission and activation products distributed in a roughly annular pattern around GZ. Sample vectors provided greater sample density closer to GZ. A 100-m^2 judgmental sample plot was placed in the area of most elevated readings (location C01) as determined from TRSs (see Figure A.3-5).

The contamination pattern of the radionuclides for Study Group 1 was consistent with the CSM in that the radiological contamination was observed to be greatest near the release point, generally decreasing with distance in a concentric pattern from GZ. As a result, information gathered during the CAI supports and validates the CSM as presented in the CAIP, and no modifications to the CSM were needed.

See Section A.3.1 for additional information on investigation activities at Study Group 1. Results of the sampling effort are summarized in Section 2.2.1.1.

2.1.2 Study Group 2, Excavations

The excavations applicable to Study Group 2 are only located at Site T-2B, Diablo. At this site, soil and debris was excavated into soil piles for disposal as part of surface contamination consolidation efforts. The project was terminated before all mounds were disposed of, and the existing soil mounds were investigated as part of this CAI to determine their content and dose. TRSs were performed in the area surrounding the soil mounds. A partial excavation of the soil mound closest to GZ was performed to determine content and radiological dose, as it was identified as a conservatively representative soil pile. Approximately 30 percent of the soil and debris from the eastern and northeastern section of the pile was excavated, leveled, and placed on the ground in an approximate 1-ft lift adjacent to the excavation (see Figure A.4-1). Internal dose was determined by grab sample analysis and external dose by TLD measurement. The results for Study Group 2 are summarized in Section 2.2.1.2.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The soil mounds are consistent with the CSM in that they are located in the area where consolidation efforts were performed. 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 3, Debris/Spills

Investigation activities at Study Group 3 included performing visual inspections, collecting soil samples, and removing selected debris. A judgmental sampling approach was used to investigate the likelihood of the soil containing a COC based upon biasing factors. Figure A.5-1 shows debris and sample locations identified for Study Group 3 in this section.

During the visual inspections of Site T-2A, Shasta, numerous debris items were concentrated around GZ to include partially melted metal tower debris, ancillary equipment pieces, cement lead-lined bunkers, and lead-lined pipes. Lead items discovered in the area adjacent to GZ include two lead-lined cement vaults, two lead-lined pipes, and numerous pieces of melted lead debris. Due to the multiple scattered lead items, eight samples were collected at a 225-ft radius around GZ based upon the visual presence of lead to bound the lead contamination. One stained area approximately 2 ft in diameter was also identified at a localized location (A66) near GZ at the Shasta site. A sample was collected of the material and the soil directly under the spill.

During the visual inspections at Site T-2B, Diablo, two lead bricks were discovered in an intact metal container on the north end of the site outside the RMA (location B84). These bricks were removed from the site as a corrective action. As the bricks were fully contained in the intact metal container, sampling was not performed.

A lead-lined concrete box located approximately 100 ft west of the Site T-2B, Diablo GZ was identified during the CAU 105 investigation (location B80). This item was addressed as part of the closed CAS 02-26-01, Lead (Concrete Box w/Lining), as part of CAU 5000, Archived-Archived Corrective Action Sites (FFACO, 1996, as amended). As a best management practice (BMP), five environmental samples were collected on each side of the box and one sample of the material in the center during the CAI. Samples were analyzed for *Resource Conservation and Recovery Act* (RCRA) metals. No contamination exceeding FALs was present in any sample. Due to the results of the analysis and the fact that the PSM was addressed by a closed CAS, this PSM will not be addressed by CAU 105 or discussed further in this document.

During the visual inspection at Site T-2, lead bricks and lead-acid batteries were identified. Individual scattered lead bricks were discovered near the GZ area, and one cluster of bricks was identified in the western area of the site. Eighteen individually scattered lead bricks were identified and removed from the GZ area. Six inches of soil under each brick was excavated and placed in a container for disposal. The cluster of bricks on the western edge of Site T-2 is located within the RMA directly south and adjacent to Road 2-04. Forty-nine lead bricks were removed from the cluster. Two lead-acid batteries were also identified during visual surveys to include two intact and one breached battery. All lead bricks and lead-acid batteries were removed from the site as a corrective action. Six inches of soil under the breached battery was excavated and placed in a drum for disposal.

Sampling was performed for environmental characterization and waste management purposes. Because the potential for release was identified, soil samples were collected from below the removed scattered lead bricks and breached lead-acid battery at Site T-2 for environmental characterization. For the lead brick cluster at the western edge of the site, composite soil samples were collected to characterize the area. A sample of the breached battery pieces was also collected for characterization purposes. Sampling of the excavated soil placed in drums was performed to characterize the soil for waste management purposes as described in Section A.8.0. See Section 2.2.1.3 for the results of the sampling performed at these Study Group 3 locations.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The debris and spills observed are consistent with the CSM and information identified in pre-field activities in that they are not randomly scattered through the sites. 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 4, Migration

Investigation activities at Study Group 4 included performing visual inspections, conducting TRSs, collecting judgmental soil samples, and placing TLDs to determine external dose. The potential exists for deposited contamination in Study Group 1 (Atmospheric Tests) at all sites to migrate as a result of stormwater runoff into drainage channels. Visual surveys were used to identify major drainages and locate sedimentation areas downstream from areas potentially impacted by testing as shown in Figure A.6-1. In addition to visual surveys, TRSs were conducted in the most significant washes at CAU 105. Elevated readings identified during the TRSs were used to help identify areas for sampling. TLDs were placed and soil samples collected at downstream sediment locations at the three study sites. To investigate the potential for the presence of buried soil contamination, samples were collected and screened at 10-centimeter (cm) intervals down to an undisturbed horizon.

A drainage area potentially impacted by the Site T-2A, Shasta test was identified in the southeast section of this site flowing to the east and slightly south. A total of six sediment accumulation areas were identified for investigation as shown in Figure A.6-2. Two sedimentation areas (A02 and A03) were selected approximately 250 ft from GZ within the RMA to evaluate this drainage. Visual inspections and TRSs were subsequently conducted to further evaluate downstream areas. Visual inspections reveal that trinitite is abundant around GZ and is migrating significant distances downstream. Trinitite was discovered approximately 1 mi downstream from GZ in the main drainage channel flowing to the east. Trinitite was also discovered south of the main drainage channel in the general drainage area. As a result, TRSs were expanded to further investigate this area. The TRSs using the PRM-470 identified elevated radiological readings in one sedimentation area approximately 1,300 ft from GZ outside the RMA. Locations A64 and A65 were established in this elevated area. Two sedimentation areas (A67 and A68) were established further downstream to fully characterize the extent of contamination within this drainage. TLDs were placed at the surface and soil samples collected at 10-cm lifts at all locations to evaluate contamination at depth. At four locations (A03, A64, A65, and A67) soil samples collected at a depth of 20 to 30 cm exceeded the surface field-screening levels (FSLs). At these locations, the surface and subsurface sample were submitted for analysis. At locations A64 and A65, samples were collected at 40 to 50 cm (below the depth that exceeded the FSL) as representative samples to fully evaluate the vertical extent of contamination. At the sediment accumulation area furthest from GZ (A68), the FSL was not exceeded at any depth.

Two drainage areas were identified as being potentially impacted by the Site T-2B, Diablo test. Both drainages were identified in the southern section of this site flowing to the south. Five sedimentation areas (B43, B44, B45, B46, and B48) were identified to characterize the drainages at this site as shown in Figure A.6-3. Trinitite, which is abundant at GZ, was observed to be migrating from the site; however, it was not as prominent as at other CAU 105 study sites. Trinitite was found approximately 75 ft south of the RMA boundary in the drainage channel. Subsequent radiological surveys were conducted in this area to better define the radiological signature of the drainage and surrounding areas.

Two drainage areas were identified for investigation at Site T-2. Drainage areas north and south of Road 2-04 on the east side of GZ were identified as the major drainages in the area impacted by the Whitney, Badger, How, and Turk tests. Both north and south drainage areas flow to the east and exhibit braided channels without well-defined main channels. A total of 10 sediment accumulation areas were selected for sampling to characterize this site as shown in Figure A.6-4. In the northern drainage area, four sedimentation areas (C39, C40, C41, and C77) were established. Visual inspections discovered that the trinitite abundant in the GZ area extended approximately 600 ft downstream from the RMA boundary. In the southern drainage area, six sedimentation areas (C63, C64, C65, C66, C78, and C79) were selected from visual and radiological surveys. Trinitite is abundant at GZ and at the RMA boundary and has migrated to the east intermittently in the braided drainage channels. Trinitite was observed to approximately 1,000 ft east of the RMA boundary at this southern drainage area at Site T-2. TRSs were conducted in both the northern and southern drainages to further evaluate the area. Results of the sampling effort are summarized in Section 2.2.1.4.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 4 is consistent with the CSM in that migration was identified as a potential pathways for the release of radiological contamination. Information gathered during the CAI supports and validates the CSM for Study Group 4 as presented in the CAIP. No modification to the CSM was needed.

2.1.5 Study Group 5, Landfills

Investigation activities at Study Group 5 included performing visual inspections, reviewing aerial survey photos, conducting TRSs, performing geophysical surveys, and removing debris from the open waste trench. Radiological surveys indicate no elevated activity in the area.

Visual inspections discovered a previously unidentified open waste trench approximately 0.7 mi east of Site T-2 as shown on Figure A.7-1. The open trench measures approximately 160 by 40 ft and is approximately 6 ft deep. This trench contains metal, wood debris, lead from an unknown source, and other debris. Approximately 140 cubic yards (yd^3) of material was collected and removed as a BMP. Geophysical surveys were conducted in the area directly adjacent to the open waste trench and the area directly to the south. Visual surveys and aerial survey photographs showed evidence of slightly depressed linear areas parallel to the open waste trench that could be indicative of buried waste trenches (i.e., landfills). Geophysical surveys were conducted to identify potential buried metallic debris. Results of the geophysical survey indicate significant amounts of metal in six buried waste trenches south of the open trench (see Figures A.7-2 and A.7-3). The results of sampling at Study Group 5 are summarized in Section 2.2.1.5.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NSO, 2012a). The contamination pattern of the radionuclides at Study Group 5 is consistent with the CSM in that landfills were identified during the planning process as being potentially present and a possible source of contamination. 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 defines the COCs identified at CAU 105. 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 105 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs for radioactivity were established in the CAIP (NNSA/NSO, 2012a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario that a site worker would be exposed to site contamination for 250 day/yr and 8 hr/day). The FALs for radioactivity were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 80 hours (i.e., the Occasional Use Area exposure scenario defines that a site worker would be exposed to site contamination for 10 day/yr and 8 hr/day). To be comparable to these action levels, the CAU 105 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 RCRA metal exceed the screening level (e.g., arsenic on the NNSS). The chemical FALs were established in Appendix C at the PAL concentrations.

2.2.1 Summary of Analytical Data

Chemical and radiological results for environmental samples collected at each of the study groups are summarized in the following subsections. 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 to determine whether a release of the waste to the surrounding environmental media could cause the presence of a COC in the environmental media. For radioactivity, results are reported as TED comparable to the radiological FAL as established in Appendix C. Calculation of the TED for each sample was accomplished through summation of internal and external dose as described in Sections A.3.2.3, A.4.2.3, and A.6.2.3.

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

Soil samples are evaluated against FALs to determine the presence of COCs and the extent of COC contamination, if present. The FALs as established in Appendix C are based on the annual exposure duration of the Occasional Use Area scenario (336 hr/yr). PSM samples are evaluated against the

PSM criteria and assumptions defined in Section 2.3 to determine whether a release of the waste to the surrounding environmental media could cause the presence of a COC in the environmental media. Discussions of the results for samples collected at CAU 105 are grouped by the nature of the release (i.e., study group).

2.2.1.1 Study Group 1, Atmospheric Tests

Based on analytical results for soil and TLD samples collected at Study Group 1, surface radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr) at any location. The maximum 95 percent UCL TED observed for the Occasional Use scenario was 3.3 mrem/yr at Site T-2A, Shasta; 4.0 mrem/yr at Site T-2B, Diablo; and 15.0 mrem/yr at Site T-2.

The average and 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for all sample locations are presented in Tables A.3-14, A.3-15, and A.3-16.

2.2.1.2 Study Group 2, Excavations

Based on analytical results for the one soil and TLD sample collected, radiological contamination does not exceed the FAL for the radiological dose (25 mrem/OU-yr). One soil sample was collected from a partially excavated soil mound at Site T-2B, Diablo for analysis. The TED value for the Occasional Use Area exposure scenarios was less than 1 mrem/yr.

The TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios for the sample location are presented in Table A.4-5.

2.2.1.3 Study Group 3, Debris/Spills

At Site T-2A, Shasta, a significant amount of lead debris of various sizes was concentrated within a 225-ft radius from GZ. It is assumed that lead contamination within this radius exceeds the FAL for lead. Eight samples were collected at the perimeter of the 225-ft radius area. The analytical results for the eight samples (A70 through A77) were found to be below the FAL limit for lead, with the maximum concentration reported at 160 milligrams per kilogram (mg/kg). Results are presented in Section A.5.0 with sample locations provided in Figure A.5-1.

No spills, lead debris, or other PSM were observed at Site T-2B, Diablo as a result of visual surveys, and no sampling was performed.

At Site T-2, lead bricks and a breached lead-acid battery were removed, and confirmatory soil samples were taken from the remaining soil and analyzed for lead. No sample results exceeded FALs. The maximum lead concentration in these sample results was 6,100 mg/kg. No confirmatory sample results from the area of 49 clustered lead bricks exceeded the FAL. The maximum lead concentrated in this area was 370 mg/kg. Results are presented in Section A.5.0 and locations provided in Figures A.5-1 and A.5-2.

2.2.1.4 Study Group 4, Migration

A total of 19 sample locations were collected for Study Group 4 in the areas shown on Figure A.6-1. Based on analytical results for surface and subsurface soil samples collected at Study Group 4, radiological contamination does not exceed the 25 mrem/OU-yr FAL at any location. The maximum 95 percent UCL TED observed for the Occasional Use scenario was 4.3 mrem/OU-yr at Site T-2A, Shasta; 2.6 mrem/OU-yr at Site T-2B, Diablo; and 4.5 mrem/OU-yr at Site T-2.

The average and the 95 percent UCL TED values for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.6-7.

2.2.1.5 Study Group 5, Landfills

The waste trenches that encompass Study Group 5 are depicted on Figure A.7-1. Sampling was not performed, as it was assumed that the waste trenches and potential buried landfills exceed the FAL for radiological and chemical constituents. The extent of the open and buried waste trenches was determined based upon geophysical survey results and visual examinations.

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 helps to ensure that DQO decisions are sound and defensible.

The DQA process as presented in Appendix B is composed of the following steps:

1. Review DQOs and Sampling Design.
2. Conduct a Preliminary Data Review.
3. Select the Test.
4. Verify the Assumptions.
5. Draw Conclusions from the Data.

The results of the DQI evaluation show that criteria were not met in the areas of accuracy and precision. However, as presented in Appendix B, these deficiencies do not affect the decision-making process.

Sample locations that support the presence and/or extent of contamination at each study group are shown in Appendix B. Based on the results of the DQA presented in Appendix B, the nature and extent of COCs at CAU 105 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 and support their intended use in the decision-making process.

2.3 Justification for No Further Action

No further corrective action is needed for the CASs within CAU 105 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 (the evaluation of CAAs is presented in Appendix E). The need for corrective action is evaluated for each study group through the resolution of DQO decisions as presented in Section 2.3.2.1. This 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/NSO, 2012c). 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 contaminants of potential concern (COPCs) to determine whether contaminant levels satisfy the criteria for a quick regulatory closure or warrant a more site-specific assessment. For radiological contaminants, this was accomplished by comparing the radiological PAL of 25 mrem/IA-yr to the TED at each sample location calculated using the industrial area exposure scenario. For chemical contaminants, this was accomplished by comparing individual source area contaminant concentration results to the Tier 1 action levels (the PALs established in the CAIP).

The Tier 2 evaluation of contaminants that exceeded Tier 1 action levels was conducted in accordance with the Soils RBCA document (NNSA/NSO, 2012c). This evaluation (presented in Appendix C) was based on risk to receptors. The risk to receptors from contaminants at CAU 105 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 105 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 105 DQOs that the Occasional Use Area exposure scenario would be appropriate in calculating receptor exposure time. In order to quantify the maximum number of hours a site worker may be present at CAU 105, 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 could 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 levels for each location were calculated using a more conservative exposure time of 80 hr/yr. Additional details of the Tier 2 evaluation for radionuclides are provided in Appendix C.

The Tier 2 evaluation for lead compared the analytical results to the Tier 2 action levels. The Tier 2 action level was calculated using EPA's Adult Lead Methodology (ALM) to estimate the concentration of lead in the blood of pregnant women and their developing fetuses who might be exposed to lead-contaminated soils (EPA, 2009). This calculation used a site-specific soil ingestion rate (of 0.0667 grams/day [g/day]) and an exposure frequency of 44 day/yr. The FAL for lead established in Appendix C using this methodology is 8,356 mg/kg.

The FALs for all CAU 105 COPCs are shown in Table 2-3.

Table 2-3
Definition of FALs for CAU 105 COPCs

COPCs	Tier 1 Based FALs	Tier 2 Based FALs	Tier 3 Based FALs
VOCs	PALs[a]	None	None
SVOCs	PALs[a]	None	None
RCRA Metals (other than lead)	PALs[a]	None	None
Lead	None	8,356 mg/kg[b]	None
Radionuclides	None	25 mrem/OU-yr	None

[a]Based on Region 9 RSLs (EPA, 2013).
[b]Based on *Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters* (EPA, 2009).

SVOC = Semivolatile organic compound
VOC = Volatile organic compound

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 Study Group 1, Atmospheric Tests

No radiological COCs were identified at any sampled location within the atmospheric depositional area at any of the three sites. Therefore, Decision I is resolved; no corrective action is needed; and Decision II does not need to be resolved.

2.3.2.2 Study Group 2, Excavations

No radiological or chemical COCs were identified at the sampled location within the excavated soil mound for Study Group 2. Therefore, Decision I is resolved; no corrective action is needed; and Decision II does not need to be resolved for this release.

2.3.2.3 Study Group 3, Debris/Spills

At Site T-2A, Shasta, it is assumed that soil within a 225-ft radius of GZ contains lead above the FAL. Decision I is resolved for this site, and a corrective action is required. Decision II is resolved by the analysis of eight verification samples collected at the perimeter of the 225-ft radius that confirmed COCs do not extend beyond this radius.

No spills, lead debris, or other potentially PSM were observed at Site T-2B, Diablo; therefore, Decision I is resolved, and no corrective action is required.

At Site T-2, PSM was identified in the form of 18 scattered lead bricks, 49 clustered lead bricks, and one breached lead-acid battery. Decision I is resolved for these releases, and corrective action is required for the PSM. The extent of COCs for the 18 scattered lead bricks and lead-acid battery was resolved based on the physical dimensions of the intact items and the verification samples that showed COCs were not present in the soil after the PSM and associated soil were removed. The 49 clustered lead bricks were in a well-defined area. The PSM was removed, and verification samples confirmed that COCs are not present in the remaining soil. Therefore, no further corrective action is needed, and Decision II is resolved for the PSM.

2.3.2.4 Study Group 4, Migration

Because no radiological COCs were identified for the atmospheric depositional area at Study Group 1, there is no potential for radiological COCs to migrate. Although lead is a COC at Site T-2A, Shasta and at Site T-2, Decision II samples demonstrated that the COC is not migrating beyond the 225-ft radius of GZ or the extent of the PSM removals. Therefore, Decision I is resolved; no corrective action is needed; and Decision II does not need to be resolved for migration from Site T-2A, Shasta; Site T-2B, Diablo; or Site T-2.

2.3.2.5 Study Group 5, Landfills

At Site T-2, it is assumed that the waste trenches identified east of the Site T-2 GZ area contain radiological and chemical contamination above the FALs. Decision I is resolved for this site, and a corrective action is required. Decision II is resolved by visual and geophysical surveys confirming the limited extent of metal and debris to a defined area.

3.0 Recommendation

Corrective actions for all five CASs at the three study sites were based on the risk assessment presented in Appendix C and the corrective action evaluation presented in Appendix E. In the risk assessment, it was determined to use the Occasional Use Area exposure scenario (with an exposure duration of 80 hr/yr of site worker exposure) as the radiological FAL for DQO decisions.

For sampled locations at all five CASs at the three study sites, surface radiological contamination does not exceed the FAL of 25 mrem/OU-yr. The selected corrective actions were based on the corrective action evaluation presented in Appendix E.

Although no locations exceed the radiological FAL at Site T-2A, Shasta (CAS 02-23-05), it is assumed that lead contamination within the 225-ft radius from GZ exceeds the FAL. Therefore, corrective action is required. The selected corrective action was closure in place with an FFACO use restriction (UR) (Figure A.3-9). The FFACO UR was established to encompass the 225-ft radius circle (see Section A.5.3) as shown on Figure A.5-3.

The selected corrective action for Site T-2B, Diablo (CAS 02-23-06) was clean closure. Lead bricks were removed at this site as a corrective action with no additional corrective action required. No locations at this site exceed the radiological FALs (Figure A.3-10).

For Site T-2 (CASs 02-23-04, 02-23-08, 02-23-09), closure in place with an FFACO UR was selected as the corrective action as shown on Figure A.3-11. Radiological contamination does not exceed the FAL at the GZ location. It is assumed that radiological and chemical contamination remains at the potential buried waste trenches located east of the GZ area. Therefore, corrective action is required for this area. The corrective action for these waste trenches was an FFACO UR for chemical and radiological COCs around the open and buried trenches as shown on Figure A.7-4. At the open waste trench, debris was removed and the trench was covered with clean fill as a BMP.

The FFACO URs implemented at each CAS will protect site workers from inadvertent exposure. The FFACO URs are shown in Attachment D-1. The FFACO URs require annual inspections to certify that postings are in place, intact, and readable. Maintenance or replacement of postings may be conducted without prior approval from NDEP.

No further corrective action is required at CAU 105 based upon implementation of corrective actions at the CAU 105 CASs. These corrective actions are evaluated in Appendix E based on technical merits focusing on reduction of toxicity, mobility and/or volume; reliability; short and long-term feasibility; and cost. The corrective actions for CAU 105 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer are valid, additional evaluation may be necessary.

In accordance with the Soils RBCA document (NNSA/NSO, 2012c) and Section 3.3 of the CAIP (NNSA/NSO, 2012a), an administrative UR was implemented as a BMP for any area where an industrial land use of the area could cause a future site worker to receive an annual dose exceeding 25 mrem/IA-yr. This assumes the worker would be exposed to site contamination for a period of 2,000 hr/yr. Administrative URs are not part of any FFACO corrective action.

To determine the extent of the area of the administrative URs, a correlation of radiation survey values to the industrial area TED values was conducted for each radiation survey (see Section A.3.4). Of these, the gamma drive-over surveys exhibited the best correlation. Based on this correlation, the radiation survey values that correspond to the 25-mrem/IA-yr PAL are 3.01 multiples of background at Site T-2A, Shasta; 2.65 at Site T-2B, Diablo; and 3.52 at Site T-2. The administrative URs are shown on Figures A.3-9 through A.3-11 and presented in Attachment D-1.

The administrative URs will be recorded and controlled in the same manner as the FFACO URs, but will not require posting or inspections. The administrative URs are presented in Attachment D-1.

All URs are recorded in the FFACO database; the Management and Operating (M&O) Contractor Geographical Information Systems (GIS); and the DOE, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) CAU/CAS files. The development of URs for CAU 105 are based on current land use. Any proposed activity within a use restricted area that would result in a more intensive use of the site would require NDEP approval.

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

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.

BN, see Bechtel Nevada.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site,* DOE/NV/11718--324. Prepared for the U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2013. Title 10 CFR, Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EPA, see U.S. Environmental Protection Agency.

FFACO, see *Federal Facility Agreement and Consent Order.*

Federal Facility Agreement and Consent Order. 1996 (as amended March 2010). Agreed to by the State of Nevada; U.S. Department of Energy, Environmental Management; U.S. Department of Defense; and U.S. Department of Energy, Legacy Management. Appendix VI, which contains the Soils Sites Strategy, was last modified May 2011, Revision No. 4.

Johnston, J., Navarro-Intera, LLC (N-I). 2012. Memorandum to S. Mergenmeier (N-I) titled "CAU 105 Sites T-2, T-2A, and T-2B Radioactive Waste Consolidation Project Information," 31 January. Las Vegas, NV.

NAC, see *Nevada Administrative Code*.

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

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

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

Navarro-Intera Geographic Information Systems. 2013. ESRI ArcGIS Software.

Nevada Administrative Code. 2012a. NAC 445A, "Water Controls." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 15 May 2013.

Nevada Administrative Code. 2012b. 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 15 May 2013.

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 15 May 2013.

REECo, see Reynolds Electrical & Engineering Co., Inc.

Reynolds Electrical & Engineering Co., Inc. 1988. *Nevada Test Site Radioactive Waste Consolidation Project, Fiscal Year 1989 Plan*. Prepared for the U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV.

USC, see *United States Code.*

United States Code. 2012. Title 42 USC 2011 et seq., "Atomic Energy Act of 1954," as amended. Washington, DC: U.S. Government Printing Office.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Nevada Test Site Orthophoto Site Atlas*, DOE/NV/11718--604. Prepared by Bechtel Nevada. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1486. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012c. *Soils Risk-Based Corrective Action Evaluation Process,* Rev. 0, DOE/NV--1475. 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. 2009. *Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters,* OSWER 9200.2-82. June. Prepared by the Lead Committee of the Technical Review Workgroup for Metals and Asbestos. Washington, DC: Office of Superfund Remediation and Technology Innovation.

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 4 June. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

Yu, C., A.J. Zielen, J.J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.5 released in October 2009.)

Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 105. CAU 105 consists of the following five CASs located in Area 2 of the NNSS (Figure A.1-1):

- 02-23-04, Atmospheric Test Site - Whitney
- 02-23-05, Atmospheric Test Site T-2A
- 02-23-06, Atmospheric Test Site T-2B
- 02-23-08, Atmospheric Test Site T-2
- 02-23-09, Atmospheric Test Site - Turk

The CAU 105 CASs were used to support atmospheric nuclear testing conducted at the Yucca Flat area. These CASs consist of a release of radioactive contamination to the surface. The five CASs within CAU 105 were grouped into three study sites based on geographic proximity and similarity of release.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 105 CAIP (NNSA/NSO, 2012a).

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 105. 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.2.5).

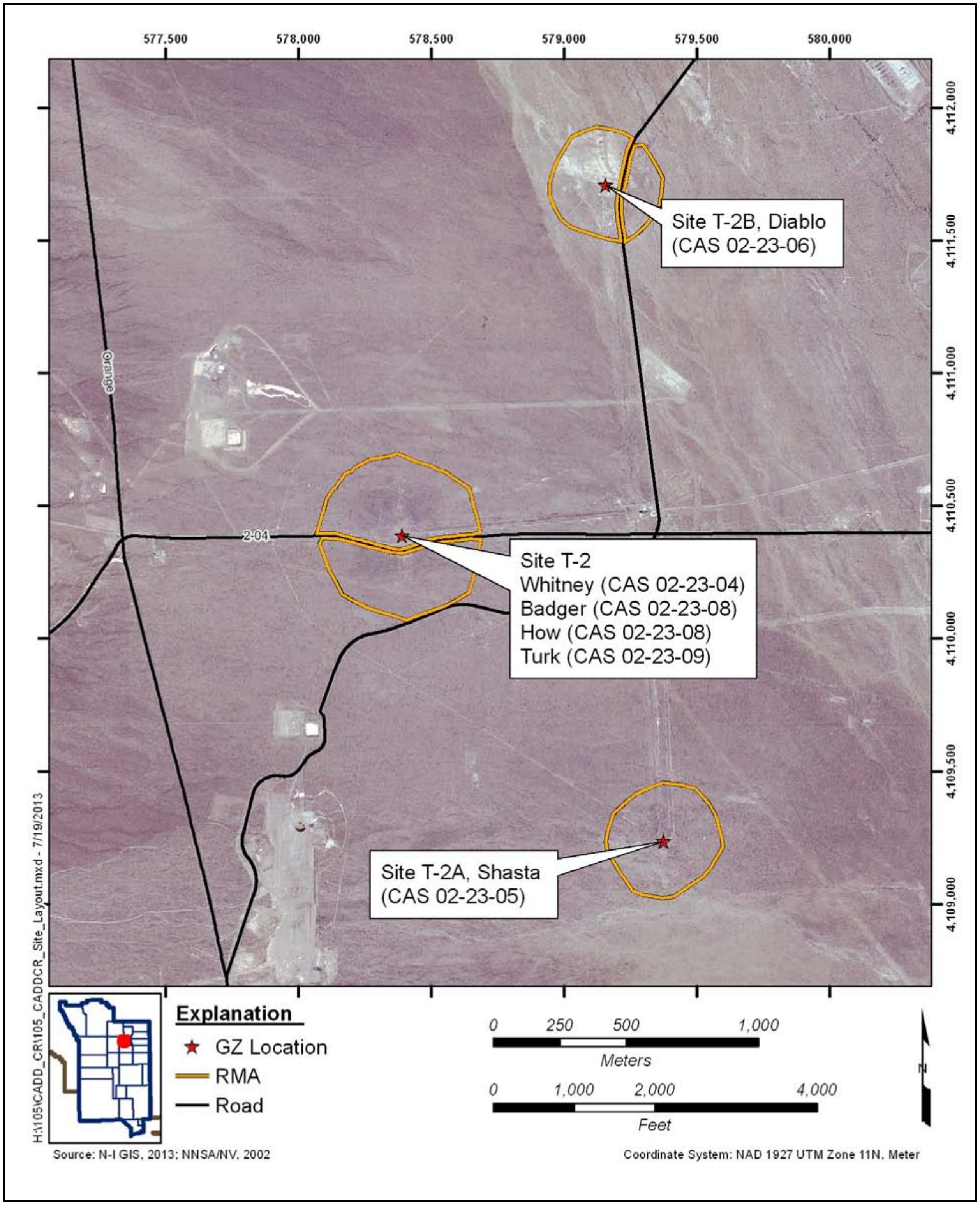


Figure A.1-1
CAU 105, Site Location Map

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.7.0 provide study-group-specific (see Section A.2.0) information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.8.0 summarizes waste management activities.
- Section A.9.0 discusses the QA and QC processes followed and the results of QA/QC activities.
- Section A.10.0 provides a summary of the investigation results.
- Section A.11.0 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, soil sample descriptions, laboratory certificates of analyses, and analytical results—are retained in CAU 105 files as hard copy files or electronic media.

A.2.0 Investigation Overview

The following CAU 105 CAI activities were conducted from October 22, 2012, through May 23, 2013:

- 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.
- Conducted geophysical surveys.
- Established sample plot and biased sample locations.
- Collected soil samples at sample plot and biased sampling locations.
- Collected QC soil samples.
- Submitted soil samples for analysis.
- Staged TLDs at environmental 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.
- Performed limited removal of PSM wastes.
- Conducted waste management activities (e.g., sampling, disposal).

The investigation and sampling program adhered to the requirements set forth in the CAIP (NNSA/NSO, 2012a) (except any deviations described herein) and in accordance with the Soils 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/NSO, 2012c).

The five CASs within CAU 105 were grouped into three sites based on geographic proximity. The investigation associated with each site is broken down into five study groups based upon a specific type of release. The sites, associated CASs, and applicable study groups are described in Table A.2-1. A description of the study groups and sites to which they are applicable are provided in Table A.2-2. The sites and associated CAS information is summarized in Figure A.1-1.

Table A.2-1
Sites

Site	CAS	Applicable Study Groups
T-2A, Shasta	02-23-05	1, 3, 4
T-2B, Diablo	02-23-06	1, 2, 3, 4
T-2, Whitney; Badger; How, Turk	02-23-04, 02-23-08, 02-23-09	1, 3, 4, 5

Table A.2-2
Study Group Descriptions

Study Group	Description	Applicable Site
1	Atmospheric Tests	All Sites (T-2A, Shasta; T-2B, Diablo; T-2)
2	Excavations	T-2B
3	Debris/Spills	All Sites (T-2A, Shasta; T-2B, Diablo; T-2)
4	Migration	All Sites (T-2A, Shasta; T-2B, Diablo; T-2)
5	Landfills	T-2

The study groups were investigated by collecting TLD samples for external radiological dose measurements and collecting soil samples for the calculation of internal radiological dose. The field investigation was completed as specified in the CAIP (NNSA/NSO, 2012a) with minor deviations as described in Section A.7.1.4, which provide the general investigation and evaluation methodologies.

A.2.1 Sample Locations

Sample locations were selected based on interpretation of site-specific TRSs and historical investigations (1994 aerial radiological survey [BN, 1999] and Radionuclide Inventory and Distribution Program (RIDP) data [McArthur and Kordas, 1985; Gray et al., 2007]); information obtained during site visits; and site conditions as provided in the CAIP (NNSA/NSO, 2012a). Sample plots for Study Group 1 were located judgmentally based on the highest radiological readings. Soil sample locations within sample plots were selected and evaluated using a probabilistic approach. Four composite samples were collected within each sample plot, and TLDs were located at the center of each sample plot. The aliquot locations were identified using a predetermined random-start, triangular grid pattern.

Judgmental sample locations for Study Group 2, 3, 4, and 5 were selected based on biasing factors such as visual identification of sedimentation areas in drainages, elevated radiological readings, staining, and locations of debris. The center of each sample plot, judgmental sample locations, and points of interest were surveyed with a GPS instrument. Appendix G presents these data in a tabular format. Specific sample locations and the rationale for selecting sample locations are shown in the study-group-specific sections (Sections A.3.0 through A.7.0).

A.2.2 Investigation Activities

The investigation activities performed at CAU 105 were consistent with the field investigation activities specified in the CAIP (NNSA/NSO, 2012a). 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 105.

A.2.2.1 Radiological Surveys

Aerial and terrestrial radiological surveys were conducted at the CAU 105 CASs. Aerial radiological surveys were performed at the sites in 1994 at an altitude of 200 ft with 500-ft flight-line spacing (BN, 1999).

TRSs were performed 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. Radiological data was also collected using gamma drive-over radiological instrumentation, which is a vehicle-towed array of multiple radiation detectors to count nondiscriminatory gamma. 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 (m/s) with the radiation detector held at a height of approximately 18 inches (in.) above the ground surface.

A.2.2.2 Field Screening

Field screening was conducted at select locations during the CAI to aid in the selection of samples submitted for analysis. Field-screening results (FSRs) are recorded on SCLs that are retained in project files.

Field screening was used at CAU 105 to evaluate the presence of buried contamination at all sites for Study Group 4 (Migration) to aid in the selection of biased samples for laboratory analyses. Field screening was limited to radiological parameters and was conducted using an NE Electra instrument. As part of Study Group 4 investigation, soil was removed from the sample location to areas with low background readings and screened for radioactivity in 10-cm-depth increments up to a total depth of 50 cm below ground surface (bgs) (see Section A.6.1.3). 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 (defined below) and also exceeded the surface reading by 20 percent. For locations where it was determined that buried contamination was present, the depth interval with the highest reading and the surface aliquot were submitted for offsite laboratory analyses.

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

A.2.2.3 Soil Sampling

Soil sampling at CAU 105 included the collection of surface and shallow subsurface soil samples within sample plots and grab sample locations. Within each sample plot, four composite samples were collected. Each composite sample was composed of nine 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.

After collection, each aliquot was carefully placed atop a sieve (#4 mesh) fitted into a bottom pan (with a plastic bag lining the pan, which limited dust generation during transfer to a sample container [metal can]). Each aliquot was slowly sieved, and oversized material that did not pass through the sieve was returned to the original sample location. After field screening of the sample, each sample was then transferred to an empty metal can. Each metal can was then sealed with a lid and a locking ring.

At drainage sample locations, samples were collected at 10-cm intervals vertically from the surface to a maximum depth of 50 cm. These samples were radiologically field screened and the surface sample and the interval with the highest FSRs were sent to the laboratory for analysis.

A.2.2.4 Internal Dose Estimates

Internal dose was estimated using the radionuclide analytical results from soil samples and the corresponding RRMG (NNSA/NSO, 2012c). Soil concentrations of plutonium isotopes are inferred from gamma spectroscopy results as described in Section B.1.1.1.1.

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/NSO, 2012c).

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/NSO, 2012c) to yield a fraction of the 25-mrem/yr dose. The fractions for all radionuclides detected in a soil sample were summed to yield a total fraction for that sample. The total fraction was then multiplied by 25 to yield an internal dose estimate (in mrem/yr) at that sample location. For probabilistic samples, a 95 percent UCL was calculated for the internal dose in a sample plot using the results of all soil samples collected in that plot (NNSA/NSO, 2012c). For judgmental sample locations where only one sample was collected (e.g., drainages), 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 plot with the maximum internal dose. The internal dose for each of these locations was calculated by multiplying this ratio (from the plot with the maximum internal dose) 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.2.2.5 External Dose Measurements

TLDs (Panasonic UD-814) were staged at CAU 105 with the objective of collecting *in situ* measurements to determine the external radiological dose. TLDs were placed in background areas (beyond the influence of CAS releases), at the approximate center of each sample plot, and at other biased locations. Each TLD was placed at a height of 1 m above the ground surface, which is consistent with TLD placement in the NNSS routine environmental monitoring program (see Section A.9.0). 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. The TLD results are discussed in Sections A.3.2.1, A.4.2.1, and A.6.2.1.

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.9.0. All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location.

The TLDs used at CAU 105 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 ba 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 locations where external dose measurements were not available (e.g., subsurface sample locations), a TLD-equivalent external dose was calculated using the subsurface sample results. This was accomplished by establishing a correlation between RESRAD-calculated external dose from surface samples and the corresponding TLD readings. The RESRAD-calculated external dose from the subsurface samples was then adjusted to TLD-equivalent values using the following formula:

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

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 105 sites are presented as net values (i.e., background radiation dose has been subtracted from the raw result). The background TLDs measure (1) dose the TLDs were exposed to while not deployed in the field and (2) dose from natural sources in areas unaffected by the CAU-related releases during field deployment.

The background TLDs were placed in areas beyond the influence of CAS releases as shown in Figure A.2-1. Due to the large area affected by the release, the dose from the background TLDs varied significantly. The background dose at CAU 105 was determined to be the average of the background TLD results from locations H01 through H05 (21.4 mrem/IA-yr).

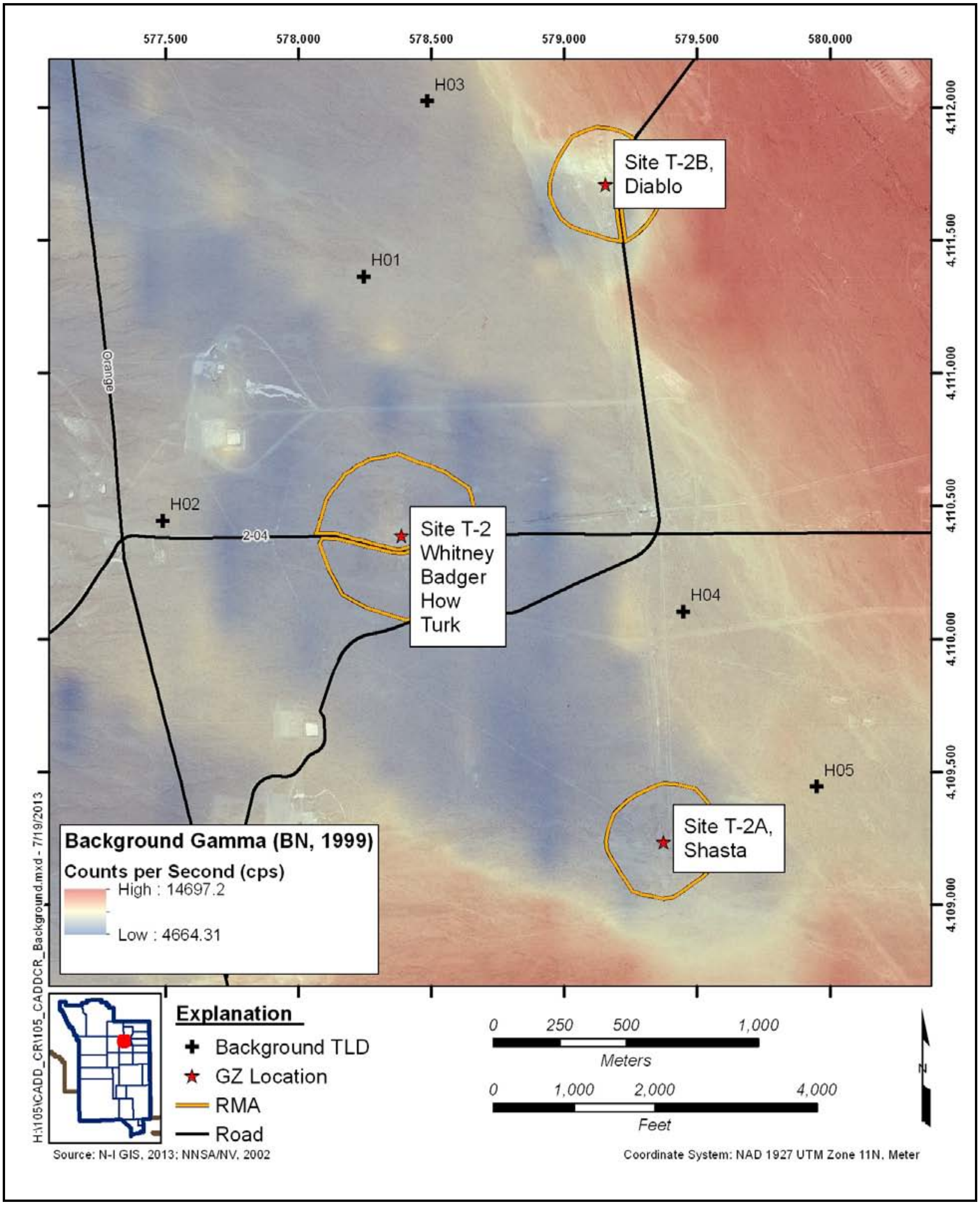


Figure A.2-1
Background Sample Locations

A.2.3 Total Effective Dose

The calculated TED represents the sum of the internal dose (calculated from soil sample results) and the external dose (calculated from TLD measurements) for each sample location. 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/NSO, 2012a) conservatively prescribes using the 95 percent UCL of the TED for DQO decisions. The 95 percent UCL of the TED at each sample location was calculated as the sum of the 95 percent UCLs of the internal and external doses (where available).

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 Laboratory Analytical Information

Radiological analyses of the collected soil samples were performed by ALS Laboratory Group, of Fort Collins, Colorado. The analytical suites and laboratory analytical methods used to analyze investigation samples are listed in the CAIP (NNSA/NSO, 2012a). Analytical results are reported in this appendix if they were detected above the minimum detectable concentrations (MDCs). The complete laboratory data packages are available in the project files.

Validated analytical data for CAU 105 investigation samples have been compiled and evaluated to determine the presence of COCs and to define the extent of COC contamination if present. The analytical results for each study group are presented in Sections A.3.0 through A.7.0.

The analytical parameters were selected through the application of site process knowledge as described in the CAIP.

A.2.5 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 105 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NSO, 2012a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,000 hours (i.e., the Industrial Area exposure scenario in which a site worker is exposed to site contamination for 250 day/yr and 8 hr/day). 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).

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. Results that are equal to or greater than FALs are identified by bold text in the study-group-specific results tables (see Sections A.3.0 through A.7.0).

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/NSO, 2012c). 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 soil 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 soil, the conservative assumption was made that any physical waste containment would fail at some point and release the contaminants to the surrounding soil. The following will be used as the criteria for determining whether a waste is PSM:

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

A.2.6 Correlation of Dose to Radiation Survey Isopleths

A boundary for a corrective action or an administrative use restriction for a particular release site may be established by using radiation survey isopleths if it can be shown that a sufficient correlation exists between TED and radiation survey values. This is accomplished by pairing each TED value with a radiation survey value from the corresponding geographic location. Correlation statistics are then used to establish the relationship between the paired values as well as an indicator of the strength of the relationship (i.e., the coefficient of determination, 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. The values from the radiation surveys were based on interpolated values at the TED location. These interpolated values were generated from a continuous spatial distribution (i.e., interpolated surface) that was estimated using an inverse distance weighted interpolation technique.

A correlation for each radiation survey was established to identify the radiation survey that has the best correlation to the Occasion Use exposure scenario TED values. This correlation was used to establish a radiation survey value corresponding to the FAL. An isopleth of this value from the selected radiological survey was then used to establish corrective action boundaries. A similar correlation of radiation survey values to the Industrial Area exposure scenario TED values was used to establish administrative UR boundaries.

A.3.0 Study Group 1, Atmospheric Tests

All sites within this CAU have a Study Group 1 component. This study group consists of a release of radioactive material to the soil surface from the atmospheric deposition of radionuclide contamination from nuclear weapons testing (comprised mainly of fission and activation products). Additional detail on the history of Study Group 1 is provided in the CAIP (NNSA/NSO, 2012a).

A.3.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following subsections.

A.3.1.1 Visual Inspections

Visual inspections at each of the three sites were conducted over the course of the field investigation during site walks, sampling efforts, and TRSs. The presence of significant amounts of trinitite was identified at all study sites. No additional samples for atmospheric depositional releases were collected as a result of the visual inspections.

A.3.1.2 Radiological Surveys

GPS-assisted TRSs were performed at each of the three sites during the CAI. The gamma drive-over surveys were conducted inside and outside the posted RMAs as part of the TRSs performed to identify the spatial distribution of radiological readings and to identify the location of the highest radiological readings at each of the study sites. The sodium iodide scintillation instrument system is designed to measure all gamma-emitting radionuclides from soils. The gamma drive-over survey is a vehicle-towed array of multiple radiation detectors connected to a Trimble Systems GPS unit for data collection. The drive-over speed was approximately 1 to 2 m/s with the radiation detector maintained at a height of approximately 12 in. above the ground surface. Count rates are expressed in units of counts per second (cps) and evaluated qualitatively as comparative relative spatial distribution in units of multiples of background. Data were post-processed, loaded into a geographical information system, color-coded, and displayed on maps of the sites.

The location of highest radiological readings at Site T-2A, Shasta was detected approximately 130 ft north and slightly east of GZ. A sample plot (A01) was established at this location. Radiological survey results and the sample plot are shown on Figure A.3-1.

The highest radiological readings at Site T-2B, Diablo were observed adjacent to the southwest side of the posted RMA approximately 900 ft from GZ. A sample plot (B01) was established at this location. A separate area of elevated radiological readings was observed to the southeast outside the RMA. The two radiologically elevated areas outside the RMA could be attributed to a slight asymmetrical nature of the atmospheric test at the time of detonation. Areas, or fingers, of concentrated activity could result in an asymmetrical distribution of fission products from GZ. This is supported by the TRSs performed at the start of the CAI that show elevated radiological areas branching out into the two observed areas as shown on Figure A.3-1.

The location of highest radiological readings at Site T-2 was detected approximately 400 ft southwest of the GZ area. A sample plot (C01) was established at this location as shown on Figure A.3-1.

In addition to the TRSs, the 1994 aerial radiological survey (BN, 1999) was used to determine the locations of the vector or grid TLD sample patterns at the Study Group 1 sites. The aerial radiological surveys identify the concentric plume (Figure A.3-2). Sample locations were selected within the plume.

A.3.1.3 Sample Collection

Soil samples and TLD samples were collected to satisfy the CAIP requirements (NNSA/NSO, 2012a) at Study Group 1. The specific CAI activities conducted at this study group are described in the following subsections.

A.3.1.3.1 TLD Samples

Table A.3-1 shows the number of TLD samples collected for each site by type (plot, grab, and background). A total of 207 TLDs were installed at Study Group 1 to measure external dose. Five TLDs (H01 through H05) were placed to measure “field” background. To aid in the determination of the proper background dose to use in TED calculation, a background isopleth map generated from the 1994 aerial radiation survey (BN, 1999) was used to verify that background TLDs represent the

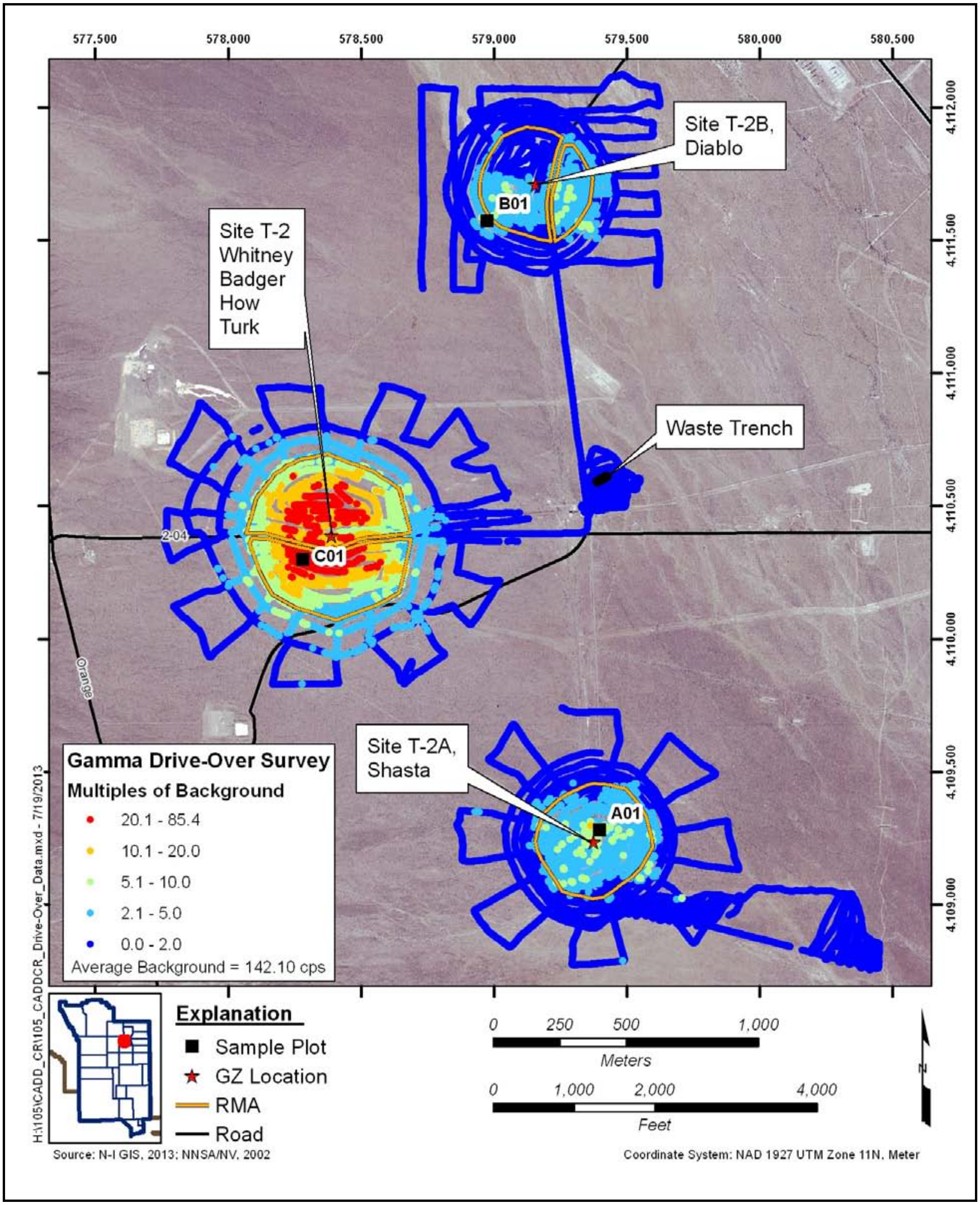


Figure A.3-1
Terrestrial Gamma Surveys of Selected Locations at CAU 105

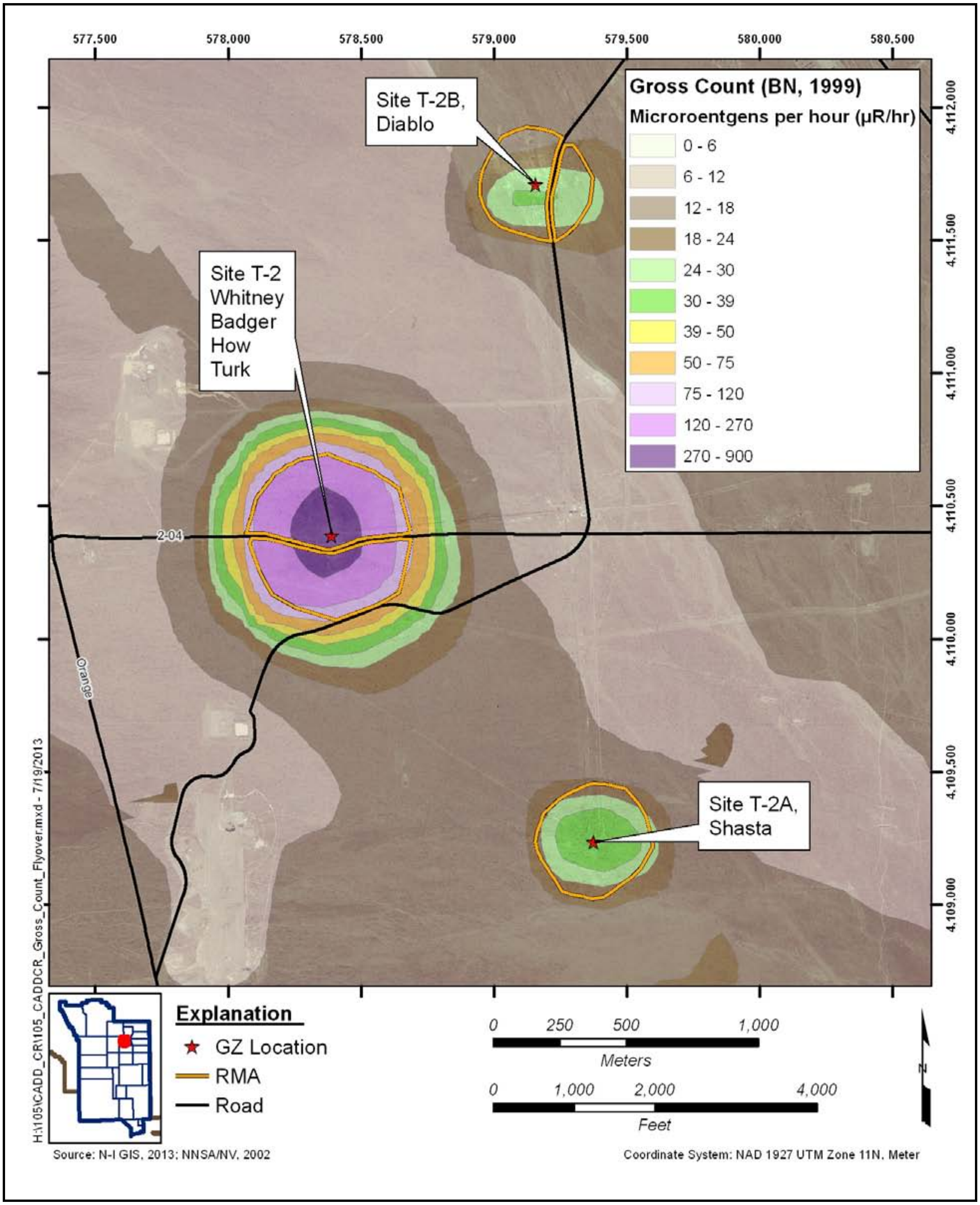


Figure A.3-2
Aerial Radiological Surveys, 1999

background dose estimated at CAU 105 TLD locations. See Figure A.2-1 for isopleths and background TLD locations. 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.

Table A.3-1
TLD Sample Summary for Study Group 1

Site	Number of TLD at Each Site	Analyses (Method)
T-2A, Shasta	61	*Nevada Test Site Routine Radiological Environmental Monitoring Plan* [a]
T-2B, Diablo	72	
T-2	69	
Background	5	
Total	**207**	

[a] BN, 2003

The TLDs listed in Table A.3-2 and represented on Figure A.3-3 were placed at Site T-2A, Shasta. Table A.3-3 lists the TLDs placed at Site T-2B, Diablo and are represented on Figure A.3-4. The TLDs placed at Site T-2 are listed in Table A.3-4 and represented on Figure A.3-5. All TLDs were measured by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.9.0.

Table A.3-2
TLDs at Site T-2A, Shasta for Study Group 1
(Page 1 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
A01	4270	10/25/2012	01/28/2013	Sample Plot
A04	6242	10/25/2012	01/28/2013	TLD at Tower Foundation
A05	6274	10/25/2012	01/28/2013	TLD Only
A06	6111	10/25/2012	01/28/2013	TLD Only
A07	6485	10/25/2012	01/28/2013	TLD Only
A08	6284	10/25/2012	01/28/2013	TLD Only
A09	6483	10/25/2012	01/28/2013	TLD Only
A10	6032	10/25/2012	01/28/2013	TLD Only

Table A.3-2
TLDs at Site T-2A, Shasta for Study Group 1
(Page 2 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
A11	6341	10/25/2012	01/28/2013	TLD Only
A12	6066	10/25/2012	01/28/2013	TLD Only
A13	6211	10/25/2012	01/28/2013	TLD Only
A14	1179	10/25/2012	01/28/2013	TLD Only
A15	6271	10/25/2012	01/28/2013	TLD Only
A16	3905	10/25/2012	01/28/2013	TLD Only
A17	4566	10/25/2012	01/28/2013	TLD Only
A18	6481	10/25/2012	01/28/2013	TLD at Tower Foundation
A19	4831	10/25/2012	01/28/2013	TLD Only
A20	4335	10/25/2012	01/28/2013	TLD Only
A21	4332	10/25/2012	01/28/2013	TLD Only
A22	6490	10/25/2012	01/28/2013	TLD Only
A23	4946	10/25/2012	01/28/2013	TLD at Tower Foundation
A24	6055	10/25/2012	01/28/2013	TLD Only
A25	6340	10/25/2012	01/28/2013	TLD Only
A26	4602	10/25/2012	01/28/2013	TLD Only
A27	4435	10/25/2012	01/28/2013	TLD Only
A28	6316	10/25/2012	01/28/2013	TLD Only
A29	6476	10/25/2012	01/28/2013	TLD Only
A30	4430	10/25/2012	01/28/2013	TLD Only
A31	6380	10/25/2012	01/28/2013	TLD Only
A32	5173	10/25/2012	01/28/2013	TLD Only
A33	6172	10/29/2012	01/28/2013	TLD Only
A34	6167	10/29/2012	01/28/2013	TLD Only
A35	1805	10/29/2012	01/28/2013	TLD Only
A36	6426	10/29/2012	01/28/2013	TLD Only
A37	6295	10/29/2012	01/28/2013	TLD Only
A38	6454	10/29/2012	01/28/2013	TLD Only
A39	6179	10/29/2012	01/28/2013	TLD Only

Table A.3-2
TLDs at Site T-2A, Shasta for Study Group 1
(Page 3 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
A40	6225	10/29/2012	01/28/2013	TLD Only
A41	5010	10/29/2012	01/28/2013	TLD Only
A42	4929	10/29/2012	01/28/2013	TLD Only
A43	6095	10/29/2012	01/28/2013	TLD Only
A44	4849	10/29/2012	01/28/2013	TLD Only
A45	3591	10/29/2012	01/28/2013	TLD Only
A46	4110	10/29/2012	01/28/2013	TLD Only
A47	6039	10/29/2012	01/28/2013	TLD Only
A48	6491	10/29/2012	01/28/2013	TLD Only
A49	3455	10/29/2012	01/28/2013	TLD Only
A50	3565	10/29/2012	01/28/2013	TLD Only
A51	6456	10/29/2012	01/28/2013	TLD Only
A52	6040	10/29/2012	01/28/2013	TLD Only
A53	6042	10/29/2012	01/28/2013	TLD Only
A54	6484	10/29/2012	01/28/2013	TLD Only
A55	6081	10/29/2012	01/28/2013	TLD Only
A56	4462	10/29/2012	01/28/2013	TLD Only
A57	6482	10/29/2012	01/28/2013	TLD Only
A58	6166	10/29/2012	01/28/2013	TLD Only
A59	6031	10/29/2012	01/28/2013	TLD Only
A60	4824	10/29/2012	01/28/2013	TLD Only
A61	4184	10/29/2012	01/28/2013	TLD Only
A62	6499	10/29/2012	01/28/2013	TLD Only
A63	6231	10/29/2012	01/28/2013	TLD Only
H04	6325	10/25/2012	01/28/2013	Background TLD Location
H04	6086	11/27/2012	01/28/2013	Background TLD Location
H04	4373	02/07/2013	05/09/2013	Background TLD Location
H05	1078	10/29/2012	01/28/2013	Background TLD Location

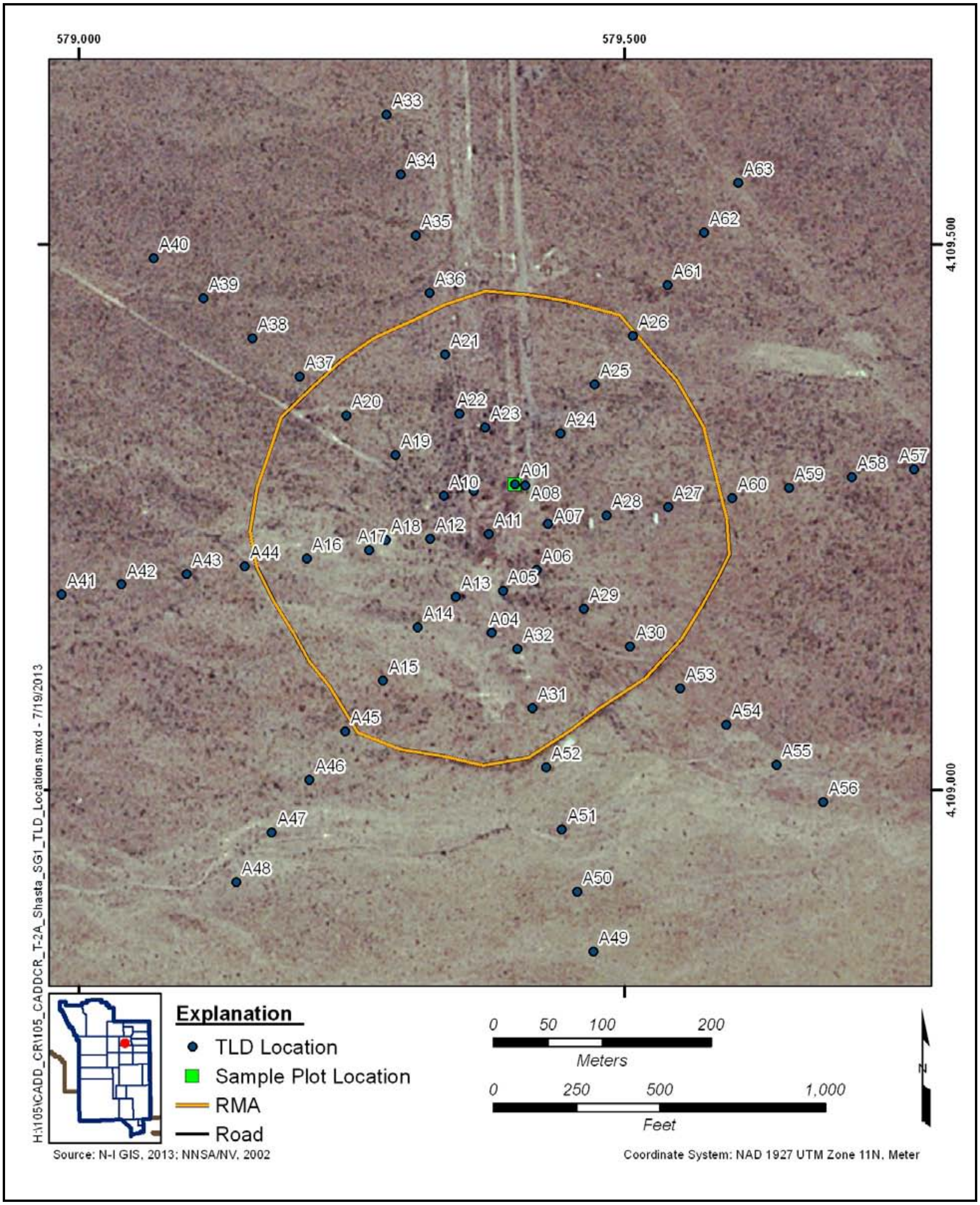


Figure A.3-3
Site T-2A, Shasta TLD and Sample Plot Locations

Table A.3-3
TLDs at Site T-2B, Diablo for Study Group 1
(Page 1 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
B01	6336	10/25/2012	01/30/2013	Sample Plot
B02	6465	10/24/2012	01/30/2013	TLD Only
B03	3381	10/24/2012	01/30/2013	TLD Only
B04	1038	10/24/2012	01/30/2013	TLD Only
B05	6308	10/24/2012	01/30/2013	TLD Only
B06	6207	10/24/2012	01/30/2013	TLD Only
B07	6220	10/24/2012	01/30/2013	TLD Only
B08	6369	10/24/2012	01/30/2013	TLD Only
B09	6323	10/24/2012	01/30/2013	TLD Only
B10	6168	10/24/2012	01/30/2013	TLD Only
B11	6400	10/24/2012	01/30/2013	TLD Only
B12	6334	10/24/2012	01/30/2013	TLD Only
B13	3461	10/24/2012	01/30/2013	TLD Only
B14	6478	10/24/2012	01/30/2013	TLD Only
B15	4734	10/24/2012	01/30/2013	TLD Only
B16	6344	10/24/2012	01/30/2013	TLD Only
B17	6155	10/24/2012	01/30/2013	TLD Only
B18	6256	10/24/2012	01/30/2013	TLD Only
B19	4359	10/24/2012	01/30/2013	TLD Only
B20	4455	10/24/2012	01/30/2013	TLD Only
B21	5078	10/24/2012	01/30/2013	TLD Only
B22	6021	10/24/2012	01/30/2013	TLD Only
B23	6293	10/24/2012	01/30/2013	TLD Only
B24	6046	10/24/2012	01/30/2013	TLD Only
B25	6120	10/24/2012	01/30/2013	TLD Only
B26	3715	10/24/2012	01/30/2013	TLD Only
B27	6348	10/24/2012	01/30/2013	TLD Only
B28	6326	10/24/2012	01/30/2013	TLD Only
B29	4723	10/24/2012	01/30/2013	TLD Only

Table A.3-3
TLDs at Site T-2B, Diablo for Study Group 1
(Page 2 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
B30	3302	10/24/2012	01/30/2013	TLD Only
B31	6498	10/24/2012	01/30/2013	TLD Only
B32	6024	10/24/2012	01/30/2013	TLD Only
B33	6058	10/24/2012	01/30/2013	TLD Only
B34	6035	10/24/2012	01/30/2013	TLD Only
B35	4529	10/24/2012	01/30/2013	TLD Only
B36	6104	10/24/2012	01/30/2013	TLD Only
B37	6106	10/24/2012	01/30/2013	TLD Only
B38	6100	10/24/2012	01/30/2013	TLD Only
B39	3458	10/24/2012	01/30/2013	TLD Only
B40	6027	10/24/2012	01/30/2013	TLD Only
B41	6091	10/24/2012	01/30/2013	TLD Only
B42	6023	10/24/2012	01/30/2013	TLD Only
B47	3472	10/25/2012	01/30/2013	TLD Only
B49	6379	10/25/2012	01/30/2013	TLD Only
B50	3176	10/25/2012	01/30/2013	TLD Only
B51	6461	10/25/2012	01/30/2013	TLD Only
B52	4708	10/25/2012	01/30/2013	TLD Only
B53	6209	10/25/2012	01/30/2013	TLD Only
B54	3727	10/25/2012	01/30/2013	TLD Only
B55	6318	10/25/2012	01/30/2013	TLD Only
B56	6343	10/25/2012	01/30/2013	TLD Only
B58	6409	10/25/2012	01/30/2013	TLD Only
B59	6156	10/25/2012	01/30/2013	TLD Only
B60	6026	10/25/2012	01/30/2013	TLD Only
B61	4614	10/25/2012	01/30/2013	TLD Only
B62	6359	10/25/2012	01/30/2013	TLD Only
B63	6214	10/25/2012	01/30/2013	TLD Only
B64	6429	10/25/2012	01/30/2013	TLD Only

Table A.3-3
TLDs at Site T-2B, Diablo for Study Group 1
(Page 3 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
B65	1480	10/25/2012	01/30/2013	TLD Only
B66	6149	10/25/2012	01/30/2013	TLD Only
B67	1646	10/25/2012	01/30/2013	TLD Only
B68	6435	10/25/2012	01/30/2013	TLD Only
B69	6363	10/25/2012	01/30/2013	TLD Only
B70	3858	10/25/2012	01/30/2013	TLD Only
B71	3879	10/25/2012	01/30/2013	TLD Only
B72	3835	10/25/2012	01/30/2013	TLD Only
B73	3429	10/25/2012	01/30/2013	TLD Only
B74	6000	10/25/2012	01/30/2013	TLD Only
B75	6345	10/25/2012	01/30/2013	TLD Only
B76	6069	10/25/2012	01/30/2013	TLD Only
B77	3737	10/25/2012	01/30/2013	TLD Only
B78	6038	11/27/2012	01/30/2013	TLD Only
H03	6339	10/24/2012	01/29/2013	Background TLD Location
H04	6325	10/25/2012	01/28/2013	Background TLD Location
H04	6495	01/08/2013	04/11/2013	Background TLD Location

A.3.1.3.2 Soil Samples

Composite soil samples were collected for Study Group 1 from three sample plots established at the study sites. All soil samples were analyzed for gamma spectroscopy; plutonium (Pu)-241; and isotopic uranium (U), Pu, and americium (Am). Analysis for strontium (Sr)-90 and technetium (Tc)-99 was performed on one sample from each site.

A summary to include the number of samples collected and analytical methods is provided in Table A.3-5. Additional information for the samples collected at the soil plots is provided in Tables A.3-6 through A.3-8 and represented on Figures A.3-3 through A.3-5.

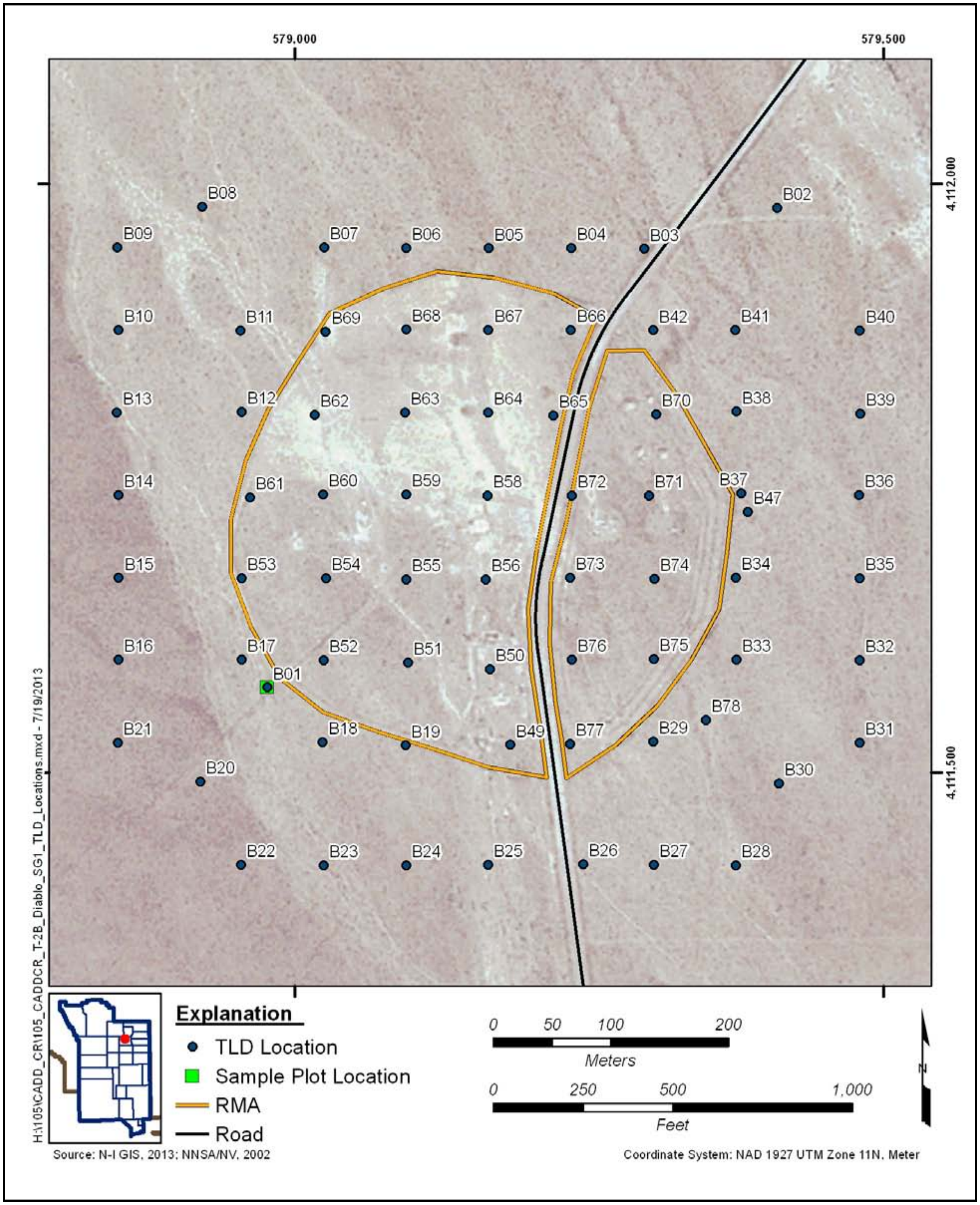


Figure A.3-4
Site T-2B, Diablo TLD and Sample Plot Locations

Table A.3-4
TLDs at Site T-2 for Study Group 1
(Page 1 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
C01	4323	10/24/2012	01/29/2013	Sample Plot
C02	3926	10/22/2012	01/29/2013	TLD Only
C03	6460	10/22/2012	01/29/2013	TLD Only
C04	6417	10/22/2012	01/29/2013	TLD Only
C05	6127	10/22/2012	01/29/2013	TLD Only
C06	6177	10/22/2012	01/29/2013	TLD Only
C07	1704	10/22/2012	01/29/2013	TLD Only
C08	6374	10/22/2012	01/29/2013	TLD Only
C09	4438	10/22/2012	01/29/2013	TLD Only
C10	4347	10/22/2012	01/29/2013	TLD Only
C11	4871	10/22/2012	01/29/2013	TLD Only
C12	2040	10/22/2012	01/29/2013	TLD Only
C13	6235	10/22/2012	01/29/2013	TLD Only
C14	6068	10/22/2012	01/29/2013	TLD Only
C15	4971	10/22/2012	01/29/2013	TLD Only
C16	6134	10/22/2012	01/29/2013	TLD Only
C17	6467	10/22/2012	01/29/2013	TLD Only
C18	6170	10/22/2012	01/29/2013	TLD Only
C19	6002	10/22/2012	01/29/2013	TLD Only
C20	6292	10/22/2012	01/29/2013	TLD Only
C21	6433	10/22/2012	01/29/2013	TLD Only
C22	3870	10/22/2012	01/29/2013	TLD Only
C23	6059	10/22/2012	01/29/2013	TLD Only
C24	3784	10/22/2012	01/29/2013	TLD Only
C25	4737	10/22/2012	01/29/2013	TLD Only
C26	6262	10/22/2012	01/29/2013	TLD Only
C27	6103	10/22/2012	01/29/2013	TLD Only
C28	6029	10/22/2012	01/29/2013	TLD Only
C29	6123	10/22/2012	01/29/2013	TLD Only

Table A.3-4
TLDs at Site T-2 for Study Group 1
(Page 2 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
C30	6436	10/22/2012	01/29/2013	TLD Only
C31	3320	10/22/2012	01/29/2013	TLD Only
C32	6053	10/22/2012	01/29/2013	TLD Only
C33	4901	10/23/2012	01/29/2013	TLD Only
C34	4292	10/23/2012	01/29/2013	TLD Only
C35	1933	10/23/2012	01/29/2013	TLD Only
C36	6131	10/23/2012	01/29/2013	TLD Only
C37	3327	10/23/2012	01/29/2013	TLD Only
C38	3894	10/23/2012	01/29/2013	TLD Only
C42	6407	10/23/2012	01/29/2013	TLD at Tower Foundation
C43	6224	10/23/2012	01/29/2013	TLD at Tower Foundation
C44	6383	10/23/2012	01/29/2013	TLD Only
C45	1729	10/23/2012	01/29/2013	TLD Only
C46	6063	10/23/2012	01/29/2013	TLD Only
C47	6047	10/23/2012	01/29/2013	TLD Only
C48	6257	10/23/2012	01/29/2013	TLD Only
C49	6230	10/23/2012	01/29/2013	TLD Only
C50	4405	10/23/2012	01/29/2013	TLD Only
C51	4599	10/23/2012	01/29/2013	TLD Only
C52	4653	10/23/2012	01/29/2013	TLD Only
C53	6025	10/23/2012	01/29/2013	TLD Only
C54	6028	10/23/2012	01/29/2013	TLD Only
C55	6057	10/23/2012	01/29/2013	TLD Only
C56	6030	10/23/2012	01/29/2013	TLD Only
C57	5049	10/23/2012	01/29/2013	TLD Only
C58	4958	10/23/2012	01/29/2013	TLD Only
C59	6048	10/23/2012	01/29/2013	TLD at Tower Foundation
C60	6011	10/24/2012	01/29/2013	TLD Only
C61	3184	10/24/2012	01/29/2013	TLD Only

Table A.3-4
TLDs at Site T-2 for Study Group 1
(Page 3 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
C62	6434	10/24/2012	01/29/2013	TLD Only
C67	6184	10/24/2012	01/29/2013	TLD Only
C68	6317	10/24/2012	01/29/2013	TLD Only
C69	6019	10/24/2012	01/29/2013	TLD Only
C70	3888	10/24/2012	01/29/2013	TLD Only
C71	6358	10/24/2012	01/29/2013	TLD Only
C72	6223	10/24/2012	01/29/2013	TLD Only
C73	4785	10/24/2012	01/29/2013	TLD Only
C74	6178	10/24/2012	01/29/2013	TLD Only
C75	3464	10/24/2012	01/29/2013	TLD Only
C76	1841	10/24/2012	01/29/2013	TLD Only
H01	4406	10/22/2012	01/29/2013	Background TLD Location
H02	6050	10/23/2012	01/29/2013	Background TLD Location
H03	6339	10/24/2012	01/29/2013	Background TLD Location
H04	6086	11/27/2012	01/28/2013	Background TLD Location

A.3.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

A.3.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. For chemical contaminants, the results are reported as individual concentrations that are comparable to their corresponding FALs. Results that are equal to or greater than FALs are identified by bold text in the results tables. The analytical parameters and laboratory methods used during this investigation were discussed in CAIP.

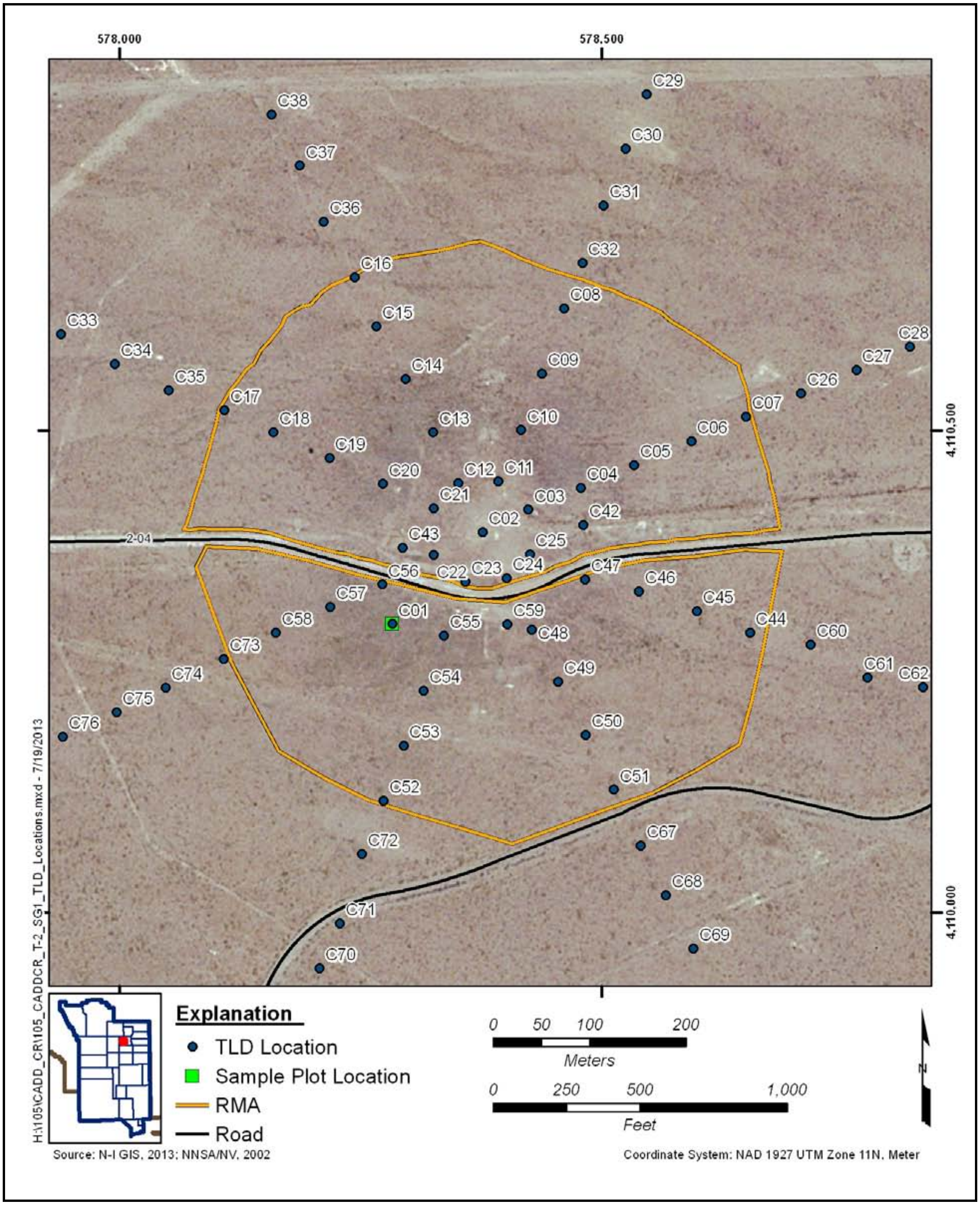


Figure A.3-5
Site T-2 TLD and Sample Plot Locations

Table A.3-5
Study Group 1 Soil Sample Summary

Sample Type	Number of Locations	Number of Soil Samples	Analyses (Method)
Plot	3	12	Pu-241; Sr-90; Tc-99 Isotopic U; Isotopic Pu; Isotopic Am; Gamma Spectroscopy (HASL-300)[a]

[a]DOE, 1997

HASL = Health and Safety Laboratory

Table A.3-6
Soil Samples Collected at Site T-2A, Shasta for Study Group 1

Sample Plot	Sample Number	Depth (cm bgs)	Matrix	Purpose
A01	AA4A601	0 - 5	Soil	Sample Plot
	AA4A602	0 - 5	Soil	Sample Plot
	AA4A603	0 - 5	Soil	Sample Plot
	AA4A604	0 - 5	Soil	Sample Plot

Table A.3-7
Soil Samples Collected at Site T-2B, Diablo for Study Group 1

Sample Plot	Sample Number	Depth (cm bgs)	Matrix	Purpose
B01	AA4B601	0 - 5	Soil	Sample Plot
	AA4B602	0 - 5	Soil	Sample Plot
	AA4B603	0 - 5	Soil	Sample Plot
	AA4B604	0 - 5	Soil	Sample Plot

Table A.3-8
Soil Samples Collected at Site T-2 for Study Group 1

Sample Plot	Sample Number	Depth (cm bgs)	Matrix	Purpose
C01	AA4C601	0 - 5	Soil	Sample Plot
	AA4C602	0 - 5	Soil	Sample Plot
	AA4C603	0 - 5	Soil	Sample Plot
	AA4C604	0 - 5	Soil	Sample Plot

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 Sections A.3.2.1, A.4.2.1, and A.6.2.1. Internal doses for each sample plot are summarized in Sections A.3.2.2, A.4.2.2, and A.6.2.2. The TEDs for each sampled location are summarized in Sections A.3.2.3, A.4.2.3, and A.6.2.3.

A.3.2.1 External Radiological Dose Measurements

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.2.2.5. 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 at each site are presented in Tables A.3-9 through A.3-11. The minimum sample size was met for all TLDs.

Table A.3-9
95% UCL External Dose for Each Exposure Scenario at Site T-2A, Shasta
(Page 1 of 3)

Location	Standard Deviation	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	0.11	3	3	**32.0**	5.4	1.6
A04	0.11	3	3	23.8	4.0	1.2
A05	0.11	3	3	**27.6**	4.6	1.4
A06	0.10	3	3	**25.3**	4.2	1.3
A07	0.12	3	3	**28.8**	4.8	1.4
A08	0.13	3	3	**38.5**	6.5	1.9
A09	0.15	3	3	**44.6**	7.5	2.2
A10	0.18	3	3	**34.6**	5.8	1.7
A11	0.16	3	3	**64.9**	10.9	3.2
A12	0.08	3	3	24.4	4.1	1.2
A13	0.13	3	3	**29.9**	5.0	1.5
A14	0.05	3	3	21.5	3.6	1.1

Table A.3-9
95% UCL External Dose for Each Exposure Scenario at Site T-2A, Shasta
(Page 2 of 3)

Location	Standard Deviation	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)
A15	0.05	3	3	13.1	2.2	0.7
A16	0.06	3	3	16.3	2.7	0.8
A17	0.11	3	3	23.6	4.0	1.2
A18	0.15	3	3	**28.1**	4.7	1.4
A19	0.17	3	3	**30.9**	5.2	1.5
A20	0.12	3	3	20.4	3.4	1.0
A21	0.13	3	3	15.6	2.6	0.8
A22	0.10	3	3	23.8	4.0	1.2
A23	0.10	3	3	**26.4**	4.4	1.3
A24	0.07	3	3	10.1	1.7	0.5
A25	0.09	3	3	17.0	2.9	0.8
A26	0.13	3	3	19.6	3.3	1.0
A27	0.21	3	3	**32.2**	5.4	1.6
A28	0.12	3	3	**32.8**	5.5	1.6
A29	0.07	3	3	19.5	3.3	1.0
A30	0.38	3	3	**29.8**	5.0	1.5
A31	0.09	3	3	7.5	1.3	0.4
A32	0.07	3	3	23.9	4.0	1.2
A33	0.06	3	3	6.0	1.0	0.3
A34	0.04	3	3	7.0	1.2	0.4
A35	0.02	3	3	2.6	0.4	0.1
A36	0.03	3	3	4.9	0.8	0.2
A37	0.08	3	3	10.1	1.7	0.5
A38	0.02	3	3	4.3	0.7	0.2
A39	0.07	3	3	6.6	1.1	0.3
A40	0.02	3	3	4.4	0.7	0.2
A41	0.04	3	3	4.1	0.7	0.2
A42	0.14	3	3	9.7	1.6	0.5

Table A.3-9
95% UCL External Dose for Each Exposure Scenario at Site T-2A, Shasta
(Page 3 of 3)

Location	Standard Deviation	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)
A43	0.01	3	3	2.9	0.5	0.1
A44	0.04	3	3	9.2	1.5	0.5
A45	0.03	3	3	6.8	1.1	0.3
A46	0.05	3	3	4.2	0.7	0.2
A47	0.01	3	3	3.3	0.6	0.2
A48	0.10	3	3	8.6	1.4	0.4
A49	0.01	3	3	4.5	0.8	0.2
A50	0.01	3	3	3.8	0.6	0.2
A51	0.06	3	3	6.0	1.0	0.3
A52	0.04	3	3	8.4	1.4	0.4
A53	0.20	3	3	**38.9**	6.5	1.9
A54	0.07	3	3	8.5	1.4	0.4
A55	0.06	3	3	7.4	1.2	0.4
A56	0.03	3	3	5.4	0.9	0.3
A57	0.04	3	3	3.6	0.6	0.2
A58	0.01	3	3	4.6	0.8	0.2
A59	0.02	3	3	5.1	0.8	0.3
A60	0.17	3	3	**40.7**	6.8	2.0
A61	0.06	3	3	3.5	0.6	0.2
A62	0.09	3	3	4.0	0.7	0.2
A63	0.05	3	3	4.2	0.7	0.2

OU = Occupational Use Area

Bold indicates the values exceeding 25 mrem/yr.

Table A.3-10
95% UCL External Dose for Each Exposure Scenario at Site T-2B, Diablo
(Page 1 of 3)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B01	0.06	3	3	**47.6**	8.0	2.4
B02	0.02	3	3	7.4	1.2	0.4
B03	0.03	3	3	7.1	1.2	0.4
B04	0.02	3	3	4.8	0.8	0.2
B05	0.02	3	3	7.4	1.2	0.4
B06	0.01	3	3	7.3	1.2	0.4
B07	0.04	3	3	4.9	0.8	0.2
B08	0.08	3	3	8.6	1.4	0.4
B09	0.04	3	3	6.2	1.0	0.3
B10	0.07	3	3	7.6	1.3	0.4
B11	0.05	3	3	6.2	1.0	0.3
B12	0.06	3	3	7.6	1.3	0.4
B13	0.02	3	3	2.1	0.4	0.1
B14	0.05	3	3	1.7	0.3	0.1
B15	0.12	3	3	5.4	0.9	0.3
B16	0.04	3	3	2.8	0.5	0.1
B17	0.04	3	3	23.3	3.9	1.2
B18	0.03	3	3	11.0	1.9	0.6
B19	0.05	3	3	8.1	1.4	0.4
B20	0.10	3	3	5.0	0.8	0.3
B21	0.03	3	3	1.5	0.3	0.1
B22	0.03	3	3	2.3	0.4	0.1
B23	0.03	3	3	4.7	0.8	0.2
B24	0.03	3	3	6.1	1.0	0.3
B25	0.06	3	3	5.4	0.9	0.3
B26	0.03	3	3	5.7	1.0	0.3
B27	0.03	3	3	7.8	1.3	0.4
B28	0.09	3	3	10.2	1.7	0.5

Table A.3-10
95% UCL External Dose for Each Exposure Scenario at Site T-2B, Diablo
(Page 2 of 3)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B29	0.07	3	3	10.2	1.7	0.5
B30	0.02	3	3	7.0	1.2	0.3
B31	0.03	3	3	8.0	1.4	0.4
B32	0.05	3	3	9.8	1.6	0.5
B33	0.04	3	3	12.0	2.0	0.6
B34	0.02	3	3	12.3	2.1	0.6
B35	0.04	3	3	7.6	1.3	0.4
B36	0.03	3	3	9.0	1.5	0.4
B37	0.08	3	3	17.2	2.9	0.9
B38	0.04	3	3	9.6	1.6	0.5
B39	0.05	3	3	8.1	1.4	0.4
B40	0.07	3	3	10.3	1.7	0.5
B41	0.09	3	3	10.9	1.8	0.5
B42	0.07	3	3	10.4	1.8	0.5
B47	0.10	3	3	19.8	3.3	1.0
B49	0.04	3	3	7.6	1.3	0.4
B50	0.07	3	3	14.6	2.5	0.7
B51	0.13	3	3	23.6	4.0	1.2
B52	0.17	3	3	**30.5**	5.1	1.5
B53	0.02	3	3	14.7	2.5	0.7
B54	0.08	3	3	**32.6**	5.5	1.6
B55	0.08	3	3	**29.3**	4.9	1.5
B56	0.06	3	3	17.3	2.9	0.9
B58	0.03	3	3	7.1	1.2	0.4
B59	0.06	3	3	9.7	1.6	0.5
B60	0.11	3	3	24.3	4.1	1.2
B61	0.10	3	3	14.8	2.5	0.7
B62	0.10	3	3	7.6	1.3	0.4

Table A.3-10
95% UCL External Dose for Each Exposure Scenario at Site T-2B, Diablo
(Page 3 of 3)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B63	0.09	3	3	9.1	1.5	0.5
B64	0.05	3	3	6.1	1.0	0.3
B65	0.03	3	3	6.5	1.1	0.3
B66	0.04	3	3	6.7	1.1	0.3
B67	0.01	3	3	5.2	0.9	0.3
B68	0.04	3	3	7.8	1.3	0.4
B69	0.03	3	3	7.1	1.2	0.4
B70	0.03	3	3	7.6	1.3	0.4
B71	0.04	3	3	14.0	2.3	0.7
B72	0.02	2	3	20.5	3.4	1.0
B73	0.13	2	3	**33.5**	5.6	1.7
B74	0.08	2	3	**35.6**	6.0	1.8
B75	0.11	2	3	24.1	4.0	1.2
B76	0.08	3	3	18.7	3.1	0.9
B77	0.03	3	3	5.6	0.9	0.3
B78	0.36	3	3	**74.6**	12.5	3.7

Bold indicates the values exceeding 25 mrem/yr.

Table A.3-11
95% UCL External Dose for Each Exposure Scenario at Site T-2
(Page 1 of 4)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C01	1.14	3	3	**295.8**	**49.7**	14.8
C02	0.19	3	3	**40.1**	6.7	2.0
C03	0.31	3	3	**115.8**	19.5	5.8
C04	0.60	3	3	**157.9**	**26.5**	7.9
C05	0.34	3	3	**133.9**	22.5	6.7

Table A.3-11
95% UCL External Dose for Each Exposure Scenario at Site T-2
(Page 2 of 4)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C06	0.13	3	3	**51.7**	8.7	2.6
C07	0.12	3	3	**35.1**	5.9	1.8
C08	0.32	3	3	**63.0**	10.6	3.1
C09	0.47	3	3	**139.0**	23.4	7.0
C10	0.61	3	3	**222.8**	**37.4**	11.1
C11	0.31	3	3	**84.5**	14.2	4.2
C12	0.34	3	3	**151.9**	**25.5**	7.6
C13	0.65	3	3	**204.6**	**34.4**	10.2
C14	0.55	3	3	**172.6**	**29.0**	8.6
C15	0.07	3	3	**57.8**	9.7	2.9
C16	0.13	3	3	**39.1**	6.6	2.0
C17	0.19	3	3	**36.5**	6.1	1.8
C18	0.29	3	3	**79.2**	13.3	4.0
C19	0.46	3	3	**174.9**	**29.4**	8.7
C20	0.15	3	3	**153.7**	**25.8**	7.7
C21	0.24	3	3	**183.6**	**30.8**	9.2
C22	0.22	3	3	**174.8**	**29.4**	8.7
C23	0.37	3	3	**122.2**	20.5	6.1
C24	0.25	3	3	**151.3**	**25.4**	7.6
C25	0.29	3	3	**112.6**	18.9	5.6
C26	0.04	3	3	16.3	2.7	0.8
C27	0.09	3	3	8.2	1.4	0.4
C28	0.05	3	3	6.2	1.0	0.3
C29	0.05	3	3	2.7	0.5	0.1
C30	0.06	3	3	4.8	0.8	0.2
C31	0.05	3	3	10.9	1.8	0.5
C32	0.09	3	3	**25.4**	4.3	1.3
C33	0.01	3	3	5.3	0.9	0.3

Table A.3-11
95% UCL External Dose for Each Exposure Scenario at Site T-2
(Page 3 of 4)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C34	0.01	3	3	4.0	0.7	0.2
C35	0.05	3	3	15.2	2.6	0.8
C36	0.07	3	3	18.3	3.1	0.9
C37	0.01	3	3	3.7	0.6	0.2
C38	0.01	3	3	2.4	0.4	0.1
C42	0.30	3	3	**65.5**	11.0	3.3
C43	0.25	3	3	**139.2**	23.4	7.0
C44	0.12	3	3	**31.6**	5.3	1.6
C45	0.08	3	3	**53.8**	9.0	2.7
C46	0.43	3	3	**139.0**	23.3	6.9
C47	0.75	3	3	**194.1**	**32.6**	9.7
C48	0.42	3	3	**223.3**	**37.5**	11.2
C49	0.41	3	3	**134.7**	22.6	6.7
C50	0.07	3	3	**49.4**	8.3	2.5
C51	0.04	3	3	19.3	3.2	1.0
C52	0.12	3	3	**34.3**	5.8	1.7
C53	0.30	3	3	**74.5**	12.5	3.7
C54	0.51	3	3	**179.1**	**30.1**	9.0
C55	0.73	3	3	**209.3**	**35.2**	10.5
C56	0.46	3	3	**115.7**	19.4	5.8
C57	0.38	3	3	**165.4**	**27.8**	8.3
C58	0.16	3	3	**71.6**	12.0	3.6
C59	0.39	3	3	**159.2**	**26.7**	8.0
C60	0.06	3	3	15.9	2.7	0.8
C61	0.05	3	3	9.5	1.6	0.5
C62	0.04	3	3	7.1	1.2	0.4
C67	0.03	3	3	13.5	2.3	0.7
C68	0.06	3	3	9.3	1.6	0.5

Table A.3-11
95% UCL External Dose for Each Exposure Scenario at Site T-2
(Page 4 of 4)

Location	Standard Deviation	Number of Elements	Minimum Sample Size (OU)	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
C69	0.09	3	3	8.6	1.4	0.4
C70	0.02	3	3	2.3	0.4	0.1
C71	0.08	3	3	6.3	1.1	0.3
C72	0.13	3	3	**25.5**	4.3	1.3
C73	0.13	3	3	**32.9**	5.5	1.6
C74	0.05	3	3	17.1	2.9	0.9
C75	0.06	3	3	7.2	1.2	0.4
C76	0.06	3	3	5.6	0.9	0.3

Bold indicates the values exceeding 25 mrem/yr.

A.3.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each Study Group 1 sample plot were determined as described in Section A.2.2.4. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at each sample plot for each exposure scenario are presented in Table A.3-12. The analytical results for the individual radionuclides in each composite sample and the corresponding calculated internal dose are presented in Appendix F. As shown in Table A.3-12, the minimum sample size was met for all samples.

Table A.3-12
95% UCL Internal Dose at Sample Plots for Each Exposure Scenario for Study Group 1

Plot or Location	Standard Deviation	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	0.01	4	3	0.9	0.2	0.1
B01	0.05	4	3	3.5	0.6	0.2
C01	0.02	4	3	2.7	0.5	0.2

Table A.3-13 presents a comparison of the internal and external doses at each sample plot. This demonstrates that internal dose at Study Group 1 comprises a small percentage of TED and does not exceed external dose at any sample plot.

Table A.3-13
Ratio of Calculated Internal Dose to External Dose at Each Plot for Study Group 1

Sample Plot	Average Internal Dose	Average External Dose	Average Total Dose	Internal to External Dose Ratio
A01	0.0	1.4	1.5	0.0
B01	0.2	2.3	2.4	0.1
C01	0.1	12.9	13.0	0.0

A.3.2.3 Total Effective Dose

The TED for each sample plot or TLD location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented for each site in Tables A.3-14 through A.3-16.

Table A.3-14
TED for Each Exposure Scenario at Site T-2A, Shasta, (mrem/yr)
(Page 1 of 3)

Plot or 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	**28.8**	**32.8**	4.8	5.5	1.4	1.7
A04	20.6	24.3	3.5	4.1	1.0	1.2
A05	24.5	**28.2**	4.1	4.7	1.2	1.4
A06	22.6	**25.8**	3.8	4.3	1.1	1.3
A07	**25.2**	**29.4**	4.2	4.9	1.3	1.5
A08	**35.1**	**39.4**	5.9	6.6	1.8	2.0
A09	**40.4**	**45.6**	6.8	7.7	2.0	2.3
A10	**29.4**	**35.3**	4.9	5.9	1.5	1.8
A11	**60.9**	**66.3**	10.2	11.1	3.1	3.3

Table A.3-14
TED for Each Exposure Scenario at Site T-2A, Shasta, (mrem/yr)
(Page 2 of 3)

Plot or 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
A12	22.1	24.9	3.7	4.2	1.1	1.3
A13	**26.2**	**30.5**	4.4	5.1	1.3	1.5
A14	20.4	21.9	3.4	3.7	1.0	1.1
A15	11.6	13.4	2.0	2.3	0.6	0.7
A16	14.5	16.7	2.4	2.8	0.7	0.8
A17	20.2	24	3.4	4.0	1.0	1.2
A18	23.6	**28.6**	4.0	4.8	1.2	1.4
A19	**25.6**	**31.5**	4.3	5.3	1.3	1.6
A20	16.8	20.8	2.8	3.5	0.8	1.0
A21	4.4	15.7	0.7	2.6	0.2	0.8
A22	21.1	24.3	3.5	4.1	1.1	1.2
A23	23.6	**27**	4.0	4.5	1.2	1.4
A24	8.0	10.3	1.3	1.7	0.4	0.5
A25	14.2	17.3	2.4	2.9	0.7	0.9
A26	15.7	20.0	2.6	3.4	0.8	1.0
A27	**25.9**	**32.8**	4.4	5.5	1.3	1.7
A28	**29.5**	**33.4**	5.0	5.6	1.5	1.7
A29	17.6	19.9	3.0	3.4	0.9	1.0
A30	17.3	30.2	2.9	5.1	0.9	1.5
A31	4.6	7.6	0.8	1.3	0.2	0.4
A32	22.0	24.4	3.7	4.1	1.1	1.2
A33	4.2	6.1	0.7	1.0	0.2	0.3
A34	5.7	7.2	1.0	1.2	0.3	0.4
A35	2.1	2.7	0.4	0.5	0.1	0.1
A36	4.0	5.0	0.7	0.8	0.2	0.3
A37	7.6	10.3	1.3	1.7	0.4	0.5
A38	3.6	4.4	0.6	0.7	0.2	0.2

Table A.3-14
TED for Each Exposure Scenario at Site T-2A, Shasta, (mrem/yr)
(Page 3 of 3)

Plot or 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
A39	4.4	6.7	0.7	1.1	0.2	0.3
A40	4.0	4.5	0.7	0.8	0.2	0.2
A41	3.0	4.2	0.5	0.7	0.2	0.2
A42	5.1	9.8	0.9	1.7	0.3	0.5
A43	2.6	2.9	0.4	0.5	0.1	0.2
A44	5.7	9.4	0.9	1.6	0.3	0.5
A45	5.9	7.0	1.0	1.2	0.3	0.4
A46	2.4	4.3	0.4	0.7	0.1	0.2
A47	3.1	3.4	0.5	0.6	0.2	0.2
A48	5.3	8.7	0.9	1.5	0.3	0.4
A49	4.2	4.6	0.7	0.8	0.2	0.2
A50	3.4	3.8	0.6	0.6	0.2	0.2
A51	4.1	6.1	0.7	1.0	0.2	0.3
A52	7.2	8.6	1.2	1.4	0.4	0.4
A53	**33.1**	**39.7**	5.6	6.7	1.7	2.0
A54	6.3	8.7	1.1	1.5	0.3	0.4
A55	5.5	7.5	0.9	1.3	0.3	0.4
A56	4.4	5.5	0.7	0.9	0.2	0.3
A57	2.4	3.7	0.4	0.6	0.1	0.2
A58	4.4	4.7	0.7	0.8	0.2	0.2
A59	4.7	5.2	0.8	0.9	0.2	0.3
A60	**36.0**	**41.6**	6.0	7.0	1.8	2.1
A61	1.6	3.5	0.3	0.6	0.1	0.2
A62	1.1	4.1	0.2	0.7	0.1	0.2
A63	2.6	4.3	0.4	0.7	0.1	0.2

Bold indicates the values exceeding 25 mrem/yr.

Table A.3-15
TED for Each Exposure Scenario at Site T-2B, Diablo (mrem/yr)
(Page 1 of 3)

Plot or 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	**47.8**	**51.1**	8.0	8.6	2.4	2.6
B02	7.1	7.8	1.2	1.3	0.4	0.4
B03	6.3	7.4	1.1	1.3	0.3	0.4
B04	4.5	5.0	0.8	0.9	0.2	0.3
B05	7.1	7.8	1.2	1.3	0.4	0.4
B06	7.5	7.8	1.3	1.3	0.4	0.4
B07	3.9	5.1	0.7	0.9	0.2	0.3
B08	6.3	8.9	1.1	1.5	0.3	0.5
B09	5.1	6.5	0.9	1.1	0.3	0.3
B10	5.5	7.9	0.9	1.3	0.3	0.4
B11	4.9	6.5	0.8	1.1	0.3	0.3
B12	5.8	7.9	1.0	1.3	0.3	0.4
B13	1.7	2.2	0.3	0.4	0.1	0.1
B14	0.1	1.7	0.0	0.3	0.0	0.1
B15	1.3	5.5	0.2	0.9	0.1	0.3
B16	1.4	2.9	0.2	0.5	0.1	0.1
B17	23.4	24.6	3.9	4.1	1.2	1.2
B18	10.7	11.6	1.8	2.0	0.5	0.6
B19	6.7	8.5	1.1	1.4	0.3	0.4
B20	1.9	5.1	0.3	0.9	0.1	0.3
B21	0.5	1.6	0.1	0.3	0.0	0.1
B22	1.5	2.4	0.3	0.4	0.1	0.1
B23	3.8	4.9	0.6	0.8	0.2	0.3
B24	5.3	6.4	0.9	1.1	0.3	0.3
B25	3.7	5.6	0.6	1.0	0.2	0.3
B26	5.1	6.0	0.9	1.0	0.3	0.3
B27	7.1	8.2	1.2	1.4	0.4	0.4

Table A.3-15
TED for Each Exposure Scenario at Site T-2B, Diablo (mrem/yr)
(Page 2 of 3)

Plot or 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
B28	7.5	10.6	1.3	1.8	0.4	0.5
B29	8.4	10.6	1.4	1.8	0.4	0.5
B30	6.7	7.4	1.1	1.2	0.3	0.4
B31	7.5	8.5	1.3	1.4	0.4	0.4
B32	8.6	10.3	1.5	1.7	0.4	0.5
B33	11.4	12.7	1.9	2.1	0.6	0.6
B34	12.3	13.0	2.1	2.2	0.6	0.7
B35	6.7	7.9	1.1	1.3	0.3	0.4
B36	8.4	9.4	1.4	1.6	0.4	0.5
B37	15.3	18.1	2.6	3.0	0.8	0.9
B38	8.5	10.0	1.4	1.7	0.4	0.5
B39	6.6	8.4	1.1	1.4	0.3	0.4
B40	8.5	10.7	1.4	1.8	0.4	0.5
B41	8.3	11.4	1.4	1.9	0.4	0.6
B42	8.6	10.9	1.5	1.8	0.4	0.6
B47	17.4	20.8	2.9	3.5	0.9	1.1
B49	6.5	8.0	1.1	1.3	0.3	0.4
B50	12.9	15.3	2.2	2.6	0.7	0.8
B51	20.5	24.8	3.4	4.2	1.0	1.3
B52	**26.1**	**31.9**	4.4	5.4	1.3	1.6
B53	14.9	15.5	2.5	2.6	0.8	0.8
B54	**31.6**	**34.4**	5.3	5.8	1.6	1.7
B55	**28.3**	**30.9**	4.8	5.2	1.4	1.6
B56	16.0	18.1	2.7	3.1	0.8	0.9
B58	6.5	7.5	1.1	1.3	0.3	0.4
B59	8.2	10.1	1.4	1.7	0.4	0.5
B60	21.7	**25.5**	3.6	4.3	1.1	1.3

Table A.3-15
TED for Each Exposure Scenario at Site T-2B, Diablo (mrem/yr)
(Page 3 of 3)

Plot or 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
B61	12.0	15.5	2.0	2.6	0.6	0.8
B62	4.4	7.8	0.7	1.3	0.2	0.4
B63	6.3	9.4	1.1	1.6	0.3	0.5
B64	4.7	6.4	0.8	1.1	0.2	0.3
B65	6.0	6.8	1.0	1.2	0.3	0.4
B66	5.5	7.0	0.9	1.2	0.3	0.4
B67	5.2	5.4	0.9	0.9	0.3	0.3
B68	6.7	8.2	1.1	1.4	0.3	0.4
B69	6.4	7.5	1.1	1.3	0.3	0.4
B70	7.1	8.0	1.2	1.3	0.4	0.4
B71	13.4	14.7	2.3	2.5	0.7	0.7
B72	20.8	21.7	3.5	3.6	1.1	1.1
B73	**30.8**	**35.2**	5.2	5.9	1.6	1.8
B74	**34.6**	**37.5**	5.8	6.3	1.8	1.9
B75	21.5	**25.3**	3.6	4.2	1.1	1.3
B76	16.8	19.6	2.8	3.3	0.9	1.0
B77	4.9	5.9	0.8	1.0	0.3	0.3
B78	**66.0**	**78.2**	11.1	13.1	3.3	4.0

Bold indicates the values exceeding 25 mrem/yr.

Table A.3-16
TED for Each Exposure Scenario at Site T-2 (mrem/yr)
(Page 1 of 4)

Plot or 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	**259.7**	**298.5**	**43.6**	**50.2**	13.0	15.0
C02	**34.0**	**40.4**	5.7	6.8	1.7	2.0

Table A.3-16
TED for Each Exposure Scenario at Site T-2 (mrem/yr)
(Page 2 of 4)

Plot or 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
C03	**106.3**	**116.7**	17.9	19.6	5.3	5.9
C04	**138.9**	**159.1**	23.3	**26.7**	7.0	8.0
C05	**123.5**	**135.0**	20.8	22.7	6.2	6.8
C06	**47.5**	**52.1**	8.0	8.8	2.4	2.6
C07	**31.3**	**35.4**	5.3	6.0	1.6	1.8
C08	**52.7**	**63.4**	8.9	10.7	2.6	3.2
C09	**124.2**	**140.1**	20.9	23.5	6.2	7.0
C10	**204.1**	**224.6**	**34.3**	**37.7**	10.2	11.3
C11	**74.8**	**85.2**	12.6	14.3	3.8	4.3
C12	**141.6**	**153.2**	23.8	**25.7**	7.1	7.7
C13	**184.4**	**206.2**	**31.0**	**34.6**	9.2	10.3
C14	**155.5**	**174.0**	**26.1**	**29.2**	7.8	8.7
C15	**56.1**	**58.3**	9.4	9.8	2.8	2.9
C16	**35.0**	**39.4**	5.9	6.6	1.8	2.0
C17	**30.5**	**36.8**	5.1	6.2	1.5	1.8
C18	**69.9**	**79.8**	11.7	13.4	3.5	4.0
C19	**160.9**	**176.3**	**27.0**	**29.6**	8.1	8.8
C20	**149.8**	**155.0**	**25.2**	**26.0**	7.5	7.8
C21	**177.2**	**185.2**	**29.8**	**31.1**	8.9	9.3
C22	**168.8**	**176.3**	**28.4**	**29.6**	8.5	8.8
C23	**110.6**	**123.2**	18.6	20.7	5.5	6.2
C24	**143.9**	**152.5**	24.2	**25.6**	7.2	7.6
C25	**103.6**	**113.5**	17.4	19.1	5.2	5.7
C26	15.1	16.5	2.5	2.8	0.8	0.8
C27	5.1	8.3	0.9	1.4	0.3	0.4
C28	4.4	6.2	0.8	1.0	0.2	0.3
C29	0.9	2.7	0.2	0.5	0.0	0.1

Table A.3-16
TED for Each Exposure Scenario at Site T-2 (mrem/yr)
(Page 3 of 4)

Plot or 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
C30	2.9	4.8	0.5	0.8	0.2	0.2
C31	9.4	11.0	1.6	1.9	0.5	0.6
C32	22.7	**25.6**	3.8	4.3	1.1	1.3
C33	5.0	5.3	0.8	0.9	0.3	0.3
C34	3.7	4.1	0.6	0.7	0.2	0.2
C35	13.7	15.3	2.3	2.6	0.7	0.8
C36	16.0	18.4	2.7	3.1	0.8	0.9
C37	3.3	3.8	0.6	0.6	0.2	0.2
C38	2.2	2.4	0.4	0.4	0.1	0.1
C42	**56.0**	**66.0**	9.4	11.1	2.8	3.3
C43	**131.9**	**140.4**	22.2	23.6	6.6	7.0
C44	**27.9**	**31.9**	4.7	5.4	1.4	1.6
C45	**51.6**	**54.3**	8.7	9.1	2.6	2.7
C46	**125.5**	**140.1**	21.1	23.5	6.3	7.0
C47	**170.4**	**195.6**	**28.6**	**32.9**	8.5	9.8
C48	**211.1**	**225.2**	**35.5**	**37.8**	10.6	11.3
C49	**121.9**	**135.8**	20.5	22.8	6.1	6.8
C50	**47.5**	**49.8**	8.0	8.4	2.4	2.5
C51	18.2	19.4	3.1	3.3	0.9	1.0
C52	**30.4**	**34.6**	5.1	5.8	1.5	1.7
C53	**64.9**	**75.1**	10.9	12.6	3.3	3.8
C54	**163.3**	**180.5**	**27.4**	**30.3**	8.2	9.0
C55	**186.1**	**210.9**	**31.3**	**35.4**	9.3	10.6
C56	**101.0**	**116.6**	17.0	19.6	5.1	5.8
C57	**153.9**	**166.8**	**25.9**	**28.0**	7.7	8.4
C58	**67.0**	**72.2**	11.3	12.1	3.4	3.6
C59	**147.2**	**160.5**	24.7	**27.0**	7.4	8.0

Table A.3-16
TED for Each Exposure Scenario at Site T-2 (mrem/yr)
(Page 4 of 4)

Plot or 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
C60	14.1	16.1	2.4	2.7	0.7	0.8
C61	7.9	9.5	1.3	1.6	0.4	0.5
C62	5.8	7.1	1.0	1.2	0.3	0.4
C67	12.5	13.6	2.1	2.3	0.6	0.7
C68	7.5	9.4	1.3	1.6	0.4	0.5
C69	5.7	8.7	1.0	1.5	0.3	0.4
C70	1.8	2.4	0.3	0.4	0.1	0.1
C71	3.5	6.3	0.6	1.1	0.2	0.3
C72	21.4	**25.7**	3.6	4.3	1.1	1.3
C73	**28.8**	**33.1**	4.8	5.6	1.4	1.7
C74	15.5	17.3	2.6	2.9	0.8	0.9
C75	5.1	7.2	0.9	1.2	0.3	0.4
C76	3.8	5.7	0.6	1.0	0.2	0.3

Bold indicates the values exceeding 25 mrem/yr.

The TED did not exceed the FAL (25 mrem/OU-yr) at any location (Figures A.3-6 through A.3-8).

A.3.3 Corrective Actions

As the TED did not exceed the FAL at any plot or TLD location, no corrective action was required for atmospheric deposition of radionuclides at any of the three sites.

A.3.4 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 determine the extent where the TED exceeds 25 mrem/IA-yr (industrial area scenario), a correlation

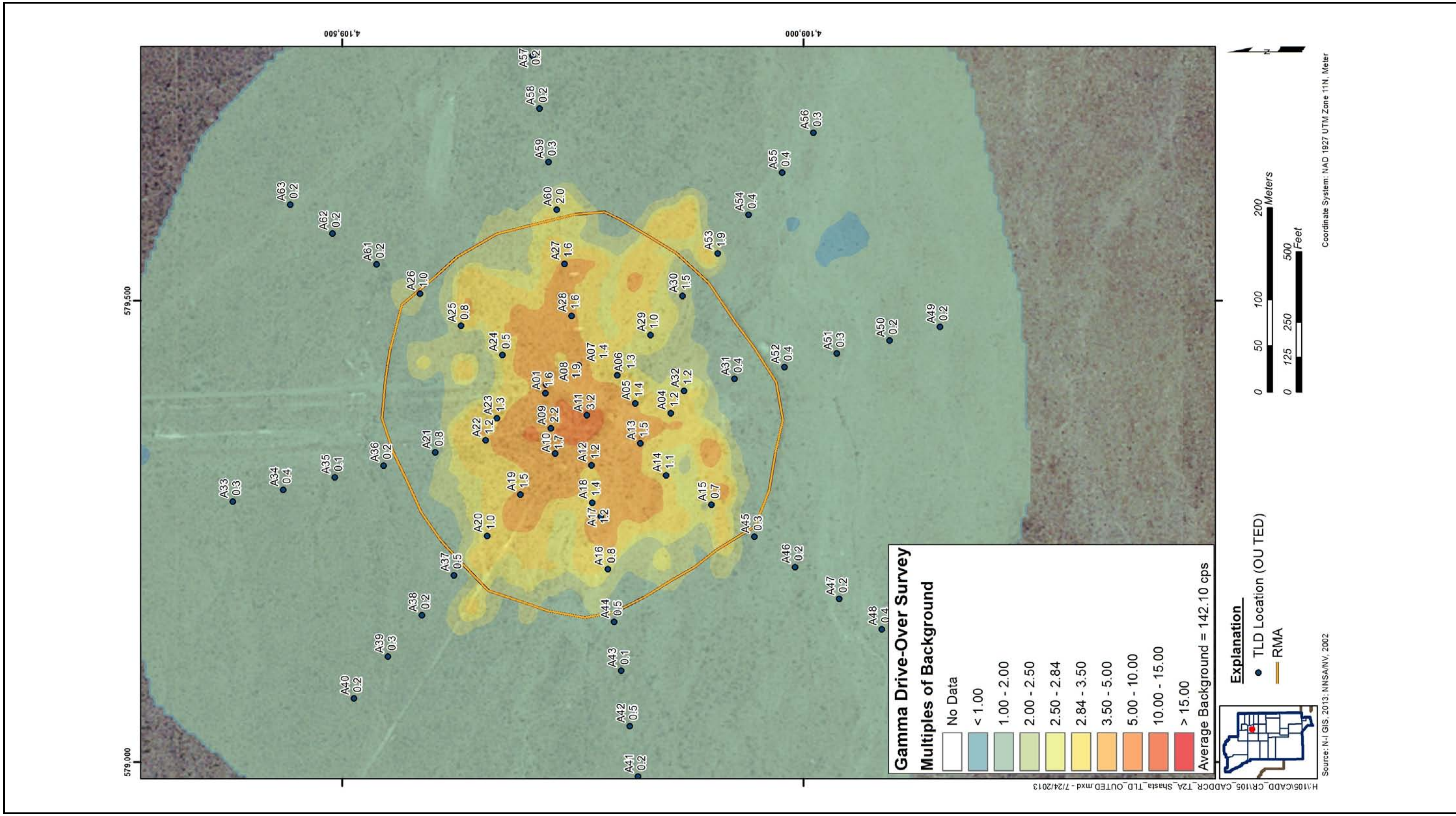


Figure A.3-6
95% UCL of the TED at Site T-2A, Shasta

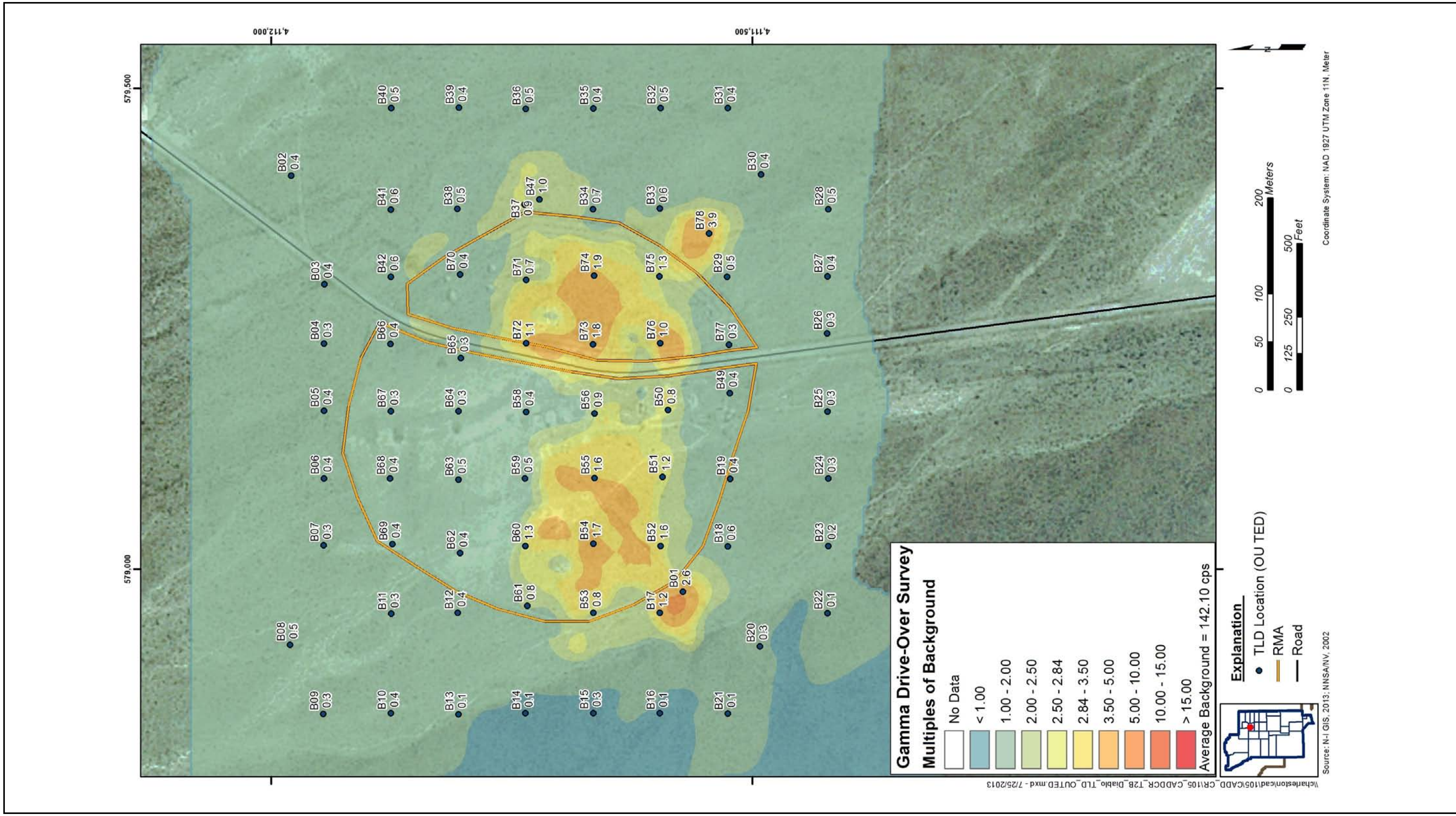


Figure A.3-7
95% UCL of the TED at Site T-2B, Diablo

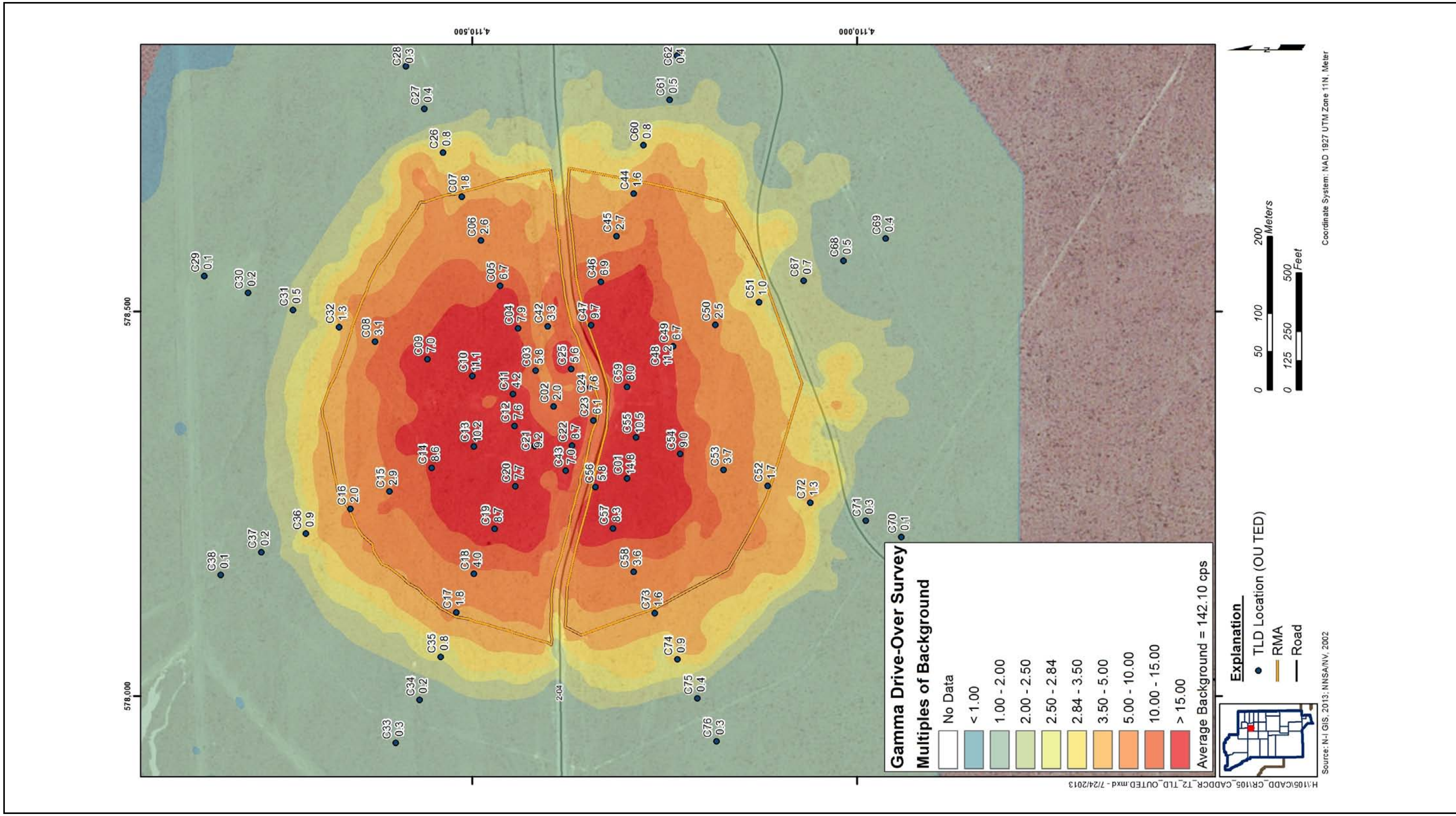


Figure A.3-8
95% UCL of the TED at Site T-2

of radiation survey values to the calculated TED values was conducted for the following radiation surveys (described in Section A.2.2.1):

- Gross count values from the 1994 aerial radiation survey (BN, 1999)
- Man-made count values from the 1994 aerial radiation survey (BN, 1999)
- The site-specific TRS (gamma drive-over survey)

A continuous spatial distribution (i.e., interpolated surface) was estimated from each of the listed radiation surveys using an inverse distance weighted interpolation technique. The calculated Industrial Area TED value for each site was then matched with a radiation survey value from the interpolated surface at the corresponding geographic location. A correlation was then calculated between these data pairs for each radiation survey. These correlations are shown in Table A.3-17. The radiation survey that exhibited the best correlation at all sites is the gamma drive-over with a correlation of 0.87 at Site T-2A, Shasta; 0.82 at Site T-2B, Diablo; and 0.94 at Site T-2. These correlations exceeds the minimum criteria of 0.80 as set in the Soils RBCA document (NNSA/NSO, 2012c). Based on these correlations, the radiation survey values that correspond to the 25-mrem/OU-yr FAL is 3.01 multiples of background at Site T-2A, Shasta; 2.65 at Site T-2B, Diablo; and 3.52 at Site T-2. The administrative UR boundaries were established to encompass these TRS isopleths. This area is shown on Figure A.3-9 for Site T-2A, Shasta; Figure A.3-10 for Site T-2-B, Diablo; and Figure A.3-11 for Site T-2.

Table A.3-17
Correlations of Industrial Area TED with Gamma Surveys

Dataset	Correlation Coefficient (r^2)		
	Site T-2A, Shasta	Site T-2B, Diablo	Site T-2
Gamma Drive-Over Survey	0.87	0.82	0.93
1994 Gamma Flyover - Gross Count	0.63	0.36	0.75
1994 Gamma Flyover - Man Made	0.67	0.37	0.77

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), the sample location with the maximum TED (location C01) will decay to less than 25 mrem/IA-yr in approximately 75 years.

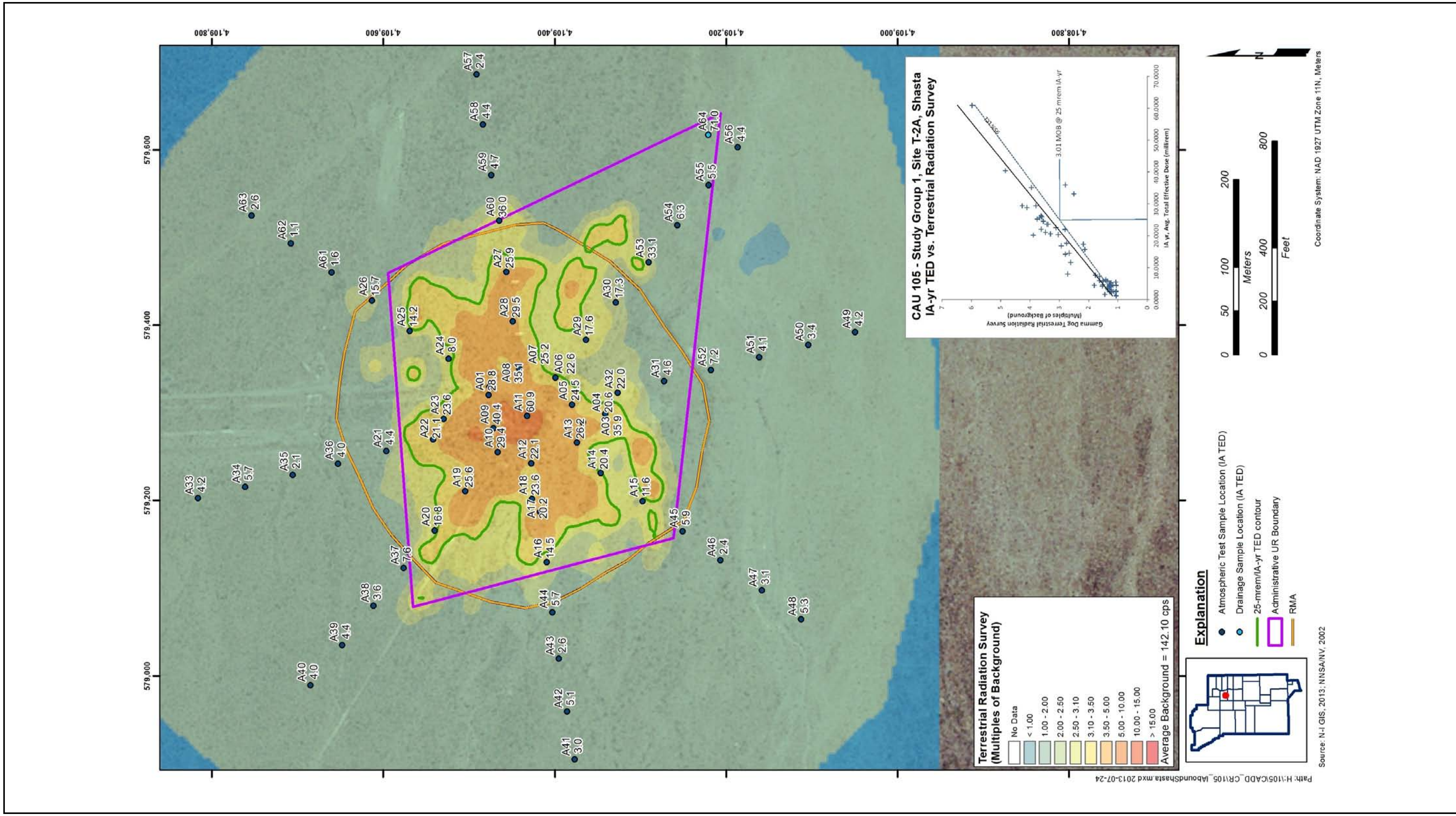


Figure A.3-9
Administrative UR Boundary for Site T-2A, Shasta

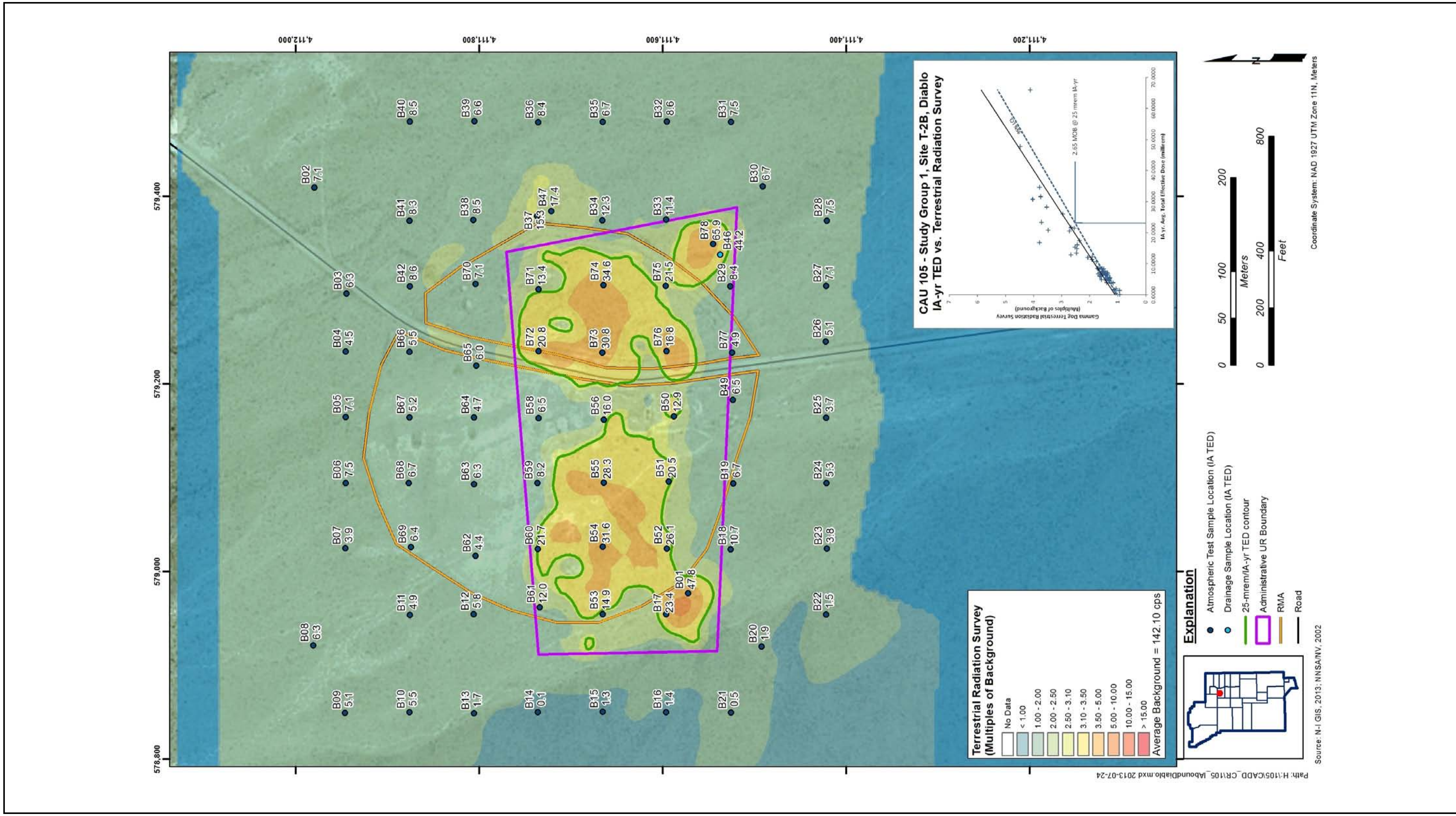


Figure A.3-10
Administrative UR Boundary for Site T-2B, Diablo

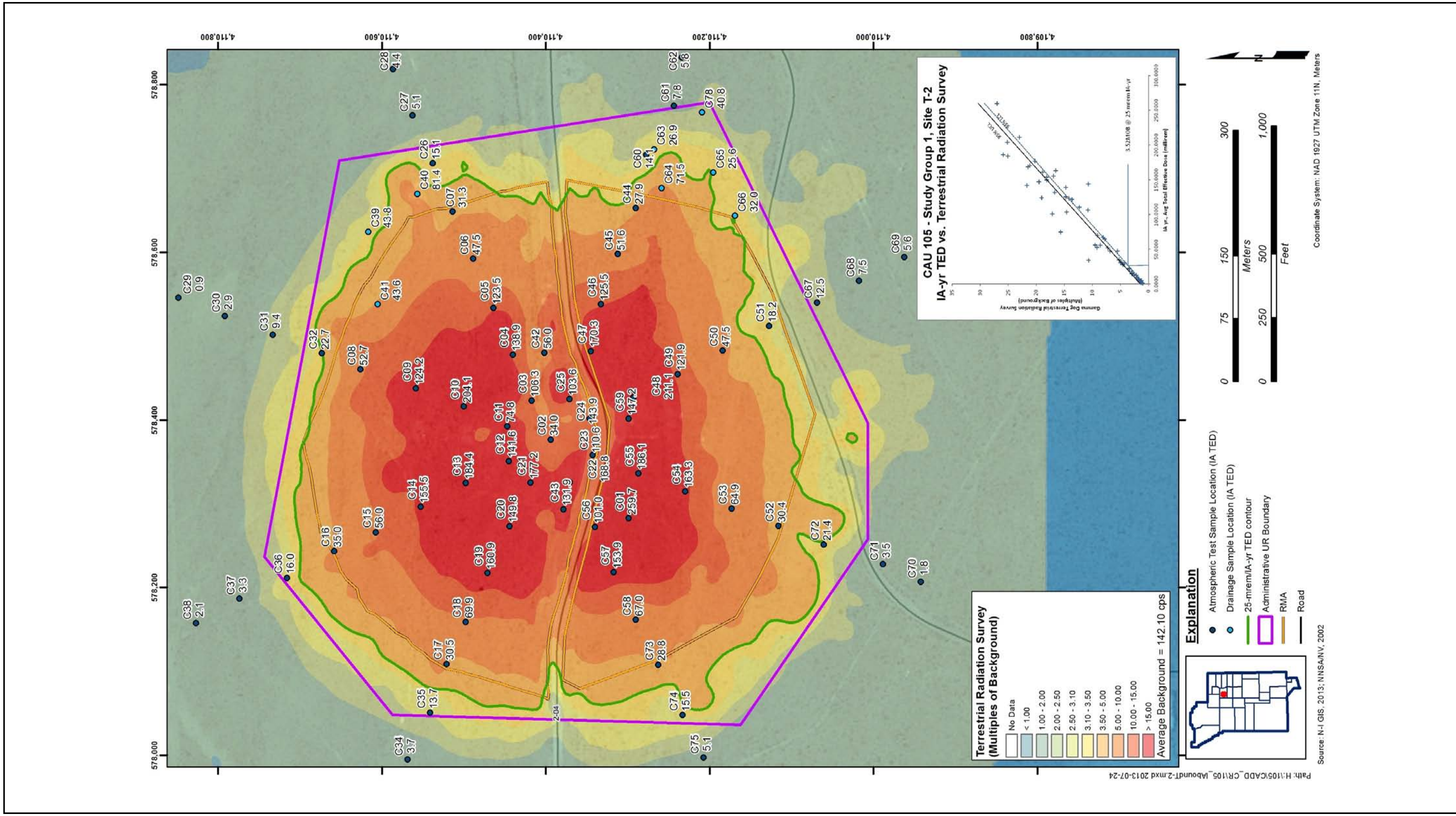


Figure A.3-11
Administrative UR Boundary for Site T-2

A.3.5 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) 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.4.0 Study Group 2, Excavations

Study Group 2 is specific to soil and debris that were mechanically graded into mounds as staging areas for disposal as part of surface contamination consolidation efforts at Site T-2B, Diablo. A partial excavation of one soil mound was performed to determine content and radiological dose. Additional detail on the history of Study Group 2 is provided in the CAIP (NNSA/NSO, 2012a).

A.4.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2012a) are described in the following subsections.

A.4.1.1 Visual Inspections

Visual inspections of Site T-2B, Diablo conducted over the course of the investigation include site walks, sampling efforts, and radiological surveys. The visual inspections identified the presence of discrete soil mounds containing debris. They also showed that all of the mounds were similar in nature, so the one closest to GZ was selected as representational.

A.4.1.2 Radiological Surveys

GPS-assisted TRSs were performed at Site T-2B, Diablo during the CAI. The TRSs were conducted in the area of the mound to identify the spatial distribution of radiological readings and to identify elevated radiological readings. No elevated readings were observed, and no sample locations were selected based upon the radiological surveys.

A.4.1.3 Sample Collection

One soil and one TLD sample were collected to satisfy the CAIP requirements (NNSA/NSO, 2012a) as shown in Figure A.4-1. The specific CAI activities conducted at this study group are described in the following subsections.

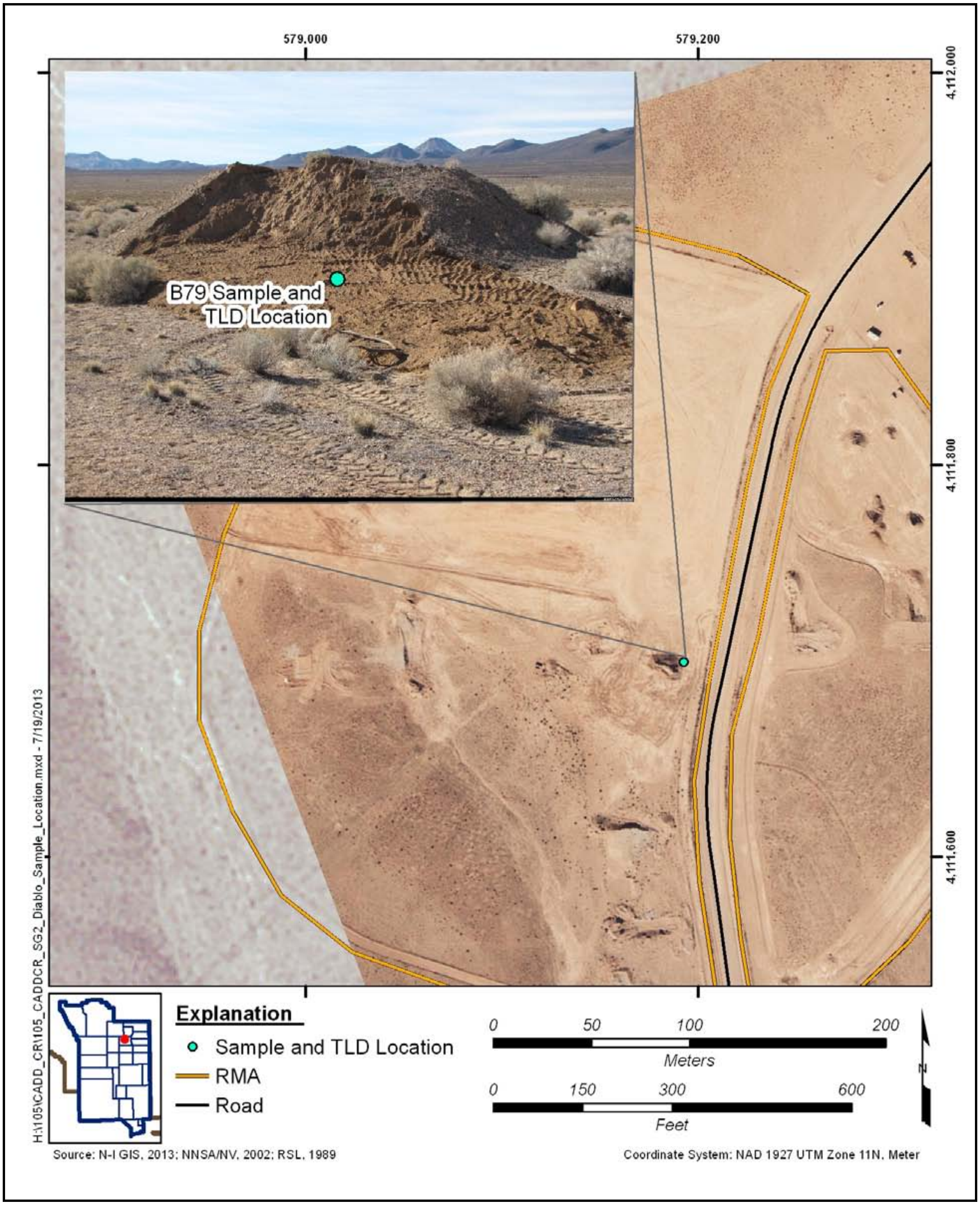


Figure A.4-1
Soil Sample and TLD Location for Study Group 2

A.4.1.3.1 TLD Samples

The results of the TLD sample collected at Site T-2B, Diablo (B79) to measure external dose from the partially excavated soil mound are listed in Table A.4-1 and shown on Figure A.4-1. One TLD (H04) was placed to measure "field" background. It was determined that the background TLD location is representative of the general area and can be used as a good estimate of true average background dose as discussed in Section A.2.2.5. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.9.0. See Figure A.2-1 for background TLD locations.

Table A.4-1
TLD at Study Group 2

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
B79	6480	01/08/2013	04/11/2013	Soil Mound Excavation Evaluation

A.4.1.3.2 Soil Sample

The soil sample collected for the Site T-2B, Diablo excavation consisted of one composite soil sample (nine aliquots) at the partially excavated soil mound. The sample location was selected at the middle of the layout area and analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am. A summary of the soil sample collected at the site (B79) to measure internal dose from the partially excavated soil mound is listed in Table A.4-2 and shown on Figure A.4-1.

Table A.4-2
Sample Collected at Study Group 2

Sample Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
B79	AA4B011	0 - 5	Soil	Environmental

A.4.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

A.4.2 Investigation Results

The following subsections present the analytical and computational results for the soil and TLD sample collected at the Site T-2B, Diablo soil mound excavation. Sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. Results that are equal to or greater than FALs are identified by bold text in the results tables. The analytical parameters and laboratory methods used during this investigation were discussed in CAIP.

The internal dose calculated from the soil sample result, and the external dose calculated from the TLD measurement were combined to determine TED at the sample location. External dose is summarized in Section A.4.2.1. Internal dose is summarized in Section A.4.2.2. The TED for the sampled location is summarized in Section A.4.2.3. Radiological results are summarized in Section A.4.3.

A.4.2.1 External Radiological Dose Measurements

The estimate for the external dose that a receptor would receive at the TLD sample location was determined as described in Section A.2.2.5. Measurements of the 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 this TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL value of the external dose for each exposure scenario are presented in Table A.4-3. The minimum sample size was met for this TLD sample.

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

Location	Standard Deviation	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)
B79	0.07	3	3	15.5	2.6	0.8

A.4.2.2 Internal Radiological Dose Estimations

The estimate for the internal dose that a receptor would receive at the Site T-2B, Diablo sample location was determined as described in Section A.2.2.4. The internal dose for each exposure scenario is presented in Table A.4-4. The analytical results for the individual radionuclides in the composite sample and the corresponding calculated internal dose are presented in Appendix F.

Table A.4-4
Internal Dose for Each Exposure Scenario at Study Group 2

Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
B79	0.2	0.0	0.0

A.4.2.3 Total Effective Dose

The TED for the composite sample and TLD location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.4-5.

Table A.4-5
TED for Each Exposure Scenario at Study Group 2 (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
B79	13.2	15.7	2.2	2.6	0.7	0.8

The results for sample location B79 at the partial soil mound excavation at Site T-2B, Diablo did not exceed the 25-mrem/OU-yr FAL (Figure A.4-1).

A.4.3 Corrective Actions

Based on the data evaluation and the proposed scenario, no COCs were identified at this study group. Because no COCs are present exceeding the FAL, no further action is required.

A.4.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) 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.5.0 Study Group 3, Debris/Spills

A component of Study Group 3 is present at all three sites. This study group consists of releases of chemical or radioactive contamination associated with debris and/or spills. Additional detail on the history of Study Group 3 is provided in the CAIP (NNSA/NSO, 2012a).

A.5.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this Study Group (NNSA/NSO, 2012a) are described in the following subsections.

A.5.1.1 Visual Inspections

Visual inspections of Study Group 3—including site walks, sampling efforts, and radiological surveys—were conducted over the course of the field investigation. Biasing factors indicating the potential release of lead contamination were identified during the investigation at all three sites. (See Table A.5-2 for a list of the samples that were collected as a result of the visual inspections.)

A.5.1.2 Radiological Surveys

GPS-assisted TRSs were performed during the CAI. The TRSs were conducted at the sites as shown on Figure A.3-1 to identify the spatial distribution of radiological readings and to identify the location of the elevated radiological readings that could indicate spills or debris. No spills or debris were identified as a result of the surveys.

A.5.1.3 Sample Collection

Twenty-nine soil samples were collected to satisfy the CAIP requirements (NNSA/NSO, 2012a) at Study Group 3. Table A.5-1 shows the type, number, and analysis of soil samples collected. This table also includes a summary of the number of samples collected for each site. Soil samples for Study Group 3 were analyzed for chemical contaminants including RCRA metals and other analysis listed in Table A.5-1. Additional information including depth and type of each soil sample collected for each site of Study Group 3 is provided in Table A.5-2. Sample locations are shown on Figure A.5-1.

Table A.5-1
Soil Sample Summary for Study Group 3

Site	Number of Locations	Number of Soil Samples	Analyses (Method)
T-2A, Shasta	9	11(1 FD)	AA4A016-24: RCRA Metals AA4A009 & AA4B301: TCLP VOC, SVOC and Metals AA4A010: VOC, SVOC, RCRA Metals, Pu-241; Sr-90; Tc-99 Isotopic U; Isotopic Pu; Isotopic Am; Gamma Spectroscopy (HASL-300)[a]
T-2	13	18 (1 FD)	RCRA Metals
Total	**22**	**29**	

[a]DOE, 1997

FD = Field duplicate
TCLP = Toxicity Characteristic Leaching Procedure

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

Sample Location	Sample Number	Depth (in. bgs)	Matrix	Purpose
Site T-2A, Shasta				
A66	AA4A009	0 - 6	Soil	Environmental
	AA4A010	0 - 6	Soil	Environmental
A70	AA4A016	0 - 6	Soil	Environmental
	AA4A017	0 - 6	Soil	FD of #AA4C016
A71	AA4A018	0 - 6	Soil	Environmental
A72	AA4A019	0 - 6	Soil	Environmental
A73	AA4A020	0 - 6	Soil	Environmental
A74	AA4A021	0 - 6	Soil	Environmental
A75	AA4A022	0 - 6	Soil	Environmental
A76	AA4A023	0 - 6	Soil	Environmental
A77	AA4A024	0 - 6	Soil	Environmental

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

Sample Location	Sample Number	Depth (in. bgs)	Matrix	Purpose
Site T-2, Whitney, Badger, How, Turk				
C80	AA4C015	6 - 8	Soil	Environmental
C81	AA4C018	6 - 8	Soil	Environmental
C82	AA4C017	6 - 8	Soil	Environmental
C83	AA4C016	6 - 8	Soil	Environmental
C84	AA4C019	6 - 8	Soil	Environmental
C85	AA4C011	6 - 8	Soil	Environmental
C86	AA4C022	6 - 8	Soil	Environmental
C87	AA4C012	6 - 8	Soil	Environmental
	AA4C013	6 - 8	Soil	FD of #AA4C012
	AA4C024	11 - 12	Soil	Environmental
C88	AA4C020	6 - 8	Soil	Environmental
C89	AA4C021	6 - 8	Soil	Environmental
C90	AA4C014	6 - 8	Soil	Environmental
C93	AA4C023	6 - 8	Soil	Environmental
C94	AA4C025	0 - 6	Soil	Environmental
	AA4C026	0 - 6	Soil	Environmental
	AA4C027	0 - 6	Soil	Environmental
	AA4C028	0 - 6	Soil	Environmental

During the preliminary investigations, lead-acid batteries, lead bricks, and lead debris were identified at the three study sites. Soil samples were collected to characterize the soil surrounding the items and debris and were analyzed for RCRA metals. A total of 27 soil samples and two duplicates were collected for Study Group 3 debris and spills at CAU 105 as shown on Figure A.5-1.

A total of nine samples were collected at Site T-2A, Shasta. Lead items discovered in the area adjacent to GZ included lead piping, lead-lined vaults, and other lead debris. Eight samples and one duplicate (AA4A016 through AA4A024) at locations A70 through A77 were collected in a 225-ft radius around GZ as a non-visual confirmation of the extent of lead that was based upon a visual

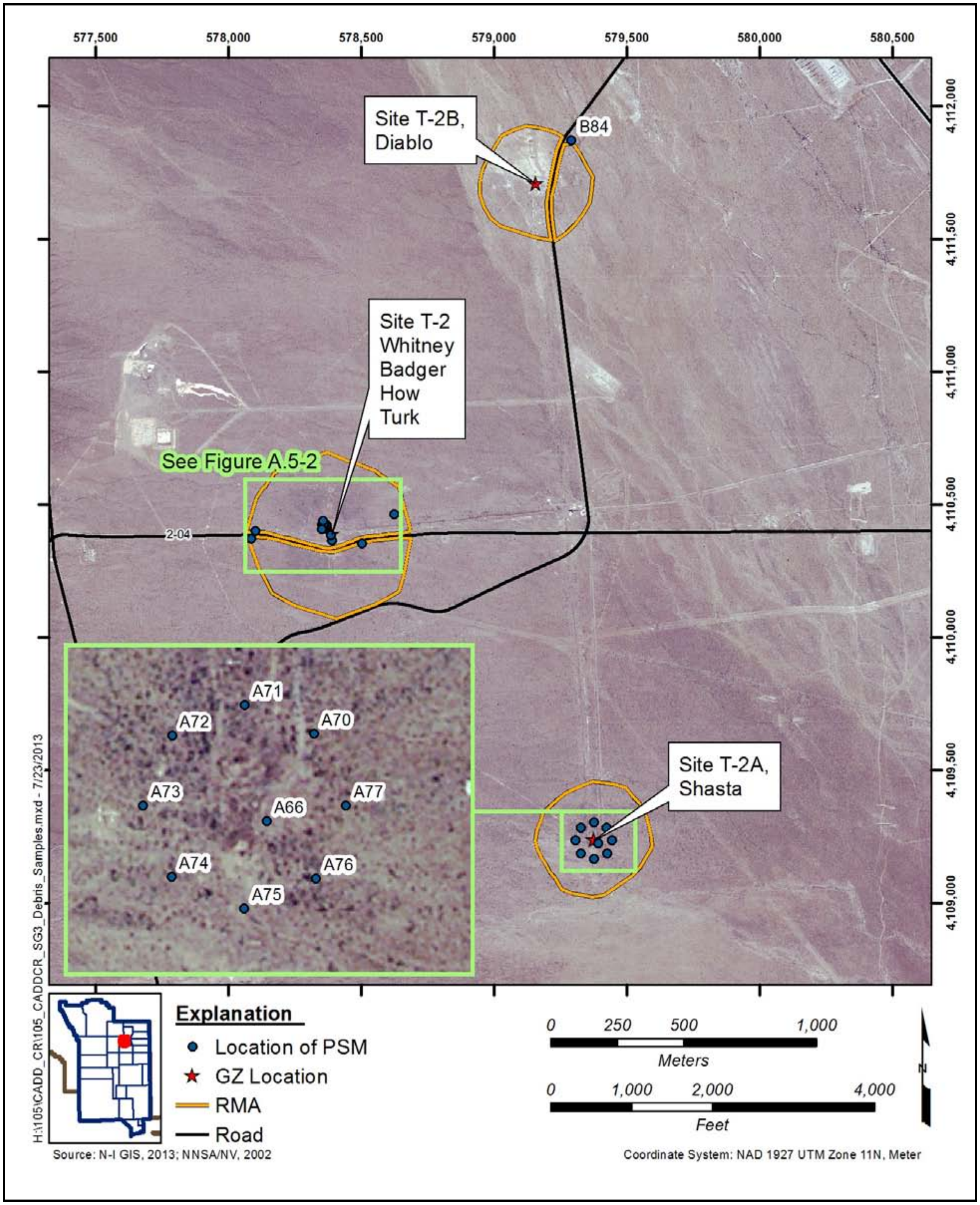


Figure A.5-1
Sample Locations for Study Group 3

survey. One approximate 2-ft diameter stained area (A66) was also identified at a location near GZ at the Shasta site. One sample (AA4A009) of the stained material was analyzed to characterize the material, and one sample (AA4A010) from the soil under the stain was analyzed to confirm extent.

No samples were collected for the two lead bricks discovered at Site T-2B, Diablo (location B84) as the bricks were contained in an intact metal container. No indications of a release were observed.

A total of 18 samples were collected at Site T-2. PSM was discovered to include lead bricks and lead-acid batteries as shown on Figure A.5-2. Eighteen scattered lead bricks (C80 through C90) were identified close to GZ, and 49 clustered lead bricks (C94) were discovered in an approximate 18-by-20-ft area on the western edge of the RMA boundary just south of Road 2-04. Three lead-acid batteries were discovered at the site to include two intact (C91 and C92) and one breached (C93) battery.

At Site T-2, 12 soil samples (AA4C011 through AA4C013 and AA4C014 through AA4C022) were collected from the remaining soil under the 18 scattered lead bricks after they were removed from Site T-2 and analyzed for RCRA metals. This was performed to confirm the extent of contamination. At location C87 the soil sample and FD (AA4C012 and AA4C013) collected directly under the lead brick exceeded the FAL for lead. Further soil was removed, and one other soil sample (AA4C024) was analyzed from the remaining soil to show results below the FAL. The 49 lead bricks were also removed from the site. Four samples (AA4C025 through AA4C028) at location C94 were collected using a sample grid pattern and analyzed for RCRA metals to confirm the extent of contamination.

Two samples associated with the breached lead-acid battery (location C93) at Site T-2 were collected. One sample (AA4C023) of the breached lead-acid battery parts was collected and analyzed for RCRA metals to confirm the extent of contamination. After the battery was removed, one sample (AA4C502) of the soil under the battery was collected for waste management purposes (Section A.8.0) and analyzed for RCRA metals. No sampling was performed for two intact lead-acid batteries discovered at locations C91 and C92 as no indication of a release was observed.

A.5.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

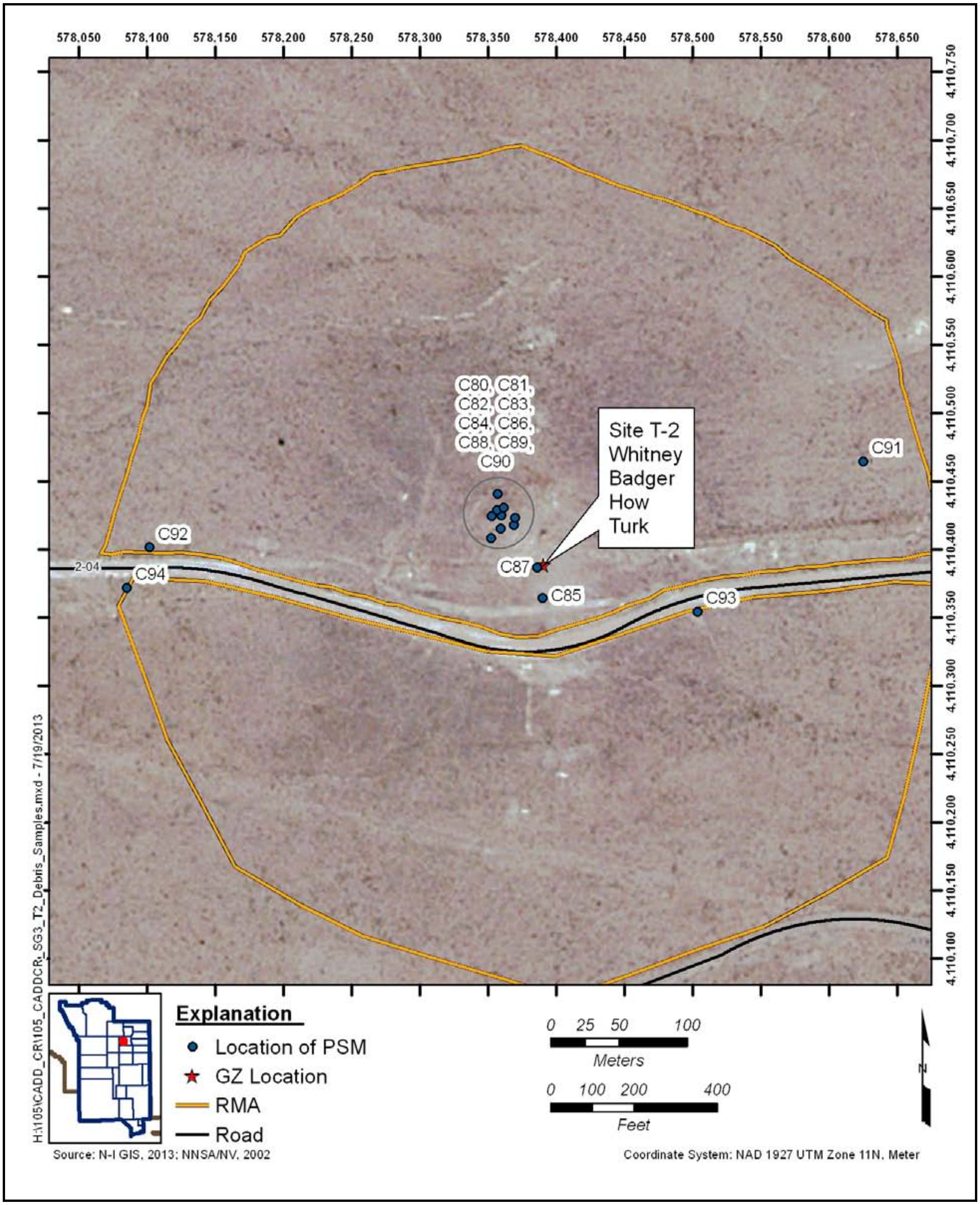


Figure A.5-2
Sample Locations at Site T-2 for Study Group 3

A.5.2 Investigation Results

The following subsections present the analytical results for soil samples collected at debris and spill areas. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The results are reported as individual concentrations that are comparable to their corresponding FALs. Sample results above the MDC are provided in Table A.5-3. Results that are equal to or greater than FALs are identified by bold text in the results tables. The analytical parameters and laboratory methods used during this investigation were discussed in CAIP.

Table A.5-3
Sample Results for Metals Detected above MDCs at Study Group 3
(Page 1 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**8,356**	**43**	**5,100**	**5,100**
A66	AA4A010	0 - 6	**80** (J)	150 (J)	--	7.5	**23,000**	0.014 (J-)	0.81	5.2 (J)
A70	AA4A016	0 - 6	5.6	180 (J)	0.22 (J-)	9.4	140 (J)	--	0.79 (J)	--
A71	AA4A018	0 - 6	5.4	150 (J)	0.13 (J-)	8	29 (J)	--	0.72 (J)	--
A72	AA4A019	0 - 6	4.7	150 (J)	0.13 (J-)	7.9	14 (J)	--	--	--
A73	AA4A020	0 - 6	4.5	130 (J)	0.16 (J-)	9.3	24 (J)	--	0.72 (J+)	--
A74	AA4A021	0 - 6	4.9	160 (J)	0.16 (J-)	7.5	23 (J)	--	0.68 (J+)	--
A75	AA4A022	0 - 6	5.2	170 (J)	0.17 (J-)	8.3	33 (J)	0.035	0.47 (J+)	--
A76	AA4A023	0 - 6	6.1	240 (J)	0.24 (J-)	8.2	43 (J)	--	0.91 (J+)	--
A77	AA4A024	0 - 6	4.8	140 (J)	0.15 (J-)	7.7	37 (J)	--	1 (J+)	--
C80	AA4C015	6 - 8	6.1	200	0.32 (J-)	12	3,500	--	0.49 (J+)	--
C81	AA4C018	6 - 8	5.8	140	0.2	8.8	820	--	0.99 (J+)	--
C82	AA4C017	6 - 8	4.5	150	0.16	8.6	270	--	0.8 (J+)	--
C83	AA4C016	6 - 8	5.5	160	0.22 (J-)	9.8	1,300	--	1.1	--
C84	AA4C019	6 - 8	6.3	150	0.15	9.9	410	--	0.61 (J+)	--
C85	AA4C011	6 - 8	8.7	160	0.16 (J-)	8.5	5,300	--	1.2	0.16
C86	AA4C022	6 - 8	5.6	190	0.14	9.5	420	--	0.68 (J+)	--

Table A.5-3
Sample Results for Metals Detected above MDCs at Study Group 3
(Page 2 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**8,356**	**43**	**5,100**	**5,100**
C87	AA4C012	6 - 8	11	150	0.19 (J-)	8.4	**13,000**	--	0.5 (J+)	0.58
	AA4C013	6 - 8	11	140	0.2 (J-)	11	**12,000**	--	0.5 (J+)	0.44
	AA4C024	11 - 12	8.6	150	0.22	8	6,100	0.033 (J-)	0.77	0.22 (J-)
C88	AA4C020	6 - 8	6.3	160	0.2	8.6	1,800	--	0.56 (J+)	--
C89	AA4C021	6 - 8	5.1	140	0.14	7.8	260	--	0.56 (J+)	--
C90	AA4C014	6 - 8	5.8	180	0.093 (J-)	8.9	680	0.055 (J+)	0.63 (J+)	--
C93	AA4C023	6 - 8	8.1	150 (J)	0.15 (J-)	9.2	2,000 (J)	--	--	--
C94	AA4C025	0 - 6	4.4	140	0.15 (J-)	7.9	35	0.017 (J-)	--	--
	AA4C026	0 - 6	4.8	130	0.13 (J-)	7.5	30	0.023 (J-)	0.7 (J-)	--
	AA4C027	0 - 6	4.1 (J-)	120	0.093 (J-)	6.4	120	0.024 (J-)	0.66 (J-)	--
	AA4C028	0 - 6	3.6 (J-)	110	0.13 (J-)	6.9	370	0.024 (J-)	--	--

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

All samples at Site T-2A, Shasta were analyzed for RCRA metals. None of the samples collected at the 225-ft radius (AA4016 through AA4024) at locations A70 through A77 exceeded the FALs. The stained material at location A66 was also sampled for TCLP VOC and SVOCs, and results indicated that the material did not exceed the FAL for any constituent. The soil directly under the spill at location A66 was analyzed for RCRA metals, with results exceeding the FAL for arsenic and lead that requires corrective action.

At Site T-2, all samples associated with the 49 lead bricks were analyzed for RCRA metals (see Appendix F for analytical sample results). A 95 percent UCL was determined for these samples and is provided in Table A.5-4. Sample results for lead were reported with a maximum concentration of 370 mg/kg. Due to the large variability in results, the standard deviation is calculated at 159.6, which results in the 95 percent UCL being calculated on the high end of the range at 326.6 mg/kg. This value is well below the FAL of 8,356 mg/kg.

Table A.5-4
95% UCL for Lead Brick Cluster Sample Area for Study Group 3 (mg/kg)

Location	Standard Deviation	Number of Samples	Minimum Sample Size	Average	95% UCL	PAL (IA)	FAL (RW)
C94	159.6	4	3	138.8	326.6	800	8,356

IA = Industrial Area
RW = Remote Work Area

See Section A.8.0 for information on the disposition of the removed lead items.

A.5.3 Corrective Actions

Lead bricks, batteries, and items identified within CAU 105 were assumed to be PSM and required corrective action. A corrective action was implemented to remove identified lead bricks, the breached battery, and associated soil. A total of two intact batteries (C91 and C92), one breached lead-acid battery (C93), two bricks in an intact container (B84), 18 scattered lead bricks (C80 through C90), and 49 lead bricks in a cluster (C94) were removed from CAU 105. The analysis of samples collected under the removed items confirms that no lead concentrations in the remaining soil exceed the FAL.

The data evaluation of lead items discovered in the area adjacent to Site T-2A, Shasta GZ reveals that no COCs above the FAL were found at the 225-ft sampling radius. The area within the sampling radius includes the spill at location A66 where lead contamination was observed above the FAL. However, as a conservative measure, it is assumed that the area within this radius exceeds the FAL for lead and requires a corrective action. A corrective action of closure in place with an FFACO UR was established to encompass the 225-ft radius around GZ and is shown on Figure A.5-3 and presented in Attachment D-1.

Based on the evaluation of spills and debris at Site T-2B, Diablo, no COCs above the FAL were identified at this site. The two lead bricks discovered in an intact container north of the RMA boundary at location B84 (Figure A.5-1) were identified as PSM, and a corrective action of clean

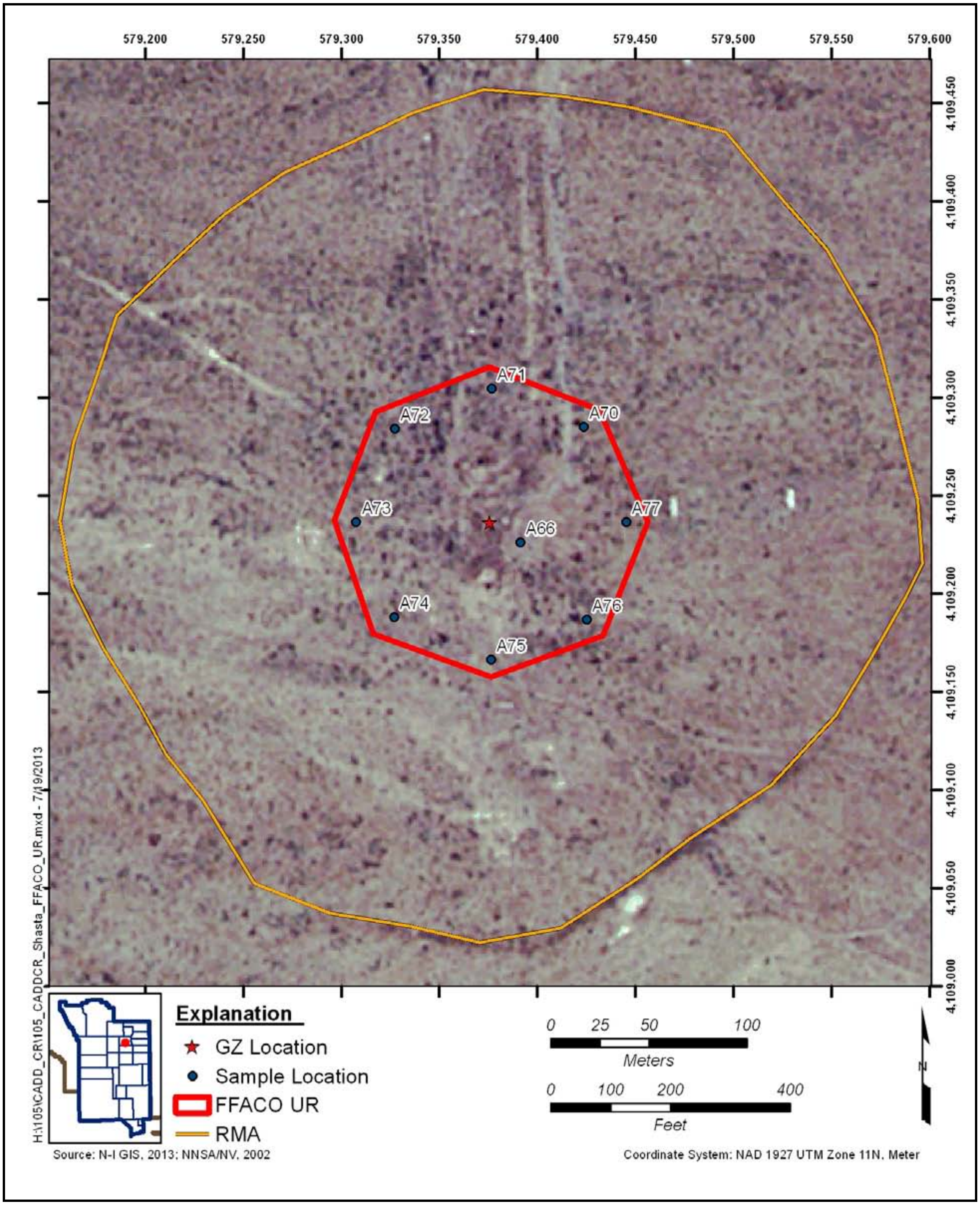


Figure A.5-3
UR Boundary for Lead at Site T-2A, Shasta

closure with removal of the lead bricks was completed during the CAI. As there was no indication of a release, sampling was not performed. Therefore, no further corrective action is needed, and the selected corrective action at Site T-2B, Diablo for debris and spills is clean closure.

Based on the data evaluation for spills and debris at Site T-2 GZ area, COCs were removed from this site. There were 18 scattered lead bricks, 49 bricks identified in a cluster, one breached lead-acid battery, and two intact lead-acid batteries removed from the site. The lead items were identified as PSM, and a corrective action of closure in place with removal of the lead items was completed during the CAI. Verification sample results confirmed that COCs are not present in the remaining soil. Therefore, no further corrective action is needed, and the selected corrective action at Site T-2 for debris and spills is closure in place.

Based on the data evaluation for spills and debris at Site T-2 waste trenches (Study Group 5), COCs were removed from the open waste trench at this site. Debris from the open waste trench was identified as PSM, and a corrective action of closure in place with removal of the debris was completed during the CAI. Therefore, no further corrective action is needed, and the selected corrective action at Site T-2 for debris and spills is closure in place as shown on Figure A.7-4.

A.5.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) 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.6.0 Study Group 4, Migration

Study Group 4 encompasses all study sites within this CAU. This study group consists of the translocation of contaminated surface soil from a Study Group 1 release by stormwater runoff into drainages. Drainages at all of the three study sites were investigated. Additional detail on the history of Study Group 4 is provided in the CAIP (NNSA/NSO, 2012a).

The drainages flowing through CAU 105 consist of several small braided washes and some prominent washes flowing to the south and east ultimately into Yucca Flat dry lake. The washes entering and leaving these areas are generally dry, but are subject to infrequent but intense stormwater flows. Based on the abundance of trinitite and TED results below the 25 mrem/OU-yr dose presented in Section A.6.2.3, it may be concluded that radionuclides are being transported downstream in the CAU 105 drainages but at radiological levels lower than the FAL. Low levels of dose were observed near the RMA boundaries and in drainages southeast of Site T-2A, Shasta and east of Site T-2. During the 56 to 60 years since the releases occurred, many large storm events have occurred, such as the El Niño-associated storms of March 1995 and February 1998 that caused regional flooding and subsequent erosion of surface soil.

A.6.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this Study Group (NNSA/NSO, 2012a) are described in the following subsections. Investigation activities were conducted to determine whether deposited contamination has migrated with stormwater runoff into drainage channels located at the sites.

A.6.1.1 Visual Inspections

Visual inspection of the drainages were conducted at all sites. Visual surveys were used to identify major drainages and locate sedimentation areas downstream from areas potentially impacted by atmospheric testing. Drainages were identified for investigation at all three study sites as shown on Figure A.6-1. One drainage area was identified at Site T-2A, Shasta; two identified at Site T-2B,

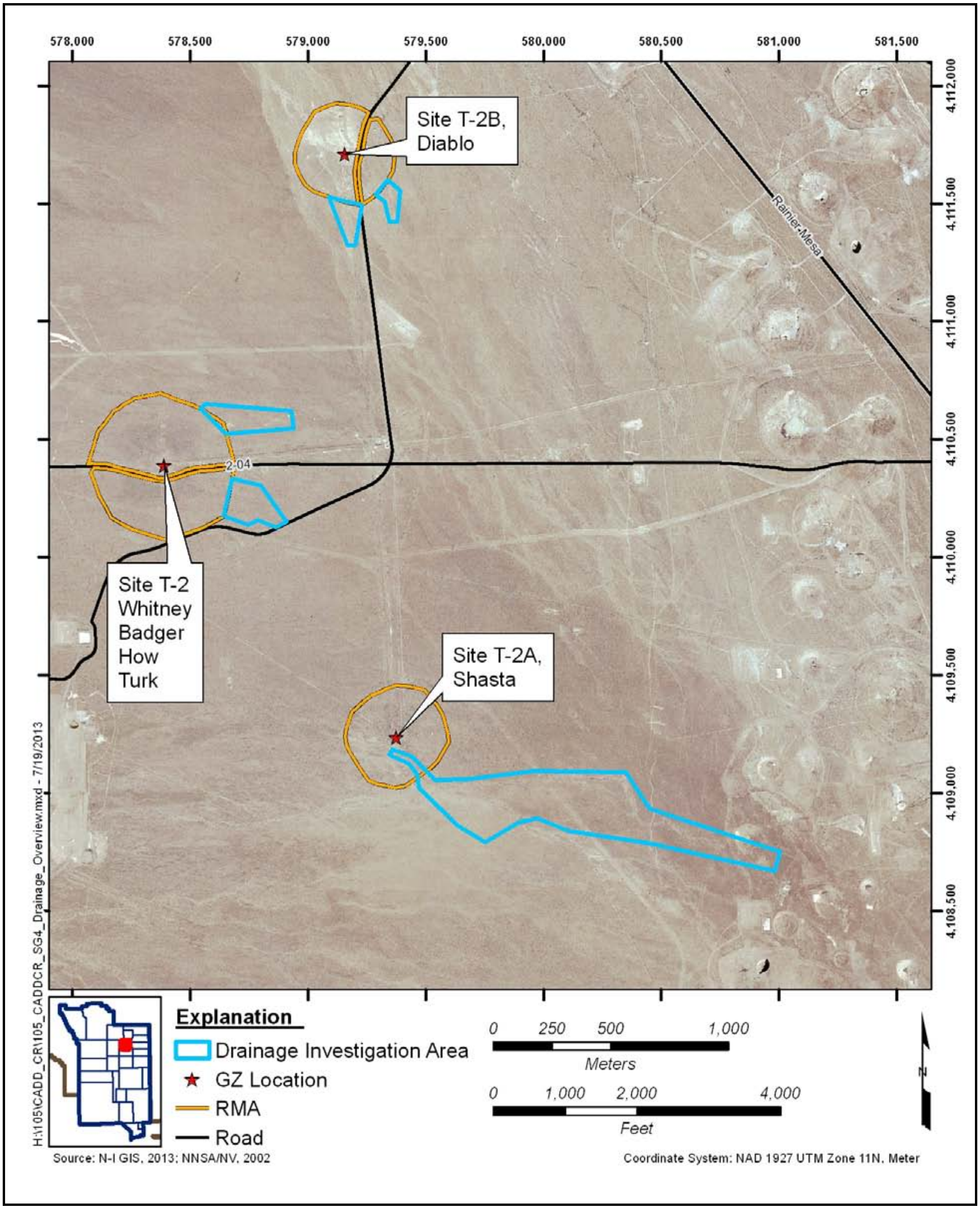


Figure A.6-1
Drainages Investigated for Study Group 4

Diablo; and two areas at Site T-2. Abundant amounts of trinitite were observed at each of the three sites. At Site T-2A, Shasta and Site T-2, significant migration of the trinitite was observed.

The drainages selected for investigation at Site T-2A, Shasta flow southeast. One major channel contained trinitite observed approximately 1 mi downstream from GZ. Trinitite was also discovered outside the major drainage channel in the general wash area to the south that parallels the drainage channel

Two drainages were selected for investigation at Site T-2B, Diablo. Drainage patterns were identified in the southern section of this site flowing to the south. Trinitite was observed at the GZ area and migration extended approximately 75 ft south of the RMA boundary.

Two drainages areas were identified for investigation at Site T-2. Drainage areas north and south of Road 2-04 on the east side of GZ were identified as the major drainages in the area impacted by the testing performed at this site. Both north and south drainage areas flow to the east and exhibit braided channels without a well defined main channel. Visual inspections indicate that the trinitite abundant in the GZ area is migrating downstream to the east. Trinitite was visually observed to extend approximately 600 ft downstream from the RMA boundary.

A.6.1.2 Radiological Surveys

Terrestrial radiological surveys were conducted at all drainage areas. These surveys were performed to examine the distribution of radiological contamination across the site, which was used to aid in the selection of soil sampling locations. Due to the observed migration of radionuclides to include trinitite during the CAI, additional surveys were completed for the extended drainage areas at all sites.

GPS-assisted gamma walk-over surveys were conducted to investigate the drainage areas for evidence of contaminant migration. Surveys were completed in active channels, over bank deposits, and at downstream areas where trinitite was observed. Readings above background were detected within the drainages. Count-rate data were collected with a TSA Systems PRM-470 model plastic scintillator. Data were logged, and position data were collected at 1-second intervals, via a Trimble Systems GeoXT GPS unit. The walkover speed was approximately 1 to 2 m/s with the radiation detector held at a height of about 0.5 m above the ground surface. Count rates for the PRM-470 are expressed in units of counts per second and evaluated qualitatively as comparative relative spatial distribution in units of multiples of background. Data were post-processed, loaded into a geographical information system, color-coded, and displayed on a map of the sites.

Surveys were performed at Site T-2A, Shasta using the PRM-470 to the east in the major drainage channel and the area south of this channel (Figure A.6-2) where trinitite was observed. One radiologically elevated area approximately 1,300 ft east of GZ was observed within the drainage channel and used to identify sample locations. Surveys performed in the area south of the major channel did not identify any significant radiologically elevated areas. Surveys using the PRM-470 that were performed at Site T-2B (Figure A.6-3) and T-2 (Figure A.6-4) detected drainage areas with slightly elevated radiological readings that were used to identify locations for sampling as discussed in Section A.6.1.3.2.

A.6.1.3 Sample Collection

The following subsections discuss the TLD and soil samples collected as part of the CAI.

A.6.1.3.1 TLD Samples

TLDs were installed at sample locations as shown on Figures A.6-2 through A.6-4. A total of 23 TLDs were collected during the drainage investigation to measure external dose as summarized in Table A.6-1. Fifteen TLDs were placed at the initiation of CAI activities before soil collection. Further radiological surveys were performed as a result of trinitite migration discovered at all three sites. Based upon these surveys, eight other TLDs were placed: five at Site T-2A, Shasta (A64, A65, A67, A68, and A69) and three at Site T-2 (C77, C78, and C79). One TLD was placed in an area where soil was not sampled (location A69). The TLDs as listed in Table A.6-2 were placed to measure external doses. All TLDs were measured by the NNSS environmental TLD monitoring program. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.9.0.

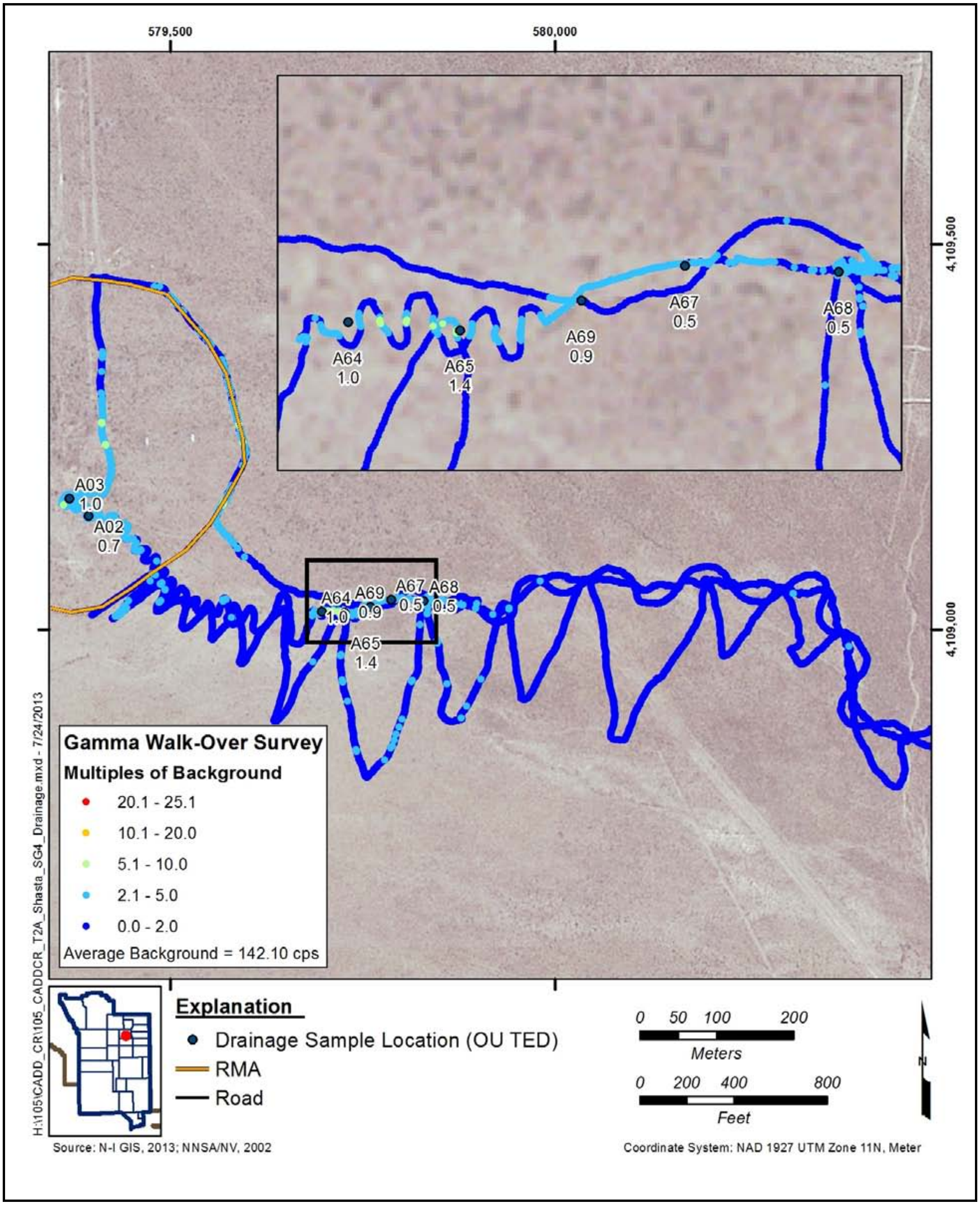


Figure A.6-2
Sample Locations Including the 95% UCL of the TED for Site T-2A, Shasta, Study Group 4

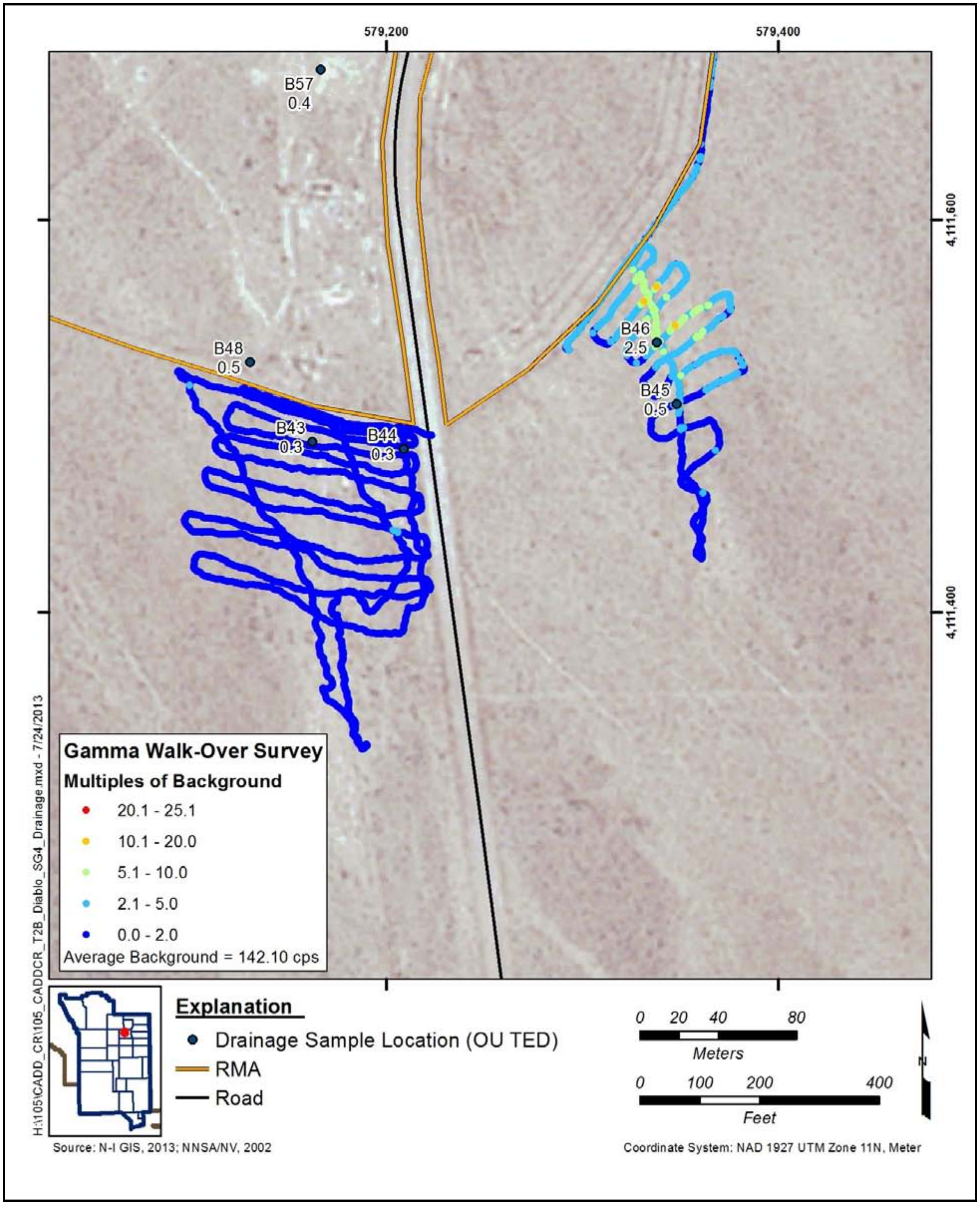


Figure A.6-3
Sample Locations Including the 95% UCL of the TED for Site T-2B, Diablo, Study Group 4

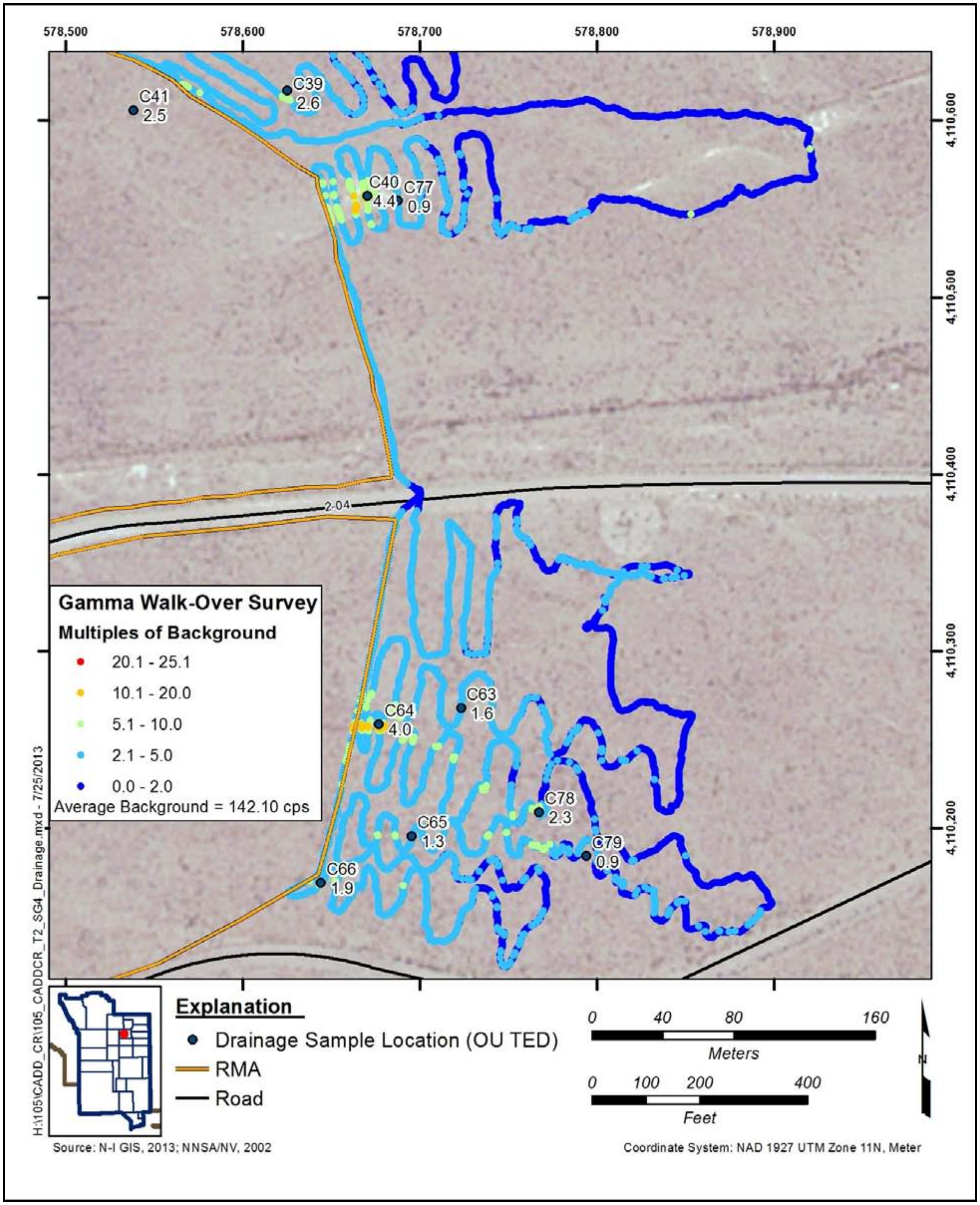


Figure A.6-4
Sample Locations Including the 95% UCL of the TED for Site T-2, Study Group 4

Table A.6-1
TLD Sample Summary for Study Group 4

Site	Number of TLDs at Each Site	Analyses (Method)
T-2A, Shasta	7	*Nevada Test Site Routine Radiological Environmental Monitoring Plan*[a]
T-2B, Diablo	6	
T-2	10	
Total	23	

[a]BN, 2003

Table A.6-2
TLDs for Study Group 4
(Page 1 of 2)

TLD Location	TLD Number	Date Placed	Date Collected	Purpose
Site T-2A, Shasta				
A02	4134	10/25/2012	01/28/2013	Evaluate Drainage
A03	4063	10/25/2012	01/28/2013	Evaluate Drainage
A64	3995	11/27/2012	01/28/2013	Evaluate Drainage
A65	6082	11/27/2012	01/28/2013	Evaluate Drainage
A67	4548	02/07/2013	05/09/2013	Evaluate Drainage
A68	4611	02/07/2013	05/09/2013	Evaluate Drainage
A69	4479	02/07/2013	05/09/2013	Evaluate Drainage
Site T-2B, Diablo				
B43	5054	10/24/2012	01/30/2013	Evaluate Drainage
B44	6064	10/25/2012	01/30/2013	Evaluate Drainage
B45	5056	10/25/2012	01/30/2013	Evaluate Drainage
B46	6332	10/25/2012	01/30/2013	Evaluate Drainage
B48	6411	10/25/2012	01/30/2013	Evaluate Drainage
B57	6375	10/25/2012	01/30/2013	Evaluate Drainage
Site T-2, Whitney, Badger, How, Turk				
C39	6496	10/23/2012	01/29/2013	Evaluate Drainage
C40	4308	10/23/2012	01/29/2013	Evaluate Drainage
C41	6272	10/23/2012	01/29/2013	Evaluate Drainage

Table A.6-2
TLDs for Study Group 4
(Page 2 of 2)

TLD Location	TLD Number	Date Placed	Date Collected	Purpose
Site T-2, Whitney, Badger, How, Turk (continued)				
C63	6190	10/24/2012	01/29/2013	Evaluate Drainage
C64	6493	10/24/2012	01/29/2013	Evaluate Drainage
C65	6089	10/24/2012	01/29/2013	Evaluate Drainage
C66	6196	10/23/2012	01/29/2013	Evaluate Drainage
C77	3980	11/27/2012	01/29/2013	Evaluate Drainage
C78	3662	11/27/2012	01/29/2013	Evaluate Drainage
C79	6125	11/27/2012	01/29/2013	Evaluate Drainage

A.6.1.3.2 Soil Samples

A total of 29 environmental samples (including one FD) from 22 biased sample locations were collected during investigation activities of the drainages at the three study sites to determine internal dose. All samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am. A summary of the collected soil samples is included in Table A.6-3. Information to include the sample location, number, and purpose for each sample are listed in Table A.6-4.

Table A.6-3
Soil Sample Summary for Study Group 4

Site	Number of Locations	Number of Soil Samples	Analyses (Method)
T-2A, Shasta	6	13 (1 FD)	Pu-241; Isotopic U; Isotopic Pu; Isotopic Am; Gamma Spectroscopy (HASL-300)[a]
T-2B, Diablo	6	6	
T-2	10	10	
Total	22	29	

[a]DOE, 1997

All samples were collected at 10-cm vertical intervals to a depth of 30 cm. Four locations (A64, A65, A67, and A68) were identified for evaluation to 50 cm to an undisturbed horizon. Depth samples were radiologically field screened, and the surface sample and any interval samples that exceeded the

Table A.6-4
Soil Samples Collected for Study Group 4
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Site T-2A, Shasta				
A02	AA4A004	0 - 10	Soil	Environmental
A03	AA4A001	0 - 10	Soil	Environmental
	AA4A002	0 - 10	Soil	FD of #AA4A001
	AA4A003	20 - 30	Soil at Depth	Environmental
A64	AA4A005	0 - 10	Soil	Environmental
	AA4A006	20 - 30	Soil at Depth	Environmental
	AA4A011	40 - 50	Soil at Depth	Environmental
A65	AA4A007	0 - 10	Soil	Environmental
	AA4A008	20 - 30	Soil at Depth	Environmental
	AA4A012	40 - 50	Soil at Depth	Environmental
A67	AA4A014	0 - 10	Soil	Environmental
	AA4A015	20 - 30	Soil at Depth	Environmental
A68	AA4A013	0 - 10	Soil	Environmental
Site T-2B, Diablo				
B43	AA4B002	0 - 10	Soil	Environmental
B44	AA4B003	0 - 10	Soil	Environmental
B45	AA4B004	0 - 10	Soil	Environmental
B46	AA4B005	0 - 10	Soil	Environmental
B48	AA4B001	0 - 10	Soil	Environmental
B57	AA4B006	0 - 10	Soil	Environmental
Site T-2, Whitney, Badger, How, Turk				
C39	AA4C004	0 - 10	Soil	Environmental
C40	AA4C001	0 - 10	Soil	Environmental
C41	AA4C003	0 - 10	Soil	Environmental
C63	AA4C006	0 - 10	Soil	Environmental
C64	AA4C005	0 - 10	Soil	Environmental
C65	AA4C009	0 - 10	Soil	Environmental

Table A.6-4
Soil Samples Collected for Study Group 4
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
Site T-2, Whitney, Badger, How, Turk (continued)				
C66	AA4C008	0 - 10	Soil	Environmental
C77	AA4C002	0 - 10	Soil	Environmental
C78	AA4C007	0 - 10	Soil	Environmental
C79	AA4C010	0 - 10	Soil	Environmental

FSL submitted for analysis. The FSL at depth was exceeded at four sample locations (A03, A64, A65, A67) at Site T-2A, Shasta.

A total of seven sedimentation areas were identified for sampling investigation at Site T-2A, Shasta as shown on Figure A.6-2. Two locations (A02 and A03) were established at the sedimentation areas closest to the GZ area. Location A03 was sampled at the 20-to-30-cm depth because FSLs were exceeded. It was also noted that trinitite was visually observed at all intervals down to 30 cm for both locations.

Two sedimentation areas (A64 and A65) outside the RMA were selected due to observed elevated radiological readings. Screening performed to a depth of 30 cm at both locations revealed a continued increase in alpha and beta readings to this depth. Screening was continued at these sites to 50 cm to an undisturbed horizon. Radiological screening levels decreased below the 20-to-30-cm interval down to an undisturbed horizon at both locations. Trinitite was visually observed on the surface at both locations and in the 20-to-30-cm sample at location A65. Soil samples were collected at the surface, 20 to 30 cm, and 40 to 50 cm at both locations.

Due to the radiological activity observed at locations A64 and A65, three other downstream sedimentation areas were identified for investigation. Locations A69, A67, and A68 were selected to provide more comprehensive migration and sedimentation data. A TLD was placed at each location, however soil samples were not submitted for analysis at A69 because the results obtained from the two downstream locations (A67 and A68) were below FALs. Radiological screening performed at A67 and A68 revealed a continued increase in alpha and beta readings to a depth of 30 cm, where the readings then decreased to the undisturbed horizon, similar to upstream locations A64 and A65. Screening levels at the two downstream locations were generally less than the upstream locations. The undisturbed horizon was observed at 30 to 40 cm at A67 and A68, which is approximately 10 cm less than the sedimentation areas immediately upstream. Trinitite was observed only at the surface at both locations A67 and A68. Soil samples were collected at the surface and at 20 to 30 cm at location A67, where the FSL was exceeded by approximately 18 percent. Although this does not exceed the 20 percent criteria for determining the presence of buried contamination, a sample was collected to provide additional characterization data.

A total of six sedimentation areas were identified for investigation at Site T-2B, Diablo as shown on Figure A.6-3. The locations were established at two drainage areas identified on the south side of this site. One location (B48) was established at a sedimentation area on the inside of the RMA. Four locations (B43 through B46) were established on the outside the RMA. Trinitite was observed on the surface at all locations. One sedimentation area (B57) was identified for sampling due to its close proximity to a soil mound close to GZ. No subsurface samples were submitted for analysis at this site as FSLs were not exceeded.

At Site T-2, a total of 10 sedimentation areas were identified for investigation as shown on Figure A.6-4. Drainages were identified in the north and south sections of this site flowing to the east. Four sedimentation areas were identified on the northern section and six areas in the southern section. Drainage channels flowing from this site are not well defined (i.e., discernible channels are not present). Trinitite is abundant at this site and was observed at the surface at most sedimentation areas selected. As a result of the radiological surveys performed in the drainage area in the northern section, four sedimentation areas were selected. Locations were based upon radiological surveys and visual inspections of the area. Sample locations C40 and C77 were selected in the most defined drainage channel in the northern section. Locations C39 and C41 were selected at a lesser defined, but significant drainage channel in close proximity. One location was located inside (C41) and one location outside (C39) of the RMA. As no FSLs were exceeded at depth, only surface samples were submitted for analyses. Trinitite was observed only at the surface at C41 and C77 and at depth at sample locations C39 and C40. As a result of the radiological surveys performed in the southern drainage area, six sedimentation areas (C63 through C66 and C78 through C79) outside the RMA were selected due to observed elevated readings. Trinitite was observed at the surface for samples

C63, C65, C66, and C78 and at depth for sample location C64 closest to the RMA. As no FSLs were exceeded at depth, only surface samples were submitted for analyses. No trinitite was observed at location C79, which is the furthest location from GZ.

A.6.1.4 Deviations

No deviations to the CAIP (NNSA/NSO, 2012a) were noted.

A.6.2 Investigation Results

The following subsections present the analytical and computational results for soil and TLD samples for Study Group 4. All sampling and analyses were conducted as specified in the CAIP (NNSA/NSO, 2012a). The results are reported as doses that are comparable to the dose-based FAL of 25 mrem/OU-yr. The analytical parameters and laboratory methods used during this investigation were discussed in the CAIP.

Sampling was planned and implemented for Study Group 4 by selecting locations of maximum expected radioactivity. TLDs collect three independent measurements of external dose that can be used to calculate a 95 percent UCL of the external dose measurement. This adds an additional level of conservatism to the external dose estimate. Therefore, 95 percent UCL of the TED estimates will be reported for this study group as the total of the individual internal dose estimate and the 95 percent UCL of the external dose estimate.

A.6.2.1 External Radiological Dose Measurements

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.2.2.5. 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.6-5.

Table A.6-5
95% UCL External Dose for Each Exposure Scenario for Study Group 4

Location	Standard Deviation	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)
Site T-2A, Shasta						
A02	0.06	3	3	13.3	2.2	0.7
A03	0.06	3	3	19.5	3.3	1.0
A64	0.10	3	3	20.3	3.4	1.0
A65	0.17	3	3	**27.2**	4.6	1.4
A67	0.04	3	3	10.4	1.8	0.5
A68	0.02	3	3	10.2	1.7	0.5
A69	0.07	3	3	17.4	2.9	0.9
Site T-2B, Diablo						
B79	0.07	3	3	15.5	2.6	0.8
B43	0.02	3	3	5.7	1.0	0.3
B44	0.05	3	3	6.8	1.1	0.3
B45	0.02	3	3	9.3	1.6	0.5
B46	0.20	3	3	**49.5**	8.3	2.5
B48	0.07	3	3	9.6	1.6	0.5
B57	0.02	3	3	9.0	1.5	0.4
Site T-2						
C39	0.26	3	3	**51.0**	8.6	2.6
C40	0.26	3	3	**88.0**	14.8	4.4
C41	0.21	3	3	**49.9**	8.4	2.5
C63	0.16	3	3	**31.7**	5.3	1.6
C64	0.31	3	3	**79.2**	13.3	4.0
C65	0.07	3	3	**26.7**	4.5	1.3
C66	0.17	3	3	**37.1**	6.2	1.9
C77	0.08	3	3	17.8	3.0	0.9
C78	0.15	3	3	**45.7**	7.7	2.3
C79	0.09	3	3	17.8	3.0	0.9

Bold indicates the values exceeding 25 mrem/yr.

A.6.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample location were determined as described in Section A.2.2.4. The internal dose for each exposure scenario is presented in Table A.6-6. The analytical results for the individual radionuclides in each grab sample and the corresponding calculated internal dose are presented in Appendix F.

Table A.6-6
95% UCL Internal Dose for Each Exposure Scenario for Study Group 4
(Page 1 of 2)

Source	Location	Industrial Area mrem/IA-yr	Remote Work Area mrem/RW-yr	Occasional Use Area mrem/OU-yr
Site T-2A, Shasta				
Drainage	A02	0.2	0.0	0.0
Drainage	A03	0.1	0.0	0.0
Drainage - Depth	A03b	0.3	0.1	0.0
Drainage	A64	0.4	0.1	0.0
Drainage - Depth	A64b	1.9	0.3	0.1
Drainage	A65	1.3	0.2	0.1
Drainage - Depth	A65b	1.4	0.2	0.1
Drainage - Depth	A64c	0.2	0.0	0.0
Drainage - Depth	A65c	0.2	0.0	0.0
Drainage	A68	0.4	0.1	0.0
Drainage	A67	0.5	0.1	0.0
Drainage - Depth	A67b	0.2	0.0	0.0
Site T-2B, Diablo				
Drainage	B48	0.0	0.0	0.0
Drainage	B43	0.1	0.0	0.0
Drainage	B44	0.0	0.0	0.0
Drainage	B45	0.1	0.0	0.0
Drainage	B46	1.6	0.3	0.1
Drainage - Sedimentation Area	B57	0.0	0.0	0.0

Table A.6-6
95% UCL Internal Dose for Each Exposure Scenario for Study Group 4
(Page 2 of 2)

Source	Location	Industrial Area mrem/IA-yr	Remote Work Area mrem/RW-yr	Occasional Use Area mrem/OU-yr
Site T-2				
Drainage	C40	2.1	0.4	0.1
Drainage	C77	0.1	0.0	0.0
Drainage	C41	0.9	0.2	0.1
Drainage	C39	1.4	0.2	0.1
Drainage	C64	2.8	0.5	0.2
Drainage	C63	0.5	0.1	0.0
Drainage	C78	0.1	0.0	0.0
Drainage	C66	0.6	0.1	0.0
Drainage	C65	1.2	0.2	0.1
Drainage	C79	0.0	0.0	0.0

A.6.2.3 Total Effective Dose

The TED for each soil sample or TLD location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.6-7. The TED at sample locations in the drainages did not exceed the 25-mrem/OU-yr FAL at any site as shown on Figures A.6-2 through A.6-4.

Table A.6-7
TED for Study Group 4 (mrem/yr)
(Page 1 of 3)

Plot or 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
Site T-2A, Shasta						
A02	11.5	13.4	1.9	2.3	0.6	0.7
A03	17.5	19.6	2.9	3.3	0.9	1.0
A03b	**35.9**	**40.3**	6.0	6.8	1.8	2.0

Table A.6-7
TED for Study Group 4 (mrem/yr)
(Page 2 of 3)

Plot or 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
Site T-2A, Shasta (continued)						
A64	17.2	20.7	2.9	3.5	0.9	1.0
A64b	**71.0**	**85.6**	11.9	14.4	3.6	4.3
A64c	6.1	7.4	1.0	1.2	0.3	0.4
A65	22.7	**28.5**	3.8	4.8	1.2	1.4
A65b	24.3	**30.5**	4.1	5.1	1.2	1.5
A65c	4.2	5.3	0.7	0.9	0.2	0.3
A67	9.4	10.9	1.6	1.8	0.5	0.6
A67b	4.9	5.7	0.8	1.0	0.3	0.3
A68	9.9	10.6	1.7	1.8	0.5	0.5
A69	15.5	17.8	2.6	3.0	0.8	0.9
Site T-2B, Diablo						
B43	5.0	5.8	0.8	1.0	0.3	0.3
B44	5.2	6.8	0.9	1.1	0.3	0.3
B45	8.7	9.4	1.5	1.6	0.4	0.5
B46	**44.2**	**51.1**	7.4	8.6	2.2	2.6
B48	7.2	9.6	1.2	1.6	0.4	0.5
B57	8.3	9.0	1.4	1.5	0.4	0.5
Site T-2						
C39	**43.8**	**52.4**	7.4	8.8	2.2	2.6
C40	**81.4**	**90.1**	13.7	15.1	4.1	4.5
C41	**43.6**	**50.8**	7.3	8.5	2.2	2.6
C63	**26.9**	**32.2**	4.5	5.4	1.4	1.6
C64	**71.5**	**82.0**	12.0	13.8	3.6	4.1
C65	**25.6**	**27.9**	4.3	4.7	1.3	1.4
C66	**32.0**	**37.8**	5.4	6.3	1.6	1.9
C77	15.1	17.9	2.5	3.0	0.8	0.9

Table A.6-7
TED for Study Group 4 (mrem/yr)
(Page 3 of 3)

Plot or 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
Site T-2 (continued)						
C78	**40.8**	**45.8**	6.9	7.7	2.0	2.3
C79	14.8	17.9	2.5	3.0	0.7	0.9

Bold indicates the values exceeding 25 mrem/yr.

A.6.3 Corrective Actions

No COCs were identified in the drainage at CAU 105. Also, there is no potential for future migration of COC levels of radioactivity in local drainages because COCs do not exist in the source area (see Section A.3.2). Therefore, no further action is required.

A.6.4 Best Management Practices

As a BMP, and 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. The administrative UR boundary were determined based upon the area where the Industrial Area TED exceeds 25 mrem/IA-yr. This area is shown on Figure A.3-9 for Site T02A, Shasta; Figure A.3-10 for Site T-2B, Diablo; and Figure A.3-11 for Site T-2.

A.6.5 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) 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.7.0 Study Group 5, Landfills

Study Group 5 encompasses only Site T-2 within this CAU. This study group consists of the potential subsurface soil contamination resulting from the burial of waste. Additional detail on the history of Study Group 5 is provided in the CAIP (NNSA/NSO, 2012a).

A.7.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2012a) are described in the following subsections. Investigation activities included performing visual inspections, reviewing aerial survey photos, conducting TRSs, performing geophysical surveys, and removing debris from the open waste trench.

A.7.1.1 Visual Inspections

Visual inspections of Study Group 5 included site walks and aerial photography review. These were also TRSs and geophysical surveys conducted over the course of the field investigation. Biasing factors (indicating the potential release of contamination) were identified at a previously unidentified open waste trench located approximately 0.7 mi east of Site T-2 GZ (Figure A.7-1). Wood and metal debris were observed in the trench. Lead items and stained soil were observed at the site. In addition, one empty steel drum was observed at the site east of the open trench. Aerial photographs and visual surveys reveal disturbed, slightly depressed linear areas parallel to the open waste trench that could be indicative of buried waste trenches (i.e., landfills). The slightly depressed linear depressions are oriented east–west and differ in the surface expression of vegetation and lithology.

A.7.1.2 Radiological Surveys

GPS-assisted TRSs were performed at Study Group 5 during the CAI. The TRSs were conducted at the site to identify the spatial distribution of radiological readings and to identify the location of elevated radiological readings. Surveys did not indicate any area above background readings at this area as shown on Figure A.7-1. The TRS performed in this area showed a range of approximately 88 to 176 cps with a mean of 133 cps.

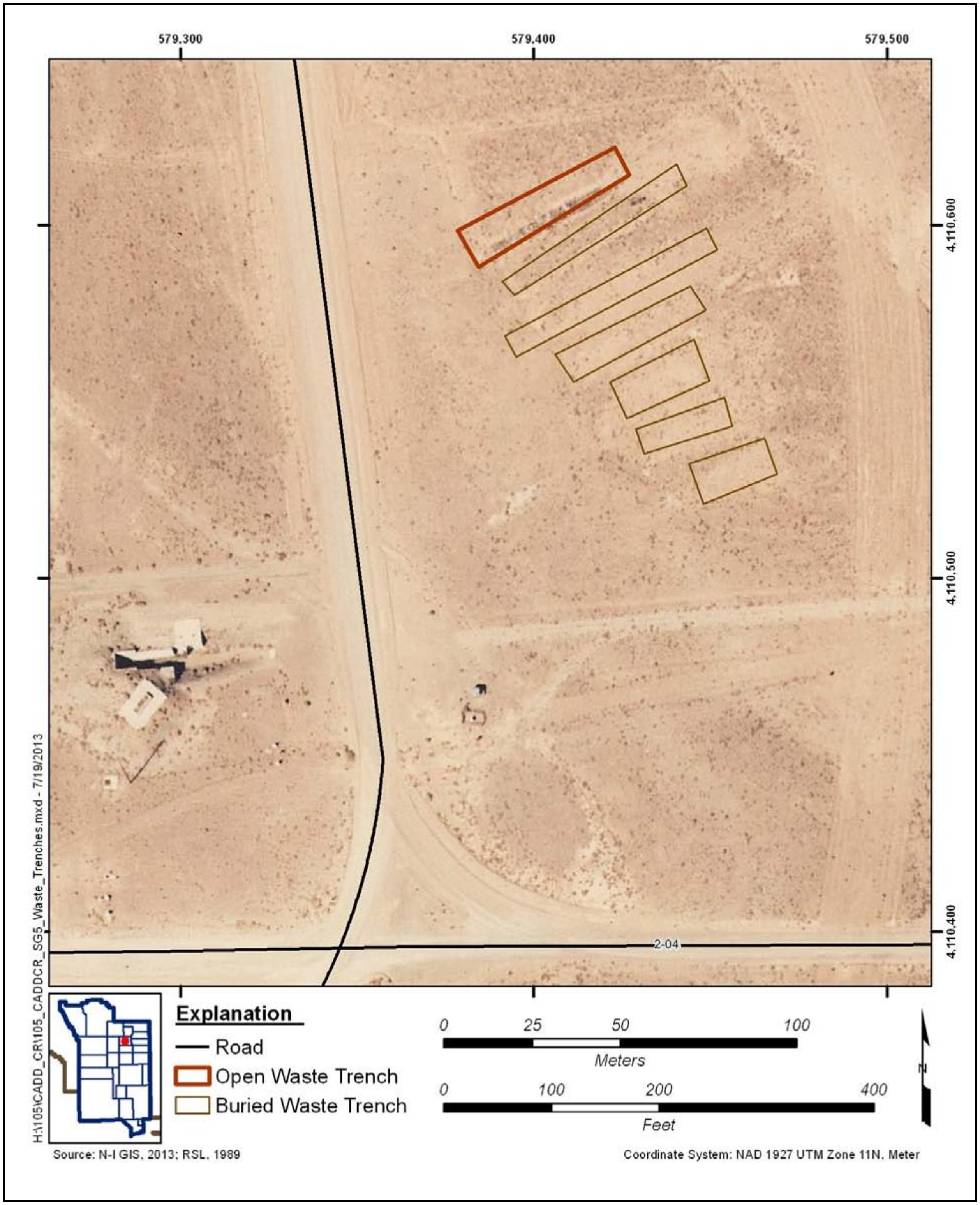


Figure A.7-1
Landfill Location at Study Group 5

A.7.1.3 Geophysical Surveys

Geophysical surveys were performed at the ends of the open trench to determine extent and in the area south of the open waste trench where buried waste trenches (i.e., landfills) were suspected. Geophysical surveys were conducted to identify potential buried metallic debris. Results of the geophysical surveys indicate significant amounts of subsurface metal south of the open trench.

The area south of the open disposal trench was surveyed with the EM61-MK2 and EM31-MK2 geophysical instruments. Both surveys produced similar results, with the instrument response data from the EM31-MK2 providing a slightly sharper indication the location of metal in the subsurface. The areas of elevated instrument response labeled Trench 1 through 6 on Figures A.7-2 and A.7-3 have the potential of representing buried metal. The elevated instrument responses at Trench 1 are due to metal in the open trench and metal debris located on the surface off the southern rim of the trench. The highest potential for buried metal in Trench 2 lies at the southwest and northeast ends with instrument responses in excess of 2,000 millivolts (mV). The highest potential for buried metal in Trench 3 is at the southwest end with an instrument response also in excess of 2,000 mV. Trenches 4 and 5 appear to contain relatively smaller amounts of metal as indicated by a lesser instrument response that is still above background. Trench 6 may not contain significant metal and may represent disturbed soil. This is indicated by a low response from the EM61-MK2 with no response from the EM31-MK2. The elevated instrument response observed west of Trench 5 is probably due to the metal debris found at the surface. The areas east and north of the open trench were surveyed using the EM61-MK2. There were no significant instrument responses in these areas. The few elevated responses that were reported appear to be associated with metal debris observed at the surface; however, this cannot be verified without removal of the surface debris.

Two instruments were used to conduct the surveys. The first was an EM61-MK2 time domain metal detector. The second was an EM31-MK2 earth conductivity meter, which provides measurement of apparent conductivity and magnetic susceptibility of the subsurface. Both instruments are produced by Geonics Limited of Mississauga, Ontario, Canada.

The EM61-MK2 detects both ferrous and non-ferrous conductivity objects with spatial resolution. Each system includes a single transmitter coil and two receiver coils. The coils are 1 by 0.5 m in size. The signal received is reported in units of millivolts. With the coils mounted on wheels, the lowermost coil is approximately 16 in. above the ground surface. The lowermost coil doubles as both a transmitter and receiver with the transmission occurring at 75 hertz. Surveys were performed in a north–south pattern with each traverse immediately adjacent and parallel to the previous traverse when possible. Survey results are shown in Figure A.7-2.

The EM31-MK2 measures the conductivity of the soil as well as detecting the presence of metal. A transmitter coil located at one end induces circular eddy current loops in the earth that are proportional to the terrain conductivity in the vicinity of that loop. The current loop generates a magnetic field that is proportional to the value of the current flowing within that loop. The unit is carried approximately 3 ft above the ground surface. Surveys were performed in a north–south pattern with a 3-m spacing. Survey results are shown in Figure A.7-3.

The area surveyed south and east of the open trench measures approximately 70 m north–south by 170 m east–west. The area to the south was surveyed using both the EM61-MK2 and the EM31-MK2 to compare results. The areas east and north were surveyed using only the EM61-MK2 as no significant metal was detected.

A.7.1.4 Deviations

Samples were not collected from the open trench at the Study Group 5 waste trenches as discussed in the CAIP (NNSA/NSO, 2012a). This was due to a decision to perform an interim corrective action that consisted of the removal and disposal of all the material contained in the open trench. Samples were not planned for the nearby buried waste trenches that were assumed to contain COCs and require corrective action. It could not be assured that PSM does not remain following the removal of waste material from the open trench. Therefore, COCs were assumed to be present at the open trench, and this trench was included with the buried waste trenches as the defined area requiring additional corrective action for Study Group 5.

A.7.2 Investigation Results

Visual inspections discovered a previously unidentified open waste trench approximately 0.7 mi east of Site T-2 as shown on Figure A.7-1. The open trench measured approximately 160 by 40 by 6 ft and contains metal, wood debris, lead from an unknown source, and other debris. Approximately 140 yd^3

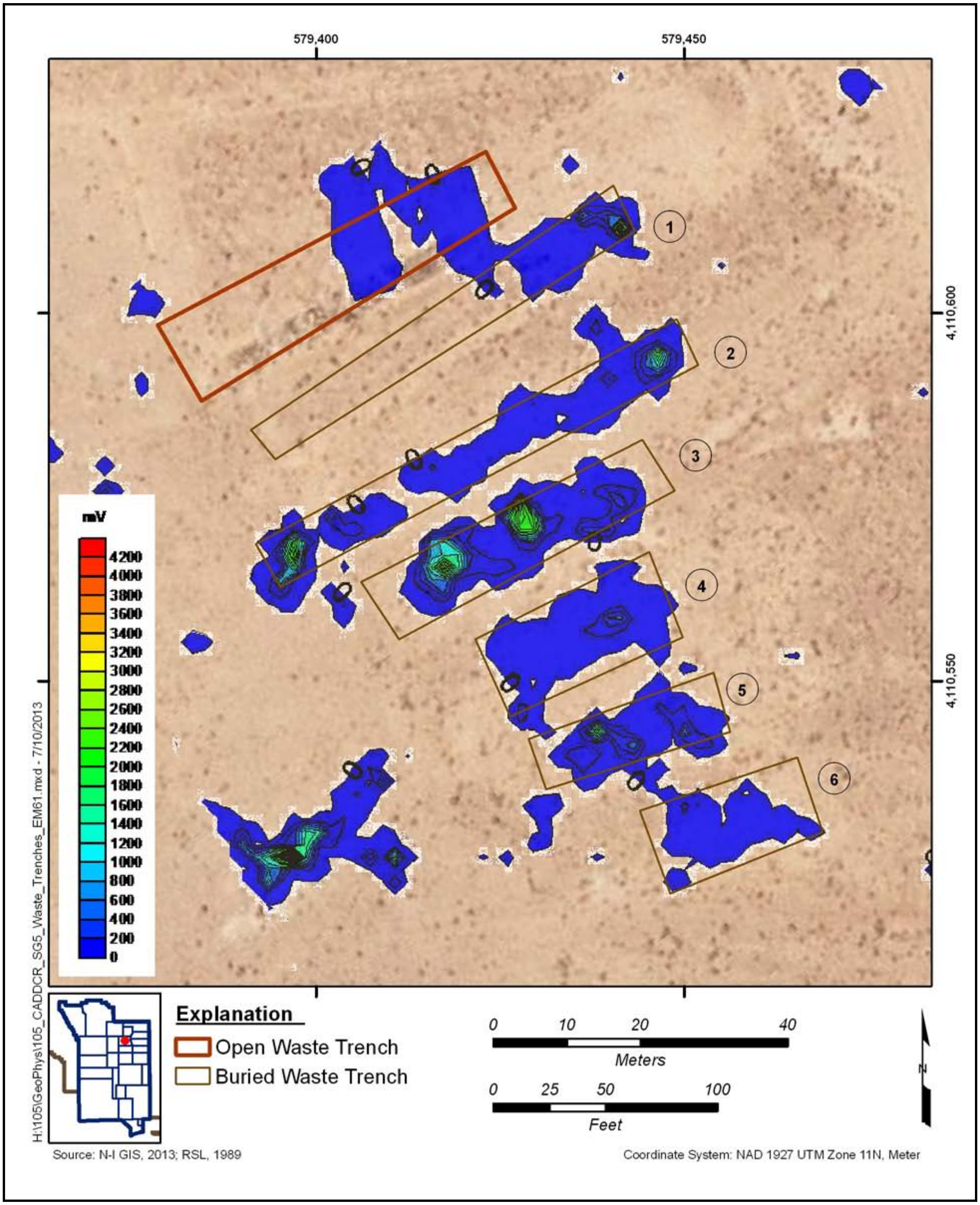


Figure A.7-2
Study Group 5 Geophysical Survey Results for EM61-MK2

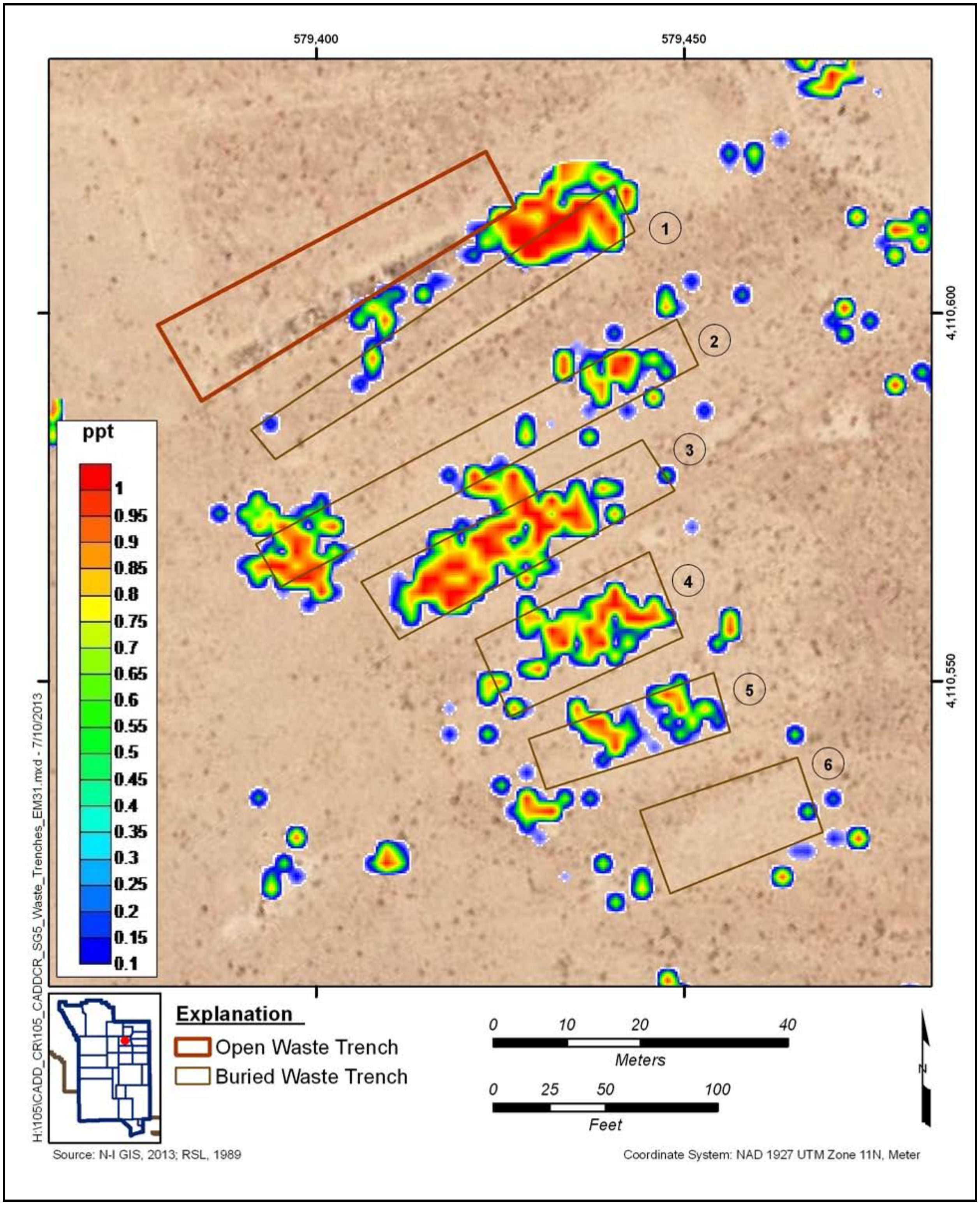


Figure A.7-3
Study Group 5 Geophysical Surveys for EM31-MK2

of material was collected and removed as a corrective action. Geophysical surveys were conducted in the area directly adjacent to the open waste trench and the area directly south to identify potential buried metallic debris.

Visual observations identified wood, metal, lead, and spill areas at the open waste trench located approximately 0.7 mi east of Site T-2 as shown on Figure A.7-1. Visual observations and aerial survey photographs indicated slightly depressed linear areas parallel to the open waste trench. Geophysical surveys were conducted in the area and resulted in the identification of buried waste trenches.

Based on the results of the geophysical surveys, it is assumed that buried contamination exists in this area and the trenches may contain PSM. Because it cannot be assured that no COCs remain at this location it is assumed that this area exceeds the FAL for chemical COCs and requires a corrective action of closure in place with UR.

A.7.3 Corrective Actions

Debris was identified in the open waste trench to include construction debris to include wood and metal. Lead was also identified as part of the debris. The debris identified within the open waste trench was removed as a corrective action, however it could not be assumed that all PSM was removed, so additional corrective action is required. A total 140 yd^3 of material was removed from this site. Other trenches are also assumed to contain PSM and require corrective action. Because it cannot be assured that no COCs remain at this location, it is assumed that this area exceeds the FAL for radiological and chemical COCs. The selected corrective action (see Appendix E) is closure in place with a UR as shown on Figure A.7-4. The FFACO UR boundary is presented in Attachment D-1.

A.7.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2012a) 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.

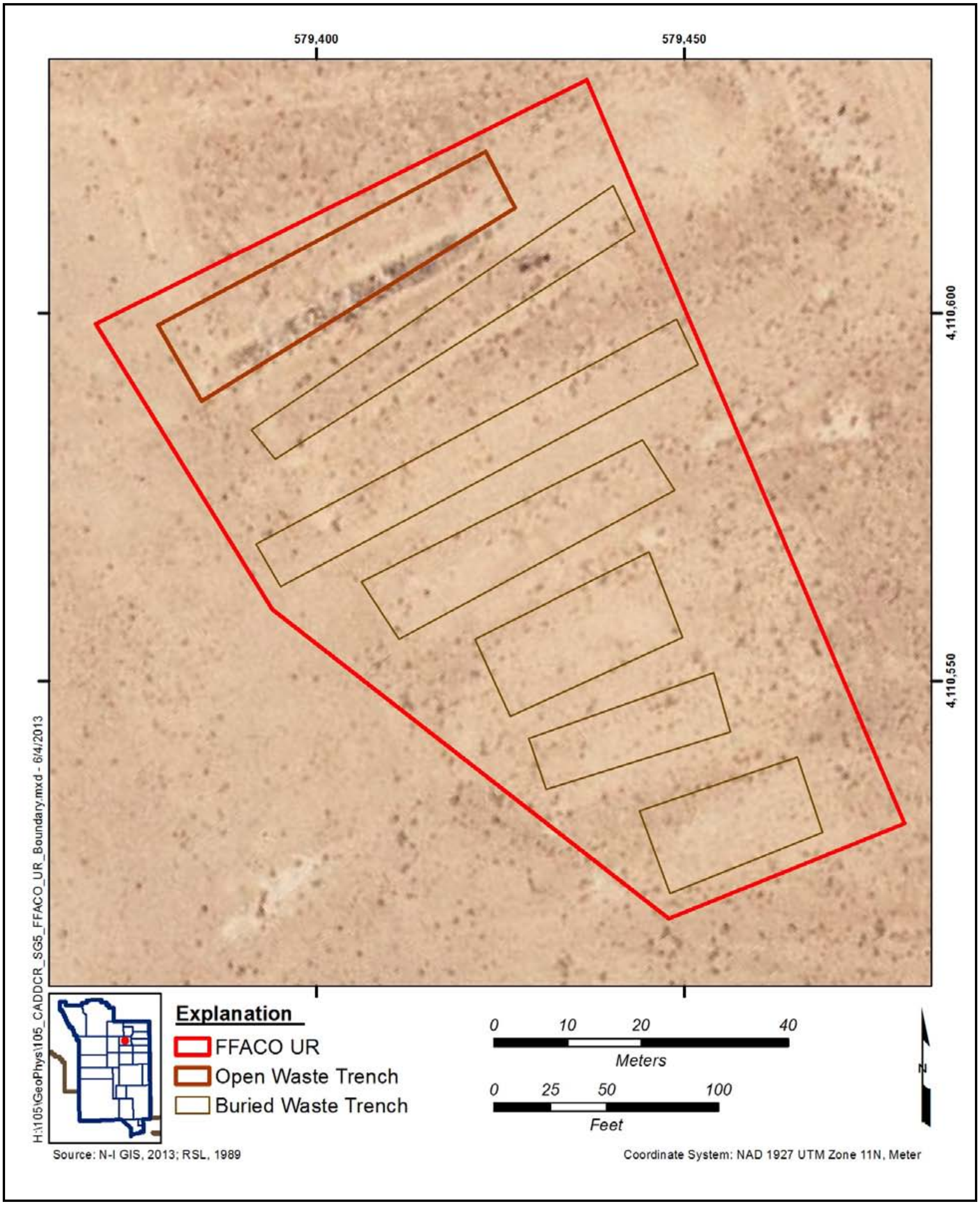


Figure A.7-4
Study Group 5 FFACO UR Boundary

A.8.0 Waste Management

Section A.8.1 addresses the characterization and management of investigation and remediation wastes. Waste management activities were conducted as specified in the CAIP (NNSA/NSO, 2012a). Wastes generated during the CAI were characterized based on process knowledge, analytical data, and FSRs. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste.

A.8.1 Generated Waste

The wastes listed in Table A.8-1 were generated during the field investigation activities of CAU 105. Investigation-derived waste (IDW) was segregated to the greatest extent possible, and waste minimization techniques were integrated into the field activities to reduce the amount of waste generated. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste.

Three satellite accumulation areas were established to manage hazardous and potentially hazardous waste generated during the CAI. The amount, type, and source of waste placed into each container were recorded in waste management logbooks that are maintained in the CAU 105 file.

Wastes generated during the investigation was segregated into the following waste streams:

- Disposable personal protective equipment (PPE) and sampling equipment
- Debris (miscellaneous debris generated from an open trench)
- Soil removed from under lead bricks
- Soil removed from under the breached lead-acid battery
- Lead waste (lead bricks and one breached lead-acid battery)
- Lead for recycle (lead bricks, lead wool, miscellaneous lead pieces)

A.8.2 Waste Characterization

The generated waste streams were characterized as Industrial Solid Waste, Low-Level Radioactive Waste (LLW), Mixed Low-Level Radioactive Waste (MLLW), and Recyclable Materials. All waste dispositions were based on process knowledge, radiological surveys, and analytical results from waste characterization samples, when necessary. Analytical results and comparison to regulatory

Table A.8-1
Investigation Waste at CAU 105

Container ID	Waste Items	Waste Type	Waste Disposition			
			Disposal Facility	Waste Volume	Disposal Date	Disposal Doc[a]
Industrial Solid Waste						
105R01	Debris	Industrial Solid Waste	Area 9 – U10c Landfill	140 yd^3	May 2013	LVF
Low-Level Radioactive Waste						
105A01	PPE, Disposable Sampling Equipment	LLW	Area 5 RWMC	55 gal	See Attachment D-2 of Appendix D	CD (pending)
Mixed Low-Level Radioactive Waste						
105A03	Lead Bricks	MLLW	Area 5 RWMC	N/A (7 bricks)	April 2013	CD
105C01	Soil	MLLW	Offsite Treatment Storage and Disposal Facility	55 gal	See Attachment D-2 of Appendix D	Onsite Hazardous Material Transfer
105C03	Soil	MLLW	Offsite Treatment Storage and Disposal Facility	10 gal	See Attachment D-2 of Appendix D	Onsite Hazardous Material Transfer
Recyclable Materials						
105A02	Lead Bricks (not waste)	Recyclable Material	Toxco Materials Management Center	N/A (10 bricks)	N/A	N/A
105A04	Lead Bricks (not waste)	Recyclable Material	Toxco Materials Management Center	N/A (49 bricks)	N/A	N/A
105A05	Lead Wool and Pieces (not waste)	Recyclable Material	Toxco Materials Management Center	2 gal	N/A	N/A
105C02	Debris (lead-acid battery)	Recyclable Material	Toxco Materials Management Center	1 battery	N/A	N/A
N/A	Lead-Acid Batteries (2)	Recyclable Material	NSTec Fleet Services	2 batteries	N/A	N/A

CD = Certificate of disposal
gal = Gallon
LVF = Landfill verification form
N/A = Not applicable
NSTec = National Security Technologies, LLC
RWMC = Radioactive Waste Management Complex

criteria are presented in Table A.8-2. Waste characterization and disposition was based on federal and state regulations, permit limitations, and disposal facility acceptance criteria. The waste disposal documentation for CAU 105 is in Attachment D-2.

Table A.8-2
Waste Characterization Results Detected for Study Group 3
(Page 1 of 2)

Sample Location	Sample Number	Sample Matrix	Parameter	Regulatory Limit	Result	Units
N/A	AA4C501	Soil	Am-241	10[a]	9.6 (J)	pCi/g
			Am-243	N/A	0.124 (J)	pCi/g
			Pu-238	10[a]	17.8 (J)	pCi/g
			Pu-239/240	10[a]	76 (J)	pCi/g
			Sr-90	100[a]	12.2 (J)	pCi/g
			U-234	100[a]	1.14	pCi/g
			U-235	100[a]	0.052	pCi/g
			U-238	100[a]	1.09	pCi/g
			Am-241	10[a]	19.3	pCi/g
			Co-60	100[a]	0.35	pCi/g
			Cs-137	100[a]	65.1	pCi/g
			Eu-152	100[a]	48.8 (J)	pCi/g
			TCLP Antimony	N/A	0.62	mg/L
			TCLP Lead	5[b]	**58**	mg/L
N/A	AA4C502	Soil	Am-241	100[a]	18 (J)	pCi/g
			Am-243	N/A	0.236 (J)	pCi/g
			Pu-238	10[a]	29.5 (J)	pCi/g
			Pu-239/249	10[a]	92 (J)	pCi/g
			Pu-241	100[a]	26.6 (J)	pCi/g
			Sr-90	100[a]	10.5 (J)	pCi/g
			U-234	100[a]	0.95	pCi/g
			U-235	100[a]	0.06	pCi/g
			U-238	100[a]	0.76	pCi/g
			Am-241	10[a]	18 (J)	pCi/g
			Cs-137	100[a]	60.5	pCi/g

Table A.8-2
Waste Characterization Results Detected for Study Group 3
(Page 2 of 2)

Sample Location	Sample Number	Sample Matrix	Parameter	Regulatory Limit	Result	Units
N/A	AA4C502	Soil	Eu-152	100[a]	45.6	pCi/g
			TLCP Antimony	N/A	0.35	mg/L
			TCLP Lead	5[b]	**33**	mg/L

[a]Radionuclide limits of NNSS U10c Landfill Permit (NNSA/NSO, 2010).
[b]TCLP limit (CFR, 2012).

Co = Cobalt
Cs = Cesium
Eu = Europium
mg/L = Milligrams per liter

J = Estimated value

Bold indicates the values exceeding the regulatory limit.

A.8.2.1 Industrial Solid Waste

Approximately 140 yd^3 of debris consisting mostly of wood, metal, paraffin wax, concrete, wires/cables, and soil was generated from an open waste trench. 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 where it was disposed of.

The PPE and disposable sampling equipment generated during site activities that were determined not to be radioactive material were bagged, marked, and placed in a roll-off container for disposition at the Area 9 U10c solid waste landfill.

A.8.2.2 Low-Level Radioactive Waste

One 55-gal container (105A01) of PPE and disposable sampling equipment was generated and characterized as LLW that is recommended for disposal at the Area 5 RWMC.

A.8.2.3 Mixed Low-Level Radioactive Waste

One 55-gal container (105C01) of soil, one 10-gal container (105C03) of soil, and seven lead bricks were generated and characterized as MLLW. The lead bricks were determined to have radiological contamination above the waste acceptance criteria of the offsite recycler and were therefore treated on site via macroencapsulation and disposed of at the Area 5 RWMC.

Container 105C01 consists of soil removed from below an area of lead bricks. Sample AA4C501 is a waste characterization sample analyzed for chemical and radiological constituents. The TCLP metals analysis of lead for sample AA4C501 produced a result of 58 mg/L, which exceeds the regulatory level of 5 mg/L, making the soil hazardous waste. In accordance with the *Nevada Test Site Performance Objective for Certification* (POC) *of Nonradioactive Hazardous Waste* (BN, 1995), all hazardous waste destined for offsite treatment and disposal requires screening for radionuclides. Sample AA4C501 exceeded the POC for Am-241, Cs-137, Pu-238, Pu-239/240, Sr-90, and U-234. Therefore, the waste is characterized as MLLW that is recommended for offsite treatment/disposal at a commercial RCRA treatment, storage, and disposal facility (TSDF), via the NNSS Area 5 Hazardous Waste Pad.

Container 105C02 consists of a dry (no electrolyte), breached lead-acid battery. The only source of chemical contamination is lead used to manufacture the battery. Therefore, the waste is characterized as RCRA-regulated hazardous waste. In accordance with the POC, all hazardous waste destined for offsite treatment and disposal requires screening for radionuclides. Sample AA4C502 was collected from the soil directly below the battery and is representative of the soil accumulated in the battery void space. Sample AA4C502 exceeded the POC for Am-241, Cs-137, Pu-238, Pu-239/240, Sr-90, and U-234. Therefore, the waste is characterized as MLLW that is recommended for treatment and disposal either on site or at an offsite TSDF.

Container 105C03 consists of soil removed from below a breached lead-acid battery. Sample AA4C502 is a waste characterization sample analyzed for chemical and radiological constituents. The TCLP metals analysis of lead for sample AA4C502 produced a result of 33 mg/L, which exceeds the regulatory level of 5 mg/L, making the soil hazardous waste. In accordance with the POC, all hazardous waste destined for offsite treatment and disposal requires screening for radionuclides. Sample AA4C502 exceeded the POC for Am-241, Cs-137, Pu-238, Pu-239/240, Sr-90, and U-234. Therefore, the waste is characterized as MLLW that is recommended for offsite treatment/disposal at a commercial RCRA TSDF, via the NNSS Area 5 Hazardous Waste Pad.

A.8.2.4 Recyclable Materials

Approximately 2 gal of lead wool including miscellaneous lead pieces, 1 dry lead-acid battery, and 59 lead bricks were generated as recyclable material that is recommended for recycling via an offsite recycler, Toxco Materials Management Center.

Two dry, intact lead-acid batteries were generated and transferred to NSTec Fleet Services for recycling.

A.9.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 105 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.9.1 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 105 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 105 files as a hard copy and electronic media.

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

A.9.1.1 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.9.1.2 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.9.1.3 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 5.0 percent of the samples collected was performed by TLI Solutions, Inc. in Golden, Colorado. Tier II and Tier III results were compared and the evaluation revealed compliance with the criteria that follows. The evaluated data was used in the investigation as a result.

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

  - retention times;
  - second column and/or second detector confirmation;
  - mass spectra interpretation;
  - interference check samples and serial dilutions;
  - post-digestion spikes and method of standard additions; and
  - breakdown evaluations.
- Perform calculation checks of
  - at least one analyte per QC sample and its recovery;
  - at least one analyte per initial calibration curve, continuing calibration verification, and second source recovery; and
  - at least one analyte per sample that contains positive results (hits); radiochemical results only require calculation checks on activity concentrations (not error).
- Verify that target compound detects identified in the raw data are reported on the results form.
- Document any anomalies for the laboratory to clarify or rectify. The contractor should be notified of any anomalies.

A.9.2 Field QC Samples

Laboratory QC samples were analyzed by the laboratory with each sample delivery group (SDG) of samples submitted for analysis for the analytical methods discussed in Sections A.3.0 through Section A.7.0. Laboratory QC samples were used to measure accuracy and precision (see Appendix B for further discussion). Initial and continuing calibrations were also performed for each SDG. When QC criteria was exceeded, quality flags were assigned to sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in CAU 105 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 to evaluate precision.

A.9.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.9.4 Laboratory Nonconformances

No nonconformance reports were issued against the laboratory during the course of the CAI investigation. All data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified.

A.9.5 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 Radiological Control Department in accordance with existing QC procedures for TLD processing. A summary of the routine environmental monitoring TLD QC program can be found in the *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003). Certification is maintained through the DOE Laboratory Accreditation Program for dosimetry.

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

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

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

A.10.0 Summary

Radionuclide and chemical contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 105. Assessment of the data generated from the CAI indicates the following:

- Surface radiological contamination does not exceed the FALs at any site (based on the Occasional Use Area exposure scenario).
- Chemical contamination is assumed to be exceed the FAL at Site T-2A, Shasta. A corrective action of closure in place was implemented at this site.
- Radiological and chemical contamination do not exceed the FALs at Site T-2B and Site T-2 (based on the Occasional Use Area exposure scenario).
- Radiological contamination and PSM is assumed to be present at the waste trenches associated with Site T-2 at levels exceeding the FALs. A corrective action of closure in place was implemented at this site.

During the investigation, PSM was discovered at all sites. At Site T-2A, Shasta, lead debris and items were discovered around the GZ area. It was assumed that lead contamination exceeded the FAL, and a corrective action of an FFACO UR was performed. At Site T-2B, Diablo, two lead bricks were discovered and removed from the site. Because the bricks were enclosed in an intact metal container and there was no sign of release, the bricks were removed as a corrective action and sampling was not performed. At Site T-2, lead bricks, lead-acid batteries, and waste trenches were discovered as PSM. One breached lead-acid battery and two intact lead-acid batteries were removed from the site as a corrective action. Sixty-seven lead bricks were also removed from the site as a corrective action. Verification sample results confirmed that no contamination above the FAL is present in the remaining soil. Debris was identified in the open waste trench associated with Site T-2 to include construction debris, wood, metal, and lead. The 140 yd^3 of debris identified within the open waste trench was removed as a corrective action. Because it could not be assumed that PSM did not exceed the FAL from the covered trenches, additional corrective action was required.

Table A.10-1 summarizes the investigation results as well as corrective actions and BMPs that were implemented during the CAI.

Table A.10-1
Summary of Investigation Results at CAU 105

Site	CAS Number	Release	COCs	Corrective Action	BMP
T-2A, Shasta	02-23-05	Atmospheric release from the Shasta test	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established
		Migration	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	None
		PSM (lead debris)	Assumed presence of lead COC	Closure in Place with FFACO UR (Figure A.5-3)	None
T-2B, Diablo	02-23-06	Atmospheric release from the Diablo test	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established
		Excavation	FAL (25 mrem/OU-yr) not exceeded at sample location	None	None
		Migration	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	None
		PSM (lead bricks)	Lead	Removal of PSM	None
T-2	02-23-04 02-23-08 02-23-09	Atmospheric release from the Whitney, Badger, How, and Turk tests	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	Administrative UR established
		Migration	FAL (25 mrem/OU-yr) not exceeded at any sample location	None	None
		PSM (lead bricks and lead-acid batteries)	Lead	Removal of PSM	None
		PSM assumed at landfills	Radiological and chemical COCs assumed	Closure in Place with FFACO UR (Figure A.7-4)	Remove debris from open trench and clean fill

A.11.0 References

BN, see Bechtel Nevada.

Bechtel Nevada. 1995. *Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste*, Rev. 0, G-E11/96.01. Las Vegas, NV.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site*, DOE/11718--324. Prepared for U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

Bechtel Nevada. 2003. *Nevada Test Site Routine Radiological Environmental Monitoring Plan*, DOE/NV/11718--804. Prepared for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. Las Vegas, NV.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2012. Title 40 CFR, Parts 260 to 282, “Hazardous Waste Management.” Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2013. Title 10 CFR, Part 835, “Occupational Radiation Protection.” Washington, DC: U.S. Government Printing Office.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Gray, K.J., D.S. Shafer, K. Self, C. Martin, and R. McArthur. 2007. *Radionuclide Inventory and Distribution Program (RIDP) Database*, Rev. 2. April. Las Vegas, NV.

McArthur, R.D., and J.F. Kordas. 1985. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #2. Areas 2 and 4*, DOE/NV/10162-20; Publication No. 45041. Las Vegas, NV: Desert Research Institute, Water Resources Center.

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

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

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

Navarro-Intera Geographic Information Systems. 2013. ESRI ArcGIS Software.

RSL, see Remote Sensing Laboratory.

Remote Sensing Laboratory. 1989. Aerial photograph “6613_066_Cropped.jpg.” Las Vegas, NV.

U.S. Department of Energy. 1997. *The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300. 28th Edition, Vol. I. February. New York, NY.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Nevada Test Site Orthophoto Site Atlas*, DOE/NV/11718--604. Prepared by Bechtel Nevada. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010. *Application for Permit to Operate a Class III Solid Waste Disposal Site at the Nevada Test Site*, DOE/NV/25946--1035. Las Vegas, NV

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1486. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2012b. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012c. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners*, EPA QA/G-9S, EPA/240/B-06/003. Washington, DC: Office of Environmental Information.

Yu, C., A.J. Zielen, J.J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User’s Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.4 released in December 2007.)

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 105 CAIP (NNSA/NSO, 2012a) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

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

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

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

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

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

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

B.1.1 Review DQOs and Sampling Design

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

B.1.1.1 Decision I

The Decision I statement as presented in the CAIP (NNSA/NSO, 2012a) is as follows: "Is any COC present in environmental media within the CAS?" For judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. For probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple contaminant analysis (NNSA/NSO, 2012b). If a COC is detected, then Decision II must be resolved.

B.1.1.1.1 DQO Provisions To Limit False Negative Decision Error

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

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

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

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

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

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

Criterion 1a

To resolve Decision I (determine whether a COC is present at a CAS), samples were collected and analyzed following these two criteria:

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

Study Group 1

Probabilistic sample plot locations were selected at the highest radiological readings as detected during the TRSs and the 2008 aerial radiological survey (NSTec, 2009). Analysis was performed for radiological contaminants as this was the potential contaminants identified during investigation planning.

Study Group 2

A judgmental sample location was selected from the middle of the partially excavated area. Analysis was performed for radiological contaminants as this was the potential contaminants identified during investigation planning.

Study Group 3

Verification samples were collected at debris locations (lead bricks, batteries) that were PSM. No COCs remain after soil removal at Site T-2. COCs are assumed to remain at Site T-2A, Shasta within a 225-ft radius around GZ and at the waste trenches associated with Site T-2. Analysis was performed for RCRA metals as a result of lead items and debris visually observed at the site.

Study Group 4

Sampling locations were selected based on the presence of sedimentations downgradient from GZ at all sites. The locations for sampling drainages consisted of selecting the first two downgradient sediment accumulation areas and additional location further downstream. Analysis was performed for radiological contaminants as this was the potential contaminants identified during investigation planning. No COCs were identified.

Criterion 1b

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 (see Section B.1.1.1.1).

- 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 (inclusive of Study Groups 1) was accomplished using a random start, systematic triangular grid pattern for sample placement. This permitted an unbiased, equal-weighted chance that any given location within the boundaries of the sample plot would be chosen. Although the TLD locations were not established at random locations (i.e., they were placed at the center of the sample plot), they provided an integrated, unbiased measurement of dose from the plot area.

The minimum number of samples required for each sample plot 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 these tables, the minimum number of sample plot and TLD samples was met or exceeded. The minimum sample size calculations were conducted as stipulated in the CAIP (NNSA/NSO, 2012a) based on the following parameters:

- A false rejection rate of 0.05
- A false acceptance rate of 0.20

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

Soil Samples				
Source	**Plot**	**Standard Deviation**	**Minimum Sample Size**	**Samples Collected**
Study Group 1	A01	0.11	3	4
	B01	0.06	3	4
	C01	1.14	3	4

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.

- The maximum acceptable gray region set to one-half the FAL (12.5 mrem/yr)
- The calculated standard deviation

Criterion 2

All samples were analyzed using the analytical methods listed in Section 3.2 of the CAIP (NNSA/NSO, 2012a) and the following radiological analytes: gamma spectroscopy; Pu-241; and isotopic Am, U, and Pu. Sr-90 and Tc-99 were also analyzed at plot locations A01, B01, and C01. In addition to the radiological analyses, samples collected in sample location A66 were also sampled for TCLP VOCs and TCLP SVOCs. Sample collected from below lead bricks and lead-acid batteries were analyzed for RCRA metals.

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Soils QAP (NNSA/NSO, 2012b). The sensitivity acceptance criterion defined in the CAIP is that analytical detection limits will be less than the corresponding FAL (NNSA/NSO, 2012a). Therefore, the criterion is that all detection limits are less than their corresponding Occasional Use area internal dose RRMGs for radionuclides. All of the analytical result detection limits for every radionuclide were less than their corresponding RRMGs; therefore, the DQI for sensitivity has been met for radionuclides, and no data were rejected due to sensitivity. This criterion was also achieved for chemical analytes. If results had not met sensitivity acceptance criterion they would not be used in making DQO decisions and would therefore be considered as rejected data. The impact on DQO decisions would be addressed in the assessment of completeness.

Criterion 3

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

Precision

Precision was evaluated as described in Section 6.2.3 of the CAIP (NNSA/NSO, 2012a) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012b). There were no analytical data qualified for precision that exceeded one-half the FAL. Therefore, 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/NSO, 2012a) and Section 4.2 of the Soils QAP (NNSA/NSO, 2012b). As stipulated in Section 4.3 of the Soils QAP, when analysis 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.

There were no analytical data qualified for accuracy that exceeded one-half the FAL. Therefore, the potential for a false negative DQO decision error is negligible, and use of the results that were qualified for accuracy can be confidently used. As the accuracy rates for all other constituents meet the acceptance criteria for accuracy, the dataset is determined to be acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NSO, 2012a) was used to address sampling and analytical requirements for CAU 105. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination [judgmental sampling] or that represent contamination of the sample plot [probabilistic sampling] and locations that bound

COCs) (Section A.2.1). The sampling locations identified in the Criterion 1a discussion meet this criterion.

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

Am-241 is reported by the gamma spectrometry method as well as the isotopic americium method. As the gamma spectrometry measurement is based on a much larger soil sample (one 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. See Appendix F for inferred plutonium concentrations.

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

Comparability

Field sampling, as described in the CAIP (NNSA/NSO, 2012a), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per DOE were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NNSS. Therefore, CAU 105 datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements.

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

Completeness

The CAIP (NNSA/NSO, 2012a) defines acceptable criteria for completeness to be that the dataset is sufficiently complete to be able to make the DQO decisions. This is initially evaluated as 80 percent of study group-specific analytes identified in the CAIP having valid results. The dataset for CAU 105 has met the completeness criteria as sufficient information is available to make the DQO decisions.

B.1.1.1.2 DQO Provisions To Limit False Positive Decision Error

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

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

B.1.1.2 Decision II

Decision II as presented in the CAIP (NNSA/NSO, 2012a) is as follows: "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. 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 soil if the wastes were to be released.

For Study Groups 1, 2, and 4, there were no COCs detected. Therefore, Decision II was resolved. The following describes the Decision II sampling that was conducted for other study groups:

Study Group 3

One location was assumed to exceed the FAL for lead due to the visual presence of lead debris. A Decision II boundary associated with the contamination was determined visually and confirmed by samples within a 225-ft radius of GZ to encompass the lead debris.

Study Group 5

The area of the open and buried waste trenches associated with Site T-2 was assumed to exceed the FAL for chemical contaminants to include lead and radionuclides based upon geophysical surveys and visual observation. Geophysical surveys were conducted at the open and buried waste trenches. Surveys were conducted in the immediate and surrounding area as determined by visual surveys and aerial photography. It was determined that metallic debris is present within the buried waste trenches. Lead items were observed in the open waste trench, and it was assumed present in the buried waste trenches.

B.1.1.3 Sampling Design

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

- Sampling of primary releases will be conducted by a combination of judgmental and probabilistic sampling approaches.

  Result. The locations of the plots were selected judgmentally, and samples were collected within each plot probabilistically as described in Section A.2.0.

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

  Result. Judgmental sampling was conducted at the drainage identified for study 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, 2012b). The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO decisions 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 CAS to the corresponding FAL. All FALs were based on an exposure duration to a site worker using the Occasional Use Area exposure scenario except for lead that was based on the Remote Work Area scenario.

The key assumptions that could impact a DQO decision are listed in Table B.1-2.

Table B.1-2
Key Assumptions

Exposure Scenario	Occasional Use Area
Affected Media	Surface, shallow, and subsurface soil; wash sediments
Location of Contamination/Release Points	Surface and subsurface soil within the three study sites, surface soil directly below or adjacent to contaminated debris, surface/shallow subsurface sediment in drainages, and surface/shallow subsurface soil from the soil mounds
Transport Mechanisms	Surface water runoff serves as the major driving force for lateral migration of contaminants while percolation of precipitation or runoff through subsurface soil provides a driver for vertical transport of contaminants. Wind may cause limited resuspension and transport of windborne contaminants; however, this transport mechanism is less likely to cause migration of contamination at levels exceeding FALs.
Preferential Pathways	Lateral transport is expected to dominate over vertical transport due to 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. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries.
Groundwater Impacts	None.
Future Land Use	Nuclear and High Explosives Test Zone.
Other DQO Assumptions	Surface contamination is present at the three atmospheric test areas due to the experiments conducted at CAU 105. Surface contamination is also present associated with radiological and hazardous debris. The CSM includes the potential for surface contamination associated with the drainages. 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 105 DQOs and Table B.1-2. All data collected during the CAI supported the CSM, and no revisions to the CSM were necessary.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NSO, 2012a) made the following commitments:

1. Decision I for the Study Group 1 release scenario will be evaluated by calculating TED at three sample plots established within the area of the highest radiological values as determined by TRS.

Result: Decision I was resolved by the collection of environmental samples in three sample plots as required in the CAIP. Decision I sample locations at all sites did not exceed the FALs.

2. TLDs will be placed in a vector or grid pattern and at sample plots at each of three study sites so that the outermost TLD on each pattern would be located beyond the 25-mrem/OU-yr dose boundary.

   Result. A total of 202 environmental TLDs were placed. There were 61 TLDs placed at Site T-2A, Shasta in a vector pattern; 72 TLDs placed at Site T-2B, Diablo in a grid pattern; and 69 TLDs placed at Site T-2 in a vector pattern. The 95 percent UCL of the average TED did not exceed the FAL.

3. The soil pile closest to GZ at Site T-2B, Diablo will be investigated to document content and estimate the TED. The soil pile will be partially excavated and the excavated soil and debris arrayed on the ground adjacent to the soil pile.

   Result. Approximately 30 percent of the soil pile closest to GZ was excavated and arrayed as required. A TLD was placed and one probabilistic soil sample collected from the middle area of the excavated soil. Debris was observed to be minimal, and the TED did not exceed the FAL.

4. Determine whether a potential release is present based on biasing factors such as stains, spills, or debris.

   Result. At Site T-2A, Shasta, one stained soil area was sampled. Lead debris was observed around GZ with historical significance. Samples were collected at a 225-ft radius from GZ to bound lead contamination. At Site T-2, a total of 67 lead bricks and 3 lead-acid batteries were located and assumed to be PSM.

5. Drainages will be surveyed by TRS for elevated radiological readings. A minimum of two sediment accumulation areas will be selected for investigation.

   Result. At Site T-2A, Shasta, one drainage area was selected and six locations investigated. At Site T-2B, Diablo, two drainages were selected and five locations investigated. At Site T-2, two drainage areas were selected for investigation and 10 locations investigated. The investigation focused on the migration of trinitite.

6. The open waste trench discovered during the investigation will be investigated using a judgmental sampling approach and geophysical surveys.

   Result. Process knowledge and visual surveys were used to characterize the debris in the open waste trench. A geophysical survey was conducted, and other potential buried trenches were identified.

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 105 CASs.

B.1.5.1 Decision Rules for Both Decision I and II

Decision rule. If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.5.2, then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling.

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

B.1.5.2 Decision Rules for Decision I

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

- **Result.** Because COCs were identified during the CAI in Study Groups 3 and 5, Decision II needed to be resolved. No COCs were identified at Study Group 1, 2, and 4, so Decision II activities were not required.

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

- **Result.** Because COCs were identified at Study Groups 3 and 5, corrective actions are required.

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

- **Result.** Hazardous debris was identified as PSM, and a corrective action of debris and soil removal was completed.

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 samples were not required for environmental contamination because no area exceeded the FALs. Decision II sampling for PSM discovered at the site was determined based upon corrective actions performed. Lead items were discovered and removed from Site T-2B, Diablo and Site T2. These interim corrective actions of removal of debris with verification sampling defined and confirmed the extent of removed COCs. Lead items and debris were not removed from Site T-2A, Shasta or the waste trenches associated with Site T-2. Lead at T-2 was bound by Decision II samples analyzed at the 225-ft radius from GZ. Geophysical surveys were used to define COC contamination at the waste trenches.

Decision rule. If valid analytical results are available for the waste characterization samples (see Section A.8.0 of the CAIP), then the decision will be that sufficient information exists to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, else collect additional waste characterization samples.

- **Result.** Valid analytical data were obtained to adequately characterize the material associated with the lead bricks and batteries. Data were determined to be adequate to determine waste types and evaluate alternatives.

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

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

NSTec, see National Security Technologies, LLC

National Security Technologies, LLC. 2009. *An Aerial Radiological Survey of Selected Areas of Area 18 – Nevada Test Site*, DOE/NV/25946--767. Prepared by C. Lyons for the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. Las Vegas, NV: Remote Sensing Laboratory.

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1486. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012c. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners*, EPA QA/G-9S, EPA/240/B-06/003. Washington, DC: Office of Environmental Information.

Appendix C

Risk Assessment

C.1.0 Risk Assessment

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NSO, 2012a). 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 105 CAIP [NNSA/NSO, 2012a]). 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/NSO, 2012b) is summarized in Figure C.1-1.

C.1.1 Scenario

CAU 105, Area 2 Yucca Flat Atmospheric Test Sites, comprises the following five CASs within Area 2 of the NNSS:

- 02-23-04, Atmospheric Test Site - Whitney
- 02-23-05, Atmospheric Test Site T-2A

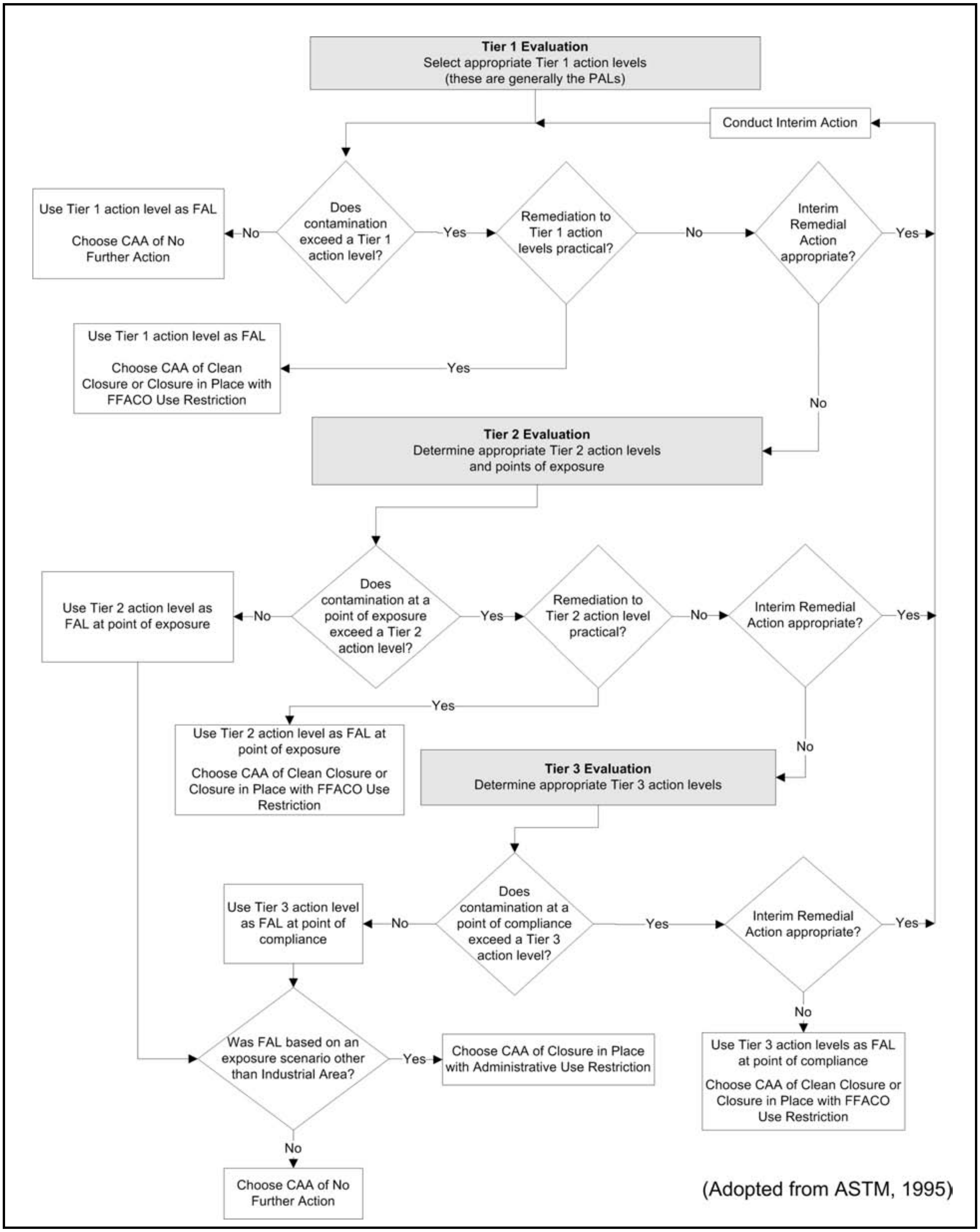


Figure C.1-1
RBCA Decision Process

- 02-23-06, Atmospheric Test Site T-2B
- 02-23-08, Atmospheric Test Site T-2
- 02-23-09, Atmospheric Test Site - Turk

CAU 105 consists of five CASs at three inactive sites located in Area 2 of the NNSS. The five CASs within CAU 105 were grouped into three study sites based on geographic proximity and similarity of release.

Site T-2A, Shasta (CAS 02-23-05) occurred as a release of contaminants associated with the atmospheric test of one nuclear weapon. This weapons-related test was performed on August 18, 1957, from a 500-ft tower (DOE/NV, 2000) with a yield of 17 kt.

Site T2-B, Diablo (CAS 02-23-06) is defined as the release of contaminants associated with the atmospheric test of one nuclear weapon. This weapons-related test was performed on July 15, 1957, from a 500-ft tower (DOE/NV, 2000) with a yield of 17 kt.

The three CASs within Site T-2 (CASs 02-23-04, 02-23-08, and 02-23-09) are defined as the release of contaminants associated with four tower tests. These CASs are grouped into one site as the weapons-related tests conducted at this site share a common GZ area and are similar in nature. The CAU 105 sites were used to support atmospheric nuclear testing resulting in a release of radioactive contaminants to the environment.

Also included in the Site T-2 scope were potential releases to the soil from debris and spills in the area generated as a result of project activities. Previously unidentified waste trenches were identified approximately 0.7 mi east of Site T-2. The area of the one open and six buried trenches is approximately 1.6 acres and contains metal, wood debris, and some lead from unknown sources.

C.1.2 Site Assessment

Investigation activities at all study sites included an evaluation of radiological and chemical contamination resulting from atmospheric testing and associated support activities. Scattered test-related debris remains at each site with no removable contamination identified. Soil samples and TLDs placed in defined patterns within the study sites were used to calculate TED to workers. Refer to Section A.3.2.3 for details on the calculation of TED.

Site T-2A, Shasta (CAS 02-23-05) encompasses an area affected by the surface release of radioactivity associated with the atmospheric testing of the Shasta test. No sample location at Site T-2A, Shasta exceeded the Occasional Use Area scenario based FAL established in this appendix (25 mrem/OU-yr). The maximum calculated TED (based on the Occasional Use Area scenario) was 3.1 mrem/yr. However, it was shown that if site use 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. The maximum calculated TED (based on the Industrial Area scenario) was 60.9 mrem/yr. Lead items with historical significance are present around GZ. Sampling was performed at a 225-ft radius from GZ to encompass the lead items, and the analytical results show no metal contamination at this radius. The area within this sampling radius is assumed to exceed the FAL for lead contamination.

Site T2-B, Diablo (CAS 02-23-06) includes an area affected by the surface release of radioactivity associated with the atmospheric testing of the Diablo test. No sample location at Site T-2B, Diablo exceeded the Occasional Use Area scenario based FAL established in this appendix (25 mrem/OU-yr). The maximum calculated TED (based on the Occasional Use Area scenario) was 3.3 mrem/yr. However, it was shown that if site use 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. The maximum calculated TED (based on the Industrial Area scenario) was 66.0 mrem/yr.

The three CASs within the Site T-2 study area (CASs 02-23-04, 02-23-08, and 02-23-09) includes an area affected by the surface release of radioactivity associated with the atmospheric testing of the Whitney, Badger, How, and Turk tests. No sample location at Site T-2A, Shasta exceeded the Occasional Use Area scenario based FAL established in this appendix (25 mrem/OU-yr). The maximum calculated TED (based on the Occasional Use Area scenario) was 13.0 mrem/yr. However, it was shown that if site use 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. The maximum calculated TED (based on the Industrial Area scenario) was 259.7 mrem/yr.

Waste trenches were observed 0.7 mi east of Site T-2. One open trench approximately 160 by 40 by 6 ft is present, and six buried waste trenches were identified from geophysical analysis. The wood, metal, and other debris in the open trench and the debris in the buried trenches are from unknown sources. Although surface radiological readings were not elevated, it is assumed that chemical and radiological contamination above FALs is present in the area.

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, the study sites at CAU 105 do not present an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at these sites. Corrective actions are required at Site T-2A, Shasta due to the presence of lead and at the waste trenches due to the assumed presence of chemical and radiological contaminants. Lead contamination is assumed to be present within a 225-ft radius from GZ at Site T-2A, Shasta and throughout the open and buried trenches. Contamination is assumed to be present that could pose a short-term threat to human health, safety, or the environment if any excavation or disturbance was performed in this area. Thus, these sites have been determined to be Classification 2 sites as defined by ASTM Method E1739.

C.1.4 Development of Tier 1 Action Level Lookup Table

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

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

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

- EPA Region 9 RSLs (EPA, 2013a).
- Background concentrations for RCRA metals will be evaluated when natural background exceeds the PAL, as is often the case with arsenic. 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 will be 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 overly conservative and is not representative of current land use.

C.1.5 Exposure Pathway Evaluation

For all CASs, 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 at the CASs. 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

Results from environmental samples were compared to Tier 1 action levels. Radionuclide concentrations in soil samples did not exceed the Tier 1 action level (i.e., PAL) at any location.

The contaminants that exceeded the Tier 1 action level (i.e., PAL) were radionuclides and lead. An exposure time based on the Industrial Area scenario (2,000 hr/yr) was used to calculate site radiological doses (TED). These values were compared to the Tier 1 action level (25-mrem/IA-yr dose) that is also based on an exposure time of 2,000 hr/yr.

The Industrial Area scenario based TEDs for all sampled locations at each CAU 105 CAS that exceed the Tier 1 action level (i.e., PAL) are listed in Table C.1-1. Based on the unrealistic but conservative assumption that a site worker would be exposed to the maximum dose at any sampled location outside any crater area or high contamination area (HCA), this site worker would receive a 25-millirem (mrem) dose at each of these CAS locations in the exposure times listed in Table C.1-2.

Table C.1-1
Locations Where TED Exceeds the Tier 1 Action Level at CAU 105 (mrem/IA-yr)
(Page 1 of 3)

Location	Average TED	95% UCL TED
Site T-2A, Shasta		
A01	28.8	32.8
A03	35.9	40.3
A05	24.5	28.2
A06	22.6	25.8
A07	25.2	29.4
A08	35.1	39.4
A09	40.4	45.6
A10	29.4	35.3
A11	60.9	66.3
A13	26.2	30.5
A18	23.6	28.6
A19	25.6	31.5
A23	23.6	27
A27	25.9	32.8
A28	29.5	33.4
A30	17.3	30.2
A53	33.1	39.7
A60	36.0	41.6
A64	71.0	85.6
A65	24.3	30.5

Table C.1-1
Locations Where TED Exceeds
the Tier 1 Action Level at CAU 105 (mrem/IA-yr)
(Page 2 of 3)

Location	Average TED	95% UCL TED
Site T-2B, Diablo		
B01	47.8	51.1
B46	44.2	51.1
B52	26.1	31.9
B54	31.6	34.4
B55	28.3	30.9
B60	21.7	25.5
B78	66.0	78.2
Site T-2		
C01	259.7	298.5
C02	34.0	40.4
C03	106.3	116.7
C04	138.9	159.1
C05	123.5	135.0
C06	47.5	52.1
C07	31.3	35.4
C08	52.7	63.5
C09	124.2	140.1
C10	204.1	224.6
C11	74.8	85.2
C12	141.6	153.2
C13	184.4	206.2
C14	155.5	174.0
C15	56.1	58.3
C16	35.0	39.4
C17	30.5	36.8
C18	69.9	79.8
C19	160.9	176.3
C20	149.8	155.0
C21	177.2	185.2
C22	168.8	176.3
C23	110.6	123.2

Table C.1-1
Locations Where TED Exceeds
the Tier 1 Action Level at CAU 105 (mrem/IA-yr)
(Page 3 of 3)

Location	Average TED	95% UCL TED
Site T-2 (continued)		
C24	143.9	152.5
C25	103.6	113.5
C32	22.7	25.6
C39	43.8	52.4
C40	81.4	90.1
C41	43.6	50.8
C42	56.0	66.0
C43	131.9	140.4
C44	27.9	31.9
C45	51.6	54.3
C46	125.5	140.1
C47	170.4	195.6
C48	211.1	225.2
C49	121.9	135.8
C50	47.5	49.8
C52	30.4	34.6
C53	64.9	75.1
C54	163.3	180.5
C55	186.1	210.9
C56	101.0	116.6
C57	153.9	166.8
C58	67.0	72.2
C59	147.2	160.5
C63	26.9	32.2
C64	71.5	82.0
C65	25.6	27.9
C66	32.0	37.8
C72	21.4	25.7
C73	28.8	33.1
C78	40.8	45.8

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

Site	Location of Maximum Dose	Average TED (mrem/IA-yr)	Minimum Exposure Time (hours)
T-2A, Shasta	A11	60.9	821
T-2B, Diablo	B78	66.0	758
T-2	C01	260.0	193

C.1.7 Evaluation of Tier 1 Results

For the locations listed in Table C.1-1, NNSA/NFO determined that remediation to the Tier 1 action level is not appropriate. The risk to receptors from contaminants at CAU 105 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 105 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 were feasible and appropriate except for lead. Therefore, the FALs for chemical contaminants other than lead at CAU 105 were established at the Tier 1 action levels.

C.1.8 Tier 1 Remedial Action Evaluation

The most exposed worker may be present at these sites for only a few hours per year, and it is not reasonable to assume that any worker would be present at this site for 2,000 hr/yr. Therefore, it was determined that it is not reasonable to remediate this site to the Tier 1 action level, and a Tier 2 evaluation will be conducted for radiological contamination.

Lead contamination was assumed to exceed the Tier 1 action level at all three sites due to the visible presence of lead items and debris. It was determined that it is not reasonable to remediate lead contamination to Tier 1 action levels due to the large affected area and difficulty in removing some items. Lead was passed on to a Tier 2 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 example, workers may be present at a site for the entire work year but only spend 10 percent of their time at the location of elevated contamination. If the worker's industrial work schedule was 8 hr/day for 250 days/yr resulting in 2,000 hr/yr (as is used for the Industrial Area exposure scenario), the appropriate annual exposure time for that worker would be 200 hr/yr. For the development of radiological Tier 2 action level, 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 study group was determined based on an evaluation of current and reasonable future activities that may be conducted at the site.

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 CAS 105 CAS 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 105 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 land use at each of the CAU 105 CASs, the following workers were identified as being potentially exposed to site contamination:

- **Inspection and Maintenance Worker.** Workers sent to conduct the annual inspection of the postings and fencing around the three study sites and waste trenches. The UR requires a periodic inspection to ensure that the fencing is intact and the signs are legible. This will require two people to spend up to 10 hr/yr at each CAS.

- **Worker at Big Explosive Experimental Facility (BEEF)**. This would include workers assigned to the BEEF facility in Area 2 of the NNSS. Work at this facility could require access to the two study sites to the south. 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).

- **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 105 CASs, 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 at any sampled location outside any crater area or HCA for the entire 40 hours, this worker would receive a maximum potential dose at each CAS as listed in Table C.1-3.

Table C.1-3
Maximum Potential Dose to Most Exposed Worker at CAU 105 Sites

Site	Most Exposed Worker	Exposure Time	Maximum Potential Dose
T-2A, Shasta	Inspection and Maintenance Worker	10 hr/yr	0.4 mrem/yr
T-2B, Diablo	Inspection and Maintenance Worker	10 hr/yr	0.4 mrem/yr
Site T-2	Inspection and Maintenance Worker	10 hr/yr	1.6 mrem/yr

In the CAU 105 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAIP [NNSA/NSO, 2012a]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 105 CASs. This exposure scenario assumes exposure to site workers who are not assigned to the area as a regular work site but may occasionally use the site for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 80 hr/yr. 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.

A site-specific outdoor industrial soil Tier 2 action level was calculated for chromium VI using site-specific inputs to standard risk procedures. This calculation process is described in the Soils RBCA document (NNSA/NSO, 2012b). This uses the EPA Region 9 RSL Calculator (EPA, 2013b) to calculate concentration limits using carcinogenic or systemic toxicity values under specific exposure conditions. The calculator uses the latest human health toxicity values (i.e., cancer slope factors or non-cancer reference doses [RfDs]), default exposure assumptions, and physical and chemical properties. The calculator was used to assess site-specific risk by changing the default parameters to reflect site-specific risk conditions. Parameters used in the calculation of this Tier 2 action level are defined in the Soils RBCA document.

The EPA's risk assessment tool for lead (the Adult Lead Methodology [ALM]) was used to calculate a Tier 2 action level for lead. This methodology is recommended by EPA because an RfD value for lead is not available. In the commercial/industrial setting, the most sensitive receptor is the fetus of a worker who has a non-residential exposure to lead. Based on the available scientific data, a fetus is more sensitive to the adverse effects of lead than an adult (National Academy of Sciences, 1993). The EPA assumes that cleanup levels that are protective of a fetus will also afford protection for male or female adult workers. An outdoor industrial soil Tier 2 action level was calculated for lead at CAU 105 using EPA's ALM to estimate the concentration of lead in the blood of pregnant women and developing fetuses who might be exposed to lead-contaminated soils (EPA, 2009). The ALM is a series of equations for calculation of fetal risks from adult exposures to specified levels of soil lead contamination. These equations conservatively estimate lead concentrations in blood based on the ingestion of lead in soil. The equations are a relationship between soil lead concentration, soil ingestion rate, and a correlation of lead ingested and blood lead concentrations from numerous studies. While the soil ingestion rate includes direct ingestion and ingestion of inhaled dust, dermal absorption is not included as dermal absorption is generally not a significant route of exposure for inorganic lead and quantifying uptake from dermal exposure to soil-borne lead is not currently recommended by EPA (EPA, 2009). This approach supports EPA's goal of limiting the risk of elevated fetal blood concentrations due to lead exposures to women of child-bearing age. The ALM model is used to estimate blood lead concentrations, which can then be correlated to estimate possible adverse health effects in persons who have been exposed.

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

Therefore, the Remote Work Area exposure scenario soil ingestion rate (0.0067 g/day) and the exposure frequency of 44 day/yr were used to calculate a Tier 2 action level for lead of 8,356 mg/kg.

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

The average and 95 percent UCL TEDs calculated using the Occasional Use Area exposure scenario were compared to the 25-mrem/OU-yr Tier 2 action level. None of the TED values exceeded the 25-mrem/OU-yr Tier 2 action level (Tables A.3-14 through A.3-16) at any of the locations that exceeded the 25-mrem/IA-yr Tier 1 action level.

The Tier 2 action level for lead was compared to maximum lead concentrations from each sample location.

At Site T-2A, Shasta, eight samples were collected at a 225-ft radius around GZ. The maximum detected lead result of 140 mg/kg at this boundary was less than the Tier 2 action level of 8,356 mg/kg. However, concentrations of lead within the boundary were assumed to be above the Tier 2 action level and are considered PSM that poses the potential to introduce COCs to the surrounding soil.

At the Site T-2 GZ area, PSM was identified in the Tier 1 Remedial Action Evaluation as requiring corrective action. The lead bricks and breached battery, as well as soil beneath them, were removed under a corrective action. Confirmation sampling was conducted on the remaining soil, and lead was not present at concentrations exceeding the Tier 2 action level. The maximum detected lead result of 6,100 mg/kg was less than the Tier 2 action level of 8,356 mg/kg. At the waste trenches located east of GZ, concentrations of chemical contaminants to include lead within the identified area are assumed to be above the Tier 2 action levels and are considered PSM that poses the potential to introduce COCs to the surrounding soil.

The Tier 2 action levels are typically 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. 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 CAS. However, for CAU 105, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from a single point location.

C.1.12 Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation for radiological contamination, the surface soils at all sites do not pose an unacceptable risk to human health and the environment. However, it is assumed that lead contamination exists at Site T-2A, Shasta at concentrations exceeding the Tier 2 action level due to the presence of lead items and debris within a 225-ft radius from GZ. Chemical and radiological contamination is also assumed to be present at the waste trenches associated with Site T-2 due to the presence of lead items and debris and unknown buried material. Based on the Tier 2 evaluation, the areas within this 225-ft radius and the waste trenches are assumed to exceed the Tier 2 action level. Any corrective action based on the Tier 2 action level would need to address the contamination in the areas listed in Table C.1-4.

Table C.1-4
Corrective Action Boundary Areas at CAU 105 CASs

Site	Area (acres)
T-2A, Shasta	3.7
Waste Trenches	1.6

As corrective actions are practical for the contamination at these CASs, the Tier 2 action level is established as the FAL for radionuclide contamination, and corrective actions will be implemented. The Tier 2 action level for lead is also established as the FAL, and corrective actions will be implemented.

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 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. 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 CAS. However, for CAU 105, the Tier 2 action levels were conservatively compared to the maximum contaminant concentration from a single point location.

Because all of the TED values for surface soils at Site T-2A, Shasta; Site T-2B, Diablo; and Site T-2 were less than the corresponding FALs at all locations (using the Occasional Use Area exposure scenario), it was determined that surface soil contamination at these locations do not warrant corrective actions for radiological constituents. However, it was assumed that radiological contamination at the waste trenches associated with Site T-2 exceeds the Tier 2 based 25-mrem/OU-yr FAL and a corrective action is necessary.

The corrective action of closure in place with URs is recommended at Site T-2A, Shasta. Lead contamination is assumed to exceed the Tier 2 based FAL of 8,356 mg/kg.

The corrective action of clean closure is recommended at Site T-2B, Diablo. Tier 2 action level FALs were not exceeded for radiological or chemical contaminants.

At the waste trenches associated with Site T-2, the corrective action of closure in place with URs is recommended. Chemical and radiological contamination is assumed to exceed the Tier 2 action level FALs.

The recommendations for 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 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.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EPA, see U.S. Environmental Protection Agency.

Moore, J., Science Applications International Corporation. 1999. Memorandum to M. Todd (SAIC), "Background Concentrations for NTS and TTR Soil Samples," 3 February. Las Vegas, NV.

NAC, see *Nevada Administrative Code*

NBMG, see Nevada Bureau of Mines and Geology.

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

National Academy of Sciences. 1993. *Measuring Lead Exposure in Infants, Children, and Other Sensitive Populations.* Washington, DC: National Academy Press:

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 15 May 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 15 May 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 Site Office. 2012a. *Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1486. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. 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. 2009. *Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters*, OSWER 9200.2-82. June. Prepared by the Lead Committee of the Technical Review Workgroup for Metals and Asbestos. Washington, DC: Office of Superfund Remediation and Technology Innovation.

U.S. Environmental Protection Agency. 2013a. *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 4 June. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

U.S. Environmental Protection Agency. 2013b. *Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSL Calculator)*. As accessed at http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search on 4 June. 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 105.

D.1.1 Site T-2A, Shasta Closure Activities

Based on the results of this investigation and an evaluation of CAAs (see Appendix E), a corrective action of closure in place with a UR was implemented to encompass the area of lead debris around GZ (Figure A.3-9). The area requiring the UR posting encompasses a 225-ft radius around Site T-2A, Shasta GZ. The established FFACO UR for Site T-2A, Shasta is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-1. UR signs were installed on the perimeter of the RMA fence that encompasses this circle. If the contamination area changes at any time in the future, the UR signs may be moved, as long as they encompass the use restricted area.

No FFACO UR for radiological contamination was established at this site as no COCs were identified at this site at levels greater than the FALs. As a BMP, an administrative UR (as presented in Attachment D-1) was established to prevent a future site worker from receiving a dose exceeding 25 mrem/yr if there were a more intensive use of the site in the future. Both FFACO and administrative URs are recorded in the FFACO database, M&O Contractor GIS, and the NNSA/NFO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the UR will require NDEP notification.

D.1.2 Site T-2B, Diablo Closure Activities

Based on the results of this investigation, a corrective action of clean closure was implemented as no surface or subsurface soil COCs were identified at this site. Two lead bricks were removed from this site as corrective actions during the CAI. No FFACO UR for radiological contamination was established at this site as no surface or subsurface soil COCs were identified at this site.

Additionally, in accordance with the Soils RBCA document (NNSA/NSO, 2012b) and Section 3.3 of the CAIP (NNSA/NSO, 2012a), an administrative UR (as presented in Attachment D-1) was established to prevent a future site worker from receiving a dose exceeding 25 mrem/yr if there were a more intensive use of the site in the future. This UR was recorded in the FFACO database, M&O

Contractor GIS, and the NNSA/NFO CAU/CAS files. Any use of the area within the UR for activities that are restricted by the URs will require NDEP notification.

D.1.3 Site T-2 Closure Activities

Based on the results of this investigation, a corrective action of closure in place was implemented at Site T-2. No FFACO UR for radiological contamination was established at the GZ area as no surface soil COCs were identified. In accordance with the Soils RBCA document (NNSA/NSO, 2012b) and Section 3.3 of the CAIP (NNSA/NSO, 2012a), an administrative UR (as presented in Attachment D-1) was established at the GZ area to prevent a future site worker from receiving a dose exceeding 25 mrem/yr if there were a more intensive use of the site in the future. This administrative UR is recorded in the FFACO database, M&O Contractor GIS, and the NNSA/NFO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the UR will require NDEP notification.

Eighteen individually scattered lead bricks were identified and removed from the GZ area at Site T-2. Forty-nine clustered lead bricks were also removed. Two lead-acid batteries were also identified to include two intact and one breached battery. All lead bricks and lead-acid batteries were removed from the site as a corrective action. The open trench identified east of GZ contained 140 yd^3 of metal, wood debris, lead from an unknown source, and other debris that was removed as a corrective action.

Based on the results of this investigation, an FFACO UR for chemical and radiological contamination was established to encompasses the area of the waste trenches (Figure A.7-4). The established UR encompasses a 1.6-acre area around the one open and six buried waste trenches, and is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-1. UR signs were installed on the perimeter of this area. If site usage changes at any time in the future, the UR signs may be moved, as long as they encompass the UR area.

D.2.0 References

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

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1486. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. Las Vegas, NV.

Attachment D-1

Use Restrictions

(14 Pages)

Use Restriction Information

CAU Number/Description: CAU 105, Area 2 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: CAS 02-23-05, Atmospheric Test Site T-2A

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
Southeast	4109376	579354
South	4109355	579297
Southwest	4109377	579237
West	4109435	579217
Northwest	4109490	579238
North	4109513	579296
Northeast	4109491	579352
East	4109434	579377

Depth: 6 in. bgs

Survey Source (GPS, GIS, etc): GPS

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Surface and subsurface contamination for lead is assumed to be present within a 225 ft radius from GZ at Site T-2A, Shasta. This site also contains lead debris that present a chemical exposure hazard as presented in the CADD/CR for CAU 105. The contamination exceeds the risk-based action level established in the CADD/CR.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 105 CAS 02-23-05, Atmospheric Test Site T-2A			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Lead metal	23,000	8,356	mg/kg

Site Controls: The use restricted area encompasses the area where contamination is assumed to exceeds the chemical FAL of 8,356 mg/kg for lead. It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. These restrictions apply to any activities that would cause site workers to be directly exposed to the lead metal. Short term, non-intrusive activities at this site are not restricted. Site controls include warning signs placed around the use-restricted area.

Use Restriction Information

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
Southeast	4109206	579641
Southwest	4109261	579157
Northwest	4109565	579078
Northeast	4109595	579459

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 use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 812 hours of exposure to the surface location with the maximum detected radioactivity. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 105.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 105 CAS 02-23-05, Atmospheric Test Site T-2A			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Cesium-137	67.8	1,626	pCi/g
Europium-152	1.4	854	pCi/g

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical site controls are required for this administrative use restriction.

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

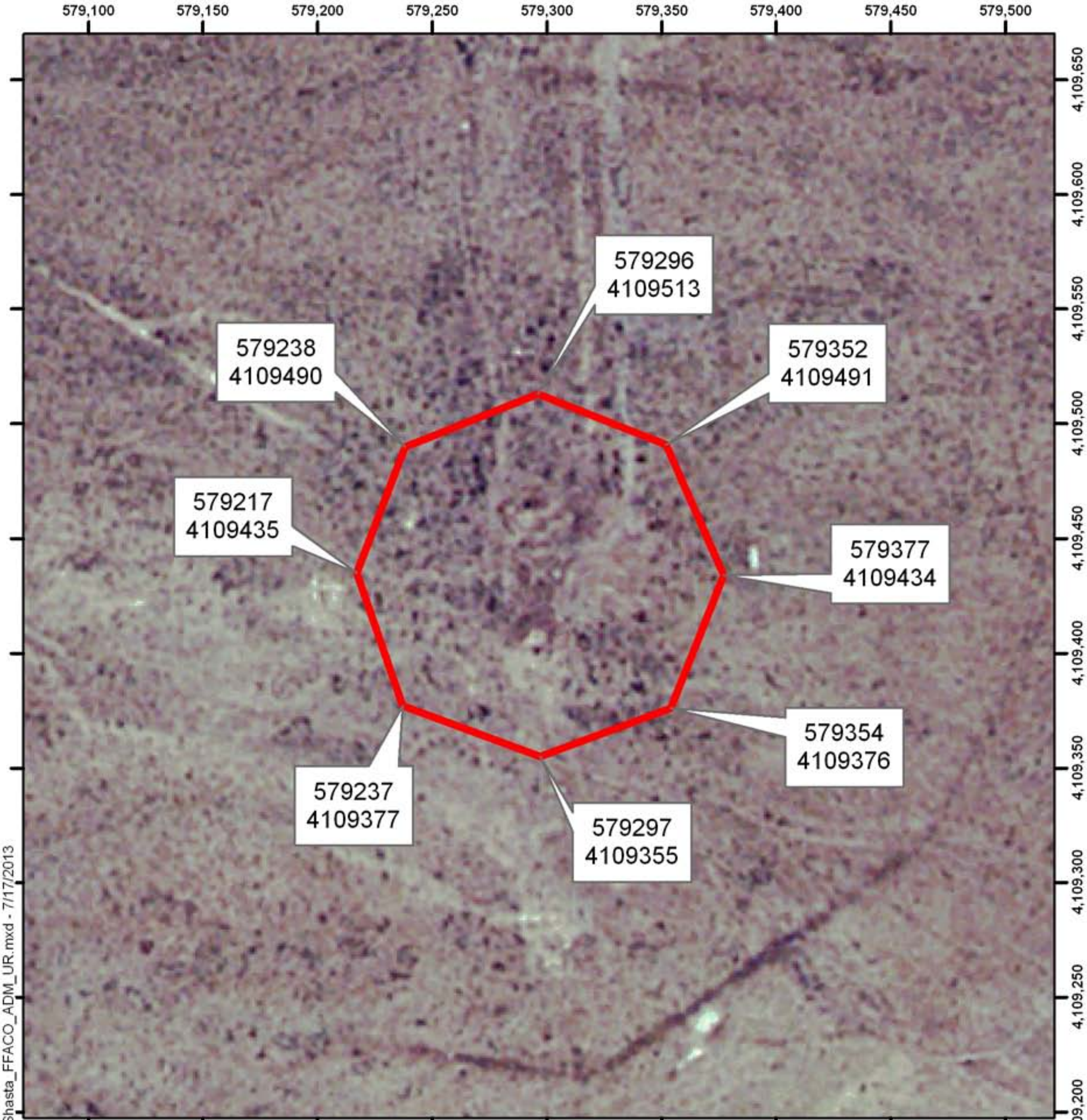
Description: The FFACO and administrative UR are recorded in the FFACO database, NNSA Nevada Field Office M7O GIS, and the NNSA Nevada Field Office CAU/CAS files. FFACO UR signs are posted at the site. No site controls are required for this administrative UR other than the administrative controls for land use at the NNSS

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

Use Restriction Information

Comments: Personnel are restricted from performing any work in this restricted are that would result in a more intensive use of the site than the current land use. Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, and maintenance of demarcation areas. Permission to conduct any restricted activities within this area requires the prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 9/10/2013



CAU 105
CAS 02-23-05, Atmospheric Test Site T-2A
FFACO UR Boundary

Explanation

FFACO UR

0 25 50 100 Meters

0 100 200 400 Feet

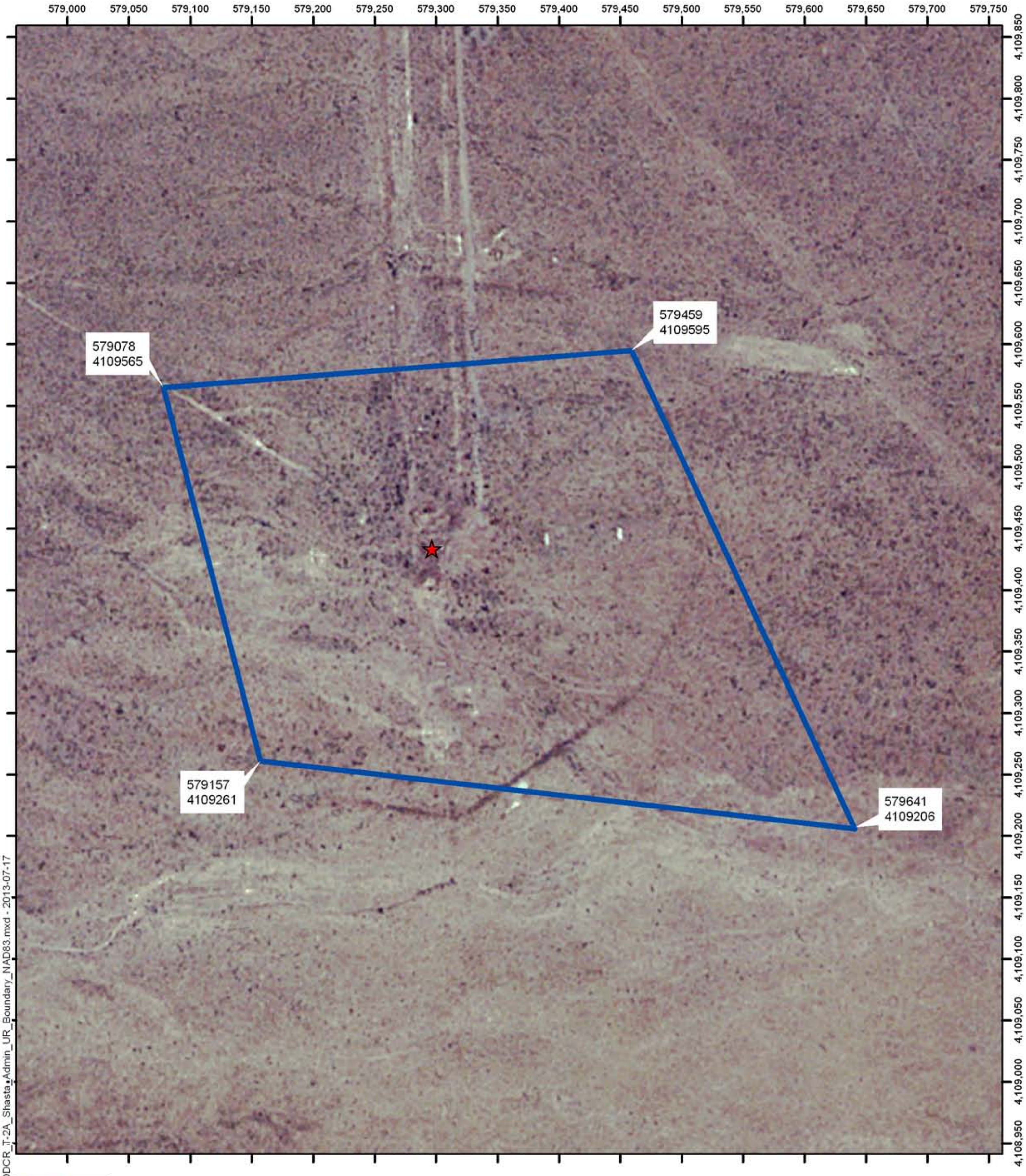
N

UNCONTROLLED When Printed

Source: N-I GIS, 2013; NNSA/NV, 2002

Coordinate System: NAD 1983 UTM Zone 11N, Meter

H:\105\CADD_CR\105_CADDCR_Shasta_FFACO_ADM_UR.mxd - 7/17/2013



H:\105\CADD_CR\105_CADDCR_T-2A_Shasta_Admin_UR_Boundary_NAD83.mxd - 2013-07-17

CAU 105
CAS 02-23-05, Atmospheric Test Site T-2A
Administrative UR Boundary

Explanation

Administrative UR

0 25 50 100 Meters

0 100 200 400 Feet

Source: N-I GIS, 2013; NNSA/NV, 2002

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Use Restriction Information

CAU Number/Description: CAU 105, Area 2 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: CAS 02-23-06, Atmospheric Test Site T-2B

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
N/A		

Depth: ______

Survey Source (GPS, GIS, etc): _______

Basis for FFACO UR(s):

Summary Statement:_________

Contaminants Table:

Maximum Concentration of Contaminants for CAU 105 CAS 02-23-06, Atmospheric Test Site T-2B			
Constituent	**Maximum Concentration**	**Action Level**	**Units**

Site Controls: _________

Use Restriction Information

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
Southeast	4111716	579309
Southwest	4111738	578836
Northwest	4111933	578832
Northeast	4111968	579261

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 use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 750 hours of exposure to the surface location with the maximum detected radioactivity. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 105.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 105 CAS 02-23-06, Atmospheric Test Site T-2B			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Thorium-232	1.8	11,840	pCi/g
Cesium-137	137.0	1,626	pCi/g
Europium-152	0.5	854	pCi/g

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical site controls are required for this administrative use restriction.

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

Description: This administrative UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. No site controls are required for this administrative use restriction other than the administrative controls for land use at the NSS.

Inspection/Maintenance Frequency: NA

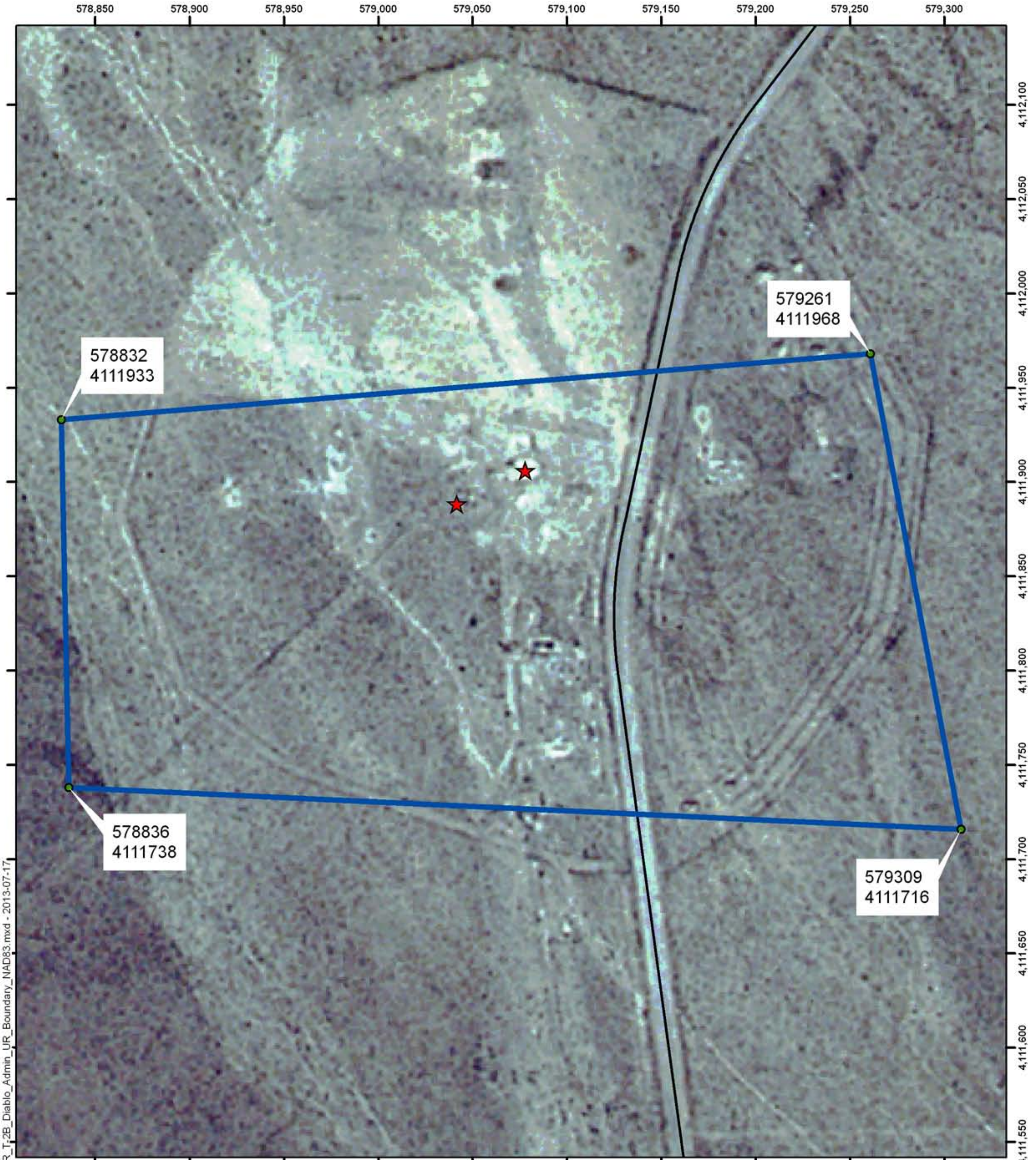
The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless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

Use Restriction Information

Comments: Personnel are restricted from performing any work in this restricted are that would result in a more intensive use of the site than the current land use. Activities included in the current land use include short duration activities such as site visits, maintenance of postings, and maintenance of demarcation areas. Permission to conduct any restricted activities within this area requires the prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 9/10/2013

Note: Effective upon acceptance of closure documents by NDEP



H:\105\CADD_CR\105_CADDCR_T-2B_Diablo_Admin_UR_Boundary_NAD83.mxd - 2013-07-17

CAU 105
CAS 02-23-06, Atmospheric Test Site T-2B
Administrative UR Boundary

Explanation

Administrative UR

0 25 50 100 Meters

0 75 150 300 Feet

N

Source: N-I GIS, 2013; NNSA/NV, 2002

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Use Restriction Information

CAU Number/Description: CAU 105, Area 2 Yucca Flat Atmospheric Test Sites
Applicable CAS Number/Description: CAS 02-23-04, Atmospheric Test Site – Whitney; CAS 02-23-08, Atmospheric Test Site T-2; CAS 02-23-09, Atmospheric Test Site - Turk

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
Southeast	4110726	579405
South	4110711	579368
Southwest	4110754	579313
Northwest	4110798	579286
Northeast	4110835	579360

Depth: 8 ft. bgs

Survey Source (GPS, GIS, etc): GPS

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Subsurface chemical and radiological contamination is assumed to be present within the 7 waste trenches with debris from unknown sources. This site also contains lead debris that present a chemical exposure hazard as presented in the CADD/CR for CAU 105. The contamination, if exposed through excavation is assumed to exceed risk-based action levels as established in the CADD/CR.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 105 CAS 02-23-04, Atmospheric Test Site – Whitney; CAS 02-23-08, Atmospheric Test Site T-2; CAS 02-23-09, Atmospheric Test Site - Turk			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	Unknown	25	mrem/yr
Pb	Unknown	8,356	mg/kg

Site Controls: The use restricted area encompasses the area where contamination is assumed to exceed risk-based action levels. These restrictions apply to any activities that would cause site workers to be directly exposed to the buried contamination. Short term, non-intrusive activities at this site are not restricted. It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed around the use-restricted area.

Note: Effective upon acceptance of closure documents by NDEP

Use Restriction Information

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
Southeast	4110398	578700
South	4110204	578317
South	4110204	578178
Southwest	4110360	577957
West	4110785	577968
Northwest	4110941	578157
Northeast	4110849	578631

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 use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicate that a worker could potentially receive a 25 mrem dose in approximately 192 hours of exposure to the surface location with the maximum detected radioactivity. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 105.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 105 CAS 02-23-04, Atmospheric Test Site – Whitney; CAS 02-23-08, Atmospheric Test Site T-2; CAS 02-23-09, Atmospheric Test Site - Turk			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Cesium-137	149	1,626	pCi/g
Europium-152	110	854	pCi/g

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure. No physical site controls are required for this administrative use restriction

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

Description: The FFACO and Administrative UR is recorded in the FFACO database, NNSA Nevada Field Office M&O GIS, and the NNSA Nevada Field Office CAU/CAS files. FFACO UR signs are posted at the site. No site controls are required for the administrative use restriction other than the administrative controls for land use at the NSS.

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

Use Restriction Information

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: Personnel are restricted from performing any work in this restricted are that would result in a more intensive use of the site than the current land use (i.e. activities consistent with the Occasional Use Are exposure scenario). Activities included in the current land use include short duration activities such as site visits, maintenance of the use restriction postings, maintenance of demarcation areas, and work on utilities. Permission to conduct any restricted activities within this area requires the prior notification to and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 9/10/2013

Note: Effective upon acceptance of closure documents by NDEP

CAU 105
CAS 02-23-04, Atmospheric Test Site Whitney
CAS 02-23-08, Atmospheric Test Site T-2
CAS 02-23-09, Atmospheric Test Site Turk
FFACO Use Restriction

Explanation

FFACO UR
Road

0 25 50 100 Feet

0 10 20 40 Meters

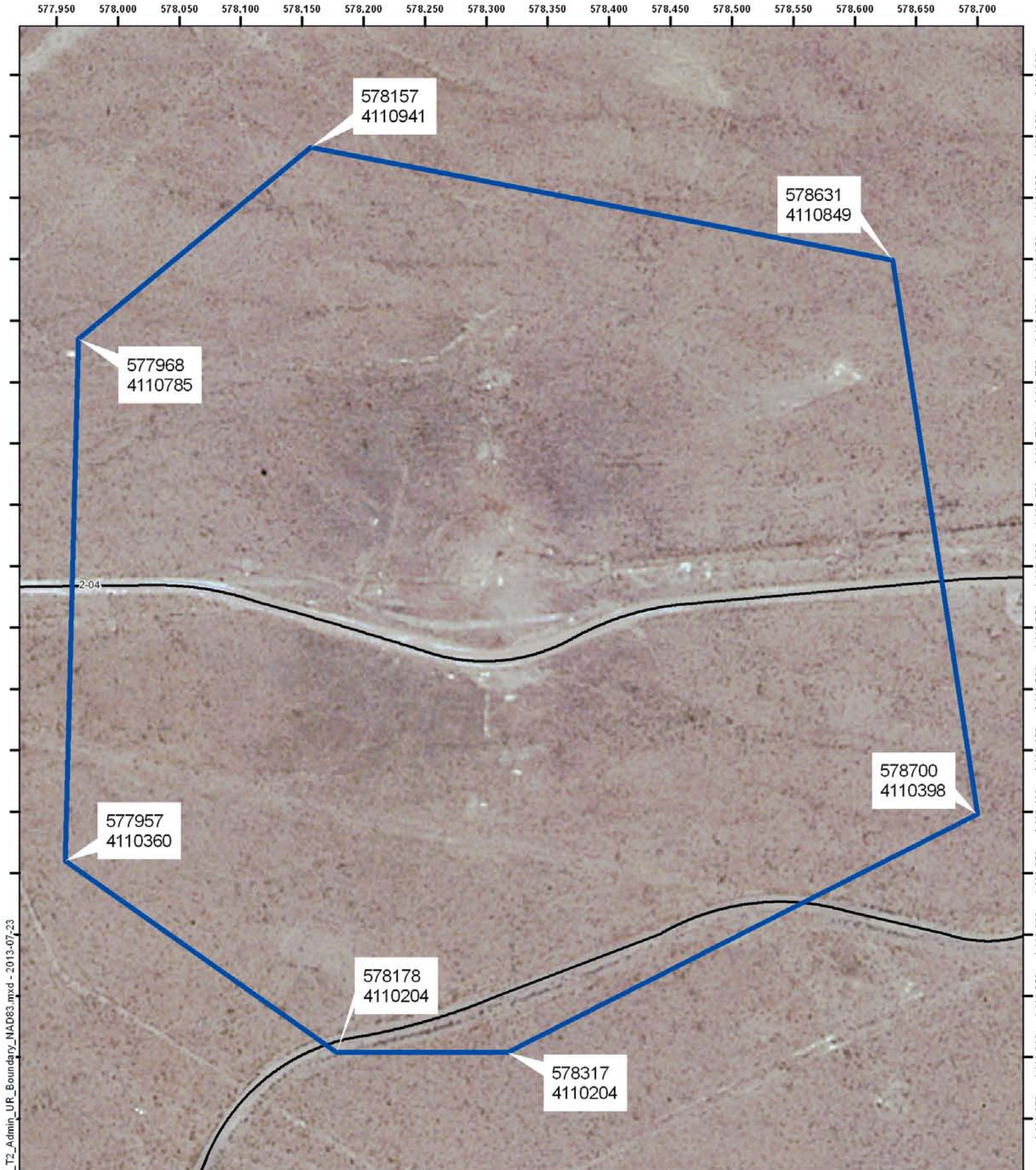
N

Source: N-I GIS, 2013; NNSA/NV, 2002

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

H:\105\CADD_CR105_CADDCR_SG5_FFACO_ADMIN_UR_Boundary_NAD83.mxd - 7/23/2013



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CAU 105
CAS 02-23-04, Atmospheric Test Site Whitney
CAS 02-23-08, Atmospheric Test Site T-2
CAS 02-23-09, Atmospheric Test Site Turk
FFACO Use Restriction

Explanation

Administrative UR

0 25 50 100 Meters

0 100 200 400 Feet

N

Source: N-I GIS, 2013; NNSA/NV, 2002

UNCONTROLLED When Printed

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Attachment D-2

Waste Disposal Documentation

(7 Pages)

NTS On-Site HazMat Transfer - Published

Tracking No: DPM13T05 **Mesa Number:**
Carrier: NSTEC ON BEHALF OF NNSA
Vehicle: G820436D
Driver: ROBERT YOUNG

Depart: 02-APR-2013 Arrival: 02-APR-2013

From: ROBERT ZION
NSTEC
BASE CAMP
PU VALLEY GATE
MERCURY, NV 89023
Area: 11
Bldg: PU VALLEY GATE
Phone: 702/295-4594
Mobile: 702/466-4231

To: ROBERT ZION
NSTEC
3-05
7-01
MERCURY, NV 89023
Area: 7
Bldg: N/A
Phone: 702/295-4594
Mobile: 702/466-4231

Entered By: ROBERT ZION
Modified By: ROBERT ZION

Date Entered: 01-APR-2013
Date Modified: 01-APR-2013

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
UN/NA 2913, RADIOACTIVE MATERIAL, SURFACE CONTAMINATED OBJECTS (SCO-II) NON FISSILE OR FISSILE-EXCEPTED, 7 WASTE RADIONUCLIDES: AM-241, PU-238, PU-239, PU-240, PU-241, CS-137, SR-90 PHYSICAL FORM: SOLID. CHEMICAL FORM: OXIDE. PACKAGE ACTIVITY: PACKAGE# 366B01: 2.36E +07 BQ. CATEGORY: FISSILE EXCEPTED, EXCLUSIVE USE SHIPMENT, EXCEPTED PACKAGING, ONSITE SHIPMENT/TRANSFER. D004, D006, D008.	1 DRUM	160.00 POUND(S) (GROSS)	162

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
WILLIAM NICOSIA @ 702-630-0223

In the event of an emergency on the Nevada Test 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 cerfify 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/ Robert H. Zion Date: 4/2/13 Time: 0930

Received by: /s/ Robert H. Zion Date: 4/2/13 Time: 11:35

UNCONTROLLED When Printed

NTS On-Site HazMat Transfer - Published

Tracking No: DPM13T06 **Mesa Number:**
Carrier: NSTEC ON BEHALF OF NNSA
Vehicle: G820436D
Driver: ROBERT YOUNG

Depart: 02-APR-2013
Arrival: 02-APR-2013

From: ROBERT ZION
NSTEC
BASE CAMP
MERCURY, NV 89023

Area: 03
Bldg: MUD PLANT
Phone: 702-295-4594
Mobile: 702-466-4231

To: ROBERT ZION
NSTEC
3-05
7-01
MERCURY, NV 89023
Area: 7
Bldg: N/A
Phone: 702-295-4594
Mobile: 702-466-4231

Entered By: ROBERT ZION
Modified By: ROBERT ZION

Date Entered: 01-APR-2013
Date Modified: 01-APR-2013

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
UN/NA 3077, HAZARDOUS WASTE, SOLID, N.O.S., 9, PG III UN/NA 3077, HAZARDOUS WASTE, SOLID, N.O.S., (LEAD, CADMIUM), 9, PG III. PACKAGE #569E02 D004, D006, D008. EXCLUSIVE USE SHIPMENT, ONSITE SHIPMENT/TRANSFER	1 DRUM	50.00 POUND(S) (GROSS)	171

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
WILLIAM NICOSIA @ 702-630-0223

In the event of an emergency on the Nevada Test 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 cerfify 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/ Robert H. Zion Date: 4/2/13 Time: 1020

Received by: /S/ Robert H. Zion Date: 4/2/13 Time: 11:35

NTS On-Site HazMat Transfer - Published

Tracking No: DPM13T07 **Mesa Number:**
Carrier: NSTEC ON BEHALF OF NNSA
Vehicle: G820436D
Driver: ROBERT YOUNG

Depart: 02-APR-2013 Arrival: 02-APR-2013

From: ROBERT ZION
NSTEC
701 ROAD
MERCURY, NV 89023

Area: 7
Bldg: CAU-104
Phone: 702-295-4594
Mobile: 702-466-4231

To: ROBERT ZION
NSTEC
3-05 ROAD
7-01 ROAD
MERCURY, NV 89023
Area: 7
Bldg: N/A
Phone: 702-295-4594
Mobile: 702-466-4231

Entered By: ROBERT ZION Date Entered: 01-APR-2013
Modified By: ROBERT ZION Date Modified: 01-APR-2013

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
UN/NA 2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, LIMITED QUANTITY OF MATERIAL, 7 WASTE. RADIONUCLIDES: AM-241, PU-238, PU-239, PU-240, PU-241 PHYSICAL FORM: SOLID. CHEMICAL FORM: OXIDE. PACKAGE ACTIVITY: PACKAGE# 104B02: 6.47E+05 BQ. PACKAGE #104B04: 3.16E+05 BQ. CATEGORY: FISSILE EXCEPTED, EXCLUSIVE USE SHIPMENT, EXCEPTED PACKAGING, ONSITE SHIPMENT/TRANSFER. D004, D006, D008	2 DRUM	260.00 POUND(S) (GROSS)	161

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
WILLIAM NICOSIA @ 702-630-0223

In the event of an emergency on the Nevada Test 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 cerfify 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/ Robert H. Zion Date: 4/2/13 Time: 11:20

Received by: /s/ Robert H. Zion Date: 4/2/13 Time: 11:35

UNCONTROLLED When Printed

NTS On-Site HazMat Transfer - Published

Tracking No: DPM13T08 **Mesa Number:**
Carrier: NSTEC ON BEHALF OF NNSA
Vehicle: G820436D
Driver: ROBERT YOUNG

Depart: 02-APR-2013 Arrival: 02-APR-2013

From: ROBERT ZION
NSTEC
BASE CAMP
MERCURY, NV 89023

Area: 02
Bldg: AREA 2 FIELD WORK
Phone: 702/295-4594
Mobile: 702/466-4231

To: ROBERT ZION
NSTEC
3-05 ROAD
7-01 ROAD
MERCURY, NV 89023
Area: 7
Bldg: N/A
Phone: 702-295-4594
Mobile: 702-466-4231

Entered By: ROBERT ZION Date Entered: 01-APR-2013
Modified By: ROBERT ZION Date Modified: 01-APR-2013

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
UN/NA 2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, LIMITED QUANTITY OF MATERIAL, 7 WASTE. RADIONUCLIDES: PU-239, CS-137 PHYSICAL FORM: SOLID. CHEMICAL FORM: OXIDE. PACKAGE ACTIVITY: PACKAGE #105A03: 5.50E+04 BQ. CATEGORY: FISSILE EXCEPTED, EXCLUSIVE USE SHIPMENT, EXCEPTED PACKAGING. ONSITE SHIPMENT/TRANSFER, D008.	1 DRUM	182.00 POUND(S) (NET)	161

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
WILLIAM NICOSIA @ 702-630-0223

In the event of an emergency on the Nevada Test 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 cerfify 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/ Robert H. Zion Date: 4/2/13 Time: 10 50

Received by: /s/ Robert H. Zion Date: 4/2/13 Time: 11:35

UNCONTROLLED When Printed

The Certificate of Disposal for LLW will be provided in an addendum.

The Onsite Hazardous Material Transfer document for MLLW will be provided in an addendum.

The Onsite Hazardous Material Transfer document for MLLW will be provided in an addendum.

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 105, 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.

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

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

- Treatment should be used to address principal threats wherever practicable and cost effective.
- Engineering controls, such as containment, should be used where wastes and contaminated soil or sediment 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 using Soils RBCA document (NNSA/NSO, 2012b). 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.1.3 Corrective Action Standards

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

Protection of Human Health and the Environment

Protection of human health and the environment is a general mandate of the RCRA statute (EPA, 1994). This mandate requires that the corrective action include any necessary protective measures. These measures may or may not be directly related to media cleanup, source control, or management of wastes.

Compliance with Media Cleanup Standards

The CAAs are evaluated for the ability to meet the proposed media cleanup standards. The media cleanup standards are the FALs defined in Section 2.3.1.

Control the Source(s) of the Release

The CAAs are evaluated for the ability to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will involve a perpetual cleanup. Therefore, each CAA must provide effective source control to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

The CAAs are evaluated for the ability to be conducted in accordance with applicable federal and state regulations (e.g., 40 CFR 260 to 282, “Hazardous Waste Management” [CFR, 2013a]; 40 CFR 761 “Polychlorinated Biphenyls,” [CFR, 2013b]; and NAC 444.842 to 444.980, “Facilities for Management of Hazardous Waste” [NAC, 2012a]).

E.1.3.1 Remedy Selection Decision Factors

The following text describes the remedy selection decision factors used to evaluate the CAAs.

Short-Term Reliability and Effectiveness

Each CAA must be evaluated with respect to its effects on human health and the environment during implementation of the selected corrective action. The following factors will be addressed for each alternative:

- Protection of the community from potential risks associated with implementation, such as fugitive dusts, transportation of hazardous materials, and explosion
- Protection of workers during implementation
- Environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

Each CAA must be evaluated for its ability to reduce the toxicity, mobility, and/or volume of the contaminated soil or sediment. Reduction in toxicity, mobility, and/or volume refers to changes in one or more characteristics of the contaminated soil by using corrective measures that decrease the inherent threats associated with that media.

Long-Term Reliability and Effectiveness

Each CAA must be evaluated in terms of risk remaining at the CAU after the CAA has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the control that may be required to manage the risk posed by treatment of residuals and/or untreated wastes.

Feasibility

The feasibility criterion addresses the technical and administrative feasibility of implementing a CAA and the availability of services and materials needed during implementation. Each CAA must be evaluated for the following criteria:

- **Construction and Operation.** The feasibility of implementing a CAA given the existing set of waste and site-specific conditions.
- **Administrative Feasibility.** The administrative activities needed to implement the CAA (e.g., permits, URs, public acceptance, rights of way, offsite approval).

- **Availability of Services and Materials.** The availability of adequate offsite and onsite treatment, storage capacity, disposal services, necessary technical services and materials, and prospective technologies for each CAA.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each CAA includes both capital, and operation and maintenance costs, as applicable. The following is a brief description of each component:

- **Capital Costs.** Costs that include direct costs that may consist of materials, labor, construction materials, equipment purchase and rental, excavation and backfilling, sampling and analysis, waste disposal, demobilization, and health and safety measures. Indirect costs are separate and not included in the estimates.

- **Operation and Maintenance Costs.** Separate costs that include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures. These costs are not included in the estimates.

E.1.4 Development of Corrective Action Alternatives

This section identifies and briefly describes the viable corrective action technologies and the CAAs considered for each CAU 105 CAS. The CAAs are based on the current nature of contamination at CAU 105, 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 105:

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

CAAs will not be evaluated for Site T-2B, Diablo because it does not require corrective actions beyond those implemented during the CAI and is recommended for clean closure. Regardless of the CAA selected, BMPs will be conducted to include implementation of an administrative UR for areas that exceed the 25-mrem/IA-yr PAL.

E.1.4.1 Alternative 1 – No Further Action

Under Alternative 1, no corrective action activities will be implemented. This alternative is a baseline case with which to compare and assess the other CAAs and their ability to meet the corrective action standards.

E.1.4.2 Alternative 2 – Clean Closure

Clean closure for Site T-2A, Shasta includes excavating and disposing of impacted soil and debris presenting a dose exceeding the FAL for lead. Closure activities include removing approximately 8,831 yd^3 of soil and debris from a 3.7-acre site at a depth of 6 in. A visual inspection will be conducted to ensure that contaminated surface debris and soil have been removed before the corrective action is completed. Verification soil samples will also be collected and analyzed for the presence of a dose exceeding the FAL after contaminated soil is removed.

Clean closure at the waste trenches associated with Site T-2 includes excavating and disposing of impacted soil and debris at the one open and six buried waste trenches. Clean closure activities include removing approximately 23,430 yd^3 of debris and soil from a 1.6-acre site to a depth of 8 ft. A visual inspection will be conducted to ensure that surface and buried debris has been removed before the corrective action is completed. Verification soil samples will also be collected and analyzed for the presence of radiological contamination and lead 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.1.4.3 Alternative 3 – Closure in Place

Closure in place for Site T-2A, Shasta includes the implementation of a UR where lead is assumed to be present at levels that exceed the FAL. This UR will restrict inadvertent contact with contaminated soil or debris by prohibiting any activity that would cause site workers to be exposed to soil with lead contamination above the FAL. Closure activities encompass 3.7 acres, and site controls include warning signs placed around the UR area.

Closure in place for the waste trenches associated with Site T-2 includes the implementation of a UR where a radiological dose is assumed to exceed the 25 mrem/OU-yr FAL and where chemical contamination is assumed to exceed the FALs. This UR will restrict inadvertent contact with contaminated soil or debris by prohibiting any activity that would cause a site worker to be exposed to a dose exceeding 25 mrem/yr or a concentration of chemicals above the FAL. Under this alternative, debris within the UR will not be removed. Closure activities encompass 1.6 acres, and site controls include warning signs placed around the UR area.

E.1.5 Evaluation and Comparison of Alternatives

Each CAA presented in Section E.1.4 will be evaluated for the CASs that contain a COC based on the general corrective action standards listed in Section E.1.2. This evaluation is presented in Tables E.1-1 and E.1-2. Any CAA that does not meet the general corrective action standards will be removed from consideration.

The remaining CAAs will be further evaluated based on the remedy selection decision factors described in Section E.1.2. This evaluation is presented in Tables E.1-3 and E.1-4. For each remedy selection decision factor, the CAAs are ranked relative to one another. The CAA with the least desirable impact on the remedy selection decision factor will be given a ranking of 1. The CAAs with increasingly desirable impacts on the remedy selection decision factor will receive increasing rank numbers. The CAAs that will have an equal impact on the remedy selection decision factor will receive an equal ranking number. The scoring listed in this table represents the sum of the remedy selection decision factor rankings for each CAA.

The evaluation of CAAs does not include corrective actions that have been completed during the CAI. The removal of lead from Site T-2B, Diablo and Site T-2 (Study Group 3) are considered to be a completed corrective action and do not require any further corrective actions.

The five EPA remedy selection decision factors are (1) short-term reliability and effectiveness; (2) reduction of toxicity, mobility, and/or volume; (3) long-term reliability and effectiveness; (4) feasibility; and (5) cost. These factors are evaluated in Table E.1-3.

Table E.1-1
Evaluation of General Corrective Action Standards for CAU 105, Site T-2A, Shasta

CAA 1, No Further Action		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	No	Workers could be exposed to contamination exceeding risk-based action levels.
Compliance with Media Cleanup Standards	No	Workers could be exposed to contamination exceeding risk-based action levels.
Control the Source(s) of the Release	Yes	The source of the release was a one-time event with no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.
CAA 2, Clean Closure		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	Yes	Contamination exceeding the risk-based action levels will be removed.
Compliance with Media Cleanup Standards	Yes	Contamination exceeding the risk-based action levels will be removed.
Control the Source(s) of the Release	Yes	The source of the release will be removed and was a one-time event with no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	Excavated waste can be managed in compliance with all standards.
CAA 3, Closure in Place		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	Yes	URs will be implemented to protect site workers from contamination exceeding the risk-based action levels.
Compliance with Media Cleanup Standards	Yes	Although COCs will not be removed, site workers will not be exposed to COCs.
Control the Source(s) of the Release	Yes	The source of the release was a one-time event with no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

Table E.1-2
Evaluation of General Corrective Action Standards for CAU 105, Waste Trenches

CAA 1, No Further Action		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	No	Workers could be exposed to contamination exceeding risk-based action levels.
Compliance with Media Cleanup Standards	No	Workers could be exposed to contamination exceeding risk-based action levels.
Control the Source(s) of the Release	Yes	The source of the release was a one-time event with no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.
CAA 2, Clean Closure		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	Yes	Contamination exceeding the risk-based action levels will be removed.
Compliance with Media Cleanup Standards	Yes	Contamination exceeding the risk-based action levels will be removed.
Control the Source(s) of the Release	Yes	The source of the release was a one-time event with no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	Excavated waste can be managed in compliance with all standards.
CAA 3, Closure in Place		
Standard	**Comply?**	**Explanation**
Protection of Human Health and the Environment	Yes	Although COCs will not be removed, site access will be controlled to prevent site workers from contamination exceeding risk-based action levels.
Compliance with Media Cleanup Standards	Yes	Although COCs will not be removed, site access will be controlled to prevent site workers from contamination exceeding risk-based action levels.
Control the Source(s) of the Release	Yes	The source of the release was a one-time event with no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

Table E.1-3
Evaluation of Remedy Selection Decision Factors for CAU 105, Site T-2A, Shasta

CAA 1, No Further Action		
Factor	**Rank**	**Explanation**
Not evaluated, as this CAA did not meet the General Corrective Action Standards		
CAA 2, Clean Closure		
Standard	**Rank**	**Explanation**
Short-Term Reliability and Effectiveness	1	This alternative is reliable and effective, but involves increased short-term exposure of site workers to COCs during debris and soil removal operations.
Reduction of Toxicity, Mobility, and/or Volume	2	This alternative will result in a decrease of toxicity and mobility of the COCs that are present, but will generate significant waste volumes. The historical significance of the site would be affected.
Long-Term Reliability and Effectiveness	2	This alternative is reliable and effective at protecting human health and the environment because removal of the contaminated soil will eliminate future exposure of site workers to COCs.
Feasibility	1	Involves the removal of large volumes of soil and debris (approximately 8,831 yd^3).
Cost	1	Cost to remove and dispose of contaminated soil and debris is estimated at $125,000.
Score	7	
CAA 3, Closure in Place		
Standard	**Rank**	**Explanation**
Short-Term Reliability and Effectiveness	2	This alternative is reliable and effective in providing increased protection of human health by preventing contact with COCs.
Reduction of Toxicity, Mobility, and/or Volume	1	This alternative will not reduce toxicity or mobility of the COCs that are present, but will not generate excavation waste volumes. The historical significance of the site would not be affected.
Long-Term Reliability and Effectiveness	1	This alternative is reliable in the long term with ongoing maintenance. It is effective in providing protection of human health by preventing inadvertent contact with COCs.
Feasibility	2	This alternative requires maintenance and long-term monitoring because no soil is removed.
Cost	2	The installation costs are estimated at $40,000. Ongoing maintenance costs for this alternative are estimated at $2,000 annually.
Score	8	

Table E.1-4
Evaluation of Remedy Selection Decision Factors for CAU 105, Waste Trenches

CAA 1, No Further Action		
Factor	**Rank**	**Explanation**
Not evaluated, as this CAA did not meet the General Corrective Action Standards		
CAA 2, Clean Closure		
Standard	**Rank**	**Explanation**
Short-Term Reliability and Effectiveness	1	This alternative is reliable and effective, but involves increased short-term exposure of site workers to COCs during debris and soil removal operations..
Reduction of Toxicity, Mobility, and/or Volume	2	This alternative will result in a decrease of toxicity and mobility but will generate significant waste volumes from the seven waste trenches.
Long-Term Reliability and Effectiveness	2	This alternative is reliable and effective at protecting human health and the environment because removal of the contaminated soil will eliminate future exposure of site workers to COCs.
Feasibility	1	Involves the removal of large quantities of soil and debris (approximately 23,430 yd^3).
Cost	1	Cost to remove and dispose of contaminated soil and debris is estimated at $500,000.
Score	7	
CAA 3, Closure in Place		
Standard	**Rank**	**Explanation**
Short-Term Reliability and Effectiveness	2	This alternative is reliable and effective in providing increased protection of human health by preventing contact with COCs.
Reduction of Toxicity, Mobility, and/or Volume	1	This alternative will not reduce toxicity or mobility of the COCs that are present, but will not generate excavation waste volumes. The historical significance of the site would not be affected.
Long-Term Reliability and Effectiveness	1	This alternative is reliable in the long term with ongoing maintenance. It is effective in providing protection of human health by preventing inadvertent contact with COCs.
Feasibility	2	This alternative requires maintenance and long-term monitoring because no soil is removed.
Cost	2	The installation costs are estimated at $40,000. Ongoing maintenance costs for this alternative are estimated at $2,000 annually.
Score	8	

The first remedy selection decision factor—short-term reliability and effectiveness—is a qualitative measure of the impacts on human health and the environment during implementation of the CAA.

While clean closure is both reliable and effective in the long term, this alternative involves increased, short-term exposure of site workers to radiological and chemical contamination during soil and debris removal. In contrast, closure in place does not require removal of soil, and there is no short-term exposure of site workers; signs are posted, and disturbance of contaminated soil and debris is not necessary.

The second remedy selection decision factor—reduction of toxicity, mobility, and/or volume—is a qualitative measure of changes in characteristics of contaminated media that result from implementation of the CAA. Under clean closure, contaminated soil or debris that exceed FALs would be removed from the area, thereby eliminating both mobility and the onsite volume of contaminated media. In contrast, closure in place does not reduce toxicity, mobility, or volume.

The third remedy selection decision factor—long-term reliability and effectiveness—is a qualitative evaluation of performance following site closure, and into the future. Removal of contaminated soil or debris for clean closure provides long-term reliability and effectiveness, whereas closure in place does not.

The fourth remedy selection decision factor—feasibility—includes an evaluation of the requirements for construction and operation as well as administrative constraints. For the closure in place alternative, no construction is required other than the installation of postings. Some maintenance and administrative requirements would be onging. For the clean closure alternative, substantial construction, operation, and administrative actions consistent with soil removal and management of generated wastes are needed.

The fifth remedy selection decision factor—cost—includes assessment of both capital (direct) costs of implementation and costs for operation and maintenance of the corrective action. As shown in Table E.1-3, the estimated cost for clean closure of the lead debris at Site T-2A, Shasta is approximately $125,000. The costs for closure in place are derived from acquiring, hanging, inspecting, and occasionally replacing, administrative UR signs (estimated to be $40,000 for the first year and $2,000 for each year thereafter). As shown in Table E.1-4, the estimated cost for closure in place of the waste trenches associated with Site T-2 would be $500,000. The costs are derived from the excavation of debris from the open waste trench and include those derived from acquiring, hanging, inspecting, and occasionally replacing, administrative UR signs (estimated to be $40,000 for the first year and $2,000 for each year thereafter).

E.2.0 Recommended Alternative

The 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 105 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer are valid, additional evaluation may be necessary.

Three CAAs were evaluated for CAU 105: no further action (CAA 1), clean closure (CAA 2), and closure in place (CAA 3). Only CAA 2 and CAA 3 met all requirements for general corrective action standards (Section E.1.2). In general, for the clean closure alternative, lead items and debris would be removed from Site T-2A, Shasta; and debris would be excavated and removed from the open and buried waste trenches associated with Site T-2. For the closure in place alternative, potential worker exposure to radiological and chemical contamination would be controlled through the implementation of URs. Both CAAs would, therefore, be protective of human health and the environment, comply with media cleanup standards, and control the source of release. As supported by the following discussion, further examination of the two CAAs by the five EPA remedy selection decision factors resulted in the selection of closure in place as the preferred CAA for both Site T-2A, Shasta and the waste trenches.

Based upon the five remedy selection decision factors, clean closure received an overall score of 7 (less desirable), whereas closure in place received an overall score of 8 (more desirable) at both Site T-2A, Shasta and the waste trenches. This result was not only the product of an examination of the two sites by the five remedy selection decision factors, but also in consideration of the current NNSS administrative controls (e.g., NNSS access restrictions and control of site activities). Decision factors included the remoteness of the sites, no nearby structures or activities, no current or planned use of the sites, the present-day stability of the soil at the sites through the evolution of a mature plant community, and the development of soil surface durability (i.e., soil crust). A corrective action of clean closure at these sites would require extensive excavations (the corrective action areas at each CAS are presented in Table E.2-1). Working in these areas is a high-risk activity involving extensive radiological and chemical controls to protect workers from inhaling or ingesting airborne radioactive and chemical particles. Excavating into buried waste trenches also pose additional risks due to unknown buried items and hazards. In addition, lead items at Site T-2A, Shasta have been determined to have potential historical significance. To excavate contaminated material would require the removal of approximately 8,831 yd^3 of material at Site T-2A, Shasta and 23,430 yd^3 of material at the waste trenches. Therefore, this removal action would pose significant safety risks, be difficult and expensive, and would not provide significant additional protection to potential future receptors. Based on the extent of the corrective action boundaries and the infeasibility of removing contamination in areas that would expose remediation workers to contamination, the corrective action of closure in place with URs for the areas encompassed by the corrective action boundaries was selected.

Table E.2-1
Corrective Action Boundary Areas at CAU 105 CASs

Site	Area (acres)
Site T-2A, Shasta	3.7
Waste Trenches	1.6

Completed corrective actions performed during the CAI included the removal of PSM and associated impacted soil. In addition to the FFACO corrective actions, BMPs were implemented that were not part of an FFACO corrective action. In accordance with the Soils RBCA document (NNSA/NSO, 2012b) and Section 3.3 of the CAIP (NNSA/NSO, 2012a), administrative URs were implemented as a BMP for any area where an industrial land use of the area could cause a future site worker to receive an annual dose exceeding 25 mrem/yr. This assumes the worker would be exposed to site contamination for a period of 2,000 hr/yr. This administrative UR was 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 for each radiation survey (1994 aerial radiation surveys [BN, 1999] and the site-specific TRS). The radiation survey with the best correlation was the TRS. The TRS values were interpolated using a kriging technique and isopleths established over the entire area of the TRS. The administrative UR boundaries were established to encompass the TRS isopleth corresponding to a dose of 25 mrem/IA-yr for each site. This would prevent any inadvertent exposure of workers to site radioactivity if a more intensive use of the site were to be considered in the future. The administrative URs will be recorded and controlled in the same manner as the FFACO URs, but will not require posting or inspections. The administrative URs are presented in Attachment D-1. A corrective action was also performed at the open waste trench that included removing debris and covering with clean-fill soil. Easily accessible surface debris at the open waste trench was collected, removed, and disposed of. Clean fill soil was placed in the open trench to surface grade level.

The development of FFACO and Administrative URs for CAU 105 are based on current land use. Any proposed activity within a use restricted area that would result in a more intensive use of the site would require NDEP approval.

E.3.0 Cost Estimates

The cost for clean closure at CAU 105 is estimated to exceed $625,000 to conduct the following activities:

- Preparation and procurement
- Grub surface contamination
- Excavation, loading, and disposal of contaminated soil (approximately 32,261 yd^3)
- Debris disposal
- Equipment decontamination

The estimated costs for clean closure of CAU 105 was based on removing contaminated soil within a 225-ft radius of GZ at Site T-2A, Shasta; and excavating the identified open and buried waste trenches associated with Site T-2. The cost for clean closure of Site T-2, Shasta was estimated to be more than $125,000. For the waste trenches, soil within the seven trenches identified during the CAI would be removed. The cost for clean closure of the waste trenches was estimated to be approximately $500,000. 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 $40,000 at each site for the first year and $2,000 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.

BN, see Bechtel Nevada.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site,* DOE/NV/11718--324. Prepared for the U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2013a. Title 40 CFR, Parts 260 to 282, "Hazardous Waste Management." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2013b. 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/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site 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 15 May 2013.

Nevada Administrative Code. 2012b. NAC 445A, "Water Controls." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 15 May 2013.

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 15 May 2013.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012a. *Corrective Action Investigation Plan for Corrective Action Unit 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada*, Rev. 0, DOE/NV--1486. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012b. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 0, DOE/NV--1475. Las Vegas, NV.

U.S. Environmental Protection Agency. 1991. *Guidance on RCRA Corrective Action Decision Documents: The Statement of Bases, Final Decision and Response to Comments*, EPA/540/G-91/011. Washington, DC: Office of Waste Programs Enforcement.

U.S. Environmental Protection Agency. 1994. *Final RCRA Corrective Action Plan*, EPA/520-R-94-004. Washington, DC: Office of Solid Waste and Emergency Response.

U.S. Environmental Protection Agency. 1996. “Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities,” 1 May. In *Federal Register*, Vol. 61, No. 85.

Appendix F

Data Tables

F.1.0 Data Tables for Study Group 1

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample plots at Study Group 1 that were detected above MDCs are presented in Tables F.1-1 and F.1-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.1-2.

Table F.1-1
Samples Results for Gamma-Emitting Radionuclides Detected above MDC at Study Group 1

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
A01	AA4A601	0 - 5	1.16	9.8	--	31.1	1.15	--
	AA4A602	0 - 5	1.19	11.5	--	35.5	1.21	--
	AA4A603	0 - 5	1.2	11.3 (J)	--	37.8	1.23 (J)	--
	AA4A604	0 - 5	1.12	17 (J)	--	59.3	1.31 (J)	--
B01	AA4B601	0 - 5	1.41	36.9 (J)	--	68.5	--	--
	AA4B602	0 - 5	1.38	75.4 (J)	--	137	--	--
	AA4B603	0 - 5	1.23	56.3 (J)	--	113	--	--
	AA4B604	0 - 5	1.16	52.5 (J)	--	93	--	--
C01	AA4C601	0 - 5	--	30.5	0.85	142	89	3.79
	AA4C602	0 - 5	--	22.5	0.82	112	110	4.14
	AA4C603	0 - 5	--	35.2 (J)	0.95	149	98 (J)	3.89 (J)
	AA4C604	0 - 5	--	30.2	0.86	129	90	3.98

Ac = Actinium

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

Table F.1-2
Sample Results for Isotopes Detected above MDCs at Study Group 1

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)										
			Am-241	Am-243	Pu-238	Inferred Pu-238	Pu-239/240	Inferred Pu-239/240	Pu-241	Inferred Pu-241	Sr-90	U-234	U-238
A01	AA4A601	0 - 5	7.1 (J)	0.119	13.1 (J)	19.9	40.3	58.9	15	24.1	--	0.78	0.65
	AA4A602	0 - 5	5.58 (J)	0.081	9.5 (J)	23.4	29.7	69.1	--	28.2	--	0.77	0.68
	AA4A603	0 - 5	12.3 (J)	0.2	18.4 (J)	23.0	58.4	67.9	20.8	27.7	--	0.93	0.83
	AA4A604	0 - 5	11.3 (J)	0.147	19.4 (J)	34.5	60.4	102.1	18.1	41.7	9.3	0.83	0.51
B01	AA4B601	0 - 5	41.2 (J)	0.57	79 (J)	70.8	221 (J)	191.9	99	85.2	--	1.59	1.04
	AA4B602	0 - 5	27.2 (J)	0.33	51.2 (J)	144.6	136 (J)	392.1	62	174.2	--	1.05	0.9
	AA4B603	0 - 5	53.8 (J)	--	108 (J)	108.0	291 (J)	292.8	130	130.0	--	1.41	1.22
	AA4B604	0 - 5	58 (J)	--	108 (J)	100.7	291 (J)	273.0	127	121.3	--	1.65	1.27
C01	AA4C601	0 - 5	30.2 (J)	0.35	51.8 (J)	52.8	286 (J)	305.6	46	55.0	--	1.36	0.91
	AA4C602	0 - 5	10.9 (J)	--	20.9 (J)	38.9	141 (J)	225.4	21.6	40.6	--	0.96	0.62
	AA4C603	0 - 5	22.9 (J)	0.39	46.3 (J)	60.9	223 (J)	352.7	53	63.5	3.58	1.16	0.77
	AA4C604	0 - 5	18.2 (J)	0.32	31.5 (J)	52.3	200 (J)	302.6	36.2	54.5	--	1.36	0.81

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

F.2.0 Data Tables for Study Group 2

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the sample plots at Study Group 2 that were detected above MDCs are presented in Tables F.2-1 and F.2-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.2-2.

Table F.2-1
Sample Results for Gamma-Emitting Radionuclides
Detected above MDCs at Study Group 2

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)			
			Ac-228	Am-241	Cs-137	Eu-152
B79	AA4B011	0 - 5	1.43	4.14 (J)	10.2	0.447 (J)

J = Estimated value

Table F.2-2
Sample Results for Isotopes Detected above MDCs at Study Group 2

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)								
			Am-241	Am-243	Pu-238	Inferred Pu-238	Pu-239/240	Inferred Pu-239/240	U-234	U-235	U-238
B79	AA4B011	0 - 5	2.88	0.099	3.77	7.9	11.1	21.5	0.83	0.05	0.79

F.3.0 Data Tables for Study Group 3

Analytical results for gamma-emitting, isotopic radionuclide, and metals environmental samples collected at spill and debris sites for Study Group 3 that were detected above MDCs are presented in Tables F.3-1 through F.3-4. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.3-2.

Table F.3-1
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at Study Group 3

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)			
			Ac-228	Am-241	Cs-137	Eu-152
A66	AA4A010	0 - 6	1.27	18.5 (J)	76	1.43 (J)

J = Estimated value

Table F.3-2
Sample Results for Isotopes Detected above MDCs at Study Group 3

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)								
			Am-241	Pu-238	Inferred Pu-238	Pu-239/240	Inferred Pu-239/240	Pu-241	Inferred Pu-241	U-234	U-238
A66	AA4A010	0 - 6	14.4	19	37.6	63	111.1	20.2	45.4	0.96	0.86

Table F.3-3
Sample Results for Metals Detected above MDCs at Study Group 3
(Page 1 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**8,356**	**43**	**5,100**	**5,100**
A66	AA4A010	0 - 6	**80** (J)	150 (J)	--	7.5	**23,000**	0.014 (J-)	0.81	5.2 (J)
A70	AA4A016	0 - 6	5.6	180 (J)	0.22 (J-)	9.4	140 (J)	--	0.79 (J)	--
A71	AA4A018	0 - 6	5.4	150 (J)	0.13 (J-)	8	29 (J)	--	0.72 (J)	--
A72	AA4A019	0 - 6	4.7	150 (J)	0.13 (J-)	7.9	14 (J)	--	--	--
A73	AA4A020	0 - 6	4.5	130 (J)	0.16 (J-)	9.3	24 (J)	--	0.72 (J+)	--
A74	AA4A021	0 - 6	4.9	160 (J)	0.16 (J-)	7.5	23 (J)	--	0.68 (J+)	--
A75	AA4A022	0 - 6	5.2	170 (J)	0.17 (J-)	8.3	33 (J)	0.035	0.47 (J+)	--
A76	AA4A023	0 - 6	6.1	240 (J)	0.24 (J-)	8.2	43 (J)	--	0.91 (J+)	--
A77	AA4A024	0 - 6	4.8	140 (J)	0.15 (J-)	7.7	37 (J)	--	1 (J+)	--
B80	AA4B012	0 - 5	5.7	170 (J)	0.3 (J-)	12	3,900 (J)	0.023 (J-)	0.33	--
C80	AA4C015	6 - 8	6.1	200	0.32 (J-)	12	3,500	--	0.49 (J+)	--
C81	AA4C018	6 - 8	5.8	140	0.2	8.8	820	--	0.99 (J+)	--
C82	AA4C017	6 - 8	4.5	150	0.16	8.6	270	--	0.8 (J+)	--
C83	AA4C016	6 - 8	5.5	160	0.22 (J-)	9.8	1,300	--	1.1	--
C84	AA4C019	6 - 8	6.3	150	0.15	9.9	410	--	0.61 (J+)	--
C85	AA4C011	6 - 8	8.7	160	0.16 (J-)	8.5	5,300	--	1.2	0.16
C86	AA4C022	6 - 8	5.6	190	0.14	9.5	420	--	0.68 (J+)	--
C87	AA4C012	6 - 8	11	150	0.19 (J-)	8.4	**13,000**	--	0.5 (J+)	0.58
	AA4C013	6 - 8	11	140	0.2 (J-)	11	**12,000**	--	0.5 (J+)	0.44
	AA4C024	11 - 12	8.6	150	0.22	8	6,100	0.033 (J-)	0.77	0.22 (J-)
C88	AA4C020	6 - 8	6.3	160	0.2	8.6	1,800	--	0.56 (J+)	--
C89	AA4C021	6 - 8	5.1	140	0.14	7.8	260	--	0.56 (J+)	--
C90	AA4C014	6 - 8	5.8	180	0.093 (J-)	8.9	680	0.055 (J+)	0.63 (J+)	--
C93	AA4C023	6 - 8	8.1	150 (J)	0.15 (J-)	9.2	2,000 (J)	--	--	--

Table F.3-3
Sample Results for Metals Detected above MDCs at Study Group 3
(Page 2 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)							
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
FALs			**23**	**190,000**	**9,300**	**33.6**	**8,356**	**43**	**5,100**	**5,100**
C94	AA4C025	0 - 5 (cm bgs)	4.4	140	0.15 (J-)	7.9	35	0.017 (J-)	--	--
	AA4C026	0 - 5 (cm bgs)	4.8	130	0.13 (J-)	7.5	30	0.023 (J-)	0.7 (J-)	--
	AA4C027	0 - 5 (cm bgs)	4.1 (J-)	120	0.093 (J-)	6.4	120	0.024 (J-)	0.66 (J-)	--
	AA4C028	0 - 5 (cm bgs)	3.6 (J-)	110	0.13 (J-)	6.9	370	0.024 (J-)	--	--

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

Bold indicates the values exceeding the FALs.

Table F.3-4
TCLP Results Detected at Study Group 3

Sample Location	Sample Number	Matrix	Parameter	Result	Regulatory Limit[a]	Units
A66	AA4A009	Solid	Arsenic	0.042 (J+)	5	mg/L
		Solid	Lead	**17** (J)	5	mg/L

[a]CFR, 2012b

J = Estimated value
J+ = The result is an estimated quantity, but the result may be biased high.

Bold indicates the values exceeding the regulatory limit.

F.4.0 Data Tables for Study Group 4

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at drainage sites for Study Group 4 that were detected above MDCs are presented in Tables F.4-1 and F.4-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Inferred plutonium concentrations used in calculating dose at a sample location are presented in Table F.4-2.

Table F.4-1
Sample Results for Gamma-Emitting Radionuclides
Detected above MDCs at Study Group 4
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)				
			Ac-228	Am-241	Co-60	Cs-137	Eu-152
A02	AA4A004	0 - 10	1.47	2.86 (J)	--	5.92	--
A03	AA4A001	0 - 10	1.02	1.77	--	6.59	0.422
	AA4A002	0 - 10	1.02	--	--	6.18	0.447
	AA4A003	20 - 30	0.89	4.93	--	12	0.6
A64	AA4A005	0 - 10	1.29	8.3 (J)	--	17.9	--
	AA4A006	20 - 30	1.18	34.9 (J)	--	67.8	0.67 (J)
	AA4A011	40 - 50	0.88	2.88	--	6.28	--
A65	AA4A007	0 - 10	1.15	24.4 (J)	--	53.2	0.48 (J)
	AA4A008	20 - 30	1.24	26.1 (J)	--	56.6	0.48 (J)
	AA4A012	40 - 50	0.98	4.43	--	10	--
A67	AA4A014	0 - 10	0.87	8.9	--	16.5	--
	AA4A015	20 - 30	0.84	4.57	--	10.2	--
A68	AA4A013	0 - 10	1.1	8.1 (J)	--	17.9	--
B43	AA4B002	0 - 10	1.44	2.85 (J)	--	5.73	0.264 (J)
B44	AA4B003	0 - 10	1.46	--	--	0.86	--
B45	AA4B004	0 - 10	1.68	2.62 (J)	--	5.7	--
B46	AA4B005	0 - 10	1.69	32.7 (J)	--	56.2	--

Table F.4-1
Sample Results for Gamma-Emitting Radionuclides
Detected above MDCs at Study Group 4
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)				
			Ac-228	Am-241	Co-60	Cs-137	Eu-152
B48	AA4B001	0 - 10	1.84	--	--	1.04	0.461 (J)
B57	AA4B006	0 - 10	1.59	--	--	1.56	0.316 (J)
C39	AA4C004	0 - 10	0.76	18.3 (J)	0.492	108	8.5 (J)
C40	AA4C001	0 - 10	1.6	27.6 (J)	0.513	116	15.9 (J)
C41	AA4C003	0 - 10	0.85	12	0.163	48.2	14.6
C63	AA4C006	0 - 10	0.83	6.05	0.148	37	5.01
C64	AA4C005	0 - 10	0.56	36.9	0.435	113	17.6
C65	AA4C009	0 - 10	1.12	15.9 (J)	0.128	56.6	6.44 (J)
C66	AA4C008	0 - 10	0.88	7.9 (J)	0.188	44.7	7.5 (J)
C77	AA4C002	0 - 10	1.19	--	--	13	5.42 (J)
C78	AA4C007	0 - 10	1.04	--	--	5.34	1.87 (J)
C79	AA4C010	0 - 10	1.25	--	--	2.57	1.1 (J)

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

Table F.4-2
Sample Results for Isotopes Detected above MDCs at Study Group 4
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)										
			Am-241	Am-243	Pu-238	Inferred Pu-238	Pu-239/240	Inferred Pu-239/240	Pu-241	Inferred Pu-241	U-234	U-235	U-238
A02	AA4A004	0 - 10	0.67 (J)	--	0.96 (J)	5.8	3.87	17.2	--	7.0	0.79	--	0.89
A03	AA4A001	0 - 10	0.68 (J)	--	0.81 (J)	3.6	6.3	10.6	--	4.3	0.66	--	0.73
	AA4A002	0 - 10	2.69 (J)	--	5.3 (J)	5.3	19.9	19.9	--	0.0	0.78	--	0.73
	AA4A003	20 - 30	1.98 (J)	0.04	3.2 (J)	10.0	18.2	29.6	--	12.1	0.56	--	0.55
A64	AA4A005	0 - 10	5.56 (J)	0.116	12.8 (J)	16.9	39.4 (J)	49.8	16.4	20.4	0.8	0.063	0.72
	AA4A006	20 - 30	24 (J)	0.35	55 (J)	70.9	157 (J)	209.6	67	85.7	1.14	--	0.73
	AA4A011	40 - 50	3.39	0.036	5.37	5.9	16.2	17.3	--	7.1	0.68	--	0.68
A65	AA4A007	0 - 10	20.3 (J)	0.23	44.8 (J)	49.6	133 (J)	146.5	54	59.9	1.13	--	0.76
	AA4A008	20 - 30	25.4 (J)	0.5	57.3 (J)	53.0	165 (J)	156.7	70	64.1	0.95	--	0.79
	AA4A012	40 - 50	12.3	0.109	21.6	9.0	62	26.6	28	10.9	0.68	--	0.68
A67	AA4A014	0 - 10	5.53	--	9.6	18.1	28.2	53.4	--	21.9	0.79	--	0.7
	AA4A015	20 - 30	8.6	0.106	15.9	9.3	44.2	27.4	--	11.2	0.73	--	0.73
A68	AA4A013	0 - 10	5.47	--	8.6	16.5	31.9	48.6	--	19.9	0.67	--	0.76
B43	AA4B002	0 - 10	1.93 (J)	--	3.15 (J)	5.5	9.2 (J)	14.8	--	6.6	0.8	--	0.78
B44	AA4B003	0 - 10	0.206 (J)	0.026	0.185 (J)	0.2	0.84 (J)	0.8	--	0.0	0.68	--	0.68
B45	AA4B004	0 - 10	1.94 (J)	--	4.76 (J)	5.0	13.2 (J)	13.6	--	6.1	0.69	--	0.68
B46	AA4B005	0 - 10	14 (J)	0.152	24.1 (J)	62.7	65 (J)	170.1	29.5	75.5	0.82	--	0.72
B48	AA4B001	0 - 10	0.258 (J)	--	0.6 (J)	0.6	1.55 (J)	1.6	--	0.0	0.79	0.045	0.87

Table F.4-2
Sample Results for Isotopes Detected above MDCs at Study Group 4
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)										
			Am-241	Am-243	Pu-238	Inferred Pu-238	Pu-239/240	Inferred Pu-239/240	Pu-241	Inferred Pu-241	U-234	U-235	U-238
B57	AA4B006	0 - 10	0.354 (J)	--	0.56 (J)	0.6	1.62 (J)	1.6	--	0.0	0.68	--	0.75
C39	AA4C004	0 - 10	17.4	0.57	26.9	31.7	257	183.3	--	33.0	1.48	--	0.85
C40	AA4C001	0 - 10	21.8	0.34	33.2	47.8	293	276.5	42	49.8	1.91	--	0.75
C41	AA4C003	0 - 10	8	--	13	20.8	77	120.2	--	21.6	1.04	--	0.63
C63	AA4C006	0 - 10	7	--	11.6	10.5	88	60.6	--	10.9	0.86	--	0.63
C64	AA4C005	0 - 10	55.3	0.56	89	63.8	280	369.7	93	66.6	1.18	--	0.85
C65	AA4C009	0 - 10	19	0.23	33.6	27.5	115	159.3	31.8	28.7	1.02	0.118	0.71
C66	AA4C008	0 - 10	9.2	0.168	16.8	13.7	95	79.2	--	14.3	1.07	--	0.83
C77	AA4C002	0 - 10	1.32	--	1.99	2.0	19.2	19.2	--	0.0	0.78	--	0.66
C78	AA4C007	0 - 10	0.8	--	1.22	1.2	7.8	7.8	--	0.0	0.63	--	0.63
C79	AA4C010	0 - 10	0.444	--	0.73	0.7	3.32	3.3	--	0.0	0.69	--	0.67

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

Appendix G

Sample Location Coordinates

G.1.0 Sample Location Coordinates

Coordinates for all sample locations at CAU 105 are provided. The southwest corner of each sample plot and the locations of individual (judgmental) sample locations for the CAU 105 study sites were surveyed using a GPS instrument. Survey coordinates for these locations are listed in Table G.1-1.

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 1 of 10)

Easting	Northing	Sample Plot/Location
Site T-2A, Shasta		
579399.7	4109280.0	A01
579393.6	4109147.7	A02
579368.4	4109169.9	A03
579378.0	4109143.8	A04
579388.7	4109182.5	A05
579419.2	4109201.9	A06
579430.1	4109243.9	A07
579409.0	4109279.1	A08
579361.6	4109274.1	A09
579334.6	4109269.4	A10
579375.7	4109234.8	A11
579321.8	4109230.0	A12
579345.4	4109176.9	A13
579310.5	4109149.1	A14
579278.7	4109100.1	A15
579209.0	4109212.0	A16
579266.0	4109219.7	A17
579281.2	4109229.2	A18
579290.0	4109306.9	A19
579245.0	4109342.9	A20
579335.7	4109399.2	A21
579348.9	4109344.6	A22

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 2 of 10)

Easting	Northing	Sample Plot/Location
Site T-2A, Shasta (continued)		
579372.4	4109332.3	A23
579441.2	4109326.6	A24
579472.8	4109371.6	A25
579507.7	4109416.0	A26
579540.0	4109259.1	A27
579483.7	4109251.6	A28
579462.6	4109166.0	A29
579505.2	4109131.4	A30
579415.4	4109074.9	A31
579402.1	4109129.4	A32
579282.1	4109618.7	A33
579295.0	4109564.0	A34
579308.7	4109508.4	A35
579321.5	4109455.4	A36
579202.4	4109379.0	A37
579159.0	4109413.9	A38
579114.1	4109450.4	A39
579068.7	4109487.6	A40
578984.0	4109179.3	A41
579038.7	4109188.3	A42
579098.8	4109197.8	A43
579151.9	4109205.2	A44
579244.1	4109053.5	A45
579211.3	4109009.4	A46
579176.7	4108961.2	A47
579143.9	4108915.2	A48
579471.5	4108852.0	A49
579456.8	4108906.9	A50

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 3 of 10)

Easting	Northing	Sample Plot/Location
Site T-2A, Shasta (continued)		
579442.7	4108963.9	A51
579428.1	4109020.6	A52
579551.2	4109093.1	A53
579593.3	4109059.5	A54
579639.1	4109023.1	A55
579682.2	4108989.1	A56
579765.4	4109293.9	A57
579708.3	4109286.4	A58
579650.5	4109276.5	A59
579598.5	4109267.5	A60
579539.4	4109462.9	A61
579572.9	4109510.7	A62
579604.4	4109556.4	A63
579696.2	4109023.4	A64
579726.4	4109021.2	A65
579787.0	4109038.6	A67
579828.5	4109036.9	A68
579759.2	4109029.2	A69
579423.6	4109285.2	A70
579376.6	4109304.7	A71
579327.2	4109284.3	A72
579307.6	4109236.5	A73
579326.9	4109188.1	A74
579376.3	4109166.5	A75
579425.1	4109186.8	A76
579445.3	4109236.5	A77

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 4 of 10)

Easting	Northing	Sample Plot/Location
Site T-2B, Diablo		
578976.7	4111572.5	B01
579409.4	4111979.6	B02
579296.5	4111944.9	B03
579234.4	4111945.5	B04
579164.6	4111945.4	B05
579094.5	4111945.5	B06
579024.9	4111945.9	B07
578921.1	4111980.8	B08
578849.3	4111946.2	B09
578850.1	4111876.0	B10
578953.8	4111875.5	B11
578954.5	4111806.3	B12
578848.8	4111805.8	B13
578850.1	4111736.1	B14
578850.3	4111665.5	B15
578850.0	4111596.4	B16
578954.7	4111596.3	B17
579023.5	4111525.8	B18
579093.8	4111523.2	B19
578919.8	4111492.3	B20
578849.6	4111525.7	B21
578954.2	4111422.0	B22
579024.2	4111421.4	B23
579094.4	4111421.4	B24
579163.9	4111421.8	B25
579245.0	4111422.5	B26
579304.6	4111422.0	B27
579374.2	4111421.3	B28

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 5 of 10)

Easting	Northing	Sample Plot/Location
Site T-2B, Diablo (continued)		
579304.2	4111526.6	B29
579410.7	4111491.1	B30
579479.5	4111525.6	B31
579479.6	4111595.6	B32
579375.0	4111596.3	B33
579374.4	4111665.7	B34
579479.3	4111665.4	B35
579478.7	4111735.8	B36
579379.1	4111737.2	B37
579374.7	4111806.7	B38
579480.0	4111805.1	B39
579479.7	4111875.5	B40
579373.9	4111876.1	B41
579304.0	4111875.8	B42
579162.4	4111486.7	B43
579208.9	4111483.2	B44
579347.9	4111506.0	B45
579338.0	4111537.5	B46
579384.3	4111721.4	B47
579130.5	4111527.3	B48
579182.9	4111523.7	B49
579165.6	4111588.0	B50
579095.9	4111593.7	B51
579024.2	4111595.5	B52
578954.6	4111665.4	B53
579026.3	4111665.4	B54
579094.6	4111664.4	B55
579162.0	4111664.1	B56

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 6 of 10)

Easting	Northing	Sample Plot/Location
Site T-2B, Diablo (continued)		
579166.6	4111676.4	B57
579163.5	4111735.5	B58
579094.4	4111736.4	B59
579023.9	4111736.2	B60
578961.8	4111734.0	B61
579016.8	4111804.0	B62
579093.2	4111805.8	B63
579164.1	4111805.8	B64
579219.5	4111803.3	B65
579234.3	4111876.2	B66
579164.3	4111875.9	B67
579094.2	4111876.7	B68
579026.1	4111874.5	B69
579306.6	4111804.2	B70
579300.7	4111735.3	B71
579235.0	4111735.5	B72
579233.5	4111666.0	B73
579305.4	4111664.5	B74
579304.6	4111596.8	B75
579235.1	4111596.1	B76
579233.4	4111524.6	B77
579349.1	4111545.1	B78
579192.8	4111699.7	B79

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 7 of 10)

Easting	Northing	Sample Plot/Location
Site T-2		
578282.9	4110299.3	C01
578376.6	4110394.5	C02
578423.2	4110417.8	C03
578478.0	4110440.6	C04
578533.5	4110464.3	C05
578592.5	4110489.0	C06
578649.1	4110514.0	C07
578460.6	4110626.7	C08
578437.8	4110558.7	C09
578416.3	4110500.3	C10
578392.7	4110447.2	C11
578351.0	4110445.6	C12
578324.8	4110498.2	C13
578296.5	4110553.1	C14
578266.0	4110607.9	C15
578243.5	4110658.5	C16
578108.7	4110521.3	C17
578159.0	4110498.1	C18
578217.3	4110471.5	C19
578273.0	4110444.4	C20
578325.3	4110419.1	C21
578325.7	4110370.8	C22
578358.2	4110343.0	C23
578401.4	4110346.7	C24
578425.0	4110371.5	C25
578706.5	4110538.4	C26
578763.6	4110562.8	C27
578818.9	4110586.7	C28

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 8 of 10)

Easting	Northing	Sample Plot/Location
Site T-2 (continued)		
578546.1	4110848.7	C29
578524.3	4110792.1	C30
578501.9	4110733.4	C31
578479.6	4110673.5	C32
577939.0	4110599.7	C33
577994.8	4110569.0	C34
578050.6	4110541.5	C35
578211.5	4110716.4	C36
578186.8	4110774.3	C37
578157.6	4110827.2	C38
578624.9	4110616.8	C39
578670.1	4110557.3	C40
578538.1	4110605.6	C41
578480.4	4110402.1	C42
578293.3	4110378.7	C43
578653.3	4110290.4	C44
578598.1	4110312.6	C45
578538.4	4110333.1	C46
578482.3	4110345.5	C47
578427.3	4110293.2	C48
578454.6	4110239.3	C49
578482.8	4110184.4	C50
578512.1	4110127.6	C51
578273.4	4110116.3	C52
578294.2	4110173.3	C53
578314.8	4110230.2	C54
578336.2	4110287.4	C55
578272.0	4110340.2	C56

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 9 of 10)

Easting	Northing	Sample Plot/Location
Site T-2 (continued)		
578218.1	4110317.3	C57
578161.5	4110290.4	C58
578401.7	4110299.1	C59
578716.5	4110277.7	C60
578775.3	4110243.8	C61
578832.6	4110234.1	C62
578723.2	4110268.2	C63
578676.9	4110258.8	C64
578695.4	4110195.9	C65
578643.8	4110169.5	C66
578539.9	4110069.4	C67
578566.1	4110017.8	C68
578594.7	4109962.8	C69
578206.9	4109942.4	C70
578227.9	4109988.7	C71
578251.4	4110060.8	C72
578107.7	4110263.0	C73
578047.7	4110233.4	C74
577997.1	4110207.7	C75
577941.0	4110182.5	C76
578687.6	4110554.5	C77
578767.2	4110209.4	C78
578794.1	4110184.4	C79
578359.3	4110415.2	C80
578359.8	4110424.8	C81
578369.9	4110423.2	C82
578368.9	4110417.9	C83
578352.6	4110424.4	C84

Table G.1-1
Sample Plot/Location Coordinates for CAU 105
(Page 10 of 10)

Easting	Northing	Sample Plot/Location
Site T-2 (continued)		
578390.0	4110364.7	C85
578356.9	4110440.7	C86
578386.1	4110386.9	C87
578356.6	4110429.0	C88
578361.3	4110430.6	C89
578352.2	4110408.5	C90
578624.9	4110464.6	C91
578102.1	4110401.6	C92
578503.5	4110354.6	C93
578085.4	4110372.0	C94
Reference Samples		
578247.5	4111363.6	H01
577490.8	4110445.1	H02
578485.3	4112023.6	H03
579450.0	4110103.1	H04
579952.3	4109444.8	H05

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

G.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 H

Nevada Division of Environmental Protection Comments

(1 Page)

August 14, 2013

Robert F. Boehlecke, Manager
Environmental Management Operations
National Nuclear Security Administration
Nevada Field Office
P. O. Box 98518
Las Vegas, NV 89193-8518

RE: Review of Draft Corrective Action Decision Document / Closure Report (CADD/CR) for Corrective Action Unit (CAU) 105: Area 2 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada
Federal Facility Agreement and Consent Order

Dear Mr. Boehlecke,

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) staff has received and reviewed the draft CADD/CR for Corrective Action Unit (CAU) 105: Area 2 Yucca Flat Atmospheric Test Sites. NDEP's review of this document did not indicate any deficiencies.

If you have any questions regarding this matter contact me at (702) 486-2850 ext. 233.

Sincerely,

/s/ Jeff MacDougall

Jeff MacDougall, Ph.D., C.P.M.
Supervisor
Bureau of Federal Facilities

ec: THM/TZ/JW/SP
N-I Central Files, MS NSF 156

cc: J. T. Fraher, DTRA/CXTS, Kirtland AFB, NM
NSTec Correspondence Management Coordinator, MS NLV008
T. A. Lantow, EMO, NNSA/NFO, Las Vegas, NV
FFACO Group, EMOS, NNSA/NFO, Las Vegas, NV
EM Records, AMEM, Las Vegas, NV

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