Nevada
Environmental
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Project

DOE/NV--1464

National Nuclear Security Administration

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 106: Areas 5, 11 Frenchman Flat Atmospheric Sites Nevada National Security Site, Nevada

Controlled Copy No.: ___
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Environmental Restoration
Project

U.S. Department of Energy
National Nuclear Security Administration
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CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 106: AREAS 5, 11 FRENCHMAN FLAT ATMOSPHERIC SITES NEVADA NATIONAL SECURITY SITE, NEVADA

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

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CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT
FOR CORRECTIVE ACTION UNIT 106:
AREAS 5, 11 FRENCHMAN FLAT ATMOSPHERIC SITES
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Kevin J. Cabble Date: 9-12-11

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Approved by: /s/ Robert F. Boehlecke Date: 9/12/11

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Federal Project Director
Environmental Restoration Project

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List of Acronyms and Abbreviations

Ac	Actinium
Ag	Silver
Am	Americium
ANPR	Advance Notice of Proposed Rulemaking
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
CA	Contamination area
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CD	Certificate of Disposal
CED	Committed effective dose
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter
Cm	Curium
COC	Contaminant of concern
COPC	Contaminant of potential concern
CR	Closure report
Cs	Cesium
CSM	Conceptual site model
CZ	Contamination zone

List of Acronyms and Abbreviations *(Continued)*

day/yr	Days per year
DOE	U.S. Department of Energy
dpm/100cm^2	Disintegrations per minute per 100 square centimeters
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DU	Depleted uranium
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
gal	Gallon
g/yr	Grams per year
GPS	Global Positioning System
GWS	Gamma walkover survey
GZ	Ground zero
HASL	Health and Safety Laboratory
hr/day	Hours per day
hr/yr	Hours per year
ICRP	International Commission on Radiological Protection

List of Acronyms and Abbreviations *(Continued)*

ID	Identification
in.	Inch
kt	Kiloton
lb	Pound
LCS	Laboratory control sample
LLW	Low-level radioactive waste
LVF	Load Verification Form
m	Meter
m^2	Square meter
MDC	Minimum detectable concentration
mg/day	Milligrams per day
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mi	Mile
M&O	Management and operating
mrem	Millirem
mrem/IA-yr	Millirem per Industrial Area year
mrem/yr	Millirem per year
MSD	Matrix spike duplicate
m/yr	Meters per year
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
Nb	Niobium
NDEP	Nevada Division of Environmental Protection
N-I	Navarro-Intera, LLC

List of Acronyms and Abbreviations (Continued)

NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSS	Nevada National Security Site
NPTEC	Nonproliferation Test and Evaluation Complex
NRDS	Nuclear Rocket Development Station
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
pH	Negative log of hydrogen ion concentration (measure of acidity)
PPE	Personal protective equipment
PRG	Preliminary Remediation Goal
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
RESRAD	Residual Radioactive
RIDP	Radionuclide Inventory and Distribution Program
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RWMC	Radioactive Waste Management Complex

List of Acronyms and Abbreviations *(Continued)*

SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TBD	To be determined
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
Th	Thorium
TLD	Thermoluminescent dosimeter
U	Uranium
UGTA	Underground test area
UR	Use restriction
URMA	Underground radioactive material area
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
%R	Percent recovery

Executive Summary

This Corrective Action Decision Document (CADD)/Closure Report (CR) has been prepared for Corrective Action Unit (CAU) 106, Areas 5, 11 Frenchman Flat Atmospheric Sites, located within Area 5 at the Nevada National Security Site, Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO). Corrective Action Unit 106 comprises four corrective action sites (CASs):

- 05-20-02, Evaporation Pond
- 05-23-05, Atmospheric Test Site - Able
- 05-45-04, 306 GZ Rad Contaminated Area
- 05-45-05, 307 GZ Rad Contaminated Area

The purpose of this CADD/CR is to provide justification and documentation supporting the recommendation that no further corrective action is needed for CAU 106 based on the implementation of corrective actions. The corrective action of clean closure was implemented at CASs 05-45-04 and 05-45-05, while no corrective action was necessary at CASs 05-20-02 and 05-23-05. Corrective action investigation (CAI) activities were performed from October 20, 2010, through June 1, 2011, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 106: Areas 5, 11 Frenchman Flat Atmospheric Sites.*

The approach for the CAI was divided into two facets: investigation of the primary release of radionuclides, and investigation of other releases (mechanical displacement and chemical releases). The purpose of the CAI was to fulfill data needs as defined during the data quality objective (DQO) process. The CAU 106 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 Industrial Area exposure scenario (2,250 hours of annual exposure). The only radiological dose exceeding the FAL was at CAS 05-45-05 and was associated with potential source material (PSM). It is also assumed that additional PSM in the form of depleted uranium (DU) and DU-contaminated debris at CASs 05-45-04 and 05-45-05 exceed the FAL. Therefore, corrective actions were undertaken at

these CASs that consisted of removing PSM and collecting verification samples. Results of verification samples show that remaining soil does not contain contamination exceeding the FALs.

Therefore, the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) provides the following recommendations:

- No further corrective actions are necessary for CAU 106.
- A Notice of Completion to NNSA/NSO is requested from the Nevada Division of Environmental Protection for closure of CAU 106.
- Corrective Action Unit 106 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) 106, Areas 5, 11 Frenchman Flat Atmospheric 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 (Figure 1-1).

Corrective Action Unit 106 comprises the four corrective action sites (CASs) shown on Figure 1-2 and listed below:

- 05-20-02, Evaporation Pond
- 05-23-05, Atmospheric Test Site - Able
- 05-45-04, 306 GZ Rad Contaminated Area
- 05-45-05, 307 GZ Rad Contaminated Area

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 106: Areas 5, 11 Frenchman Flat Atmospheric Sites* (NNSA/NSO, 2011).

1.1 Purpose

This report provides documentation and justification for the closure of CAU 106. This includes a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed. The investigative activities were conducted in accordance with the CAIP. The corrective actions include the following:

- No further action at CAS 05-20-02, Evaporation Pond
- No further action at CAS 05-23-05, Atmospheric Test Site - Able
- Clean closure at CAS 05-45-04, 306 GZ Rad Contaminated Area
- Clean closure at CAS 05-45-05, 307 GZ Rad Contaminated Area

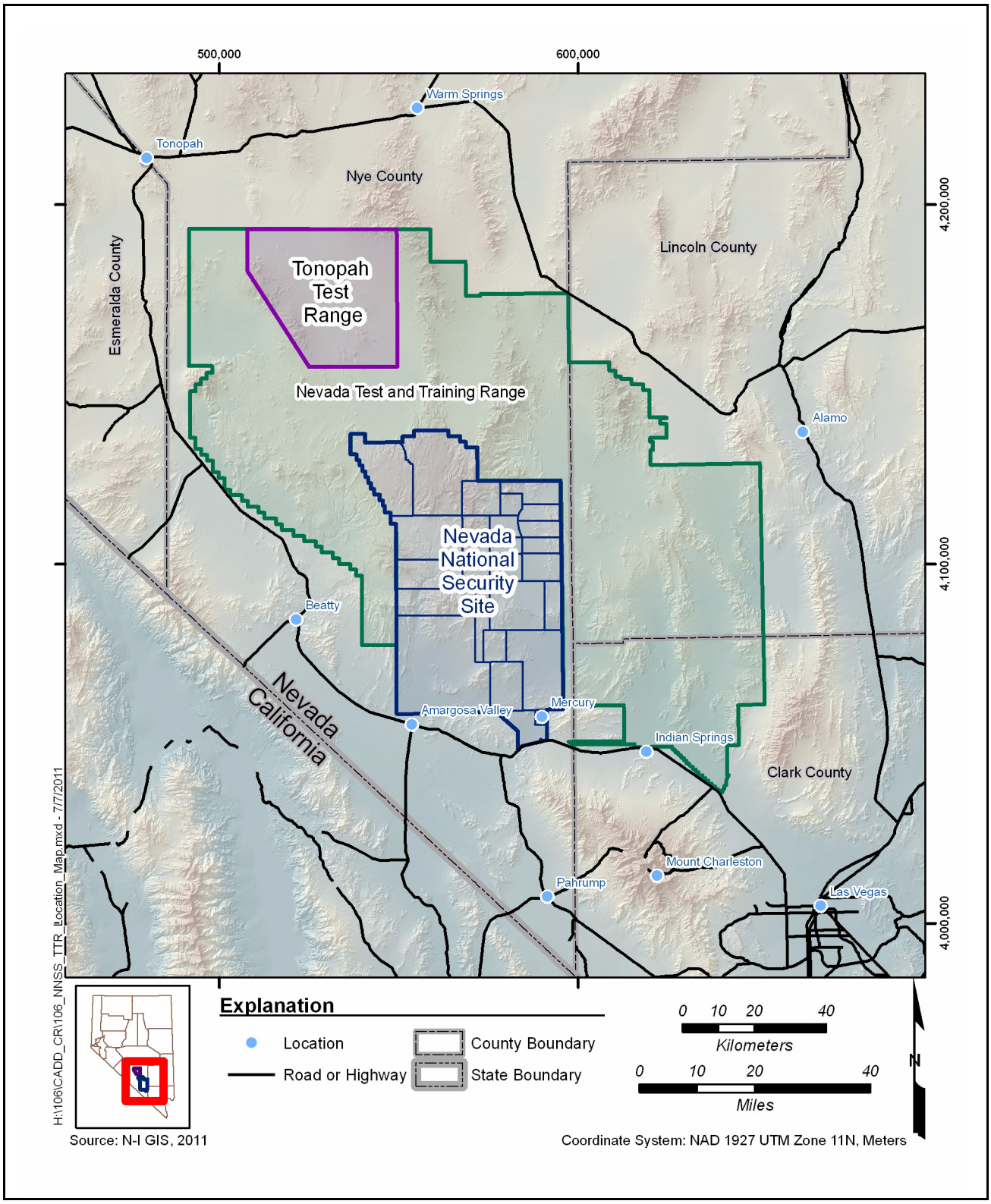

Figure 1-1
Nevada National Security Site

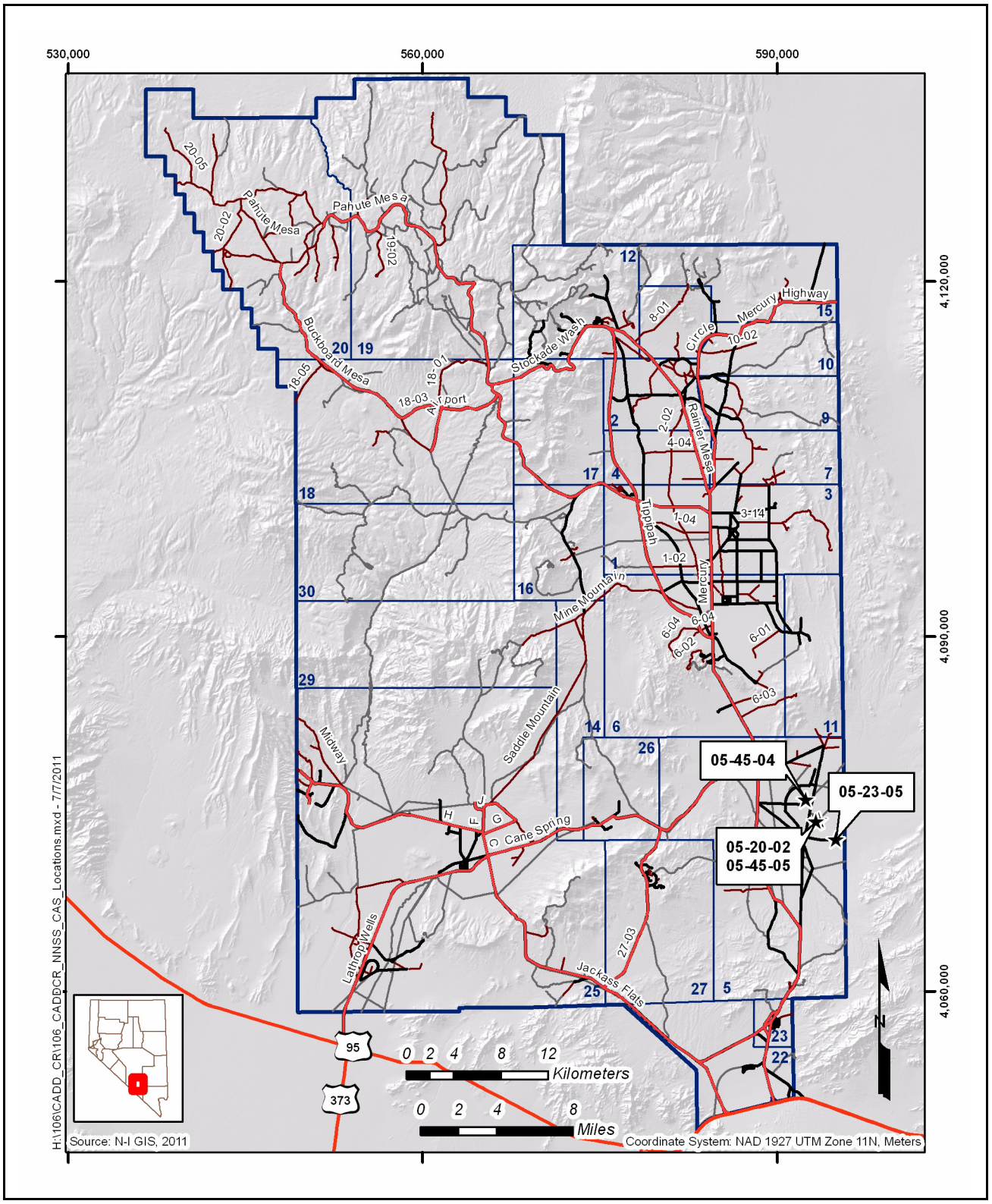

Figure 1-2
CAU 106, CAS Location Map

Based on the implementation of these corrective actions, no further corrective actions are necessary at CAU 106. The CAIP provides information relating to site history as well as the scope and planning of the investigation, and therefore, this information will not be repeated in this document. Corrective Action Unit 106 consists of four inactive sites on the NNSS and are summarized below.

Corrective Action Site 05-20-02 (referred to as Cambric Ditch in this document) consists of a release of tritium-contaminated groundwater from Well RNM-2s to the surface of Cambric Ditch that extends approximately 1 mi in a southeast direction to an evaporation pond located on the northwest shore of Frenchman Lake. The surface release was a result of a 16-year study between 1975 and 1991 involving groundwater pumping and discharge to better understand the migration of radionuclides in groundwater from the Cambric test cavity.

Corrective Action Site 05-23-05 (referred to as Able in this document) is centrally located on Frenchman Lake in Area 5, approximately 400 feet (ft) southwest of the historic Underground Parking Garage associated with the Priscilla test. The Able test was conducted on April 1, 1952, as part of Operation Tumbler-Snapper. Able consists of the atmospheric deposition of radionuclides to the surface soil from the detonation of a weapons-effect test with a 1-kiloton (kt) yield at 800 ft above the ground surface.

Corrective Action Site 05-45-04 (referred to as 306 GZ in this document) is located on the gentle slopes of Frenchman Flat in Area 5, approximately 1.25 mi north of Frenchman Lake and 1,200 ft north of 5-07 Road near the Kay Blockhouse (CAU 204). The 306 GZ site contains a posted underground radioactive material area (URMA) and contamination area (CA), and consists of a release of surface and near-surface contamination from abandoned wastes, particularly depleted uranium (DU) contaminants released to the soil.

Corrective Action Site 05-45-05 (referred to as 307 GZ in this document) is located just off the northwest shore of Frenchman Lake in Area 5. The 307 GZ site contains an area posted as an URMA and consists of a release of surface and near-surface contamination from abandoned wastes, particularly DU contaminants released to the soil.

1.2 Scope

The corrective action investigation (CAI) for CAU 106 was completed by demonstrating through gamma walkover surveys (GWSs), geophysical surveys, and environmental soil sample analytical results the nature and extent of contaminants of concern (COCs) at any CAS. For radiological releases, a COC is defined as the presence of radionuclides that present a dose to a receptor exceeding 25 millirem per year (mrem/yr). For chemical releases, a COC is defined as the presence of a contaminant above its corresponding final action level (FAL).

The scope of the investigation activities at CAU 106 included performing visual inspections, collecting environmental and quality control (QC) samples, and conducting geophysical surveys and GWSs. The scope of the corrective action activities included evaluating corrective action alternatives (CAAs), performing removal of potential source material (PSM), and documenting and justifying closure activities.

1.3 CADD/CR Contents

This document is divided into the following sections and appendices:

Section 1.0, "Introduction," summarizes the document purpose, scope, and contents.

Section 2.0, "Corrective Action Investigation Summary," summarizes the investigation field activities and 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 project objectives, field investigation and sampling activities, investigation results, waste management, and quality assurance (QA). Sections A.3.0 through A.6.0 provide specific information regarding field activities, sampling methods, and laboratory analytical results from the investigation.

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*, presents an evaluation of risk associated with the establishment of FALs.

Appendix D, *Closure Activity Summary*, provides details on the completed closure activities, and includes the required verification activities and supporting documentation.

Appendix E, *Evaluation of Corrective Action Alternatives*, provides a discussion of the results of the CAI, the alternatives considered, and the rationale for the recommended alternative.

Appendix F, *Sample Location Coordinates*, presents the northing and easting coordinates for each sample plot, the biased sample locations, and other points of interest.

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

1.3.1 Applicable Programmatic Plans and Documents

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

- CAIP for CAU 106, Areas 5, 11 Frenchman Flat Atmospheric Sites (NNSA/NSO, 2011)
- *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002)
- FFACO (1996, as amended)

1.3.2 Data Quality Assessment Summary

The CAIP (NNSA/NSO, 2011) contains the DQOs as agreed to by stakeholders 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 ensure that DQO decisions are sound and defensible.

Based on this evaluation, the nature and extent of COCs at CAU 106 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 sections summarize the investigation activities and investigation results, and justify why no further corrective action is required at CAU 106. Detailed investigation activities and results for individual CAU 106 CASs are presented in Appendix A of this document.

2.1 Investigation Activities

Corrective action investigation activities were performed as set forth in the CAIP (NNSA/NSO, 2011) from October 20, 2010, through June 1, 2011. The purpose of the CAU 106 CAI was to provide the additional information needed to resolve the following project-specific DQOs:

- Determine whether COCs are present in the soils associated with CAU 106.
- Determine the extent of identified COCs.
- Ensure adequate data have been collected to evaluate closure alternatives under the FFACO.

The scope of the CAI included the following activities:

- Inspected and verified the CAS components identified in the CAIP (NNSA/NSO, 2011).
- Performed site inspections to look for biased sampling locations.
- Conducted GWSs at Able, 306 GZ, and 307 GZ.
- Conducted geophysical surveys at 306 GZ and 307 GZ.
- Collected soil samples at biased sampling locations.
- Removed PSM for disposal.
- Submitted soil samples for offsite laboratory analysis.
- Collected Global Positioning System (GPS) coordinates of sample locations and points of interest.

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the releases at each CAS were classified into one of the following two categories:

- **Primary releases** (referred to as "test releases" in the CAU 106 CAIP)—This release category is specific to the atmospheric deposition of radionuclide contamination onto the soil surface that has not been displaced through excavation or migration. The contamination associated with the primary releases is limited to the top 5 centimeters (cm) of undisturbed soil. Sampling surface soils to a depth of 5 cm is appropriate for areas that have not been disturbed, as numerous studies of soils contaminated by atmospheric deposition following nuclear testing at the NNSS have shown that more than 90 percent of the radioactivity in undisturbed soil is contained within the top 5 cm of soil (McArthur and Kordas, 1983, 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CADD/CR, surface is defined as the upper 5 cm of soil.

- **Other releases** (referred to as "non-test releases" in the CAU 106 CAIP)—This release category includes any radionuclide contamination from test activities that is not limited to the surface 5 cm of soil. This includes radionuclide contaminants that were initially deposited onto the soil surface (as in the primary release category) but have subsequently been displaced through excavation or migration. This category also includes radionuclides that were deposited under mechanisms other than atmospheric deposition. This includes the release of radioactivity to the soil from contaminated debris (specifically DU) at the 306 GZ and 307 GZ sites, surface discharge of tritium-contaminated groundwater at Cambric Ditch, and any other chemical or radiological contamination discovered during the investigation through the identification of biasing factors that are not a part of a previously identified release. The depth of radiological or chemical contamination from other releases is dependent upon the nature of the release or subsequent movement through excavation or migration. Investigation of other releases was accomplished through measurements of soil contamination using a judgmental sampling scheme at depths dependent upon the nature of the release, or by conservative assumptions that contamination is present at depth based on process knowledge.

The CASs were investigated by collecting judgmental soil samples. The data collected at the site that contribute to the decisions made for site closure include (1) laboratory analysis of the soil samples (i.e., individual radionuclide and/or chemical results), (2) radiological walkover surveys of selected areas of the CASs, (3) geophysical surveys of selected areas of the CASs, and (4) investigation of geophysical anomalies. The field investigation was completed as specified in the CAIP (NNSA/NSO, 2011).

Confidence in judgmental sampling scheme decisions was established qualitatively through validation of the CSM and verification that the selected sampling locations meet the DQO criteria.

The potential dose from radiological contaminants at each soil sample location was determined based on the laboratory analytical results of soil samples and residual radioactive material guidelines (RRMGs) that were calculated using the Residual Radioactive (RESRAD) computer code (Yu et al., 2001) (see Attachment C-1). The RRMGs are the activity concentrations of individual radionuclides in surface soil that would cause a receptor to receive a dose equal to the radiological FAL (25 mrem/yr). The doses from each of the radionuclides are then summed to produce the total potential dose.

The following sections summarize specific investigation activities conducted at each CAS. Additional information regarding the CAI at each CAS is presented in Appendix A.

2.1.1 Cambric Ditch

Investigation activities at Cambric Ditch included calculating a maximum tritium concentration in soil based on historical groundwater analytical results, performing visual inspections and radiological surface scans, and collecting surface soil samples. During the visual inspection and radiological surface scan of soils in the ditch and pond, no biasing factors were identified. In Section A.8.3.1.1 of the CAIP, a calculation was made to conservatively estimate the theoretical maximum tritium concentration in soil at the discharge point. The theoretical maximum soil concentration was calculated to be 131 picocuries per gram (pCi/g). This concentration is insignificant in comparison to the RRMG of 7,250,000 pCi/g for tritium under the Industrial Area exposure scenario. Therefore, the potential dose from tritium contamination in soil above the FAL of 25 millirem per Industrial Area year (mrem/IA-yr) at Cambric Ditch is not theoretically possible.

For confirmation purposes, two surface soil samples were collected at the default sample location at the groundwater discharge point near Well RNM-2s. See Section A.3.1 for additional information on investigation activities at Cambric Ditch. Results of the sampling effort are reported in Section 2.2.

2.1.2 Able

Investigation activities at Able included performing visual inspections, conducting a GPS-assisted GWS, field screening, and collecting surface soil samples. During visual inspections, no biasing factors were identified. The GWS (conducted with a TSA Systems PRM-470 model plastic

scintillator) showed no areas of elevated radiological readings. Sampling activities to determine the presence of contamination included the collection and field screening of six soil samples at four locations. See Section A.4.1 for additional information on investigation activities at Able. Results of the sampling effort are reported in Section 2.2.

2.1.3 306 GZ

Investigation activities at 306 GZ included performing visual inspections, conducting geophysical surveys, conducting GPS-assisted GWSs, field screening, and collecting soil samples. During visual inspections and "mag and flag" surveys, biasing factors such as metallic debris, stained soil, and PSM were identified. The geophysical survey (conducted with an EM61-MK2 time-domain metal detector) identified five subsurface anomalies within the URMA. These anomalies were excavated and subsequently identified as metallic debris (both non-PSM and PSM). Radiological surveys were conducted throughout the 306 GZ site (using a beta and low-energy gamma 44-21 plastic scintillator). The results showed that the highest gamma radiation readings corresponded to locations containing PSM.

All identified PSM were removed as part of a corrective action. Following the removal of PSM, field-screening and verification-sampling activities were conducted to confirm the absence of PSM. A total of seven verification soil samples (including one field duplicate [FD]) were collected from six PSM removal locations. One additional biased sample was collected from within the stained soil horizon identified within the URMA. See Section A.5.1 for additional information on investigation activities conducted at 306 GZ. Results of the sampling effort are reported in Section 2.2.

2.1.4 307 GZ

Investigation activities at 307 GZ included performing visual inspections, conducting geophysical surveys, conducting GPS-assisted GWSs, field screening, and collecting surface soil samples. During visual inspections and "mag and flag" surveys, biasing factors such as metallic debris and PSM were identified. The geophysical survey (conducted with an EM61-MK2 time-domain metal detector) identified one subsurface anomaly within the URMA, which was identified as metallic debris (non-PSM). Radiological surveys were conducted throughout the 307 GZ site (using a beta

and low-energy gamma 44-21 plastic scintillator). The results showed that the highest gamma radiation readings corresponded to locations containing PSM.

All identified PSM were removed as part of a corrective action. Following the removal of PSM, field-screening and verification-sampling activities were conducted to confirm the absence of PSM. A total of four verification soil samples (including one FD) were collected from PSM removal locations. See Section A.6.1 for additional information on investigation activities conducted at 307 GZ. Results of the sampling effort are reported in Section 2.2.

2.2 Results

The data summary provided in Section 2.2.1 defines the COCs identified at CAU 106. Section 2.2.2 summarizes the assessment made in Appendix B, which demonstrates that the investigation results satisfy the DQO data requirements.

2.2.1 Summary of Analytical Data

Environmental samples were evaluated against FALs to determine the presence of COCs, determine the extent of COCs, if present, and evaluate the need for corrective action. The FALs for both chemical and radiological constituents are defined in Section 2.3. Details about the analytical methods used and a detailed comparison of environmental sample results to the FALs (as well as RRMGs for radiological constituents) are presented in Appendix A.

For chemical constituents, the maximum results of soil samples collected from material remaining at each CAS (excluding samples from material that were removed during the CAI) are presented in the following sections.

For radioactivity, the estimated total effective dose (TED) for each soil sample collected from material remaining at each CAS (excluding samples from material that were removed during the CAI) is presented in the following sections. Calculation of the dose for each sample was accomplished through summation of each radionuclide contributor as described in Sections A.4.2.1, A.5.2.3, and A.6.2.4.

2.2.1.1 Cambric Ditch

The tritium analytical results from the two soil samples (106F001 and 106F002) collected at Cambric Ditch did not exceed minimum detectable concentrations (MDCs); therefore, the results support the conclusion established in the CAIP that tritium is not present above the FAL at Cambric Ditch.

2.2.1.2 Able

Six soil samples were collected from four locations at a depth of 0 to 5 cm below ground surface (bgs) at Able. As shown in Table 2-1, the estimated TED for each of the six samples was below the FAL of 25 mrem/IA-yr. Sample locations are shown in Figure A.4-1, and Table A.4-2 presents the detected radionuclides for each sample, a comparison to their respective RRMGs, and the fraction of dose of each radionuclide contributing to the TED.

Table 2-1
Estimated TEDs at Sample Locations (mrem/yr)

Able (CAS 05-23-05)		306 GZ (CAS 05-45-04)		307 GZ (CAS 05-45-05)	
Sample Number	Estimated TED	Sample Number	Estimated TED	Sample Number	Estimated TED
106B001	3.17	106D001	0.36	106E001	0.23
106B002[a]	--	106D002	0.19	106E002	2.29
106B003	1.83	106D003	0.30	106E003	3.42
106B004	1.80	106D004	0.94	106E005	1.89
106B005	3.25	106D005	4.44		
106B006	5.93	106D006	1.54		
		106D007	2.70		
		106D008	0.43		

[a]Sample 106B002 was collected and submitted to the laboratory, but was not analyzed independently by the laboratory.

2.2.1.3 306 GZ

Eight samples were collected from seven locations at 306 GZ. The maximum results for chemical constituents are presented in Table 2-2, and the estimated TED for radioactivity from each sample is presented in Table 2-1. Sample 106D007 was a biased sample collected from a horizon of stained

Table 2-2
Maximum Concentrations of Detected Chemical Contaminants
for CAS 05-45-04, 306 GZ Rad Contaminated Area

Contaminant	Maximum Result	Sample Number	Depth (in. bgs)	Location	FAL	Unit
Arsenic	4	106D001	10–12	D01	23	mg/kg
Barium	130	106D003	0–6	D03	190,000	mg/kg
Beryllium	0.77	106D007	4–6	D06	2,000	mg/kg
Cadmium	1.8 (J)	106D007	4–6	D06	800	mg/kg
Chromium	7.6	106D006	0–6	D05	39.2[a]	mg/kg
Hexavalent Chromium	0.48 (J)	106D006	0–6	D05	5.6	mg/kg
Lead	11	106D006	0–6	D05	800	mg/kg
Mercury	0.021 (J-)	106D006	0–6	D05	34	mg/kg
Selenium	0.31	106D003	0–6	D03	5,100	mg/kg

[a] FAL based on hexavalent chromium PAL with a 6:1 ratio

mg/kg = Milligrams per kilogram
PAL = Preliminary action level

J = Estimated value
J- = Result is an estimated quantity, but may be biased low.

soil present between 4 and 10 inches (in.) bgs within the URMA (see Figure A.5-4). The chemical results and estimated TED for this sample did not exceed the respective FALs.

Because of the presence of PSM containing radiological COCs at this CAS, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for the surface contamination is clean closure. The identified PSM and, where appropriate, associated soil were removed and disposed of, and verification samples were collected from remaining soil. As shown in Table 2-1, the estimated TEDs for verification samples 106D001 through 106D006 and 106D008 are below the FAL of 25 mrem/IA-yr, and no COCs remain in the soil. Sample locations are shown in Figure A.5-4, and Table A.5-3 presents the detected radionuclides for each sample, a comparison to their respective RRMGs, and the fraction of dose of each radionuclide contributing to the TED.

2.2.1.4 307 GZ

Four verification samples and one PSM sample were collected from three locations at 307 GZ. The maximum results for chemical constituents are presented in Table 2-3, and the estimated TED for radioactivity from each sample is presented in Table 2-1. Sample 106E004 was collected from oxidized DU to confirm the assumption that the material exceeds PSM criteria (i.e., FAL of 25 mrem/IA-yr). Results presented in Table A.6-4 confirm the oxidized DU is PSM.

Table 2-3
Maximum Concentrations of Detected Chemical Contaminants for CAS 05-45-05, 307 GZ Rad Contaminated Area

Contaminant	Maximum Result	Sample Number	Depth (in. bgs)	Location	FAL	Unit
1,2,4-Trimethylbenzene	0.0052 (J)	106E002	0–6	E02	260	mg/kg
Arsenic	4.5	106E001	0–2	E01	23	mg/kg
Barium	260	106E002	0–6	E02	190,000	mg/kg
Beryllium	1	106E001	0–2	E01	2,000	mg/kg
	1	106E002	0–6	E02	2,000	mg/kg
Cadmium	0.56	106E002	0–6	E02	800	mg/kg
Chromium	7.3	106E001	0–2	E01	39.2[a]	mg/kg
Hexavalent Chromium	0.23 (J-)	106E002	0–6	E02	5.6	mg/kg
Lead	110	106E001	0–2	E01	800	mg/kg
Mercury	0.018 (J-)	106E002	0–6	E02	34	mg/kg
Selenium	0.29 (J+)	106E003	0–6	E02	5,100	mg/kg
Total Xylenes	0.0059	106E002	0–6	E02	2,700	mg/kg

[a]FAL based on hexavalent chromium PAL with a 6:1 ratio

J = Estimated value
J+ = Result is an estimated quantity, but may be biased high.
J- = Result is an estimated quantity, but may be biased low.

Because of the presence of PSM containing radiological COCs at this CAS, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for the surface contamination is clean closure. The PSM and soil associated with sample 106E004 were removed and disposed of, and verification sample 106E005 was collected from remaining soil. Other identified PSM (e.g., debris) were also removed and disposed of, and

additional verification samples 106E001 through 106E003 were collected from remaining soil. As shown in Table 2-1, the estimated TEDs for verification samples 106E001 through 106E003 and 106E005 are below the FAL of 25 mrem/IA-yr, and no COCs remain in the soil. Sample locations are shown in Figure A.6-2, and Table A.6-4 presents the detected radionuclides for each sample, a comparison to their respective RRMGs, and the fraction of dose of each radionuclide contributing to the TED.

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 ensures that the right type, quality, and quantity of data are available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps ensure that DQO decisions are sound and defensible.

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

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

The results of the DQI evaluation show that precision, accuracy, and completeness indicators did not meet the associated criteria for selected analytes. The only analyte that failed to meet the precision criterion was europium (Eu)-154, while cadmium was the only analyte that failed to meet the accuracy criterion. As presented in Appendix B, there is a negligible potential for these deficiencies to cause a false negative decision error. Therefore, the Eu-154 and cadmium results that were qualified for accuracy/precision can be confidently used for comparison to respective FALs. The DQI criterion for completeness was not met for the analyte 1,4-dioxane. As presented in Appendix B, because this analyte has not been detected at the NNSS and there is no reason to suspect the presence of 1,4-dioxane at any of the CAU 106 CASs, the absence of usable results for 1,4-dioxane does not preclude the resolution of the DQO decisions. All other DQI criteria were met. The DQA determined that information generated during the investigation supports the CSM

assumptions and that the data collected support their intended use in the decision-making process. Based on the results of the DQA presented in Appendix B, the DQO requirements have been met.

2.3 Justification for No Further Action

The corrective action of clean closure was selected and PSM removed at 306 GZ and 307 GZ. The corrective action of no further action was selected for Cambric Ditch and Able, where no COCs were identified. These corrective actions were selected to ensure protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2008) based on an evaluation of risk, feasibility, and cost effectiveness (the evaluation of CAAs is presented in Appendix E). No further corrective action is needed for the four CASs within CAU 106 based on implementation of these corrective actions.

2.3.1 Final Action Levels

The chemical PALs are based on the *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs* [Preliminary Remediation Goals]*), Screening Levels for Chemical Contaminants* in industrial soils (EPA, 2011) except where natural background concentrations of *Resource Conservation and Recovery Act* (RCRA) metals exceed the screening level (e.g., arsenic on the NNSS). The chemical FALs are established in Appendix C at the PAL concentrations.

The establishment of the FALs (presented in Appendix C) was based on risk to receptors. The risk to receptors from contaminants at CAU 106 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 of the area where all four CASs are located determined that it is not reasonable to assume that any worker would be present in this area on a full-time basis (DOE/NV, 1996). In the CAU 106 DQOs, it was determined that the Occasional Use Area exposure scenario best represented actual current and projected use of the area where the CASs are located. 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 area for intermittent or short-term activities. Site workers under this scenario are assumed to be in the area for an equivalent of 80 hours per year (hr/yr). This is consistent with the evaluation of land use as presented in Appendix C, which determined that the most exposed worker would be a military/emergency

response trainee. However, it was determined that corrective actions based on the PALs (using the Industrial Area exposure scenario that assumes a receptor is exposed to the location of maximum contamination for 2,250 hr/yr) would be feasible and appropriate, because the area in which the CAU 106 CASs are located is in proximity to the Nonproliferation Test and Evaluation Complex (NPTEC) and could be included in future NPTEC activities. Therefore, the FALs were established at the PALs (Tier 1 risk-based screening levels [RBSLs]).

3.0 Recommendation

No further corrective action is required at CAU 106 based on implementation of corrective actions at the CAU 106 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 106 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer valid, additional evaluation may be necessary.

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

4.0 References

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*.

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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.

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Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 106. Corrective Action Unit 106 consists of four CASs located in Area 5 of the NNSS (Figure 1-2):

- 05-20-02, Evaporation Pond
- 05-23-05, Atmospheric Test Site - Able
- 05-45-04, 306 GZ Rad Contaminated Area
- 05-45-05, 307 GZ Rad Contaminated Area

Corrective Action Site 05-20-02 (referred to as Cambric Ditch in this document) consists of a release of tritium-contaminated groundwater from Well RNM-2s to the surface of Cambric Ditch that extends approximately 1 mi in a southeast direction to an evaporation pond located on the northwest shore of Frenchman Lake. The surface release was a result of a 16-year study between 1975 and 1991 involving groundwater pumping and discharge to better understand the migration of radionuclides in groundwater from the Cambric test cavity.

Corrective Action Site 05-23-05 (referred to as Able in this document) is centrally located on Frenchman Lake in Area 5, approximately 400 ft southwest of the historic Underground Parking Garage associated with the Priscilla test. The Able test was conducted on April 1, 1952, as part of Operation Tumbler-Snapper. Able consists of the atmospheric deposition of radionuclides to the surface soil from the detonation of a weapons-effect test with a 1-kt yield at 800 ft above the ground surface.

Corrective Action Site 05-45-04 (referred to as 306 GZ in this document) is located on the gentle slopes of Frenchman Flat in Area 5, approximately 1.25 mi north of Frenchman Lake and 1,200 ft north of 5-07 Road near the Kay Blockhouse (CAU 204). The 306 GZ site contains a posted URMA and CA and consists of a release of surface and near-surface contamination from abandoned wastes, particularly DU contaminants released to the soil.

Corrective Action Site 05-45-05 (referred to as 307 GZ in this document) is located just off the northwest shore of Frenchman Lake in Area 5. The 307 GZ site contains an area posted as an URMA and consists of a release of surface and near-surface contamination from abandoned wastes, particularly DU contaminants released to the soil.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 106 CAIP (NNSA/NSO, 2011).

A.1.1 Project Objectives

The primary objective of the investigation was to obtain sufficient information to complete corrective actions and support the recommendation for closure of each CAS in CAU 106. This objective was achieved by identifying the nature and extent of COCs and by evaluating, selecting, and implementing acceptable CAAs.

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

A.1.2 Contents

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

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

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

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 106 CAI were conducted from October 20, 2010, through June 1, 2011. The following CAI activities were conducted at the CASs within CAU 106:

- Inspected and verified the CAS components identified in the CAIP (NNSA/NSO, 2011).
- Performed site inspections to look for biased sampling locations.
- Conducted radiological walkover surveys at Able, 306 GZ, and 307 GZ.
- Conducted geophysical surveys at 306 GZ and 307 GZ.
- Collected soil samples at biased sampling locations.
- Removed PSM for disposal.
- Submitted soil samples for offsite laboratory analysis.
- Collected GPS coordinates of sample locations and points of interest.

The investigation and sampling program adhered to the requirements set forth in the CAIP (NNSA/NSO, 2011). Samples were collected, documented, and analyzed as prescribed in the CAIP. Quality control samples (e.g., duplicate samples) were collected as required by the Industrial Sites QAPP (NNSA/NV, 2002) and the CAIP.

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the releases at each CAS were classified into one of the following two categories:

- **Primary releases** (referred to as "test releases" in the CAU 106 CAIP)—This release category is specific to the atmospheric deposition of radionuclide contamination onto the soil surface that has not been displaced through excavation or migration. The contamination associated with the primary releases is limited to the top 5 cm of undisturbed soil. Sampling surface soils to a depth of 5 cm is appropriate for areas that have not been disturbed, as numerous studies of soils contaminated by atmospheric deposition following nuclear testing at the NNSS have shown that more than 90 percent of the radioactivity in undisturbed soil is contained within the top 5 cm of soil (McArthur and Kordas, 1983, 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CADD/CR, surface is defined as the upper 5 cm of soil.

- **Other releases** (referred to as "non-test releases" in the CAU 106 CAIP)—This release category includes any radionuclide contamination from test activities that is not limited to the surface 5 cm of soil. This includes radionuclide contaminants that were initially deposited onto the soil surface (as in the primary release category) but have subsequently been displaced through excavation or migration. This category also includes radionuclides that were deposited under mechanisms other than atmospheric deposition. This includes the release of

radioactivity to the soil from contaminated debris (specifically DU) at the 306 GZ and 307 GZ sites, surface discharge of tritium-contaminated groundwater at Cambric Ditch, and any other chemical or radiological contamination discovered during the investigation through the identification of biasing factors that are not a part of a previously identified release. The depth of radiological or chemical contamination from other releases is dependent upon the nature of the release or subsequent movement through excavation or migration. Investigation of other releases was accomplished through measurements of soil contamination using a judgmental sampling scheme at depths dependent upon the nature of the release, or by conservative assumptions that contamination is present at depth based on process knowledge.

The CASs were investigated by collecting judgmental soil samples. The data collected at these sites that contribute to the decisions made for site closure include (1) laboratory analysis of the soil samples (i.e., individual radionuclide and/or chemical results), (2) radiological walkover surveys of selected areas of the CASs, (3) geophysical surveys of selected areas of the CASs, and (4) investigation of geophysical anomalies. The field investigation was completed as specified in the CAIP (NNSA/NSO, 2011) and as described in Sections A.2.1 through A.2.4, which provide the general investigation and evaluation methodologies used at the CASs.

A.2.1 Sample Locations

Locations selected for sampling were based on interpretation of site-specific GWSs, geophysical surveys, 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 CAU 106 CAIP (NNSA/NSO, 2011). Actual environmental sample locations are shown on the figures included in Sections A.3.0 through A.6.0. The sample locations and CAS points of interest were surveyed with a GPS instrument. Appendix F presents these data in a tabular format. The soil sample locations (Tables A.3-1, A.4-1, A.5-1, and A.6-1) for the CASs in CAU 106 are shown on Figures A.3-1, A.4-1, A.5-4, and A.6-2.

A.2.2 Investigation Activities

The investigation activities as listed in Section A.2.0 were performed at CAU 106 and were consistent with the field investigation activities stipulated in the CAIP (NNSA/NSO, 2011). The investigation strategy provided the necessary information to establish the nature and extent of

contamination associated with each CAS. The following sections describe the specific investigation activities that took place at CAU 106.

A.2.2.1 Geophysical Surveys

Geophysical surveys were conducted at 306 GZ and 307 GZ to investigate the potential for buried materials in each of the posted URMAs. The surveys were conducted using an EM61-MK2 time-domain metal detector that is capable of detecting both ferrous and non-ferrous objects. An Allegro CE/DOS data logger was used to collect the data produced by the EM61, while a Trimble Model GeoXT was connected to the data logger to supply real-time positioning information. Both pre- and post-surveys used the same EM61 equipment configuration to ensure comparable results (i.e., wheel-mounted equipment).

Handheld geophysical instruments (i.e., magnetometers) were used to perform "mag and flag" surveys at both 306 GZ and 307 GZ to assist in the identification of metallic debris on the ground surface outside the posted radiological areas. A 100-ft radius circle was established around the URMA and CA at 306 GZ and the URMA at 307 GZ with each survey area marked out in 10-ft lanes to ensure a 100 percent coverage survey was performed.

A.2.2.2 Radiological Surveys

Ground-level radiological surveys were conducted at selected CAU 106 CASs. Aerial radiological surveys were performed at Able in 1994 at an altitude of 200 ft with 500-ft flight-line spacing (BN, 1999).

Ground-level GWSs were performed to identify specific locations for biased sample locations. Count-rate data were collected with a TSA Systems PRM-470 model plastic scintillator, a beta and low-energy gamma 44-21 plastic scintillator, and/or a field instrument for the detection of low-energy radiation (FIDLER). Count-rate and position data were collected and recorded at 1-second intervals via a Trimble Model GeoXT GPS unit. The walkover speed was approximately 1 to 2 meters per second with the radiation detector held at a height of approximately 18 in. above the ground surface.

A.2.2.3 Field Screening

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

Field screening was used at CAU 106 to evaluate the presence of buried contamination at Able and to aid in the selection of biased samples for laboratory analyses at 306 GZ and 307 GZ. Field screening was limited to radiological parameters and was conducted using an NE Electra instrument. As part of the primary release investigation at Able, soil was removed at the sample location and screened for radioactivity in 5-cm-depth increments to a total depth of 15 cm bgs (see Section A.4.1.3). These FSRs were used to determine whether a layer or layers of subsurface contamination could be distinguished from surface contamination. Buried contamination was considered to be present only if the depth interval reading exceeded the FSL and there was a greater than 50 percent difference between the depth interval reading and the surface soil reading. For locations where it was determined that buried contamination was present, the depth interval with the highest reading from each aliquot was composited into a sample to be sent 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 are collected from the top 5 cm of soil 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.2.2.4 Soil Sampling

Soil sampling for the primary and other releases at CAU 106 consisted of the collection of surface and subsurface judgmental soil samples at biased locations. For the Able site, each sample was collected using a "vertical-slice cylinder and bottom-trowel" method. This required inserting a cylinder with an inside diameter of 3.5 in. vertically to a depth of 5 cm, excavating the outside soil

along one side of the cylinder (to permit trowel placement), and inserting a trowel horizontally along the bottom of the cylinder. This method captured a 5-cm cylindrical-shaped section of the soil. Buried contamination was suspected at Able; therefore, selected locations were screened vertically from the surface to a maximum depth of 15 cm at 5-cm intervals.

For other (non-test) releases, samples were collected using a "scoop and trowel" method (surface hand-grab sampling). Where required, hand excavation and/or hand augers were used to access subsurface depth intervals. Subsurface samples were collected and sent to the laboratory for analysis if biasing factors were present that indicated potential contamination or for Decision II purposes.

A.2.3 Laboratory Analytical Information

Radiological analyses of the collected soil samples were performed by ARS International, of Port Allen, Louisiana. Chemical 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 Table A.2-1. Analytical results are reported in this appendix if they were detected above the MDCs. The complete laboratory data packages are available in the project files.

The analytical results for each CAS are presented in Sections A.3.0 through A.6.0. The analytical parameters were selected through the application of site process knowledge as described in the CAIP (NNSA/NSO, 2011).

A.2.4 Comparison to Action Levels

The radiological PALs and FALs are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 106 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, 2011) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,250 hours (i.e., the Industrial Area exposure scenario in which a site worker is exposed to site contamination for 10 hours per day [hr/day], 225 days per year [day/yr]). The radiological PALs were established as the FALs in Appendix C.

Table A.2-1
Laboratory Analyses and Methods, CAU 106 Investigation Samples[a]

Analysis	Analytical Method[b]
Isotopic U	Aqueous/Non-aqueous - DOE EML HASL-300[c] U-02-RC
Isotopic Pu	Aqueous - DOE EML HASL-300[c] Pu-10-RC Non-aqueous - DOE EML HASL-300[c] Pu-02-RC
Gamma Spectroscopy	Aqueous - EPA 901.1[d] Non-aqueous - DOE EML HASL-300[c] Ga-01-R
Sr-90	Aqueous - EPA 905.0[d] Non-aqueous - DOE EML HASL-300[c] Sr-02-RC
Tritium	Aqueous - EPA 906.0[d] Non-aqueous - Laboratory Procedure[e]
VOCs	8260[f]
SVOCs	8270[f]
PCBs	8082[f]
Metals	6010/6020[f]
Hexavalent Chromium	7196[f]
Mercury	Aqueous - 7470[f] Non-aqueous - 7471[f]

[a]Investigation samples include both environmental and associated QC samples.
[b]The most current accepted EPA, DOE, ASTM, NIOSH, or equivalent analytical method may be used, including approved Laboratory Standard Operating Procedures (NNES, 2009).
[c]*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997).
[d]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA, 1980).
[e]Laboratory standard operating procedures in accordance with industry standards and the N-I Statement of Work requirements (NNES, 2009).
[f]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2009).

ASTM = ASTM International
EML = Environmental Measurements Laboratory
EPA = U.S. Environmental Protection Agency
HASL = Health and Safety Laboratory
NIOSH = National Institute for Occupational Safety and Health
PCB = Polychlorinated biphenyl
Pu = Plutonium
Sr = Strontium
SVOC = Semivolatile organic compound
U = Uranium
VOC = Volatile organic compound

Results for both the primary releases and other releases are presented in Sections A.3.2, A.4.2, A.5.2, and A.6.2. For CAU 106, radiological results are reported as individual radionuclide concentrations that are comparable to their respective RRMGs, which are used to facilitate the determination of a radiation dose estimate for each soil sample. The radiation dose estimate that an individual radionuclide contributes toward the total dose for a particular soil sample is presented as a fraction value and is obtained by dividing the radionuclide concentration for that particular sample by the

respective RRMG. The fraction values of all the detected radionuclides in each sample are then summed and multiplied by 25 to obtain the estimated TED for that sample. The TED is then compared to the dose-based FAL of 25 mrem/IA-yr as established in Appendix C. Chemical results are reported as individual concentrations that are comparable to individual FALs as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the CAS-specific results tables (see Sections A.3.0 through A.6.0).

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. 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, 2006). If COCs are present, corrective action must be considered for the CAS.

A corrective action may also be required if a waste present within a CAS contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and release the contaminants to the surrounding media. 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 not to 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 waste. If the resulting soil concentration exceeds the FAL, then the waste would be considered 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 waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004). If the resulting dose exceeds the FAL, then the waste would be considered 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 PSM.

A.3.0 CAS 05-20-02, Evaporation Pond

Corrective Action Site 05-20-02 (Cambric Ditch) is located northwest of Frenchman Lake and extends to the west towards Well RNM-2s (east of the 5-01 Road in Area 5). Cambric Ditch consists of a release of tritium-contaminated groundwater from Well RNM-2s to the surface of Cambric Ditch that then flowed into the evaporation pond. This release occurred during a 16-year study from 1975 to 1991. Additional details are provided in the CAIP (NNSA/NSO, 2011).

A.3.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2011) are described in the following sections.

A.3.1.1 Visual Inspections

Visual inspections of Cambric Ditch were conducted at several locations along the ditch spanning the discharge point near Well RNM-2s to the evaporation pond at the edge of Frenchman Lake and including the offshoot ditch near the 307 GZ site. No biasing factors (indicating the potential release of contamination) were identified, and no additional samples were collected as a result of the visual inspection.

A.3.1.2 Sample Collection

A total of two samples (one environmental sample and one FD) were collected from one location (F01) during investigation activities at Cambric Ditch. Both samples were analyzed for tritium only. The sample identifications (IDs), locations, and types are listed in Table A.3-1.

Table A.3-1
Samples Collected at CAS 05-20-02, Evaporation Pond (Cambric Ditch)

Sample Location	Sample Number	Depth (in. bgs)	Matrix	Purpose	Tritium
F01	106F001	0–6	Soil	Environmental, Full Lab QC	X
	106F002	0–6	Soil	FD of #106F001	X

X = Analyzed

A radiological scan of the surface soils was conducted from Well RNM-2s to a discharge point approximately 30 ft downstream. As no elevated radiological readings were detected, the default sample location (F01) was established in the area directly below the groundwater discharge point from Well RNM-2s as shown in Figure A.3-1.

A.3.1.3 Deviations

No deviations to the CAIP (NNSA/NSO, 2011) were noted.

A.3.2 Investigation Results

This section summarizes the conclusion presented in the CAIP (NNSA/NSO, 2011) that tritium concentrations above the FAL were not expected at Cambric Ditch and provides the analytical results for tritium analysis performed on the samples collected at Cambric Ditch.

As presented in Section A.8.3.1.1 of the CAIP, a calculation was made to conservatively estimate the theoretical maximum tritium concentration in soil at the discharge point. The calculation used the unrealistic assumption that the soil at the discharge point currently contains (at a holding capacity of 15 percent moisture content) the undiluted groundwater from the historical discharge that had the highest concentration of tritium (decayed to the present time). The maximum tritium concentration of the historical discharge was decay corrected to be 521,967 picocuries per liter (pCi/L). The decay-corrected tritium concentration in groundwater (pCi/L) was then converted to a soil concentration (pCi/g), which resulted in the maximum theoretical soil concentration of 131 pCi/g. This concentration is insignificant in comparison to the FAL of 7,250,000 pCi/g for tritium under the Industrial Area exposure scenario. Therefore, the potential dose from tritium contamination in soil above the FAL of 25 mrem/IA-yr at Cambric Ditch is not theoretically possible.

To support this conclusion, sample 106F001 (including FD 106F002) was collected and analyzed for tritium. The tritium analytical results obtained from these samples did not exceed MDCs (i.e., non-detects); therefore, the results support the conclusions established in the CAIP that tritium is not present in soil above the FAL at Cambric Ditch.

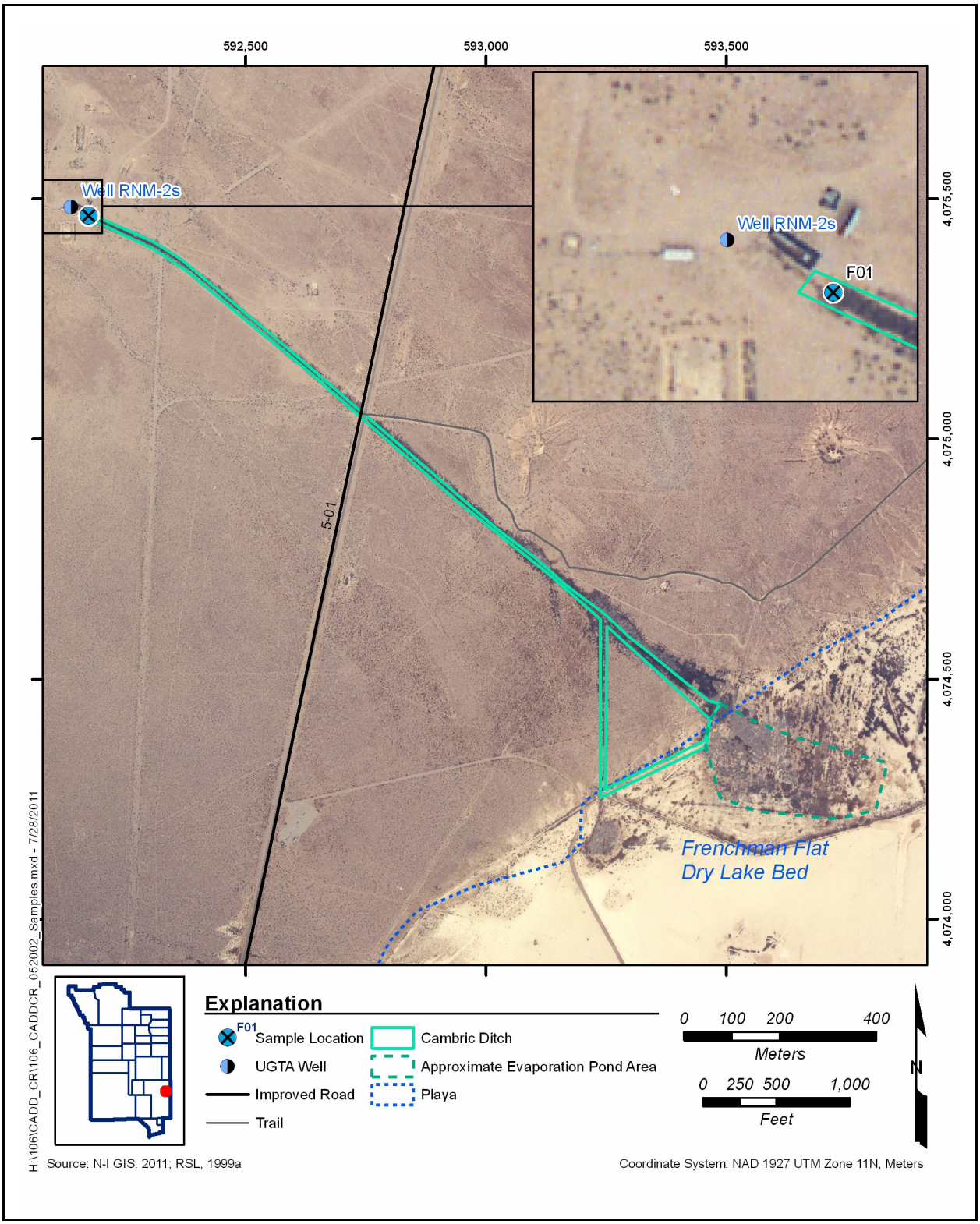

Figure A.3-1
Cambric Ditch Sample Locations

A.3.3 Nature and Extent of Contamination

The analytical results for the soil samples collected within Cambric Ditch support the conclusion stated in the CAIP that tritium is not present in soil at concentrations above the FAL at this CAS. As no COCs are present at this CAS, defining the nature and extent of contamination has been satisfied.

A.3.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2011) were met at this CAS. 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 CAS 05-23-05, Atmospheric Test Site - Able

Corrective Action Site 05-23-05 is centrally located on Frenchman Lake in Area 5, approximately 400 ft southwest of the historic Underground Parking Garage associated with the Priscilla test. Able consists of the atmospheric deposition of radionuclides to the surface soil from the detonation of a weapons-effect test conducted above the ground surface on April 1, 1952, as part of Operation Tumbler-Snapper. Additional details on the history of Able are provided in the CAIP (NNSA/NSO, 2011).

A.4.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2011) are described in the following sections.

A.4.1.1 Visual Inspections

Visual inspections of the area at the Able ground zero were conducted over the course of the field investigation and included site walks, sampling efforts, and radiological surveys. No test-related debris or equipment was identified, no biasing factors (e.g., stains or odors) were noted in the area of ground zero, and there are no major drainages exiting the Able site. Thus, the visual inspections conducted at Able noted no additional biasing factors.

A.4.1.2 Radiological Surveys

A GPS-assisted GWS was conducted at Able. This survey was performed to examine the distribution of radiological contamination across the site, which was used as input into the selection of the soil sampling locations. Count-rate data were collected with a TSA Systems PRM-470 model plastic scintillator. Data were post-processed, loaded into a geographical information system, color coded, and displayed on a map of Able. Figure A.4-1 presents a graphic representation of the data from the GWS (displayed as multiples of background counts).

The results of the GWS showed no areas of elevated radiological readings. Therefore, the sample location was biased to the ground zero marker default location.

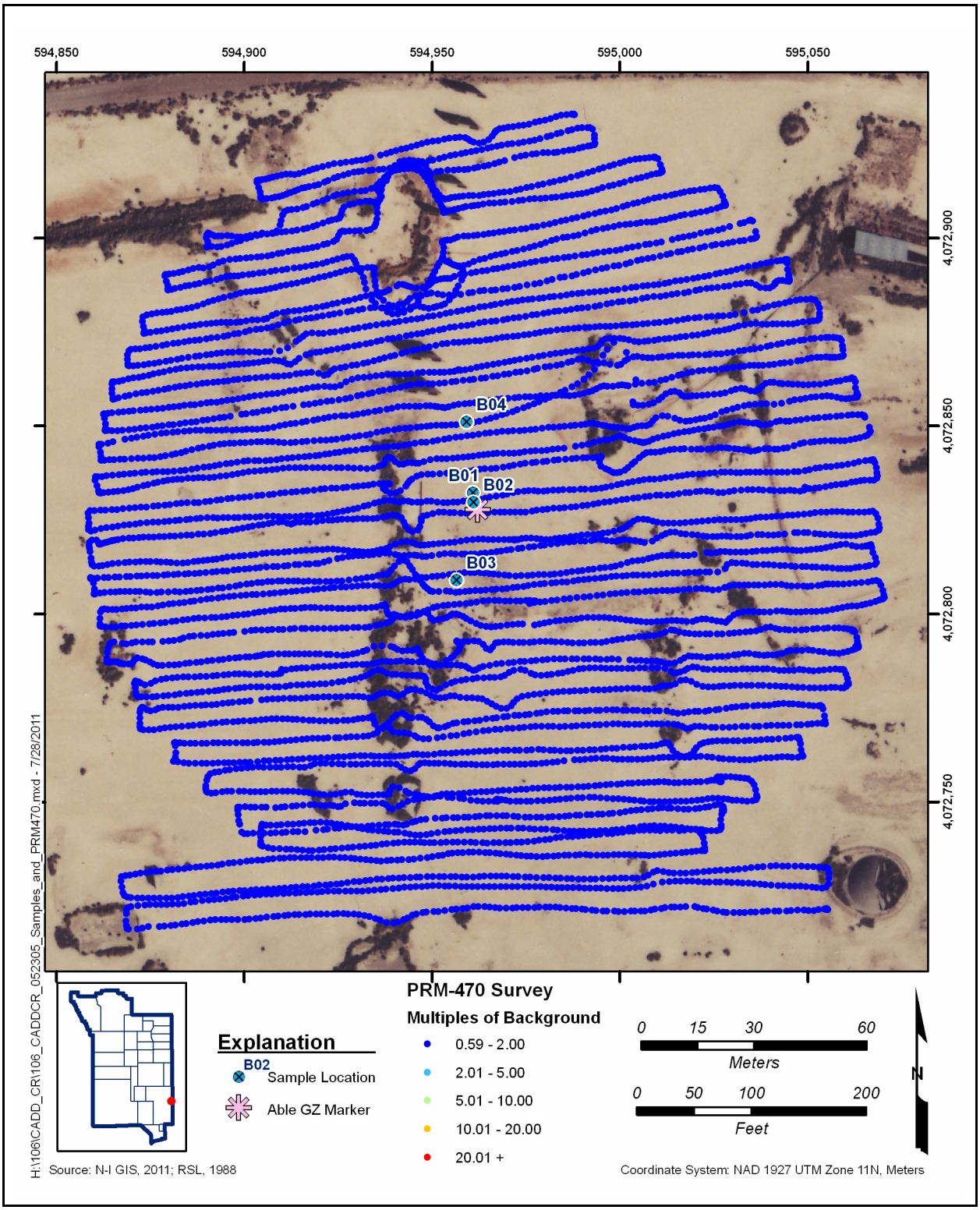

Figure A.4-1
Gamma Walkover Surveys and Sample Locations at Able

A.4.1.3 Field Screening

Field screening was conducted at Able to evaluate the alpha and beta/gamma contamination levels on the surface of the soil. All soil samples were field screened after collection prior to placement into 1-gallon (gal) metal cans or amber glass jars, and results were compared to screening values collected from a background soil location. The FSRs were used to determine whether buried contamination exists at Able. All four sample locations were field screened to a depth of 15 cm. None of the depth intervals exceeded FSLs, indicating buried contamination is not a concern at Able. Therefore, no subsurface soil samples were submitted to the laboratory for analysis. These field-screening data were recorded on SCLs and are retained in the project files.

A.4.1.4 Sample Collection

For the primary release at Able, a total of six samples (four environmental samples and two FDs) were collected at four locations during investigation activities at Able. All samples were analyzed for gamma spectroscopy, Sr-90, and isotopic U and Pu. The sample IDs, locations, and types are listed in Table A.4-1.

Table A.4-1
Samples Collected at CAS 05-23-05, Atmospheric Test Site - Able

Sample Location	Sample Number	Depth (cm bgs)	Matrix	Purpose	Gamma Spectroscopy	Plutonium	Sr-90	Uranium
B01	106B001	0–5	Soil	Environmental	X	X	X	X
	106B002	0–5	Soil	FD of #106B001	X	X	X	X
B02	106B003	0–5	Soil	Environmental	X	X	X	X
	106B004	0–5	Soil	FD of #106B003	X	X	X	X
B03	106B005	0–5	Soil	Environmental, Full Lab QC	X	X	X	X
B04	106B006	0–5	Soil	Environmental	X	X	X	X

X = Analyzed

Because the GWS identified no areas with elevated radiological readings, the initial sample location (B01) was established at the posted ground zero (i.e., default location per the CAIP). Sample location B01 is approximately 1 meter (m) north of the ground zero marker. Results from the environmental sample collected at this location (106B001) showed an elevated presence of Pu-239/240 even though FSLs were not exceeded. The FD at this location (106B002) was inadvertently combined with the original sample by the laboratory and therefore could not be analyzed independently; as a result, the Pu-239/240 results could not be verified. Although the Pu-239/240 soil concentration of sample 106B001 was well below the RRMG, it was decided to collect another surface sample and FD at location B02 (1 m away from B01) to determine whether the Pu-239/240 analytical results at location B01 were erroneous. It was also decided to collect, and submit for laboratory analysis, two additional surface samples at locations approximately 30 m from ground zero (B03 to the southwest and B04 to the northwest) to determine whether low levels of Pu-239/240 are present and ubiquitous within lake bed sediments in this area. Final sample locations (Table A.4-1) are shown on Figure A.4-1.

A.4.1.5 Deviations

No deviations to the CAIP (NNSA/NSO, 2011) were noted, other than the collection of additional samples.

A.4.2 Investigation Results

The following sections present the analytical results exceeding the MDCs for soil samples collected at this CAS. All sampling and analyses were conducted as specified in the CAIP. The analytical parameters and laboratory methods used during this investigation are discussed in Section A.2.0 and listed in Table A.2-1.

A.4.2.1 Radiological Results

Table A.4-2 presents the individual radionuclide concentrations detected above MDCs from gamma spectroscopy and isotopic analysis, their respective RRMGs, and an estimated TED (sum of fractions) for each sample. The individual radionuclide concentrations are comparable to their respective RRMGs, which are used to facilitate the determination of a radiation dose estimate for each soil sample. The radiation dose estimate that an individual radionuclide contributes toward the total dose for each soil sample is presented as the fraction value in Table A.4-2. This fraction value is

Table A.4-2
Radiological Sample Results above MDCs at CAS 05-23-05, Atmospheric Test Site - Able

Sample Location	Sample Number	Depth (cm bgs)	COPC (pCi/g)										TED
			Th-232[a, b] (Ac-228)	Am-241[b]	Cs-137[b]	Eu-152[b]	Eu-154[b]	Pu-238[c]	Pu-239/240[c]	U-234[c]	U-235	U-238[c]	
RRMGs			**506.7**	**1,503**	**72.9**	**38.26**	**35.71**	**2,416**	**2,207**	**18,650**	**255.5**	**1,423**	**FAL (25 mrem/IA-yr)**
B01	106B001	0–5	1.27	4.53	0.32	0.83	0.07	2.24	178.86	0.96	--	1.06	N/A
		Fraction	0.003	0.003	0.004	0.022	0.012	0.001	0.081	0.000	--	0.001	3.17
	106B002[d]	0–5	--	--	--	--	--	--	--	--	--	--	N/A
		Fraction	--	--	--	--	--	--	--	--	--	--	N/A
B02	106B003	0–5	1.41	12.37 (J)	0.32	1.2 (J)	--	0.71 (J)	55.27 (J)	1.06	0.04[c]	1.1	N/A
		Fraction	0.003	0.008	0.004	0.031	--	0.000	0.025	0.000	0.000	0.001	1.83
	106B004	0–5	1.54	17.71 (J)	0.34	1.24 (J)	--	0.49 (J)	42.32 (J)	0.99	--	0.98	N/A
		Fraction	0.003	0.012	0.005	0.032	--	0.000	0.019	0.000	--	0.001	1.80
B03	106B005	0–5	1.46	10.28 (J)	0.4	1.32 (J)	--	1.97 (J)	173.67 (J)	0.91	0.04[c]	1.04	N/A
		Fraction	0.003	0.007	0.005	0.034	--	0.001	0.079	0.000	0.000	0.001	3.25
B04	106B006	0–5	1.32	0.69 (J)	0.11	1.99 (J)	1.02 (J)	--	1.79 (J)	1.1	0.06[c]	1.06	N/A
		Fraction	0.003	0.000	0.002	0.052	0.179	--	0.001	0.000	0.000	0.001	5.93

[a]Result is Th-232 as analyzed via its daughter (Ac-228) in secular equilibrium.
[b]Gamma-emitting radionuclide
[c]Isotopic radionuclide
[d]Sample 106B002 was collected and submitted to the laboratory, but was not analyzed independently by the laboratory.

Ac = Actinium
Am = Americium
COPC = Contaminant of potential concern
Cs = Cesium
N/A = Not applicable
Th = Thorium

J = Estimated value
-- = Not detected above MDCs

obtained by dividing the radionuclide concentration for that sample by the respective RRMG. The fraction values of all the detected radionuclides in each sample are then summed and multiplied by 25 to obtain the estimated TED for that sample. The TED is then compared to the dose-based FAL of 25 mrem/IA-yr as established in Appendix C.

None of the individual radionuclide concentrations exceeded their respective RRMGs, and none of the samples collected at Able exceeded the FAL of 25 mrem/IA-yr.

A.4.3 Nature and Extent of Contamination

Based on the analytical results for the soil samples collected at this CAS, no COCs were identified. Therefore, defining the nature and extent of contamination has been satisfied.

A.4.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2011) were met at this CAS. 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 CAS 05-45-04, 306 GZ Rad Contaminated Area

Corrective Action Site 05-45-04 (306 GZ) is located on the gentle slopes of Frenchman Flat in Area 5, approximately 1.25 mi north of Frenchman Lake and 1,200 ft north of 5-07 Road near the Kay Blockhouse (CAU 204). The 306 GZ site contains a posted URMA and CA, and consists of a release of surface and near-surface contamination from abandoned wastes, particularly DU that released contaminants to the soil. Additional details on the history of 306 GZ are provided in the CAIP (NNSA/NSO, 2011).

A.5.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2011) are described in the following sections.

A.5.1.1 Visual Inspections

Visual inspections of 306 GZ were conducted over the course of the field investigation and included site walks, geophysical surveys, and radiological surveys. The presence of scattered pieces of metallic debris was identified and noted both inside and outside the radiologically posted areas. Any PSM (pieces of DU, DU-contaminated debris, oxidized DU) encountered outside the posted areas was flagged for removal, and a GPS coordinate was collected. Visual inspections of the ground surface were aided with the support of hand-held geophysical instruments to identify potentially contaminated debris (see Section A.5.1.2 for details of the geophysical surveys).

A horizon of patchy, dark soil staining was identified from about 4 to 10 in. bgs during the investigation of geophysical anomalies and evaluation of the vertical extent of elevated radioactivity within the posted URMA. Additional biased samples were collected at locations D06 and D07 as a result of this biasing factor indicating a potential release of contamination. A photo of the stained soil horizon is shown in Figure A.5-1.

Figure A.5-1
Photo of Stained Soil Horizon within the URMA at 306 GZ

A.5.1.2 Geophysical Surveys

An EM61-MK2 time-domain metal detector was used to investigate the potential for buried material within the URMA. The survey identified five anomalies within the boundary of the URMA, warranting further investigation as potential buried material. Excavation of the anomalies labeled "a" through "e" as shown in Figure A.5-2 confirmed the presence of nine additional pieces of metallic debris down to approximately 1 ft bgs. All debris encountered during the excavation were screened for radioactivity and removed for disposal. A post-excavation survey was conducted with the EM61 following the anomaly investigation and verified the absence of unidentified anomalies buried in the URMA (Figure A.5-2). The anomaly labeled "f" is probably a small piece of non-PSM debris inadvertently moved aside while the center anomalies were being excavated by hand as it was not present in the pre-survey. Additionally, radiological field screening conducted during the excavation would have detected this debris if it was PSM.

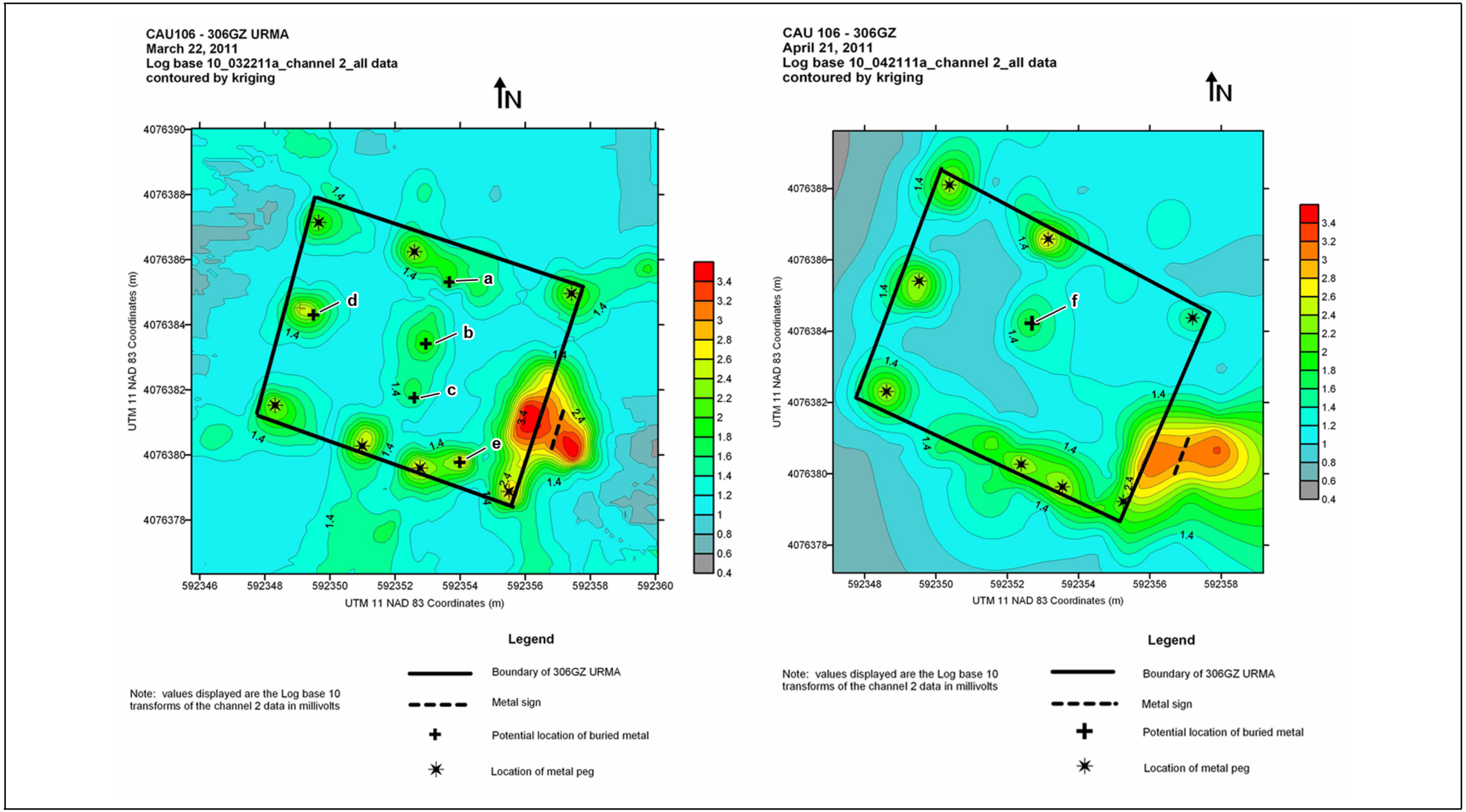

Figure A.5-2
EM61 Geophysical Survey Results at 306 GZ

To assist in the identification of metallic debris on the ground surface outside the posted radiological areas, two overlapping 100-ft radius circles of the posted URMA and CA were surveyed with hand-held geophysical instruments capable of detecting ferrous and non-ferrous metal. Ten-foot wide survey lanes were established within the 100-ft radius circles to ensure 100 percent coverage. The geophysical "mag and flag" survey identified metal debris from the surface to a maximum depth of 12 in. Each piece of material identified with the hand-held magnetometer was scanned for radioactivity. All material indicating elevated radioactivity was considered PSM, segregated from non-PSM debris, and containerized for disposal, and a GPS coordinate was collected. Figure A.5-3 is a photo showing the 10-ft survey lanes marked on the ground surface with flagged PSM locations. In accordance with the CAIP, one 50-ft step-out was added to the survey area because PSM was identified within 50 ft of the initial boundary. The 50-ft step-out originated from the PSM location labeled 306GZ-01 and extended southward. The extent of the "mag and flag" survey boundary is shown in Figure A.5-4 in relation to the GWS results. No other PSM was encountered within the 50-ft step-out. The "mag and flag" survey identified seven pieces of PSM and approximately 5 gal of non-PSM metallic debris outside the radiologically posted areas.

A.5.1.3 Radiological Surveys

The GPS-assisted GWSs were performed at 306 GZ during the CAI. An initial 100-ft radius of the posted URMA and CA was surveyed with a beta and low-energy gamma 44-21 plastic scintillator following the completion of the geophysical "mag and flag" survey. The GWSs utilized the 10-ft survey lanes established during the "mag and flag" survey. The objective of the GWSs was to locate areas of elevated radiological surface readings that help identify potential biased sample locations and contaminated debris outside the posted areas not found during the "mag and flag" survey. The GWS results also provide surface radiological conditions after contaminated debris and soil were removed before the GWSs. Figure A.5-4 presents a graphic representation of the data from the GWSs (displayed as multiples of background counts). It is important to note that the apparent trails of elevated readings originating from locations labeled 306GZ-05, 306GZ-09, and 306GZ-11 are a function of the instrument response characteristics and do not represent actual elevated materials away from those locations.

Figure A.5-3
Photo of "Mag and Flag" Survey Area at 306 GZ

The results of the GWS performed within the boundary of the URMA are presented on Figure A.5-4 and show that the highest gamma radiation readings are present near the center of the URMA. A biased sample location was identified and selected for sample collection at the center of the URMA (location D05).

The results of the GWSs performed outside the URMA and CA utilizing the "mag and flag" geophysical survey lanes identified an additional four locations containing PSM within and just outside the initial survey boundary (labeled 306GZ-09, 306GZ-10, 306GZ-11, and 306GZ-12 on Figure A.5-4). In accordance with the CAIP, three 50-ft step-outs were added to the GWS area because PSM was identified within 50 ft of the initial survey boundary. The first step-out originated from the PSM locations labeled 306GZ-09 and 306GZ-10 on Figure A.5-4. Location 306GZ-12 was

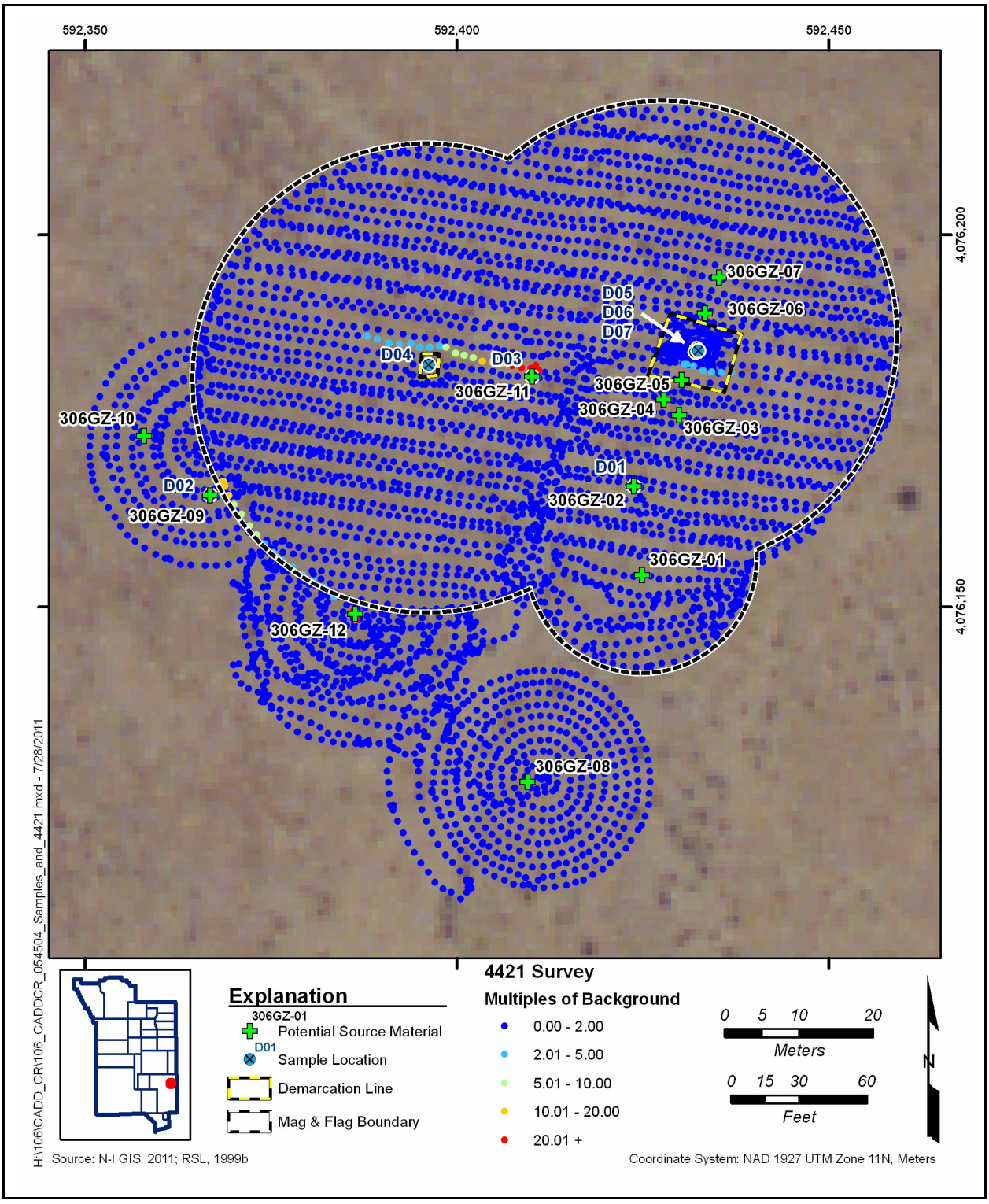

Figure A.5-4
Gamma Walkover Survey Results and Locations of Interest at 306 GZ

discovered during the first step-out survey, so another 50-ft step-out was performed. An additional 50-ft radius step-out survey was performed around PSM location 306GZ-08 because this location was outside any of the previous survey areas. After all three step-out surveys were completed, no other PSM was encountered, and the GWS is considered complete.

The PSM locations labeled 306GZ-02, 306GZ-09, and 306GZ-11 are associated with high radiological readings outside the posted areas and PSM removal locations, and thus were chosen as biased sample locations D01, D02, and D03, respectively.

A.5.1.4 Field Screening

Field screening was performed to determine biasing factors (i.e., elevated radioactivity) in surface and subsurface soils within the URMA. The area of the URMA was divided into nine relatively equal areas, and one borehole was hand augured into each of the nine areas to an average depth of 18 in. bgs. Soil brought to the surface with the hand auger was field screened at regular intervals with an Electra and compared to FSLs. Downhole *in situ* radiological screening also was conducted at each borehole with the 44-21 plastic scintillator, and results were qualitatively compared to an *in situ* background value. Results of the radiological field screening indicated the highest readings were located near the center of the URMA and extended to a depth of approximately 12 to 15 in. bgs. These results provided a biasing factor for sample collection at locations D05, D06, and D07.

To qualitatively investigate the vertical extent of elevated radiological readings within the posted CA, three locations labeled "a," "b," and "c" were selected for hand augering, and soil was field screened at 6-in. intervals until FSRs were below FSLs. The three locations were selected based on radiological scanning of the surface and known locations of PSM (debris). The FSRs indicate the following: (1) soil contamination is localized where contaminated debris (PSM) was identified and removed; (2) the highest soil FSRs were detected at location "a," where PSM with the highest removable contamination was identified and removed; and (3) the FSRs exceeded FSLs to a depth of 18 in. at location "a," whereas the FSRs slightly exceeded FSLs to a depth of 6 in. at locations "b" and "c." A biased sample location (D04) was established at location "a" based on the PSM survey data and elevated soil FSRs.

A.5.1.5 Sample Collection

Environmental samples were collected at 306 GZ to investigate surface releases associated with site activities and subsurface releases associated with potential waste material buried within the boundary of the posted URMAs. A total of eight samples (seven environmental samples and one FD) were collected during investigation activities at 306 GZ. All soil samples were analyzed for gamma spectroscopy, Sr-90, isotopic U and Pu, and beryllium, while selected locations were analyzed for RCRA metals, hexavalent chromium, VOCs, SVOCs, and/or PCBs. The sample IDs, locations, and types are listed in Table A.5-1.

Verification samples 106D001 and 106D002 were collected from locations D01 and D02, respectively, following the removal of oxidized DU and/or small nodule-like pieces of DU conservatively assumed to be PSM. A biased sample location was established at location D03 based on GWS results and the presence of PSM (306GZ-11). After removing the piece of PSM identified at 306GZ-11, verification samples 106D003 and 106D004 (FD) were collected from underlying soil directly in contact with the PSM.

Verification surface sample 106D005 at location D04 within the posted CA was collected from soil directly in contact with PSM showing removable alpha contamination. The PSM were removed before sampling. Verification surface sample 106D006 at location D05 was selected based on the highest surface radiological reading near the center of the URMA as well as an area where PSM were removed. Visual inspections conducted while geophysical anomalies were being investigated by hand excavation identified a horizon of discolored, darker stained soil. Sample 106D007 at location D06 was collected from 4 to 6 in. bgs within this stained horizon. Sample 106D008 from location D07 was collected to define vertical extent of potential contamination related to both the stained soil horizon and elevated radiological readings and to serve as a verification sample following additional PSM removal in the subsurface soil. This sample was collected from the base of an excavated area measuring 2 ft by 5 ft with hand tools at a depth of 12 to 15 in. bgs.

Final sample locations (Table A.5-1) are shown on Figure A.5-4.

A.5.1.6 Deviations

No deviations to the CAIP (NNSA/NSO, 2011) were noted.

Table A.5-1
Samples Collected at CAS 05-45-04, 306 GZ Rad Contaminated Area

Sample Location	Sample Number	Depth (in. bgs)	Matrix	Purpose	Gamma Spectroscopy	Hexavalent Chromium	Metals	Beryllium	PCBs	Plutonium	Sr-90	SVOCs	Uranium	VOCs
D01	106D001	10–12	Soil	Environmental	X	X	X	X	X	X	X	X	X	X
D02	106D002	0–6	Soil	Environmental	X	--	--	X	--	X	X	--	X	--
D03	106D003	0–6	Soil	Environmental	X	X	X	X	X	X	X	X	X	X
	106D004	0–6	Soil	FD of #106D003	X	X	X	X	X	X	X	X	X	X
D04	106D005	0–6	Soil	Environmental	X	X	X	X	X	X	X	X	X	X
D05	106D006	0–6	Soil	Environmental, Full Lab QC	X	X	X	X	X	X	X	X	X	X
D06	106D007	4–6	Soil	Environmental	X	X	X	X	X	X	X	X	X	X
D07	106D008	12–15	Soil	Environmental	X	X	X	X	X	X	X	X	X	X
N/A	106D301	N/A	Water	Trip Blank	--	--	--	--	--	--	--	--	--	X
N/A	106D302	N/A	Water	Trip Blank	--	--	--	--	--	--	--	--	--	X
N/A	106D303	N/A	Water	Trip Blank	--	--	--	--	--	--	--	--	--	X
N/A	106D304	N/A	Water	Field Blank	X	X	X	X	X	X	X	X	X	X
N/A	106D305	N/A	Water	Trip Blank	--	--	--	--	--	--	--	--	--	X

-- = Not required
X = Analyzed

A.5.2 Investigation Results

The following sections present the analytical results exceeding the MDCs for soil samples collected at this CAS. All sampling and analyses were conducted as specified in the CAIP. The analytical parameters and laboratory methods used during this investigation are discussed in Section A.2.0 and listed in Table A.2-1.

A.5.2.1 VOCs, SVOCs, and PCBs

No VOCs, SVOCs, or PCBs were detected above MDCs.

A.5.2.2 Metals

Analytical results for RCRA metals, total beryllium, and hexavalent chromium that were detected above MDCs are presented in Table A.5-2. No metal results exceeded their respective PALs. The FALs were established at the corresponding PAL concentrations.

A.5.2.3 Radiological Results

Table A.5-3 presents the individual radionuclide concentrations detected above MDCs from gamma spectroscopy and isotopic analysis, their respective RRMGs, and an estimated TED (sum of fractions) for each sample. The individual radionuclide concentrations are comparable to their respective RRMGs, which are used to facilitate the determination of a radiation dose estimate for each soil sample. The radiation dose estimate that an individual radionuclide contributes toward the total dose for each soil sample is presented as the fraction value in Table A.5-3. This fraction value is obtained by dividing the radionuclide concentration for that sample by the respective RRMG. The fraction values of all the detected radionuclides in each sample are then summed and multiplied by 25 to obtain the estimated TED for that sample. The TED is then compared to the dose-based FAL of 25 mrem/IA-yr as established in Appendix C.

None of the individual radionuclide concentrations exceeded their respective RRMGs, and none of the samples collected at 306 GZ exceeded the FAL of 25 mrem/IA-yr.

Table A.5-2
Sample Results for Metals Detected above MDCs at CAS 05-45-04, 306 GZ Rad Contaminated Area

Sample Location	Sample Number	Depth (in. bgs)	COPC (mg/kg)								
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Hexavalent Chromium	Lead	Mercury	Selenium
FALs			**23**	**190,000**	**2,000**	**800**	**39.2[a]**	**5.6**	**800**	**43**	**5,100**
D01	106D001	10–12	4	120	--	--	5	--	7.9	0.0095 (J-)	--
D03	106D003	0–6	3.8	130	--	0.092 (J)	4.7	--	9.2	0.013 (J-)	0.31
	106D004	0–6	3.1	97	--	0.076 (J)	4.1	--	7.9	0.017 (J-)	--
D04	106D005	0–6	3.2	98	--	0.05 (J)	4.3	--	10	0.012 (J-)	--
D05	106D006	0–6	3.9	120	0.74	1.5 (J)	7.6	0.48 (J)	11	0.021 (J-)	--
D06	106D007	4–6	2.7	110	0.77	1.8 (J)	7.3	--	10	0.014	--
D07	106D008	12–15	2	68	0.22 (J-)	0.072 (J)	2.4	--	4	0.0086	--

[a] FAL based on hexavalent chromium PAL with a 6:1 ratio

J = Estimated value
J- = Result is an estimated quantity, but may be biased low.
-- = Not detected above MDCs

Table A.5-3
Radiological Sample Results above MDCs at CAS 05-45-04, 306 GZ Rad Contaminated Area

Sample Location	Sample Number	Depth (in. bgs)	COPC (pCi/g)								TED
			Th-232[a,b] (Ac-228)	Cs-137[b]	Eu-155[b]	Pu-239/240[c]	Sr-90[c]	U-234[c]	U-235	U-238[c]	
RRMGs			**506.7**	**72.9**	**958.3**	**2,207**	**7,714**	**18,650**	**255.5**	**1,423**	**FAL (25 mrem/IA-yr)**
D01	106D001	10–12	2.21	--	--	0.73	0.34	2.21	0.29[c]	12.16	N/A
		Fraction	0.004	--	--	0.000	0.000	0.000	0.001	0.009	0.36
D02	106D002	0–6	2.07	--	--	0.13	--	1.72	0.09[c]	4.08	N/A
		Fraction	0.004	--	--	0.000	--	0.000	0.000	0.003	0.19
D03	106D003	0–6	3.95	0.17	--	1.88	--	0.97	--	1.2	N/A
		Fraction	0.008	0.002	--	0.001	--	0.000	--	0.001	0.30
	106D004	0–6	15.86	0.25	0.93	1.28	--	1.02	0.06[c]	1.21	N/A
		Fraction	0.031	0.003	0.001	0.001	--	0.000	0.000	0.001	0.94
D04	106D005	0–6	1.85	--	--	0.1	--	18.87	3.38[c]	227.18	N/A
		Fraction	0.004	--	--	0.000	--	0.001	0.013	0.160	4.44
D05	106D006	0–6	2.06	0.25	--	0.12	--	10.8	1.58[c]	67.3	N/A
		Fraction	0.004	0.003	--	0.000	--	0.001	0.006	0.047	1.54
D06	106D007	4–6	1.83	0.1	--	0.08	--	19.48	3.19[c]	127.34	N/A
		Fraction	0.004	0.001	--	0.000	--	0.001	0.012	0.089	2.70
D07	106D008	12–15	2.01	--	--	0.06	--	3.52	0.38[c]	16.53	N/A
		Fraction	0.004	--	--	0.000	--	0.000	0.001	0.012	0.43

[a]Result is Th-232 as analyzed via its daughter (Ac-228) in secular equilibrium
[b]Gamma-emitting radionuclide
[c]Isotopic radionuclide

-- = Not detected above MDCs

A.5.2.4 Potential Source Material

Visual observations, radiological surveys, and screening results showed the presence of DU, DU-contaminated debris, or oxidized DU within the CAS boundary. The oxidized DU and debris with elevated radiological screening results were conservatively assumed to be PSM and were removed for disposal as part of the corrective action. Following the removal of PSM at select locations where residual radiological contamination was indicated, verification soil samples were collected (locations D01–D05 and D07). Analytical results confirmed that the PSM was adequately removed and that no COCs remain.

A.5.3 Nature and Extent of Contamination

Based on the analytical results for soil samples collected at 306 GZ following removal of PSM, there were no identified COCs. Therefore, defining the nature and extent of contamination has been satisfied.

A.5.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2011) were met at this CAS. 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 CAS 05-45-05, 307 GZ Rad Contaminated Area

Corrective Action Site 05-45-05 (307 GZ) is located just off the northwest shore of Frenchman Lake in Area 5. The 307 GZ site contains an area posted as an URMA and consists of a release of surface and near-surface contamination from abandoned wastes, particularly DU that released contaminants to the soil. Additional details on the history of 307 GZ are provided in the CAIP (NNSA/NSO, 2011).

A.6.1 Corrective Action Investigation Activities

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2011) are described in the following sections.

A.6.1.1 Visual Inspections

Visual inspections of 307 GZ were conducted over the course of the field investigation and included site walks, geophysical surveys, and radiological surveys. The presence of scattered pieces of metallic debris was identified and documented both inside and outside the radiologically posted area. Due to the volume of small pieces of debris and DU-impacted PSM inside the posted URMA, individual PSM were not inventoried. All PSM (pieces of DU, DU-contaminated debris, oxidized DU) encountered outside the posted area were recorded and flagged for removal. Visual inspections of the ground surface were aided with the support of hand-held magnetometers to identify potentially contaminated debris (see Section A.6.1.2 for details of the geophysical surveys).

Visual inspections conducted within the posted URMA identified a small volume of highly oxidized DU in soil near the northwest corner. The oxidized DU is yellow in color, easy to identify both visually and through highly elevated radiological screening results, and conservatively assumed to be PSM. The biased sample 106E004 was collected from this material to confirm this assumption.

Biasing factors other than elevated radioactivity (e.g., staining) were not identified inside or outside the URMA during the investigation.

A.6.1.2 Geophysical Surveys

An EM61-MK2 time-domain metal detector was used to investigate the potential for buried material within the URMA. The survey identified one anomaly within the boundary of the URMA. This anomaly was associated with a known piece of nonradioactive steel debris located on the ground surface (see Figure A.6-1). The areas of higher responses shown outside the URMA are associated with fence posts that could not be removed (east and southeast sides) and metal tools used for survey reference points (southwest and northwest corners) and do not represent unknown anomalies. Because no other potentially buried debris was identified by the EM61 survey, no additional excavation was necessary, and a post-survey of the URMA was not conducted.

To assist in the identification of metallic debris on the ground surface outside the posted radiological areas, an initial 100-ft radius circle of the posted URMA was surveyed with hand-held geophysical instruments capable of detecting ferrous and non-ferrous metal. Ten-foot survey lanes were established within the 100-ft radius circle to ensure 100 percent coverage (see Figure A.5-3 for example). The geophysical "mag and flag" survey identified metal debris from the surface to a maximum depth of 12 in. Each piece of material identified with the hand-held magnetometer was scanned for radioactivity. All material indicating elevated radioactivity was considered PSM, segregated from non-PSM debris, and containerized for disposal, and a GPS coordinate was collected. The extent of the "mag and flag" survey boundary is shown in Figure A.6-2 in relation to the GWS results. No PSM was identified within 50 ft of the initial boundary; therefore, no step-out surveys were necessary. The survey identified one piece of PSM (labeled 307GZ-01) and less than 5 gal of non-PSM metallic debris outside the radiologically posted areas.

A.6.1.3 Radiological Surveys

The GPS-assisted GWSs were performed at 307 GZ during the CAI. An initial 100-ft radius of the posted URMA was surveyed with a beta and low-energy gamma 44-21 plastic scintillator following the completion of the hand-held geophysical instrument surveys. The GWSs utilized the 10-ft survey lanes established during the "mag and flag" survey. The objective of the GWSs was to locate areas of elevated radiological surface readings that help identify potential biased sample locations and contaminated debris outside the posted areas not found during the "mag and flag" survey. The GWS results also provide surface radiological conditions after contaminated debris and soil were removed

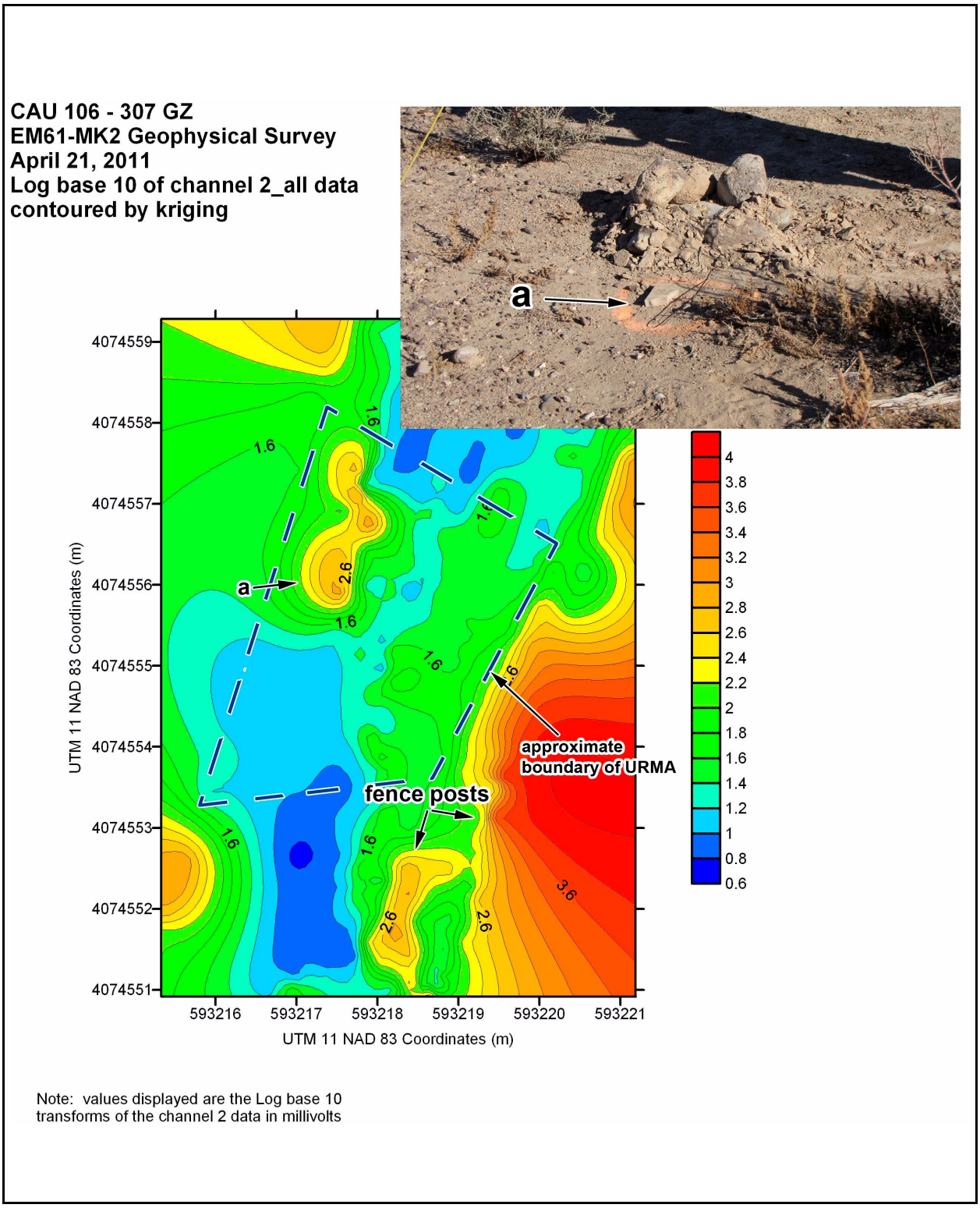

Figure A.6-1
EM61 Geophysical Survey Results at 307 GZ

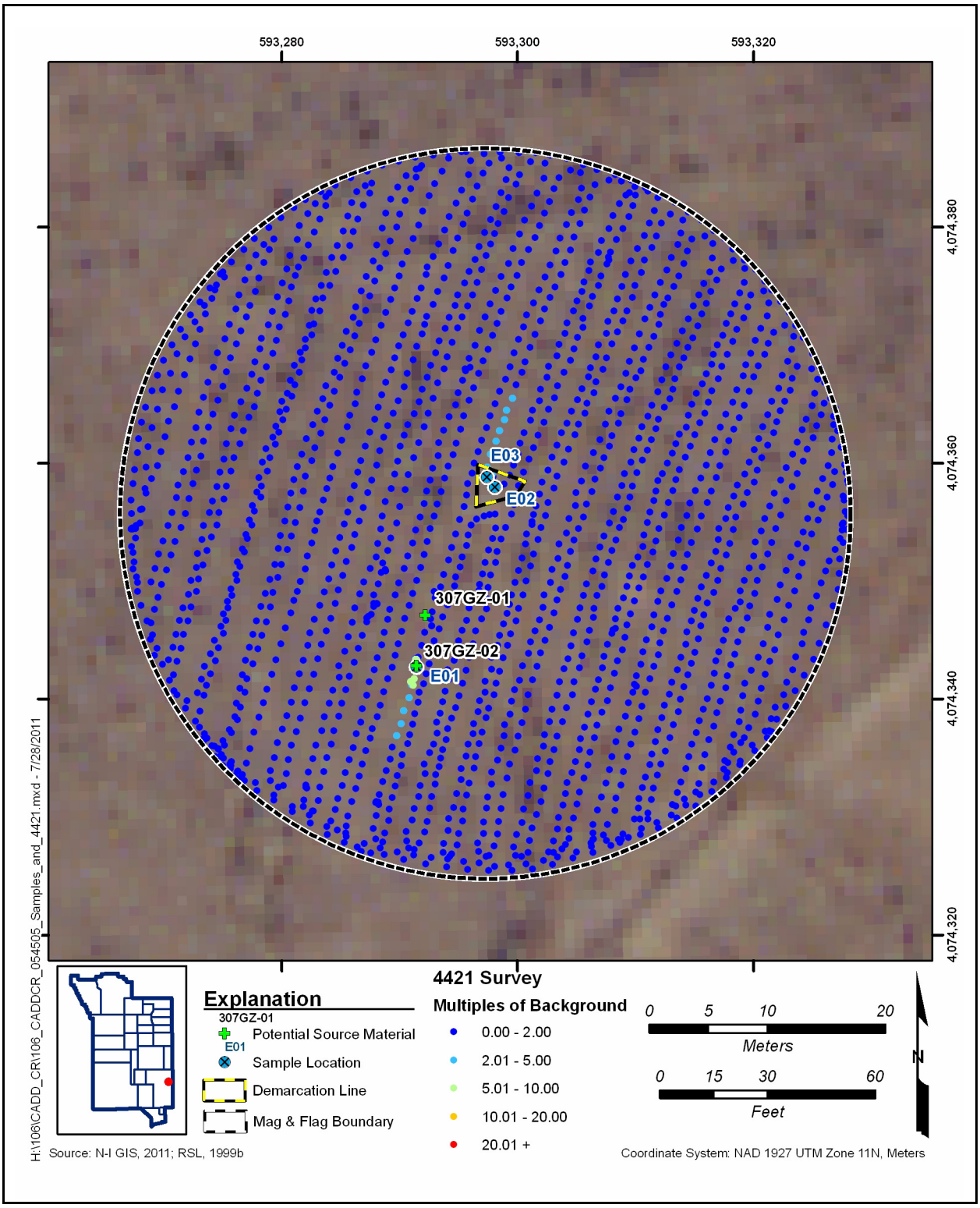

Figure A.6-2
Gamma Walkover Surveys and Locations of Interest at 307 GZ

before the GWSs. Figure A.6-2 presents a graphic representation of the data from the GWSs (displayed as multiples of background counts). It is important to note that the apparent trails of elevated readings originating from the location labeled 307GZ-02 are a function of the instrument response characteristics and do not represent actual elevated materials away from that location.

The results of the GWS performed outside the URMA utilizing the "mag and flag" geophysical survey lanes identified one additional location containing PSM within the initial survey boundary (labeled 307GZ-02 shown in Figure A.6-2). This location was chosen as a biased sample location (E01) due to the presence of PSM and elevated radiological readings. No additional 50-ft step-out surveys were necessary as no PSM was identified within 50 ft of the initial boundary.

A GWS was not performed inside the URMA due to the small size of the area. Instead, the 44-21 plastic scintillator was used to scan the surface inside the URMA fence line for the highest gamma radiation readings. Two biased sample locations were identified and selected for sample collection near the center and along the western edge of the URMA (locations E02 and E03).

A.6.1.4 Field Screening

Field screening was performed within the posted URMA to determine biasing factors (i.e., elevated radioactivity) for sample collection and to qualitatively investigate the vertical extent of elevated radiological readings. Three locations were identified and labeled "a," "b," and "c" based on radiological scanning of the surface and known locations of PSM (debris). The three locations were hand augured and soil lifts were field screened with an NE Electra until FSRs were below FSLs. The FSRs exceeded FSLs to a depth of 6 to 8 in. bgs at all three locations. Location "a" had the highest beta/gamma readings near 92,000 disintegrations per minute per 100 square centimeters (dpm/100cm^2) beta/gamma. A biased sample location (E02) was established at location "a" based on the elevated soil FSRs. The field-screening activity did not include the previously identified oxidized DU (PSM) in the northwest corner of the URMA, which had FSRs at approximately 8,000 dpm/100cm^2 alpha and 2,800,000 dpm/100cm^2 beta/gamma measured on the NE Electra.

A.6.1.5 Sample Collection

Environmental samples were collected at 307 GZ to investigate surface releases associated with site activities and subsurface releases associated with potential buried waste within the boundary of the posted URMA. A total of five samples (three environmental samples, one PSM, and one FD) from three locations were collected during investigation activities at 307 GZ. All soil samples were analyzed for gamma spectroscopy, Sr-90, and isotopic U and Pu, while selected locations were analyzed for RCRA metals, beryllium, hexavalent chromium, VOCs, SVOCs, and/or PCBs. The sample IDs, locations, and types are listed in Table A.6-1.

Table A.6-1
Samples Collected at CAS 05-45-05, 307 GZ Rad Contaminated Area

Sample Location	Sample Number	Depth (in. bgs)	Matrix	Purpose	Gamma Spectroscopy	Hexavalent Chromium	Metals	Beryllium	PCBs	Plutonium	Sr-90	SVOCs	TCLP Metals	Uranium	VOCs
E01	106E001	0–2	Soil	Environmental	X	X	X	X	X	X	X	X	--	X	X
E02	106E002	0–6	Soil	Environmental	X	X	X	X	X	X	X	X	--	X	X
	106E003	0–6	Soil	FD of #106E002	X	X	X	X	X	X	X	X	--	X	X
E03	106E004[a]	0–6	Soil	PSM	X	--	--	--	--	X	X	--	--	X	--
	106E005	0–6	Soil	Environmental	X	--	--	--	--	X	X	--	--	X	--
	106E501	0–6	Soil	Waste Management	--	--	--	--	--	--	--	--	X	--	--
N/A	106E301	N/A	Water	Trip Blank	--	--	--	--	--	--	--	--	--	--	X
N/A	106E302	N/A	Water	Trip Blank	--	--	--	--	--	--	--	--	--	--	X
N/A	106E303	N/A	Water	Field Blank	X	X	X	X	X	X	X	X	--	X	X

[a]The soil associated with this sample has since been removed under a clean closure corrective action.

TCLP = Toxicity Characteristic Leaching Procedure

-- = Not required
X = Analyzed

Verification surface samples 106E002 and 106E003 (FD) were collected at location E02 within the posted URMA following a general PSM removal activity. This location was based on surface radiological readings at field-screening location "a" (not including the highly oxidized DU). Biased sample location E01 was established outside the posted URMA based on GWS results and the presence of PSM designated as 307GZ-02, which was removed for disposal. Verification sample 106E001 was collected from the soil directly in contact with the removed PSM.

Sample 106E004 was collected directly from the oxidized DU (PSM) identified during visual inspections at location E03. Following the hand excavation and removal of the oxidized DU, verification sample 106E005 was collected at location E03 from soil underlying this PSM.

Final sample locations (Table A.6-1) are shown on Figure A.6-2.

One waste characterization sample (106E501) was collected directly from the oxidized DU, and results are discussed in Section A.7.0.

A.6.1.6 Deviations

No deviations to the CAIP (NNSA/NSO, 2011) were noted.

A.6.2 Investigation Results

The following sections present the analytical results exceeding the MDCs for soil samples collected at this CAS. All sampling and analyses were conducted as specified in the CAIP. The analytical parameters and laboratory methods used during this investigation are discussed in Section A.2.0 and listed in Table A.2-1.

A.6.2.1 SVOCs and PCBs

No SVOCs or PCBs were detected above MDCs.

A.6.2.2 VOCs

Analytical results for VOCs that were detected above MDCs are presented in Table A.6-2. No VOC results exceeded their respective PALs; therefore, the FALs were established at the corresponding PAL concentrations.

Table A.6-2
Sample Results for VOCs Detected above MDCs
at CAS 05-45-05, 307 GZ Rad Contaminated Area

Sample Location	Sample Number	Depth (in. bgs)	COPC (mg/kg)	
			1,2,4-Trimethylbenzene	Total Xylenes
FALs			260	2,700
E02	106E002	0–6	0.0052 (J)	0.0059

J = Estimated value

A.6.2.3 Metals

Analytical results for RCRA metals, total beryllium, and hexavalent chromium that were detected above MDCs are presented in Table A.6-3. No metal results exceeded their respective PALs; therefore, the FALs were established at the corresponding PAL concentrations.

A.6.2.4 Radiological Results

Table A.6-4 presents the individual radionuclide concentrations detected above MDCs from gamma spectroscopy and isotopic analysis, their respective RRMGs, and an estimated TED (sum of fractions) for each sample. The individual radionuclide concentrations are comparable to their respective RRMGs, which are used to facilitate the determination of a radiation dose estimate for each soil sample. The radiation dose estimate that an individual radionuclide contributes toward the total dose for each soil sample is presented as the fraction value in Table A.6-4. This fraction value is obtained by dividing the radionuclide concentration for that sample by the respective RRMG. The fraction values of all the detected radionuclides in each sample are then summed and multiplied by 25 to obtain the estimated TED for that sample. The TED is then compared to the dose-based FAL of 25 mrem/IA-yr as established in Appendix C.

Table A.6-3
Sample Results for Metals Detected above MDCs at CAS 05-45-05, 307 GZ Rad Contaminated Area

Sample Location	Sample Number	Depth (in. bgs)	COPC (mg/kg)								
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Hexavalent Chromium	Lead	Mercury	Selenium
FALs			**23**	**190,000**	**2,000**	**800**	**39.2[a]**	**5.6**	**800**	**43**	**5,100**
E01	106E001	0–2	4.5	240	1	--	7.3	0.22 (J-)	110	0.015 (J-)	--
E02	106E002	0–6	4.2	260	1	0.56	6.4	0.23 (J-)	26	0.018 (J-)	--
	106E003	0–6	4	220	0.9	--	6.1	--	22	0.013 (J-)	0.29 (J+)

[a] FAL based on hexavalent chromium PAL with a 6:1 ratio

J+ = Result is an estimated quantity, but may be biased high.
J- = Result is an estimated quantity, but may be biased low.
-- = Not detected above MDCs

Table A.6-4
Radiological Sample Results above MDCs at CAS 05-45-05, 307 GZ Rad Contaminated Area

Sample Location	Sample Number	Depth (in. bgs)	COPC (pCi/g)								TED
			Th-232[a,b] (Ac-228)	Cs-137[b]	Eu-155[b]	Pu-239/240[c]	Sr-90[c]	U-234[c]	U-235	U-238[c]	
RRMGs			**506.7**	**72.9**	**958.3**	**2,207**	**7,714**	**18,650**	**255.5**	**1,423**	**FAL (25 mrem/IA-yr)**
E01	106E001	0–2	1.77	0.31	--	0.12	--	0.98 (J)	0.06 (J)[c]	1.67 (J)	N/A
		Fraction	0.003	0.004	--	0.000	--	0.000	0.000	0.001	0.23
E02	106E002	0–6	1.66	0.28	--	0.1	--	23.96 (J)	5.74[b]	86.13 (J)	N/A
		Fraction	0.003	0.004	--	0.000	--	0.001	0.022	0.061	2.29
	106E003	0–6	1.7	0.37	--	1.49	--	40.28 (J)	6.2[b]	143.83 (J)	N/A
		Fraction	0.003	0.005	--	0.001	--	0.002	0.024	0.101	3.42
E03	106E004[d]	0–6	--	--	8.34(J+)	--	31.66 (J+)	5,408.44	**430.5[c]**	**18,899.47**	N/A
		Fraction	--	--	0.009	--	0.004	0.290	1.685	13.281	**381.73**
	106E005	0–6	1.49	0.25	--	0.09	--	21.61	3.65[b]	76.22	N/A
		Fraction	0.003	0.003	--	0.000	--	0.001	0.014	0.054	1.89

[a]Result is Th-232 as analyzed via its daughter (Ac-228) in secular equilibrium
[b]Gamma-emitting radionuclide
[c]Isotopic radionuclide
[d]The soil associated with this sample has since been removed under a clean closure corrective action.

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

Bold indicates the values exceeding the RRMGs and/or FAL.

Two of the individual radionuclide concentrations exceeded their respective RRMGs (U-235 and U-238) in sample 106E004 and are considered COCs. The estimated TED for sample 106E004 (381.73 mrem/yr) also exceeded the FAL. This sample was taken directly from PSM (oxidized DU). The PSM was removed for disposal, and verification sample 106E005 was collected. The results from sample 106E005 confirm that the COCs were removed to concentrations less than the RRMG and that the estimated TED was below the FAL.

A.6.2.5 Potential Source Material

Visual observations, radiological surveys, and screening results show the presence of DU, DU embedded on debris, or oxidized DU within the CAS boundary. Oxidized DU and debris with elevated radiological screening results identified at the CAS were conservatively assumed to be PSM. One sample was collected directly from material (106E004 at location E03) considered to be PSM to confirm the assumption that contaminants are above PSM criteria (i.e., FAL of 25 mrem/IA-yr). Results are discussed in Section A.6.2.4. The PSM identified at 307 GZ was removed as part of the corrective action. Following the removal of PSM at select locations where residual radiological contamination was indicated, verification soil samples were collected (locations E01–E03). Analytical results confirmed that the PSM was adequately removed and that no COCs remain.

A.6.3 Nature and Extent of Contamination

Based on the analytical results for soil samples collected at 307 GZ following removal of PSM, there were no identified COCs. Therefore, defining the nature and extent of contamination has been satisfied.

A.6.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2011) were met at this CAS. 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 Waste Management

The following sections describe the waste management activities completed during the CAI at CAU 106 and the final disposition of the waste. All waste was managed in accordance with federal and state regulations, permit limitations, and disposal facility acceptance criteria. Waste management activities were conducted as specified in the CAIP (NNSA/NSO, 2011). A summary of the waste streams generated, the waste type (i.e., characterization), and final waste disposition is provided in Table A.7-1.

In an effort to reduce the amount of waste generated, waste minimization techniques were integrated into the field activities, and waste was segregated to the greatest extent possible. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste during field activities. Decontamination activities were planned and executed to minimize the volume of rinsate generated. As described below, waste generated at CAS 05-45-04 (306 GZ) and CAS 05-45-05 (307 GZ) consisted of the same waste stream and was therefore able to be consolidated into a single container.

A.7.1 Investigation-Derived Waste

The following waste streams were generated during the CAU 106 field investigation:

- Disposable personal protective equipment (PPE) and sampling equipment
- DU and DU-contaminated soil and debris
- Scrap metal

All waste streams were field screened as generated to comply with the radiological release limits of Table 4-2 of the *Nevada Test Site Radiological Control Manual* (NNSA/NSO, 2010b).

A.7.2 Waste Characterization

The results of soil samples collected and used for waste characterization purposes and the maximum concentrations detected above MDCs are reported and compared to regulatory criteria in Table A.7-2. The analytical suite was tailored to characterize the waste for disposal and to support recommended

Table A.7-1
Waste Summary

Waste Characterization						Waste Disposition			
Container ID	Waste Item	Hazardous	Radioactive	Hydrocarbon	PCBs	Disposal Facility	Waste Volume	Disposal Date	Disposal Document
106E02	Soil and Debris	No	Yes	No	No	Area 5 RWMC	55 gal (200 lb, gross weight)	TBD	CD[a]
N/A	Scrap Metal	No	No	No	No	Area 9, U10c	10 gal	Pending[b]	LVF

[a]Copies of waste disposal documents are located in Appendix D, Attachment D-1.
[b]Industrial waste placed in the roll-off container at Building 23-153 is disposed of at the end of the year, or as it reaches its volume capacity.

CD = Certificate of Disposal
lb = pound
LVF = Load Verification Form
RWMC = Radioactive Waste Management Complex
TBD = To be determined

corrective actions. Results were reviewed against federal regulations, state regulations, and DOE directives/policies/guidance, as well as waste disposal criteria for NNSS disposal facilities.

A.7.2.1 Industrial Waste

Industrial wastes were characterized based upon radiological surveys and process knowledge. Industrial solid waste generated at CAU 106 consisted of scrap metal, and disposable sampling equipment and PPE.

During investigation activities at 306 GZ and 307 GZ, metal debris scattered across the ground surface was surveyed with radiological instruments and segregated into either a scrap metal container or a container of radiologically contaminated debris. As a result of the segregation, two 5-gal poly containers of scrap metal were generated and placed in the roll-off container at Building 23-153 for ultimate disposal at the Area 9 U10c landfill.

The disposable sampling equipment and PPE were collected daily, field screened, bagged, labeled, and placed in the roll-off container at Building 23-153 for ultimate disposal at Area 9 U10c landfill.

A.7.2.2 Low-Level Waste

A total of 27 gal of DU-contaminated soil and debris (identified as PSM) were generated during investigation activities at 306 GZ and 307 GZ and consolidated into a single 55-gal drum (106E02). Approximately 10 gal of soil and debris waste from 306 GZ and approximately 17 gal of soil and debris waste from 307 GZ were generated. Of the 27 gal of waste, approximately 1.5 gal or 5 percent consists of small metal fragments from the ground surface that had elevated radiological readings associated with DU. These metal fragments were segregated from the non-contaminated scrap metal and containerized. Soil that was visibly contaminated with small amounts of yellow uranium oxide at 306 GZ and significant amounts of yellow uranium oxide at 307 GZ were removed and containerized.

This waste stream was characterized using radiological survey data from soil and debris and analytical results from samples 106D005, 106E002 (and field duplicate 106E003), 106E004, and 106E501. Sample 106D005 represents soil collected from a biased location at 306 GZ where a DU-contaminated debris item with the highest radiological readings was located. Samples 106E002, 106E003 (field duplicate of 106E002), and 106E004 all represent soil collected and

removed from biased locations with the highest elevated radiological readings at 307 GZ. Analytical data show that sample 106E004 represents the most contaminated soil. Sample 106E501 is a direct sample of the waste collected specifically for TCLP metals analysis to support waste disposal.

Table A.7-2 shows the maximum concentrations of detected analyses from the samples used for waste characterization compared to regulatory criteria. No hazardous constituents or PCBs were detected at concentrations that exceed regulatory criteria. Based on the analytical results (Table A.7-2), the material was characterized as low-level radioactive waste (LLW) and will be disposed of at the Area 5 Radioactive Waste Management Complex (RWMC) in accordance with NNSS waste acceptance criteria (NNSA/NSO, 2010a). The disposal documentation for CAU 106 is in Appendix D (Attachment D-1).

Table A.7-2
Maximum Detected Concentrations for Waste Characterization Samples

Sample Number	Matrix	Parameter	Result	Regulatory Criterion	Unit
106E003	Soil	Cs-137	0.37	100[a]	pCi/g
106E003	Soil	Pu-239/240	1.49	10[a]	pCi/g
106E004	Soil	Eu-155	8.34 (J+)	2,000[a]	pCi/g
106E004	Soil	Sr-90	31.66 (J+)	100[a]	pCi/g
106E004	Soil	U-234	**5,408.44**	100[a]	pCi/g
106E004	Soil	U-235	**430.5**	100[a]	pCi/g
106E004	Soil	U-238	**18,899.47**	100[a]	pCi/g
106E501	Soil	Lead	0.08	5[b]	mg/L

[a]Radionuclide limits in NNSS, U10c landfill permit
[b]RCRA TCLP limit

mg/L = Milligrams per liter

J+ = Result is an estimated quantity, but may be biased high.

Bold indicates the values for an individual constituent exceed regulatory criteria.

A.8.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 106 CAI. The following sections 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 samples, 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 Industrial Sites QAPP (NNSA/NV, 2002).

A.8.1 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 106 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 project files as a hard copy and electronic media.

All data analyzed as part of this investigation were subjected to Tier I and Tier II evaluations. A Tier III evaluation was performed on approximately 14 percent of the data analyzed.

A.8.1.1 Tier I Evaluation

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

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

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

A.8.1.2 Tier II Evaluation

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

- Correct detection limits achieved.
- Sample date, preparation date, and analysis date for each sample.
- Holding time criteria met.
- Quality control batch association for each sample.
- Cooler temperature upon receipt.
- Sample pH for aqueous samples, as required.
- Detection limits properly adjusted for dilution, as required.
- Blank contamination evaluated and applied to sample results/qualifiers.
- Matrix spike/matrix spike duplicates (MSD) percent recoveries (%R) and relative percent differences (RPDs) evaluated and qualifiers applied to laboratory results, as necessary.
- Field duplicate RPDs evaluated using professional judgment and qualifiers applied to laboratory results, as necessary.
- Laboratory duplicate RPDs evaluated and qualifiers applied to laboratory results, as necessary.
- Surrogate %R evaluated and qualifiers applied to laboratory results, as necessary.
- Laboratory control sample %R evaluated and qualifiers applied to laboratory results, as necessary.

- Initial and continuing calibration evaluated and qualifiers applied to laboratory results, as necessary.
- Internal standard evaluation.
- Mass spectrometer tuning criteria.
- Organic compound quantitation.
- Inductively coupled plasma interference check sample evaluation.
- Graphite furnace atomic absorption QC.
- Inductively coupled plasma serial dilution effects.
- Recalculation of 10 percent of laboratory results from raw data.

Tier II evaluation for 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.
- Quality control sample results (duplicates, laboratory control samples [LCSs], laboratory blanks) evaluated and used to determine laboratory result qualifiers.
- Sample results, uncertainty, and MDC evaluated.
- Detector system calibrated with National Institute of Standards and Technology (NIST)-traceable sources.
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations.
- Detector system response to daily or weekly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system.
- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements.
- Documentation of all QC sample preparation complete and properly performed.

- Spectra lines, photon emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration.

A.8.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 14 percent of the sample radiological data was performed by TLI Solutions, Inc., in Golden, Colorado. Tier II and Tier III results were compared, and where differences are noted, data were reviewed and changes were made accordingly. This review included the following additional evaluations:

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

  - second column and/or second detector confirmation,
  - mass spectra interpretation,
  - interference check samples and serial dilutions,
  - post-digestion spikes and method of standard additions,
  - breakdown evaluations.

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

A.8.2 Field QC Samples

Field QC samples consisted of three full laboratory QCs collected and submitted for analysis by the laboratory analytical methods shown in Table A.2-1. Full laboratory QC samples are used to measure accuracy and precision associated with the matrix (see Appendix B for further discussion).

During the CAI, five FDs were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in Table A.2-1. For these samples, the duplicate results (i.e., RPDs between the environmental sample results and their corresponding FD sample results) were evaluated for precision.

A.8.2.1 Laboratory QC Samples

Analysis of QC preparation blanks, LCSs, and laboratory duplicate samples was performed on each sample delivery group (SDG) in which inorganic analyses were requested. Initial and continuing

calibration and LCSs were performed for each SDG. The results of these analyses were used to qualify associated environmental sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

A.8.3 Field Nonconformances

One field deviation was identified where a trip blank was not included with a batch of samples being analyzed for VOCs at 306 GZ. Trip blanks are used to determine whether a false positive reporting error has occurred. Because no VOCs were detected in any sample taken from 306 GZ, this field deviation does not impact the validity of the data.

A.8.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to inconsistencies in the analytical instrumentation operation, sample preparations, extractions, missed holding times, and fluctuations in internal standard and calibration results. A total of seven laboratory-generated nonconformances were issued for CAU 106. Two nonconformances were resolved by reanalyzing affected samples. Two nonconformances were resolved by re-reporting corrected data. The remaining three nonconformances were not resolved. The first unresolved nonconformance was issued regarding an elevated detection limit for acetonitrile that was above the contract-required detection limit for two samples. However, the reporting limit was less than the FAL. Therefore, there is no impact on the corrective action decision. The second unresolved nonconformance was issued regarding the laboratory mistakenly compositing two individual samples for analysis. The samples were an environmental sample and its associated FD, so compositing them did not cause an effective sample dilution on one sample or the other. The consequence is that the FD was lost. However, in all, enough FDs were taken to meet the DQO criterion of 5 percent. The third nonconformance was issued for the laboratory disposing of samples without notifying Navarro-Intera, LLC (N-I). This would be detrimental only if the samples had to be reanalyzed. Because the data for these samples were acceptable, reanalysis was not required, and there is no impact on the corrective action decision.

A.9.0 Summary

Radionuclide, inorganic, and organic contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 106. Assessment of the data generated from investigation activities indicates that PSM with COCs that exceeded the FAL of 25 mrem/IA-yr for radiological releases were present at CASs 05-45-04 and 05-45-05. Therefore, corrective action was required. The following summarizes the results for each CAS.

CAS 05-20-02, Evaporation Pond

Based on field observations and analytical results for surface soil (0 to 6 in. bgs) samples collected at this CAS, the potential dose from tritium concentrations in soil at the site does not exceed the FAL of 25 mrem/IA-yr. Therefore, no corrective action is required.

CAS 05-23-05, Atmospheric Test Site - Able

Based on field observations and analytical results for surface soil (0 to 5 cm bgs) samples collected at this CAS, the surface radiological contamination at the site does not exceed the FAL of 25 mrem/IA-yr. Therefore, no corrective action is required.

CAS 05-45-04, 306 GZ Rad Contaminated Area

Based on field observations and analytical results for soil samples collected at this CAS, no chemical contaminants exceeding the FAL are present, and radiological contamination at the site does not exceed the FAL of 25 mrem/IA-yr. However, PSM identified at the site was conservatively assumed to exceed PSM criteria (i.e., FALs for isotopic U). Based on the presence of PSM and results of the CAA evaluation in Appendix E, the corrective action of clean closure was implemented. Verification samples collected from soil after the removal of PSM indicate that no COCs above FALs remain in the soil.

CAS 05-45-05, 307 GZ Rad Contaminated Area

Based on field observations and analytical results for soil samples collected at this CAS, no chemical contaminants exceeding the FAL are present, and radiological contamination at the site does not exceed the FAL of 25 mrem/IA-yr. However, PSM containing U-235 and U-238 above PSM criteria

is present at the site, so it was conservatively assumed that all other PSM identified also exceeds the PSM criteria. Based on the presence of PSM and results of the CAA evaluation in Appendix E, the corrective action of clean closure was implemented. Verification samples collected from soil after the removal of PSM indicate that no COCs above FALs remain in the soil.

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Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 106 CAIP (NNSA/NSO, 2011) 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 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. The five steps are briefly summarized as follows:

Step 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.

Step 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.

Step 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.

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

Step 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, 2011). 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, 2011) is as follows: "Is any COC present in environmental media within the CAS?" Any analytical result for a COPC above a 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, 2006).

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:

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

Criterion 1

To resolve Decision I for the other release at Cambric Ditch, a sample location was placed at the Well RNM-2s groundwater discharge point near the head of Cambric Ditch. This location is the default sample location (as stipulated in the DQOs) and represents the most likely location to contain a COC if a COC exists anywhere within this CAS.

To resolve Decision I for the primary release at Able, initial sample locations were placed at the posted ground zero, which was identified as the default sample location in the absence of biasing factors (as stipulated in the DQOs) based on the proximity to the detonation.

To resolve Decision I for the other releases at 306 GZ and 307 GZ, locations for sampling were selected based on the presence of PSM and other biasing factors such as GWS measurements, elevated field screening, and soil staining.

Criterion 2

Decision I samples were analyzed using the analytical methods listed in Tables 3-3 and 3-4 of the CAIP (NNSA/NSO, 2011) and for the chemical and radiological parameters listed in Section A.2.2.2 of the CAIP (NNSA/NSO, 2011). Verification samples were based on the contaminants detected in the Decision I samples.

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The sensitivity acceptance criterion defined in the CAIP is that analytical detection limits will be less than the corresponding FAL (NNSA/NSO, 2011). Therefore, the criteria are that all detection limits are less than their corresponding industrial area dose RRMGs for radionuclides and industrial soil FALs for chemical analytes. As all of the analytical result detection limits for radionuclides were less than their corresponding RRMGs and chemical analytes less than their corresponding FALs, the DQI for sensitivity has been met, and no data were rejected due to sensitivity.

Criterion 3

To satisfy the third criterion, the entire dataset, as well as individual sample results, was assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NSO, 2011). 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, 2011). Table B.1-1 provides the results for all constituents that were qualified for precision.

Table B.1-1
Precision Measurements

Parameter	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Eu-154	Gamma	4	18	77.78
U-234	Isotopic U	3	18	83.33
U-235	Isotopic U	1	15	93.33
U-238	Isotopic U	3	18	83.33

As shown in Table B.1-1, the precision rate for the isotope Eu-154 did not meet the criteria of 80 percent specified in the CAIP (NNSA/NSO, 2011). The precision evaluations were based on differences in laboratory duplicate sample results (i.e., RPDs) or normalized differences. High variability in the sample matrix suggests that discrete particles of contamination are present within the samples. This is more likely to occur when contaminant levels are very low as is the case with the samples failing the precision criteria. As shown in Table B.1-2, the potential for a false negative DQO decision error is negligible because the highest reported result for the contaminant that was qualified for precision is still small in comparison to the RRMG. Therefore, the results that were qualified for precision can be confidently used to support the DQO decision. As the precision rates for all other constituents meet the acceptance criteria for precision, the database is determined to be acceptable for the DQI of precision.

Table B.1-2
Maximum Contaminant Result Qualified for Precision

Parameter	Analyses	Maximum Result	RRMG (pCi/g)
Eu-154	Gamma	1.02	35.71

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NSO, 2011). As shown in Table B.1-3, the CAIP criterion of 80 percent accuracy was not met for cadmium. The samples qualified for cadmium accuracy were estimated based on the matrix spike, MSD, and serial dilution associated with these samples that failed laboratory criteria. This indicates the potential that the actual contaminant concentrations are greater or less than the reported result.

Table B.1-3
Accuracy Measurements[a]

Parameter	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Acenaphthene	SVOCs	1	10	90
Cadmium	Metals	6	10	40

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

The potential for a false negative DQO decision error is negligible because the highest reported cadmium result that was qualified for accuracy (1.8 mg/kg) is only 0.22 percent of the FAL (800 mg/kg). Therefore, the cadmium results that were qualified for accuracy can be confidently used to support the DQO decision. As the accuracy rates for all other constituents meet the acceptance criteria for accuracy, the database is determined to be acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NSO, 2011) was used to address sampling and analytical requirements for CAU 106. 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 1 discussion meet this criterion. Therefore, the analytical data acquired during the CAU 106 CAI are considered representative of the population parameters.

Comparability

Field sampling, as described in the CAIP (NNSA/NSO, 2011), 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 not only other methods used in industry and government practices, but most importantly other investigations conducted for the NNSS. Therefore, project 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, 2011) 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 in Table 6-1 of the CAIP as 80 percent of CAS-specific analytes identified in the CAIP having valid results.

Rejected data (i.e., data that either were qualified as rejected or failed the criterion of sensitivity) were not used in the resolution of DQO decisions and are not counted toward meeting the completeness acceptance criterion. Table B.1-4 provides the rejected data for the CAU 106 CASs. 1,4-dioxane fell below the completeness criteria of 80 percent. This constituent has not been detected at the NNSS; as a result, there is no reason to suspect the presence of 1,4-dioxane at any of the CAU 106 CASs. Therefore, the absence of usable results for 1,4-dioxane does not preclude the resolution of the DQO decisions. The dataset for CAU 106 has met the general 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. Quality assurance/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.

Table B.1-4
Rejected Measurements[a]

Analyte	Chemical Abstracts Service Number	Analysis	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Acetonitrile	75-05-8	VOCs	2	10	80
1,4-Dioxane	123-91-1	VOCs	9	10	10

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

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, 2011) is as follows: "If a COC is present, is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include the following:

- Lateral and vertical extent of COC contamination
- Information needed to determine potential remediation waste types
- Information needed to evaluate the potential for COC migration

As neither COCs nor TED was detected above FALs at Able and Cambric Ditch, Decision II sampling was not necessary at these CASs.

Decision II samples were collected from waste materials identified during the visual surveys that were determined to have a potential for containing PSM and verification samples following removal of PSM at the 306 GZ and 307 GZ CASs. Verification samples show that the extent of COCs associated with the PSM was defined. The PSM sample results were evaluated using the PSM criteria listed in Section 3.4 of the CAIP. This provided sufficient information to determine the PSM status of the wastes and to characterize the wastes for disposal.

B.1.1.3 Sampling Design

The CAIP (NNSA/NSO, 2011) stipulated that the following sampling processes would be implemented:

1. 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 Well RNM-2s groundwater discharge point at Cambric Ditch. Judgmental sampling was conducted at the 306 GZ and 307 GZ sites where elevated radiological readings were detected and where PSM was identified and removed.

2. Sampling of the primary release at Able will be conducted by judgmental sampling approaches.

   Result: The locations of the samples were selected judgmentally, and samples were collected at each location as described in Section A.2.0.

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. 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/IA-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 Industrial Area exposure scenario.

The key assumptions that could impact a DQO decision are listed in Table B.1-5.

Table B.1-5
Key Assumptions

Exposure Scenario	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to contaminants of potential concern through oral ingestion or inhalation of soil and/or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials.
Affected Media	Surface and shallow subsurface soil, and abandoned DU and DU-contaminated wastes (e.g., metal debris).
Location of Contamination/Release Points	Surface soils at all four CASs (include soil in contact with waste items) and shallow subsurface soils within the boundaries of URMAs.
Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside the boundaries of the CASs. Percolation of precipitation through subsurface media serves as a minor driving force for vertical migration of contaminants.
Preferential Pathways	None.
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 of each CAS.
Groundwater Impacts	None.
Future Land Use	Industrial.
Other DQO Assumptions	Field screening showed that potentially buried contamination at Able due to accumulation of lake sediments over time was not present. The sensitivity analysis of the analytical data shows the analytical methods selected were appropriate for detecting potential contaminants.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 106 DQOs and Table B.1-5, and all data collected during the CAI supported CSMs.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NSO, 2011) made the following commitments:

1. For Cambric Ditch, if no biasing factors could be identified along the ditch, the groundwater discharge point at Well RNM-2s would be selected as the default sample location (Section 4.2.2 of the CAIP).

Result: No biasing factors were observed during a visual inspection and radiological scan of the ditch from the discharge point to 30 ft downstream; therefore, the sample was collected at the default sample location.

2. For Able, if no biasing factors could be identified through visual observations and GWS, the the posted ground zero would be selected as the default sample location (Section 4.2.2 of the CAIP).

   Result: As no biasing factors were observed, a sample was collected at the default sample location. Additional samples were collected at approximately 30 m from the posted ground zero to confirm the presence of low concentrations of Pu-239/240 in the lake bed sediments.

3. If buried contamination exists at the primary release at Able, it will be conservatively assumed that the highest level of contamination observed (from surface or subsurface samples) provides dose to site workers. Therefore, it must be determined whether buried contamination exists at Able, and if so, the sample depth interval with the highest screening value will be submitted for laboratory analysis; otherwise only surface samples will be submitted.

   Result: At each sample location, 5-cm increments of soil were collected and field screened for radioactivity to a depth of 15 cm. The FSRs were compared to FSLs. Since all FSRs were below FSLs, it was assumed buried contamination does not exist at Able, and only surface samples were submitted for laboratory analysis.

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 106 CASs.

B.1.5.1 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: Verification samples collected after removing PSM show that the extent of COCs at 306 GZ and 307 GZ has been defined. No COCs were identified in soil samples collected at Able and Cambric Ditch. Therefore, no Decision II samples are required at these CASs.

Decision Rule: If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.5.2 of the CAIP (NNSA/NSO, 2011), then work will be suspended

and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

Result: The COC contamination was found to neither be inconsistent with the CSM nor extend beyond the spatial boundaries; therefore, work was not suspended.

Decision Rule: If a COC exists at any CAS, then a corrective action will be determined, else no further action will be necessary.

Result: Because COCs associated with PSM (i.e., DU) were identified for 306 GZ and 307 GZ, corrective actions are required. No COCs were identified at Able and Cambric Ditch; therefore, no corrective action is required at these two CASs.

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 identified, else no further action will be necessary.

Result: Waste items (DU, DU-contaminated debris, and oxidized DU) were identified at both the 306 GZ and 307 GZ CASs and were assumed to be PSM. These wastes require corrective action.

B.1.5.2 Decision Rules for Decision II

Decision Rule: If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.5.2 of the CAIP (NNSA/NSO, 2011), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

Result: The COC contamination was found to neither be inconsistent with the CSM nor extend beyond the spatial boundaries; therefore, there was no need to suspend work.

Decision Rule: If the population parameter (the observed concentration of any COC) in the Decision II population of interest exceeds the corresponding FAL in any bounding direction, 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: Contaminants of concern in the form of PSM were present at 306 GZ and 307 GZ. Therefore, verification samples were collected to define the extent of COCs.

Decision Rule: If valid analytical results are available for the waste characterization samples defined in Section A.8.0, then the decision will be that sufficient information exists to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, else additional waste characterization samples will be collected.

Result: To make final determinations of the remediation waste types for the PSM removed from the 306 GZ and 307 GZ sites, one additional waste characterization sample was required (106E501).

B.2.0 References

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Appendix C

Risk Assessment

C.1.0 Risk Assessment

The risk-based corrective action (RBCA) process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with Section 445A.227 of the NAC, which lists the requirements for sites with soil contamination (NAC, 2008a). Section 445A.22705 of the NAC (NAC, 2008b) 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 remediation standards.

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 RBSLs based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 106 CAIP [NNSA/NSO, 2011]). 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 Site-Specific Target Levels (SSTLs) using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs 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. Total concentrations of total petroleum hydrocarbons will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

- Tier 3 evaluation—Conducted by calculating Tier 3 SSTLs 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 *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) is summarized in Figure C.1-1.

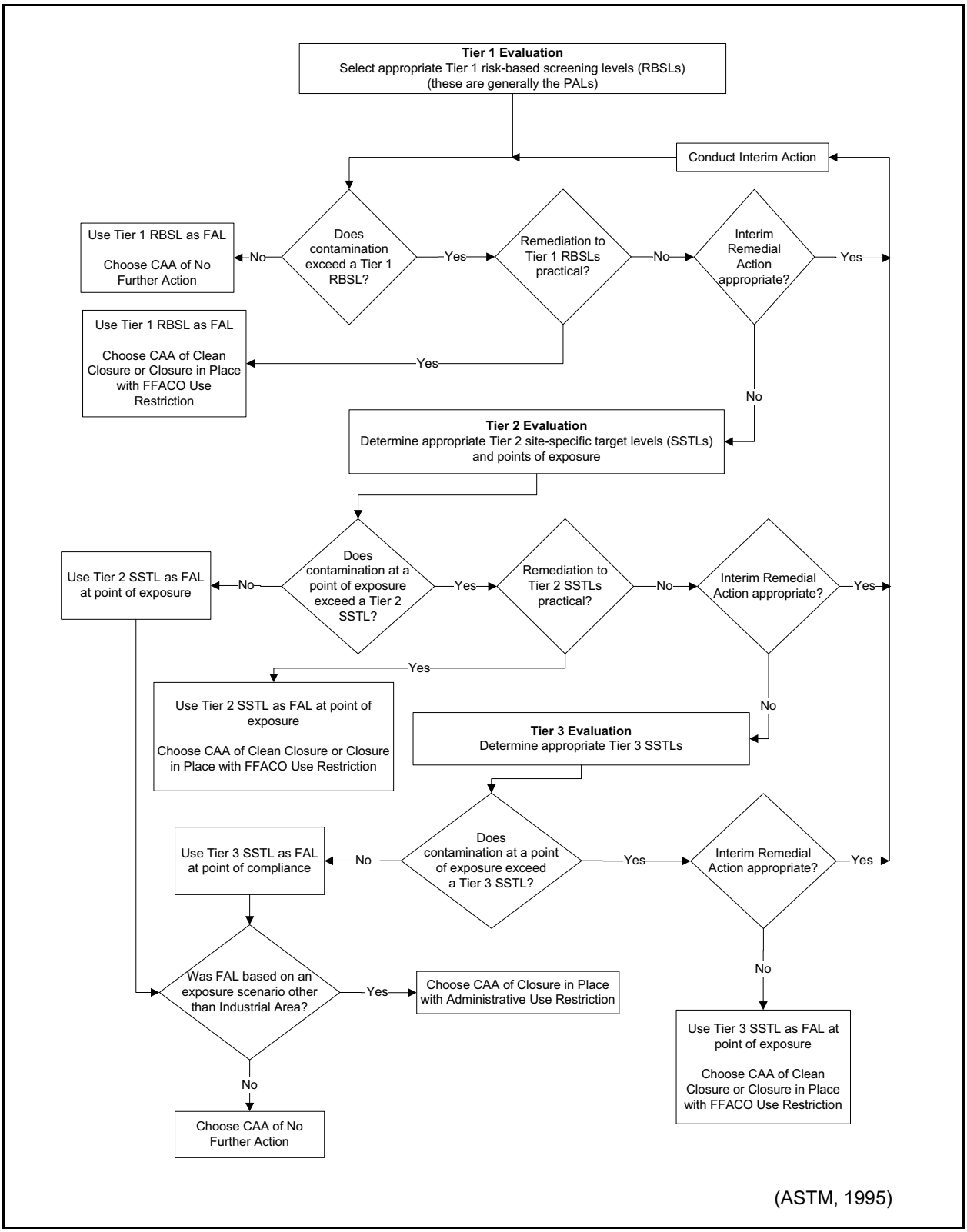

Figure C.1-1
Risk-Based Corrective Action Decision Process

C.1.1 A. Scenario

Corrective Action Unit 106, Areas 5, 11 Frenchman Flat Atmospheric Sites, comprises the following four CASs within Area 5 of the NNSS:

- 05-20-02, Evaporation Pond
- 05-23-05, Atmospheric Test Site - Able
- 05-45-04, 306 GZ Rad Contaminated Area
- 05-45-05, 307 GZ Rad Contaminated Area

Corrective Action Site 05-20-02 (referred to as Cambric Ditch in this document) consists of a release of tritium-contaminated groundwater from Well RNM-2s to the surface of Cambric Ditch that extends approximately 1 mi in a southwest direction to an evaporation pond located on the northwest shore of Frenchman Lake. The surface release was a result of a 16-year study between 1975 and 1991 involving groundwater pumping and discharge to better understand the migration of radionuclides in groundwater from the Cambric test cavity.

Corrective Action Site 05-23-05 (referred to as Able in this document) is centrally located on Frenchman Lake in Area 5, approximately 400 ft southwest of the historic Underground Parking Garage associated with the Priscilla test. The Able test was conducted on April 1, 1952, as part of Operation Tumbler-Snapper. Able consists of the atmospheric deposition of radionuclides to the surface soil from the detonation of a weapons-effect test with a 1-kt yield at 800 ft above the ground surface.

Corrective Action Site 05-45-04 (referred to as 306 GZ in this document) is located on the gentle slopes of Frenchman Flat in Area 5, approximately 1.25 mi north of Frenchman Lake and 1,200 ft north of 5-07 Road near the Kay Blockhouse (CAU 204). The 306 GZ site contains a posted URMA and CA, and consists of a release of surface and near-surface contamination from abandoned wastes, particularly DU contaminants released to the soil.

Corrective Action Site 05-45-05 (referred to as 307 GZ in this document) is located just off the northwest shore of Frenchman Lake in Area 5. The 307 GZ site contains an area posted as an URMA and consists of a release of surface and near-surface contamination from abandoned wastes, particularly DU contaminants released to the soil.

C.1.2 B. Site Assessment

The CAI at Cambric Ditch involved visual inspections and radiological screening within the ditch for biasing factors. As no biasing factors were identified, biased soil samples were collected at the default sample location at the groundwater discharge point near Well RNM-2s. The CAI results indicate that no COC concentrations in soil samples were detected above the PALs.

The CAI at Able involved visual inspections, GWSs, and field screening to determine biased sample locations. No biasing factors were identified, so soil samples were collected from the default sample location near the ground zero marker. The CAI results indicate that no COC concentrations in soil samples were detected above the PALs.

The CAI at 306 GZ involved visual inspections of the posted radiological areas and surrounding area for biasing factors, EM61 geophysical surveys to investigate the potential for buried materials within the posted URMA, "mag and flag" surveys to identify metallic debris on the ground surface, GWSs and field screening to identify biasing factors, and soil sample collection. Based on CAI results, DU, DU-contaminated debris, and oxidized DU were identified at this CAS and conservatively assumed to be PSM. The estimated TEDs for verification samples 106D001–106D005 and 106D008 collected following the removal of PSM are below the FAL of 25 mrem/IA-yr and confirm that no COCs remain in the soil.

The CAI at 307 GZ involved visual inspections of the posted radiological areas and surrounding area for biasing factors, EM61 geophysical surveys to investigate the potential for buried materials within the posted URMA, "mag and flag" surveys to identify metallic debris on the ground surface, GWSs and field screening to identify biasing factors, and soil sample collection. Based on CAI results, DU, DU-contaminated debris, and oxidized DU were identified at this CAS and conservatively assumed to be PSM. Sample 106E004, collected directly from oxidized DU in soil, confirmed this assumption, because U-235 and U-238 were identified as COCs and the total dose exceeds the FAL (25 mrem/IA-yr). The estimated TEDs for verification samples 106E001–106D003 and 106E005 collected following the removal of PSM are below the FAL of 25 mrem/IA-yr and confirm that no COCs remain in the soil.

Table C.1-1 presents the maximum concentrations of chemical contaminants and their corresponding PALs, maximum individual radionuclide concentrations and their corresponding RRMGs, and the maximum TED for each CAS and the PAL of 25 mrem/IA-yr. The RRMGs are based on the Industrial Area exposure scenario with both the internal and external pathways activated (see Attachment C-1).

Table C.1-1
Maximum Reported Values for Tier 1 Comparison
(Page 1 of 2)

Chemical Parameter	PALs	Unit	Maximum Reported Value		
			CAS		
			05-23-05	05-45-04	05-45-05
1,2,4-Trimethylbenzene	260	mg/kg	--	--	0.0052 (J)
Arsenic	23	mg/kg	--	4	4.5
Barium	190,000	mg/kg	--	130	260
Beryllium	2,000	mg/kg	--	0.77	1
Cadmium	800	mg/kg	--	1.8 (J)	0.56
Chromium	39.2[a]	mg/kg	--	7.6	7.3
Hexavalent Chromium	5.6	mg/kg	--	0.48 (J)	0.23 (J-)
Lead	800	mg/kg	--	11	110
Mercury	34	mg/kg	--	0.021 (J-)	0.018 (J-)
Selenium	5,100	mg/kg	--	0.31	0.29 (J+)
Total Xylenes	2,700	mg/kg	--	--	0.0059
Radiological Parameter	**RRMGs**	**Unit**	**Maximum Reported Value**		
			CAS		
			05-23-05	05-45-04	05-45-05
Th-232[b] (Ac-228)	506.7	pCi/g	1.54	15.86	1.77
Am-241	1,503	pCi/g	17.71 (J)	--	--
Cs-137	72.9	pCi/g	0.4	0.25	0.37
Eu-152	38.2	pCi/g	1.99 (J)	--	--
Eu-154	35.7	pCi/g	1.02 (J)	--	--
Eu-155	958.3	pCi/g	--	0.93	8.34 (J+)
Pu-238	2,416	pCi/g	2.24	--	--
Pu-239/240	2,207	pCi/g	178.86	1.88	1.49
Sr-90	7,714	pCi/g	--	0.34	31.66 (J+)
U-234	18,650	pCi/g	1.1	19.48	5,408.44
U-235	255.5	pCi/g	0.06	3.38	**430.5**
U-238	1,423	pCi/g	1.1	227.18	**18,899.47**

Table C.1-1
Maximum Reported Values for Tier 1 Comparison
(Page 2 of 2)

Radiological Dose	PAL	Unit	Maximum Reported TED		
			CAS		
			05-23-05	05-45-04	05-45-05
	25	mrem/IA-yr	5.93	4.44	**381.73**

[a]FAL based on hexavalent chromium PAL with a 6:1 ratio
[b]Result is Th-232 as analyzed via its daughter (Ac-228) in secular equilibrium.

J = Estimated value
J+ = Result is an estimated quantity, but may be biased high.
J- = Result is an estimated quantity, but may be biased low.
-- = Not detected above PALs

Bold indicates the values exceeding the FALs.

C.1.3 C. 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, none of the CASs present an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at these sites. Based on this information, Cambric Ditch and Able are determined to be Classification 4 sites as defined by ASTM Method E1739 (ASTM, 1995) and pose no demonstrated near- or long-term threats. However, corrective actions are required at both the 306 GZ and 307 GZ sites due to the presence of PSM exceeding or assumed to exceed the FAL of 25 mrem/IA-yr. At both CASs, PSM is present that could pose a short-term threat to human health, safety, or the environment. Thus, both CASs have been determined to be Classification 2 sites as defined by ASTM Method E1739.

C.1.4 D. Development of Tier 1 Lookup Table of RBSLs

Tier 1 RBSLs are defined as the PALs listed in the CAIP (NNSA/NSO, 2011) 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, they may be defined as the Tier 1 RBSL (i.e., PAL) value if implementing a corrective action based on the Tier 1 RBSL would be appropriate.

The PALs are based on an Industrial Area scenario which assumes that a full-time industrial worker is present at a particular location for his or her entire career (10 hr/day, 225 day/yr for a duration of 25 years). The 25-mrem/yr dose-based Tier 1 RBSL 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 2,250 hours.

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

- *Pacific Southwest, Region 9: Regional Screening Levels (Formerly PRGs), Screening Levels for Chemical Contaminants* (EPA, 2011).
- 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 RSLs from another EPA region may be chosen.

The PALs were developed based on the Industrial Area exposure scenario. Because the areas of the CAU 106 CASs do not have assigned work stations and are considered to be in Occasional Use Areas, the use of PALs based on the Industrial Area exposure scenario is conservative.

C.1.5 E. Exposure Pathway Evaluation

For each CAS, the DQOs stated that site workers would be exposed to COCs only through oral ingestion or inhalation of, or dermal contact with or absorption of, contaminated 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 CAU 106 CASs. The limited migration demonstrated by the analytical results, elapsed time since the suspected release, and depth to groundwater support the selection and evaluation of only surface and shallow subsurface contacts as the complete exposure pathways. Ingestion of groundwater is not considered to be a significant exposure pathway.

C.1.6 F. Comparison of Site Conditions with Tier 1 RBSLs

All analytical results from CAU 106 samples were less than corresponding Tier 1 RBSLs (i.e., PALs) except for those listed in Table C.1-2.

Table C.1-2
Contaminants of Potential Concern Detected above Tier 1 RBSLs

CAS	COPCs		TED
	U-235	U-238	
307 GZ	X	X	X

X = Detected above Tier 1 RBSLs

The contaminants and TED listed in Table C.1-2 are associated with highly oxidized DU. In addition, several pieces of DU or DU-contaminated debris as well as additional oxidized DU locations were identified in areas at 306 GZ and 307 GZ that were not sampled. These waste items are assumed to contain sufficient quantities of radiological contaminants (i.e., uranium and uranium-daughter products) to cause the underlying soil to exceed the Tier 1 RBSLs when they are eventually released to the soil.

C.1.7 G. Evaluation of Tier 1 Results

At the 306 GZ and 307 GZ CASs, waste materials are present that are assumed to exceed Tier 1 RBSLs. The risk to receptors from these contaminants 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. The maximum potential exposure time for the most exposed worker at any CAU 106 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 sites included in CAU 106 identified the general types of work activities that are currently conducted in Area 5 to include short-term testing and experimentation, short-duration

exercises and training such as nuclear emergency response, and maintenance of infrastructure and testing facilities in Area 5.

In order to estimate the amount of time a site worker might spend conducting current or future activities, the NNSA/NSO and/or management and operating (M&O) contractor departments responsible for these activities were consulted. Under the current land use at each of the CAU 106 CASs, the workers identified as being potentially exposed to site contamination are military and/or emergency response trainees conducting training near the CASs and who may inadvertently enter into the CAS areas. Although these trainees may work in Area 5 up to 20 weeks per year (800 hr/yr assuming a 40-hour work week), none of the general training areas are located at any CAS location, so any potential exposure would be far less than the 800 hr/yr. For the purposes of estimating exposure of these workers, it is assumed that a trainee would not be exposed to site contamination more than 80 hr/yr by inadvertently entering a CAS location. However, it was determined that corrective actions based on the PALs (using the Industrial Area exposure scenario that assumes a receptor is exposed to the location of maximum contamination for 2,250 hr/yr) would be feasible and appropriate, because the CAU 106 CASs are in proximity to the NPTEC and could be included in future NPTEC activities.

Therefore, it was determined that a corrective action of clean closure based on the Tier 1 RBSLs at 306 GZ and 307 GZ would be feasible and appropriate. Also, contamination exceeding Tier 1 RBSLs was found at neither Able nor Cambric Ditch. Therefore, the FALs were established at the Tier 1 RBSLs, the waste materials at 306 GZ and 307 GZ were determined to be PSM, and corrective actions are required at these two CASs.

C.1.8 H. Tier 1 Remedial Action Evaluation

A corrective action of clean closure was implemented at 306 GZ and 307 GZ to remediate the PSM. Verification soil samples were collected to confirm that all PSM was remediated to Tier 1 RBSLs.

C.1.9 I. Tier 2 and Tier 3 Evaluation

As all contaminant FALs were established as the Tier 1 RBSLs, a Tier 2 or Tier 3 evaluation was not considered necessary.

C.2.0 Recommendations

As shown in Table C.1-2, no COCs were identified from the analysis of samples, and no PSM was identified during CAI activities at Cambric Ditch and Able (CASs 05-20-02 and 05-23-05). The corrective action of no further action was selected for these CASs. The PSM identified at the remaining two CASs (306 GZ and 307 GZ) requires corrective actions that were implemented during the CAI.

306 GZ (CAS 05-45-04)

Although no COCs were identified at this CAS, the CAI identified that DU, DU-contaminated debris, and oxidized DU (or uranium oxide) are present at 306 GZ. These waste items were conservatively assumed to exceed PSM criteria for uranium isotopes and warrant corrective action. A corrective action of clean closure was implemented during the CAI. The corrective action will be protective of human health, safety, and the environment, based on the removal of PSM and the absence of COCs in verification samples.

307 GZ (CAS 05-45-05)

As U-235 and U-238 were identified in sample 106E004 above PSM criteria, they are considered PSM. The CAI identified that additional DU, DU-contaminated debris, and oxidized DU are present at 307 GZ. All these waste items were conservatively assumed to exceed PSM criteria for uranium isotopes and warrant corrective action. A corrective action of clean closure was implemented during the CAI. The corrective action will be protective of human health, safety, and the environment, based on the removal of PSM and the absence of COCs in verification samples.

The corrective actions for CAU 106 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

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Attachment C-1

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 106 Areas 5, 11 Frenchman Flat Atmospheric Sites Nevada National Security Site, Nevada

(10 Pages)

Introduction

This appendix promulgates tables of Residual Radioactive Material Guidelines (RRMGs) for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios, for use in the evaluation of Soils Project sites. These exposure scenarios are described in the document *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). Two sets of RRMGs were calculated for each of the three exposure scenarios: one set using only the inhalation and ingestion pathways (e.g., internal dose), and one set that added the external gamma pathway (e.g., internal and external dose). The second set is needed to evaluate "other release" soil samples where thermoluminescent dosimeters (TLDs) were not emplaced to measure the external dose.

Background

The *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006), provides a Nevada Division of Environmental Protection (NDEP)-approved process for the derivation of soil sampling final action levels that are congruent with the risk-based corrective action process. This document is used by the Navarro-Intera, LLC, Soils Project as well.

The Residual Radioactive (RESRAD) computer code, version 6.5 (Yu et al., 2001), and the guidance provided in NNSA/NSO (2006) were used to derive RRMGs for use in the Soils Project. The RRMGs are radionuclide-specific values for radioactivity in surface soils, expressed in units of picocuries per gram (pCi/g). A soil sample with a radionuclide concentration that is equal to the RRMG value for that radionuclide would present a potential dose of 25 millirem per year (mrem/yr) to a receptor under the conditions described in the exposure scenario. When more than one radionuclide is present, the potential dose must be evaluated by summing the fractions for each radionuclide (i.e., the measured concentration divided by the RRMG for the radionuclide). The resultant sum of the fractions value is then multiplied by 25.0 to obtain an estimate of the dose.

The RRMGs are specific to a particular exposure scenario. The dose estimates obtained from the use of RRMGs are valid only when the assumptions provided in the exposure scenario for the intended land-use hold true. In most cases at the Nevada National Security Site (NNSS), the Industrial Area exposure scenario is quite conservative and is bounding for most anticipated future land uses.

A recent revision to 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2011) had adopted new, more sophisticated, dosimetric models and new dosimetric terms. Internal dose is now to be expressed in terms of the Committed Effective Dose (CED), and International Commission on Radiological Protection (ICRP) 72 dose conversion factors are to be used.

Methods

Calculations were performed using the RESRAD code, version 6.5 (Yu et al., 2001). The ICRP 72 dose conversion factors were used. The RESRAD input parameters were verified and checkprinted.

The radionuclide niobium (Nb)-94 was previously added to the RRMGs to accommodate work in Area 25 that is related to the Nuclear Rocket Development Station (NRDS). The radionuclides silver (Ag)-108m, curium (Cm)-243, and Cm-244 were recently detected on one or more Soils Project sites, and RRMGs were calculated to demonstrate that their contribution to the total effective dose (TED) is negligible.

The RESRAD calculations have identified that for all radionuclides evaluated, with one exception: The maximum potential dose occurs at time-zero. The RRMGs provided in this memorandum do reflect those for time-zero. The exception previously mentioned is the radionuclide thorium (Th)-232, which has several daughters with short half-lives. Because the daughter activity "grows in," and because RRMGs include the contributions from daughters, the maximum potential dose for Th-232 actually occurs at 10.21 years. A RRMG for Th-232 at 10.21 years was not selected, and the RRMG for time-zero was used, for the following reasons:

- RESRAD suggests a set of RRMGs for use when the overall total dose is at its maximum. Considering the contributions from all radionuclide contaminants of potential concern (COPCs), this would be at time-zero.
- The additional dose from the in-growth of Th-232 daughters is offset by the radioactive decay of other radionuclides that would be present (e.g., cesium [Cs]-137).
- The additional dose from the in-growth of Th-232 daughters is very small when compared to the basic dose limit of 25 mrem/yr. For example, if Th-232 were found at a concentration of 100 pCi/g, the increase in potential dose from time-zero to 10.21 years would only be 0.52 millirem (mrem). To date, Th-232 has only been seen on Soils Project sites at environmental levels of about 1.5 to 3 pCi/g.

Assumptions and Default Parameters

Appendix B to DOE/NV--1107 (NNSA/NSO, 2006) lists the RESRAD code variables (i.e., input parameters) for the three exposure scenarios. These pre-determined values were used to calculate the RRMGs, with a few exceptions as described in Table 1.

Results

The RRMGs are presented in Tables 2 to 7. The abbreviation "RRMG" in each of the six tables includes a subscript to indicate the scenario and the exposure pathways that are activated. When referencing a set of RRMGs, the subscripts should be included to avoid confusion and a potential misapplication of the RRMGs.

Table 1: RESRAD Input Parameters

Item #	RESRAD Parameter	Industrial Area	Remote Work Area	Occasional Use Area	Explanation
1	Area of CZ (m^2)	1,000			Appendix B states "Site Specific." Previously, 100 m^2 was selected to conform to the maximum area of contamination limitation in DOE Order 458.1 (DOE, 2011). Going forward, 1,000 m^2 has been selected to add conservatism and realism to the RRMGs. The 1,000 m^2 RRMGs will be applied to 100-m^2 evaluation areas.
2	Thickness of CZ (m)	0.05			Appendix B states "Site Specific." This depth encompasses the bulk of the potential contamination and includes the maximum concentration.
3	Cover Depth	0.00			Appendix B states "Site Specific." Cover depth only affects the time delay before contamination becomes available for erosion and airborne suspension. Increasing the cover depth, in some cases, may lead to lower dose estimates.
4	Precipitation (m/yr)	0.144			Appendix B states "Site Specific." The selected value is the average annual rainfall as recorded at Camp Desert Rock.
5	Indoor Time Fraction	**[0.1712]**	**[0.0256]**	0	The stated value was 0, conservatively assuming no time is spent indoors. The new value more accurately reflects the Industrial Area scenario in which 66% of the time is spent indoors. $\left(\frac{2{,}250 \text{ hours on-site}}{8{,}760 \text{ hours in a year}}\right) 0.6666 \text{ indoors} = 0.1712$ The same correction was made for the Remote Work Area scenario.
6	Soil Ingestion Rate (g/yr)	**[43.43]**	20.2	4.8	The stated value was 108, assuming that all time is spent outdoors under a 480-mg/day soil ingestion rate. The new value more accurately reflects the soil ingestion rate of 193 mg/day when both indoor and outdoor time fractions are considered. Refer to page 14 of DOE/NV--1107 (NNSA/NSO, 2006).
7	Indoor Dust Filtration Factor	**[0.4]**	**[0.4]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
8	Shielding Factor External Gamma	**[0.7]**	**[0.7]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
9	Pathway 1 – External Gamma	Suppressed	Suppressed	Suppressed	In general, external dose at Soils Projects will be evaluated via TLDs or direct measurement with a dose-rate meter. Soil samples and RRMGs are used to determine the internal dose component only. The pathway was activated for the second set of RRMGs for each scenario to allow the evaluation of biased sample locations where TLDs were not emplaced.

Note 1: Items 1–4 above are site-specific default values that were selected for the Soils Project.
Note 2: Table B.1-1 in Appendix B contains several errors. The bold and bracketed values are corrections to those values.

CZ = Contamination zone
g/yr = Grams per year
m = Meter
m^2 = Square meter
m/yr = Meters per year
mg/day = Milligrams per day

Table 2: Soils Project – Industrial Area Exposure Scenario – Internal Dose Only

Radionuclide	**$RRMG_{(IA-I)}$** (pCi/g)
Ag-108m	2.737E+06
Am-241	2.816E+03
Cm-243	3.852E+03
Cm-244	4.735E+03
Co-60	5.513E+05
Cs-137	1.409E+05
Eu-152	1.177E+06
Eu-154	8.469E+05
Eu-155	5.588E+06
Nb-94	3.499E+06
Pu-238	2.423E+03
Pu-239/240	2.215E+03
Sr-90	5.947E+04
Th-232	2.274E+03
U-234	1.960E+04
U-235	2.089E+04
U-238	2.120E+04

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Industrial Area exposure scenario.

Table 3: Soils Project – Industrial Area Exposure Scenario – Internal & External Dose

Radionuclide	**$RRMG_{(IA-IE)}$** (pCi/g)
Ag-108m	9.281E+01
Am-241	1.503E+03
Cm-243	3.155E+02
Cm-244	4.713E+03
Co-60	1.833E+01
Cs-137	7.290E+01
Eu-152	3.826E+01
Eu-154	3.571E+01
Eu-155	9.583E+02
Nb-94	9.653E+01
Pu-238	2.416E+03
Pu-239/240	2.207E+03
Sr-90	7.714E+03
Th-232	5.067E+02
U-234	1.865E+04
U-235	2.555E+02
U-238	1.423E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Industrial Area exposure scenario.

Table 4: Soils Project – Remote Work Area Exposure Scenario – Internal Dose Only

Radionuclide	**$RRMG_{(RWA-I)}$** (pCi/g)
Ag-108m	3.389E+07
Am-241	1.612E+04
Cm-243	2.223E+04
Cm-244	2.716E+04
Co-60	7.229E+06
Cs-137	1.955E+06
Eu-152	1.324E+07
Eu-154	9.741E+06
Eu-155	6.645E+07
Nb-94	3.966E+07
Pu-238	1.388E+04
Pu-239/240	1.268E+04
Sr-90	8.075E+05
Th-232	1.341E+04
U-234	1.379E+05
U-235	1.496E+05
U-238	1.554E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Remote Work Area exposure scenario.

Table 5: Soils Project – Remote Work Area Exposure Scenario – Internal & External Dose

Radionuclide	**$RRMG_{(RWA-IE)}$** (pCi/g)
Ag-108m	6.204E+02
Am-241	9.239E+03
Cm-243	2.083E+03
Cm-244	2.715E+04
Co-60	1.225E+02
Cs-137	4.874E+02
Eu-152	2.557E+02
Eu-154	2.387E+02
Eu-155	6.406E+03
Nb-94	6.452E+02
Pu-238	1.390E+04
Pu-239/240	1.269E+04
Sr-90	5.522E+04
Th-232	3.292E+03
U-234	1.314E+05
U-235	1.709E+03
U-238	9.572E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Remote Work Area exposure scenario.

Table 6: Soils Project – Occasional Use Area Exposure Scenario – Internal Dose Only

Radionuclide	**$RRMG_{(OUA-I)}$** (pCi/g)
Ag-108m	2.762E+08
Am-241	4.555E+04
Cm-243	6.307E+04
Cm-244	7.68E+04
Co-60	7.421E+07
Cs-137	2.756E+07
Eu-152	8.174E+07
Eu-154	6.353E+07
Eu-155	4.751E+08
Nb-94	2.492E+08
Pu-238	3.922E+04
Pu-239/240	3.582E+04
Sr-90	9.949E+06
Th-232	3.852E+04
U-234	4.470E+05
U-235	4.922E+05
U-238	3.361E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Occasional Use Area exposure scenario.

Table 7: Soils Project – Occasional Use Area Exposure Scenario - Internal & External Dose

Radionuclide	**$RRMG_{(OUA-IE)}$** (pCi/g)
Ag-108m	2.087E+03
Am-241	2.797E+04
Cm-243	6.886E+03
Cm-244	7.653E+04
Co-60	4.122E+02
Cs-137	1.640E+03
Eu-152	8.604E+02
Eu-154	8.031E+02
Eu-155	2.156E+04
Nb-94	2.171E+03
Pu-238	3.915E+04
Pu-239/240	3.573E+04
Sr-90	1.955E+05
Th-232	1.062E+04
U-234	4.252E+05
U-235	5.749E+03
U-238	3.219E+04

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Occasional Use Area exposure scenario.

References

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Appendix D

Closure Activity Summary

D.1.0 Closure Activity Summary

The following sections document CAU 106 closure activities conducted from November 5, 2010, through May 23, 2011. Corrective actions were completed at 306 GZ (CAS 05-45-04) and 307 GZ (CAS 05-45-05). The remaining two CASs (Cambric Ditch and Able) have been shown not to have released contamination to the environment, and no PSM was identified; therefore, these two CASs did not require further action and are not discussed in this appendix.

The following sections provide the supporting documentation to verify the completion of closure activities. Analytical results from verification samples are presented in Appendix A under the specific CAS narration. Details regarding waste characterization, waste volumes, and final disposition are presented in Section A.7.0. Waste disposal documentation is included in Attachment D-1 of this appendix; copies are also available for review in the CAU 106 project files.

D.1.1 306 GZ Closure Activities

A corrective action of clean closure was implemented at this CAS by removing all identified PSM (pieces of DU, DU-contaminated debris, and oxidized DU) from the ground surface and within the posted CA and URMA. Clean closure consisted of removing PSM using hand tools from inside the posted CA, inside the posted URMA, and at 12 distinct locations within a 150-ft radius of the posted CA and URMA. The PSM was identified using a combination of visual observations, hand-held magnetometers capable of detecting ferrous and non-ferrous metal debris, EM61 geophysical survey results, and GWS and field screening measurements indicating elevated radioactivity. Figure A.5-4 in Appendix A shows the 12 PSM locations identified outside the posted areas (labeled 306GZ-01 through 306GZ-12). The PSM removed from posted radiological areas were not inventoried during removal. As a best management practice (BMP), non-PSM debris (i.e., scrap metal) was also removed and containerized to prevent redundant screening during the CAI.

The PSM at locations 306GZ-02 and 306GZ-09 consisted of oxidized DU and small nodule-like pieces of DU in the matrix of surface soil (see Figure D.1-1). The PSM and associated soil were removed, and verification samples 106D001 and 106D002 were collected from underlying soil.

The PSM at the remaining 10 locations outside the posted areas were distinct pieces of PSM debris that were easily removed. Figure D.1-1 shows an example of debris removed as PSM. The soil beneath each piece of debris was field screened for radioactivity after removal, and no residual contamination was identified at these locations. However, it was decided to collect verification sample 106D003 (and FD 106D004) at location 306GZ-11 (sample location D03) to confirm the FSRs and demonstrate that COCs above FALs are not present in the soil. This location was chosen because it was one of only two locations containing both PSM as debris and elevated GWS measurements outside the posted areas. Note that the GWS was performed after the initial PSM removal effort using the hand-held magnetometers.

The PSM inside the posted CA consisted of pieces of DU, DU-contaminated debris, and small volumes of oxidized DU in surface soils. Field screening was utilized to detect and segregate PSM showing elevated radioactivity. Verification sample 106D005 (location D04) was collected from soil in the area where the most highly contaminated piece of PSM along with oxidized DU was removed.

The PSM inside the posted URMA consisted of pieces of DU, DU-contaminated debris, and small volumes of oxidized DU in surface soils. Field screening was utilized to detect and segregate PSM showing elevated radioactivity. Following the removal of all visible pieces of PSM (i.e., debris) at the surface, verification sample 106D006 (location D05) was collected at the location exhibiting the highest FSRs in soil. Verification sample 106D008 (location D07) was collected from shallow subsurface soil following hand excavation to investigate geophysical anomalies and remove PSM detected in the shallow subsurface.

The corrective action at 306 GZ was accomplished by removing identified PSM with hand tools. Approximately 10 gal of contaminated soil and debris were removed from this CAS, containerized into a 55-gal drum with waste from 307 GZ, and disposed of as LLW. The analytical results of the verification samples as presented in Section A.5.0 support the clean closure of 306 GZ (CAS 05-45-04). Figures D.1-2 and D.1-3 document closure activities from this CAS.

Figure D.1-1
Example of Oxidized DU (Top) and
Example of DU-Contaminated Debris (Bottom)

Figure D.1-2
306 GZ Anomaly Excavation, Part 1

Figure D.1-3
306 GZ Anomaly Excavation, Part 2

D.1.2 307 GZ Closure Activities

A corrective action of clean closure was implemented at this CAS by removing all identified PSM (pieces of DU, DU-contaminated debris, and oxidized DU) from the ground surface and within the posted URMA. Clean closure consisted of removing PSM using hand tools from inside the posted URMA and at two distinct locations within a 100-ft radius of the posted URMA. The PSM was identified using a combination of visual observations, hand-held magnetometers capable of detecting ferrous and non-ferrous metal debris, and GWS and field screening measurements indicating elevated radioactivity. Figure A.6-2 in Appendix A shows the two PSM locations identified outside the posted areas (labeled 307GZ-01 and 307GZ-02). The PSM removed from posted radiological areas were not inventoried during removal. As a BMP, non-PSM debris (i.e., scrap metal) was also removed and containerized to prevent redundant screening during the CAI.

The PSM at the two locations outside the posted URMA were distinct pieces of PSM debris that were easily removed. Figure D.1-1 shows an example of debris removed as PSM. The soil beneath each piece of debris was field screened for radioactivity after removal, and no residual contamination was identified at these two locations. However, it was decided to collect verification sample 106E001 at location 306GZ-02 (sample location E01) to confirm the FSRs and demonstrate that COCs above FALs are not present in the soil. This location was chosen because it was the only elevated GWS measurement detected outside the posted area. Note that the GWS was performed after the initial PSM removal effort using the hand-held magnetometers.

The PSM inside the posted URMA consisted of pieces of DU, DU-contaminated debris, and small volumes of oxidized DU in surface soils. Field screening was utilized to detect and segregate PSM showing elevated radioactivity. Following the removal of all visible pieces of PSM (i.e., debris), verification samples 106E002 and 106E003 (FD) were collected at the location exhibiting the highest FSRs in soil (location E02) excluding the area with oxidized DU. A small area of oxidized DU was identified on the west/northwest side of the URMA. This PSM and associated soil were hand excavated and removed utilizing FSRs to guide the excavation, and verification sample 106E005 (location E03) was collected from underlying soil.

The corrective action at 307 GZ was accomplished by removing identified PSM with hand tools. Approximately 17 gal of contaminated soil and debris were removed from this CAS, containerized

into a 55-gal drum with waste from 306 GZ, and disposed of as LLW. The analytical results of the verification samples as presented in Section A.6.0 support the clean closure of 307 GZ (CAS 05-45-05).

Attachment D-1

Disposal Documentation

(1 Page)

Certificate of Disposal

This is to certify that the Waste Stream No. LITN000000006, Revision 14, shipment number ITL11009, with container number 106E02 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Nicole Nastanski	N-I	Waste Coordinator
Shipped by	Organization	Title
/s/ Nicole Nastanski		9/22/11
Signature		Date
Jon Tanaka	NSTec	Waste Specialist
Received by	Organization	Title
/s/ Jon Tanaka		09-22-2011
Signature		Date

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 106, 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.

All CAAs for CAU 106 are based on the presumption that all areas within the current NNSS boundary will be controlled in perpetuity and restricted from release to the public. Therefore, only industrial activities are permitted, and risks to receptors under residential scenarios will not be considered. Should the control of the NNSS change in the future to include public access or residential use, the selected CAAs may need to be reconsidered.

E.1.1 Corrective Action Objectives

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

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

- Treatment should be used to address principal threats wherever practicable and cost effective.
- Engineering controls, such as containment, should be used where wastes and contaminated media can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable.
- A combination of methods (e.g., treatment, engineering, and institutional controls) should be used, as appropriate, to protect human health and the environment.
- Institutional controls should be used primarily to supplement engineering controls as appropriate for short- or long-term management to prevent or limit exposure.

- Innovative technologies should be considered where such technologies offer potential for comparable or superior performance or implementability, less adverse impacts, or lower costs.
- Usable groundwater should be returned to maximum beneficial use wherever practicable.
- Contaminated soils should be remediated as necessary to prevent or limit direct exposure and to prevent the transfer of unacceptable concentrations of contaminants from soils to other media.

Implementation of the corrective action will ensure that contaminants remaining at each release site will not pose an unacceptable risk to human health and the environment and that conditions at each site are in compliance with all applicable laws and regulations.

E.1.2 Screening Criteria

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

Corrective action alternatives 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 protective measures necessary to ensure the requirements are met. 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.

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., Title 40 of the *Code of Federal Regulations* (CFR) 260 to 282, "Hazardous Waste Management" [CFR, 2011a]; 40 CFR 761 "Polychlorinated Biphenyls," [CFR, 2011b]; and NAC 444.842 to 980, "Facilities for Management of Hazardous Waste" [NAC, 2008]).

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 (e.g., fugitive dusts, transportation of hazardous materials, and explosion)
- Protection of workers during implementation
- Adverse environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

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

Long-Term Reliability and Effectiveness

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

Feasibility

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

- Construction and Operation—The feasibility of implementing a CAA given the existing set of waste and site-specific conditions.
- Administrative Feasibility—The administrative activities needed to implement the CAA (e.g., permits, use restrictions [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, and is provided in Section E.3.0. 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—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 CAAs

This section identifies and briefly describes the viable corrective action technologies and the CAAs considered for Cambric Ditch, Able, 306 GZ, and 307 GZ. Contamination exceeding FALs was not detected in any samples at Cambric Ditch or Able; therefore, CAAs were not developed for those CASs. Potential source material exceeding FALs was identified at 306 GZ and 307 GZ; therefore, CAAs were developed for these CASs.

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 106:

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

E.1.4.1 Alternative 1—No Further Action

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

E.1.4.2 Alternative 2—Clean Closure

Alternative 2 includes excavating and disposing of PSM and contaminated soil presenting a dose exceeding the 25-mrem/IA-yr FAL to a depth of 0.5 ft bgs (the extent of contamination based on analytical results). A visual inspection will be conducted to ensure that PSM and contaminated soil have been removed before the completion of the corrective action. Verification soil samples will also be collected and analyzed for the presence of a dose exceeding the 25-mrem/IA-yr FAL following removal of PSM and contaminated soil.

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

For radiological contamination, Alternative 3 includes the implementation of a UR where a radiological dose is present at levels that exceed the 25-mrem/IA-yr FAL. This UR will restrict inadvertent contact with contaminated media (i.e., PSM) by prohibiting any activity that would cause a site worker to be exposed to a dose exceeding 25 mrem/yr. Under this alternative, debris within an area where a radiological dose exceeds the 25-mrem/IA-yr FAL will not be removed.

E.1.5 Evaluation and Comparison of Alternatives

Each CAA presented in Section E.1.4 will be evaluated based on the general corrective action standards listed in Section E.1.2. This evaluation is presented in Table E.1-1. Any CAA that does not meet the general corrective action standards will be removed from consideration.

Only CAAs 2 and 3 met the corrective action standards and will be further evaluated based on the remedy selection decision factors described in Section E.1.2. This evaluation is presented in Table E.1-2. 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.

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

CAS 05-45-04, 306 GZ Rad Contaminated Area, and CAS 05-45-05, 307 GZ Rad Contaminated Area		
CAA 1, No Further Action		
Standard	Comply?	Explanation
Protection of Human Health and the Environment	No	Would not protect a worker from contact with COCs.
Compliance with Media Cleanup Standards	No	Would not protect a worker from contact with COCs.
Control the Source(s) of the Release	No	Surface contamination is present exceeding the FALs and is subject to migration.
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 would be removed.
Compliance with Media Cleanup Standards	Yes	Contamination exceeding the risk-based action levels would be removed.
Control the Source(s) of the Release	Yes	The source of the release at each site was a one-time occurrence. There are no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	Excavated waste would be managed in compliance with all standards.
CAA 3, Closure in Place with Administrative Controls		
Standard	Comply?	Explanation
Protection of Human Health and the Environment	Yes	A UR would be implemented to protect excavation workers from inadvertant contact with COCs.
Compliance with Media Cleanup Standards	Yes	Although COCs would not be removed, the CASs would be controlled to prevent workers from contacting COCs.
Control the Source(s) of the Release	Yes	The source of the release at each site was a one-time occurrence. There are no ongoing releases.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

The five EPA remedy selection decision factors are short-term reliability and effectiveness; reduction of toxicity, mobility, and/or volume; long-term reliability and effectiveness; feasibility; and cost. These factors are provided in Table E.1-2.

Table E.1-2
Evaluation of Remedy Selection Decision Factors

CAS 05-45-04, 306 GZ Rad Contaminated Area, and CAS 05-45-05, 307 GZ Rad Contaminated Area		
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 PSM removal operations.
Reduction of Toxicity, Mobility, and/or Volume	2	This alternative will result in a decrease of toxicity and mobility, but will generate waste volumes.
Long-Term Reliability and Effectiveness	2	This alternative is reliable and effective at protecting human health and the environment because removal of the contaminated media will eliminate future exposure of site workers to COCs.
Feasibility	2	Removal of PSM and contaminated soil is feasible due to small volume and ability to be remediated with hand tools.
Cost	2	The costs associated with removal and waste disposal for this alternative are estimated at less than $2,000 and are less than the costs estimated for the other CAAs.
Score	9	
CAA 3, Closure in Place with Administrative Controls		
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 waste volumes.
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	1	This alternative is easily implemented, but requires maintenance and long-term monitoring.
Cost	1	The costs associated with installation are estimated at approximately $15,000 and ongoing maintenance at approximately $1,000 per year thereafter for this alternative, and are higher than the costs estimated for the other CAAs.
Score	6	

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 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 media that exceed FALs (to a depth of 0.5 ft bgs) 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 media 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 for 306 GZ and 307 GZ, removal of contaminated media is easily implemented by hand tools, and management of generated wastes is minor.

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. The estimated cost for clean closure is less than that for closure in place due to minimal waste disposal costs and ability to remove a small volume of contaminated soil and PSM by hand. The costs for closure in place include those derived from acquiring, hanging, inspecting, and occasionally replacing UR signs.

E.2.0 Recommended Alternative

Three CAAs were evaluated for 306 GZ and 307 GZ: 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, near-surface soils and PSM would be removed from the sites to a depth of 0.5 ft bgs within small, well-defined areas. For the closure in place alternative, potential worker exposure to radiological 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 clean closure as the preferred CAA for both 306 GZ and 307 GZ.

Based upon the five remedy selection decision factors, clean closure received an overall score of 9 (more desirable), whereas closure in place received an overall score of 6 (less desirable). This result was the product of not only an examination of the two CAAs by the five remedy selection decision factors, but also consideration of the close proximity of the sites to nearby activities, the relative ease of removing contaminated soil and PSM with hand tools, and the small volume of waste to be generated (less than 55 gal). Therefore, this removal action is easy to implement, relatively inexpensive, and provides significant protection to potential future receptors.

Therefore, selection of the CAA of clean closure for both 306 GZ and 307 GZ is consistent with past practices for CASs that contain COCs and PSM where removal is feasible and cost-effective. However, if the control of the NNSS should change in the future to include public access or residential use, the selected CAAs may need to be reconsidered.

E.3.0 Cost Estimates

The cost for clean closure is estimated at less than $2,000 to conduct the following activities for both 306 GZ and 307 GZ:

- Excavate, load, and dispose of PSM and contaminated soil (approximately 6.5 cubic feet).

The estimated cost for clean closure of CAU 106 was based on removing PSM and contaminated soil above the FAL of 25 mrem/IA-yr, specifically PSM in the form of DU, DU-impacted debris, and oxidized DU both inside and outside the posted areas at 306 GZ and 307 GZ. This includes limited hand excavation, processing, transportation, and disposal.

The costs for closure in place, however, are those derived from acquiring, hanging, inspecting, and occasionally replacing UR signs, and are estimated to be approximately $15,000 for the first year and $1,000 for each year thereafter.

E.4.0 References

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2011a. Title 40 CFR, Parts 260 to 282, "Hazardous Waste Management." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2011b. 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*.

Nevada Administrative Code. 2008. 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 8 July 2011.

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

Sample Location Coordinates

F.1.0 Sample Location Coordinates

The individual (judgmental) sample locations for the CAU 106 CASs were surveyed using a GPS instrument. Survey coordinates for these locations are listed in Table F.1-1

Table F.1-1
Sample Location Coordinates for CAU 106 CASs

Easting[a]	Northing[a]	Sample Location
Cambric Ditch		
592,173.1	4,075,464.9	F01
Able		
594,960.9	4,072,832.3	B01
594,961.0	4,072,829.7	B02
594,956.6	4,072,809.0	B03
594,959.2	4,072,851.1	B04
306 GZ		
592,423.9	4,076,167.4	D01
592,366.8	4,076,165.1	D02
592,396.2	4,076,182.5	D03
592,410.1	4,076,180.9	D04
592,432.3	4,076,184.7	D05
592,432.0	4,076,184.3	D06
592,432.5	4,076,184.4	D07
307 GZ		
593,291.4	4,074,342.7	E01
593,298.1	4,074,358.0	E02
593,297.4	4,074,358.8	E03

[a]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

Appendix G

Nevada Division of Environmental Protection Comments

(2 Pages)

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

Brian Sandoval, Governor
Leo M. Drozdoff, P.E., Director
Colleen Cripps, Ph.D., Administrator

August 23, 2011

Robert F. Boehlecke
Federal Project Director
Environmental Restoration Project
National Nuclear Security Administration
Nevada Site 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) 106: Areas 5, 11 Frenchman Flat Atmospheric 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) 106: Areas 5, 11 Frenchman Flat Atmospheric Sites, Nevada National Security Site, Nevada. 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., CPM
Supervisor
Bureau of Federal Facilities

JJM/JW/KC:*jjm*

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