RECORD OF TECHNICAL CHANGE

Technical Change No. CAU 539 CR ROTC-1 Page 1 of 1

Project/Job No. WBS 1.6.1.3.09.39 Date 9/22/2011

Project/Job Name Industrial Sites Project/ CAU 539:Areas 25 and 26 Railroad Tracks

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The following technical changes (including justification) are requested by:

Dawn Peterson	CAU 539 CAU Lead
(Name)	(Title)

Description of Change:

Appendix F "Use Restrictions," Attachment 1 (table of survey area coordinates): Reverse the column headings of "Northing" and "Easting" in the table so that "Easting" is listed in the second column and "Northing" is listed in the third column. There is no change to the survey coordinates listed in the table.

Justification:

During the recordation of the survey coordinates of the CAU 539 Use Restriction into the Facility Information Management System (FIMS), it was noted the column headings for the survey coordinates were incorrectly labeled in Appendix F, Attachment 1 of the CAU 539 Closure Report.

The project time will be Unchanged by approximately 0 days.

Applicable Project-Specific Document(s):

Closure Report for Corrective Action Unit 539: Areas 25 and 26 Railroad Tracks, , Nevada National Security Site, Nevada, Revision 0 (June 2011)

Approved By: /s/ Kevin Cabble Date 9-27-11
NNSA/NSO Federal Sub-Project Director

/s/ Kevin Cabble Date 9-27-11
for NNSA/NSO Federal Project Director

/s/ Jeff MacDougall Date 9/28/11
NDEP

Use Restriction Information

CAU Number/Description: CAU 539, Areas 25 and 26 Railroad Tracks
Applicable CAS Number/Description: CAS 25-99-21, Area 25 Railroad Tracks

Contact (Federal Sub-Project Director/Sub-Project): Kevin Cabble Industrial Sites Subproject Manager

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
See Attachment 1 (table for 83 UR points)		

Depth: Surface to 5 feet below ground surface

Survey Method (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: The FFACO UR was implemented to protect site workers from inadvertent exposure to radiological contaminants. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 67 hours of exposure to the surface location with the maximum detected radioactivity. Also, radiological contaminated debris was identified on, within, and/or underlying the railroad ballast (surface gravel). This contaminated soil and debris, if exposed through surface disturbance or excavation, could cause a site woker to receive a dose exceeding 25 mrem/yr. The analytical results and locations of all samples collected are presented in the Closure Report for CAU 539.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 539 CAS 25-99-21, Area 25 Railroad Tracks			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Total Effective Dose (TED)	834.5	25	mrem/2,250 hours

Site Controls: The UR area encompasses the entire set of railroad tracks in Area 25 (excluding road crossings but including sections where railroad ties and/or rails were removed) up to 15 feet laterally on both sides of the railroad centerline where contamination exceeds the FAL of 25 mrem in 2,250 hours (the Industrial Area annual exposure scenario). To permit vehicle travel, the UR area excludes existing road crossings over the tracks and parallel access roads along the railroad track. It is established at the coordinates referenced above and depicted in the attached figures. Site controls include warning signs placed along both sides of tracks, at every existing road crossing, and at facility boundary fence lines where tracks enter facilities. Warning signs will be placed in a manner that will result in informing workers who travel on the roads adjacent to the railroad and that cross the railroad.

Administrative Use Restriction Physical Description*: N/A

Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
Southeast (N/A)	N/A	N/A

Depth: N/A

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

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

Use Restriction Information

Basis for Administrative UR(s):

Summary Statement: N/A

Contaminants Table:

Maximum Concentration of Contaminants for CAU 539 CAS 25-99-21, Area 25 Railroad Tracks			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
N/A	N/A	N/A	N/A

Site Controls: N/A

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

Description: **The UR must be entered into the NNSA/NSO Facility Information Management System (FIMS) and the FFACO database.**

Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure the signs are in place and readable and to verify no evidence of intrusion to the surface soils.

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

Comments: Radiologically contaminated Potential Source Material (PSM) is located on, within, and/or below the railroad ballast (i.e., surface gravel/soil covering the railroad grade). The removal of the ballast and the PSM contained within the ballast was not feasible due to volume of ballast along the approximately 9 miles of railroad tracks included in this CAS and the unknown/unidentified locations of the contaminated PSM. Personnel are restricted from removing any materials and/or performing any type of work or activity that may disturb the surface soils/ballast. Should any portion of the railroad track be identified for future work, permission to conduct activities within this area requires notification of the NDEP. The nature of the UR area allows for portions of the track to be investigated for radiological contaminants and potentially removed from the UR upon notification of the NDEP.

Submitted By: /s/ Kevin Cabble **Date:** 6-14-11

Attachment 1 - FFACO Use Restriction Physical Description: Surveyed Area (UTM, Zone 11, NAD 27, meters):
(Page 1 of 2)

UR Points (Southeast)	Easting	Northing
7	568,240.7	4,074,320.7
8	568,230.0	4,074,310.5
9	568,187.6	4,074,325.5
10	568,179.3	4,074,322.8
11	568,089.0	4,074,442.1
12	568,100.0	4,074,448.7
13	568,147.7	4,074,409.6
14	568,041.8	4,074,694.2
15	567,950.4	4,074,725.1
16	567,907.0	4,074,625.9
17	567,900.9	4,074,570.4
18	567,883.2	4,074,556.0
19	567,845.9	4,074,637.8
20	567,836.8	4,074,725.1
21	567,504.6	4,075,278.2
22	567,256.0	4,075,495.2
23	566,355.4	4,075,962.0
24	566,259.8	4,075,977.7
25	566,258.4	4,075,997.2
26	566,312.7	4,076,004.4
27	566,101.0	4,076,162.1
28	566,003.5	4,076,184.3
29	565,817.2	4,076,192.0
30	565,603.0	4,076,203.8
31	565,424.6	4,076,239.7
32	565,139.8	4,076,321.3
33	564,893.5	4,076,365.9
34	564,655.1	4,076,375.5
35	564,539.4	4,076,345.9
36	564,483.6	4,076,291.9
37	564,468.3	4,076,300.2
38	564,506.9	4,076,371.6
39	563,110.1	4,076,369.8
40	563,015.8	4,076,338.2
41	562,947.2	4,076,278.1
42	562,568.1	4,075,665.0
43	562,406.1	4,075,137.6
44	562,792.7	4,075,082.1
45	562,791.5	4,075,073.0
46	562,489.7	4,075,113.8
47	562,421.8	4,075,089.9
48	562,381.0	4,075,012.8
49	562,191.7	4,074,017.0
50	562,137.0	4,073,730.0

Attachment 1 - FFACO Use Restriction Physical Description: Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points (Southeast)	Easting	Northing
51	562,177.1	4,073,633.5
52	562,176.3	4,073,581.8
53	562,131.6	4,073,508.3
54	562,035.0	4,073,488.5
55	562,063.7	4,073,634.9
56	562,128.5	4,073,741.6
57	562,140.4	4,073,819.4
58	562,111.8	4,073,883.3
59	562,053.4	4,073,913.5
60	561,982.8	4,073,926.3
61	561,984.3	4,073,935.3
62	562,054.9	4,073,922.6
63	562,133.8	4,073,938.2
64	562,182.7	4,074,019.1
65	562,372.0	4,075,014.8
66	562,372.1	4,075,015.2
67	562,389.9	4,075,141.1
68	562,556.6	4,075,671.9
69	562,889.6	4,076,204.6
70	562,891.6	4,076,321.8
71	562,792.7	4,076,368.2
72	561,618.4	4,076,363.5
73	561,565.1	4,076,356.8
74	561,508.3	4,076,334.3
75	561,462.3	4,076,298.3
76	561,450.6	4,076,310.7
77	561,501.8	4,076,341.2
78	561,562.5	4,076,376.0
79	564,878.5	4,076,388.3
80	565,092.6	4,076,347.6
81	565,583.4	4,076,225.2
82	566,080.2	4,076,195.2
83	566,080.2	4,076,195.2
0	566,080.2	4,076,195.2
1	566,309.3	4,076,025.5
2	566,375.4	4,075,961.6
3	567,310.6	4,075,482.8
4	567,537.5	4,075,279.0
5	567,831.8	4,074,751.9
6	568,031.7	4,074,735.9

Nevada
Environmental
Restoration
Project

DOE/NV--1454

National Nuclear Security Administration

Closure Report for Corrective Action Unit 539: Areas 25 and 26 Railroad Tracks Nevada National Security Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

June 2011

Environmental Restoration
Project

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CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 539: AREAS 25 AND 26 RAILROAD TRACKS NEVADA NATIONAL SECURITY SITE, NEVADA

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

Controlled Copy No.: ___

Revision No.: 0

June 2011

CLOSURE REPORT FOR
CORRECTIVE ACTION UNIT 539:
AREAS 25 AND 26 RAILROAD TRACKS
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Kevin Cabble Date: 6-14-11

Kevin J. Cabble
Federal Sub-Project Director
Industrial Sites Sub-Project

Approved by: /s/ Robert F. Boehlecke Date: 6/14/11

Robert F. Boehlecke
Federal Project Director
Environmental Restoration Project

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List of Acronyms and Abbreviations

Ac	Actinium
ALM	Adult Lead Methodology
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
CAA	Corrective action alternative
CAI	Corrective action investigation
CAS	Corrective action site
CAU	Corrective action unit
CDC	Centers for Disease Control and Prevention
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COC	Contaminant of concern
COPC	Contaminant of potential concern
CR	Closure report
Cs	Cesium
CSM	Conceptual site model
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
E-MAD	Engine Maintenance, Assembly, and Disassembly
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
ETS-1	Engine Test Stand No. 1
FADL	Field activity daily log

List of Acronyms and Abbreviations *(Continued)*

FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
ft^3	Cubic foot
GPS	Global Positioning System
GWS	Gamma walkover survey
HASL	Health and Safety Laboratory
ID	Identification
IDW	Investigation-derived waste
in.	Inch
LCS	Laboratory control sample
LLW	Low-level waste
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mi	Mile
MLLW	Mixed low-level waste
mrem/IA-yr	Millirem per Industrial Area year
mrem/OU-yr	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate

List of Acronyms and Abbreviations *(Continued)*

N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
Nb	Niobium
NCRP	National Council on Radiation Protection and Measurements
NDEP	Nevada Division of Environmental Protection
N-I	Navarro-Intera, LLC
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
NRDS	Nuclear Rocket Development Station
PAL	Preliminary action level
PB	Preparation blank
PbB	Blood lead concentration
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PPE	Personal protective equipment
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*

List of Acronyms and Abbreviations *(Continued)*

REOP	Real Estate/Operations Permit
RfD	Reference dose
RMA	Radioactive material area
RMSF	Radioactive Materials Storage Facility
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RWMC	Radioactive Waste Management Complex
SAFER	Streamlined Approach for Environmental Restoration
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TBD	To be determined
TCA	Test Cell A
TCC	Test Cell C
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
Th	Thorium
TLD	Thermoluminescent dosimeter
TSDF	Treatment, storage, and disposal facility
U	Uranium
UCL	Upper confidence limit
UR	Use restriction
UTM	Universal Transverse Mercator
VOC	Volatile organic compound

List of Acronyms and Abbreviations *(Continued)*

yd^3	Cubic yard
μg/dL	Micrograms per deciliter
%R	Percent recovery

Executive Summary

This Closure Report (CR) presents information supporting the closure of Corrective Action Unit (CAU) 539: Areas 25 and 26 Railroad Tracks, Nevada National Security Site, Nevada. This CR complies with the requirements of the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management. The corrective action sites (CASs) within CAU 539 are located within Areas 25 and 26 of the Nevada National Security Site. Corrective Action Unit 539 comprises the following CASs:

- 25-99-21, Area 25 Railroad Tracks
- 26-99-05, Area 26 Railroad Tracks

The purpose of this CR is to provide documentation supporting the completed corrective actions and provide data confirming that the closure objectives for CASs within CAU 539 were met. To achieve this, the following actions were performed:

- Reviewed documentation on historical and current site conditions, including the concentration and extent of contamination.
- Conducted radiological walkover surveys of railroad tracks in both Areas 25 and 26.
- Collected ballast and soil samples and calculated internal dose estimates for radiological releases.
- Collected *in situ* thermoluminescent dosimeter measurements and calculated external dose estimates for radiological releases.
- Removed lead bricks as potential source material (PSM) and collected verification samples.
- Implemented corrective actions as necessary to protect human health and the environment.
- Properly disposed of corrective action and investigation wastes.
- Implemented an FFACO use restriction (UR) for radiological contamination at CAS 25-99-21. The approved UR form and map are provided in Appendix F and will be filed in the DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), Facility Information Management System; the FFACO database; and the NNSA/NSO CAU/CAS files.

From November 29, 2010, through May 2, 2011, closure activities were performed as set forth in the *Streamlined Approach for Environmental Restoration (SAFER) Plan for Corrective Action Unit 539: Areas 25 and 26 Railroad Tracks, Nevada Test Site, Nevada*. The purposes of the activities as defined during the data quality objectives process were as follows:

- Determine whether contaminants of concern (COCs) are present.
- If COCs are present, determine their nature and extent, implement appropriate corrective actions, and properly dispose of wastes.

Analytes detected during the closure activities were evaluated against final action levels (FALs) to determine COCs for CAU 539. Assessment of the data generated from closure activities revealed the following:

- At CAS 26-99-05, the total effective dose for radiological releases did not exceed the FAL of 25 millirem per Industrial Area year. Potential source material in the form of lead bricks was found at three locations. A corrective action of clean closure was implemented at these locations, and verification samples indicated that no further action is necessary.
- At CAS 25-99-21, the total effective dose for radiological releases exceeds the FAL of 25 millirem per Industrial Area year. Potential source material in the form of lead bricks was found at eight locations. A corrective action was implemented by removing the lead bricks and soil above FALs at these locations, and verification samples indicated that no further action is necessary. Pieces of debris with high radioactivity were identified as PSM and remain within the CAS boundary. A corrective action of closure in place with a UR was implemented at this CAS because closure activities showed evidence of remaining soil contamination and radioactive PSM. Future land use will be restricted from surface and intrusive activities.

Closure activities generated waste streams consisting of industrial solid waste, recyclable materials, low-level radioactive waste, and mixed low-level radioactive waste. Wastes were disposed of in the appropriate onsite landfills.

The NNSA/NSO provides the following recommendations:

- Clean closure is required at CAS 26-99-05.
- Closure in place is required at CAS 25-99-21.
- A UR is required at CAS 25-99-21.

- A Notice of Completion to the NNSA/NSO is requested from the Nevada Division of Environmental Protection for closure of CAU 539.

- Corrective Action Unit 539 should be moved from Appendix III to Appendix IV of the FFACO.

1.0 Introduction

This Closure Report (CR) presents information supporting closure of Corrective Action Unit (CAU) 539: Areas 25 and 26 Railroad Tracks, Nevada National Security Site (NNSS), Nevada. This complies with the requirements of 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. Corrective Action Unit 539 contains corrective action sites (CASs) located in Areas 25 and 26 of the NNSS. The NNSS is located approximately 65 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1). 2Corrective Action Unit 539 comprises the following two CASs that are shown on Figure 1-2:

- CAS 25-99-21, Area 25 Railroad Tracks
- CAS 26-99-05, Area 26 Railroad Tracks

1.1 Purpose

This CR provides documentation and justification for the closure of CAU 539 without further corrective action. This justification is based on process knowledge and the results of the investigative activities conducted in accordance with the *Streamlined Approach for Environmental Restoration (SAFER) Plan for Corrective Action Unit 539: Areas 25 and 26 Railroad Tracks, Nevada Test Site, Nevada* (NNSA/NSO, 2010). The SAFER Plan provides information relating to site history as well as the scope and planning of the investigation. Therefore, this information will not be repeated in this CR.

The Area 25 Railroad Tracks (CAS 25-99-21) is approximately 9 mi in length and has been inactive since 1973. The Area 26 Railroad Tracks (CAS 26-99-05) is approximately 2 mi in length and has been inactive since 1964. Once the track system was inactivated, no further maintenance was performed, and the railroad tracks in both Areas 25 and 26 remain in various states of disrepair. Additional information relating to the site history, planning, and scope of the closure is presented in the SAFER Plan (NNSA/NSO, 2010).

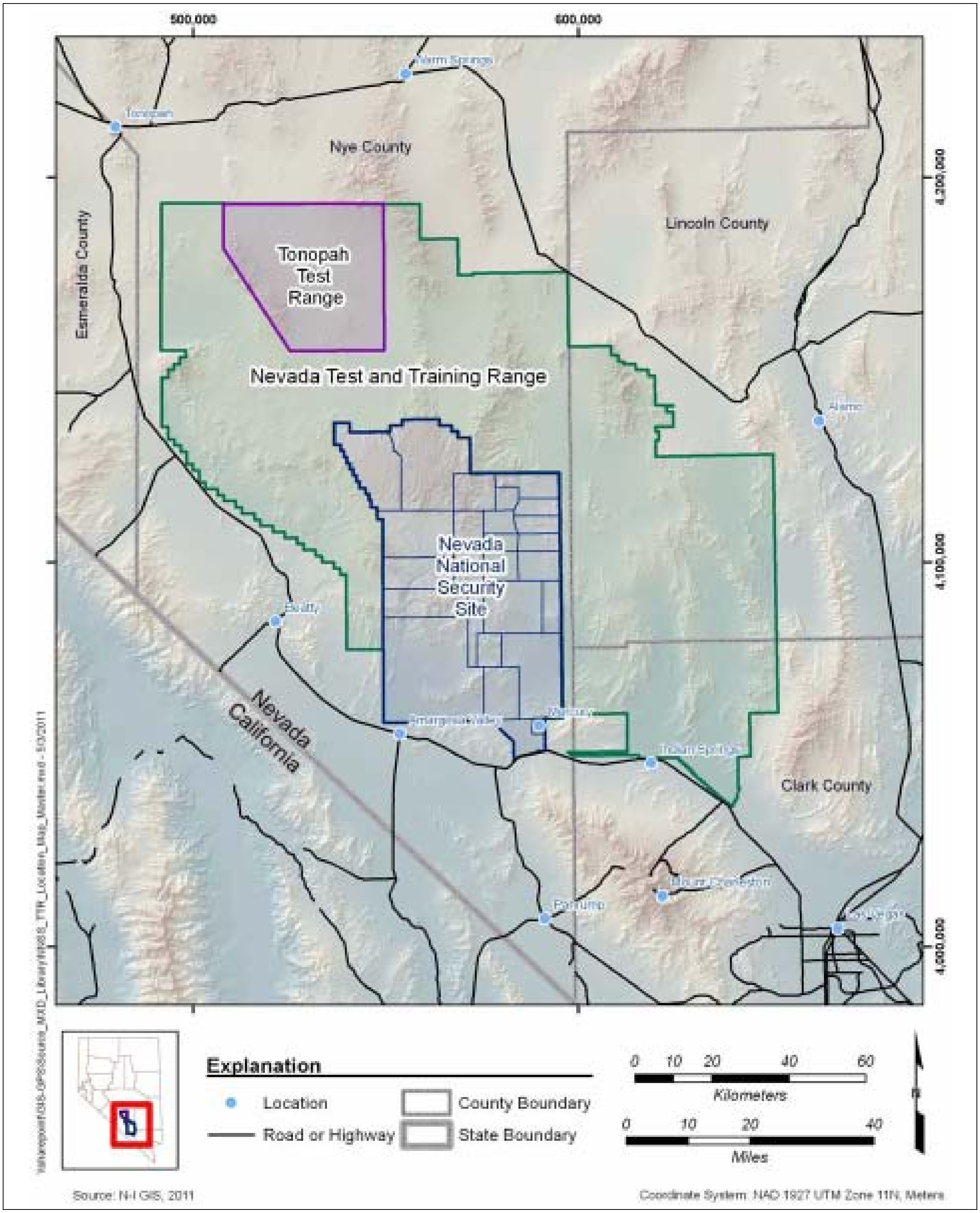

Figure 1-1
Location of the Nevada National Security Site

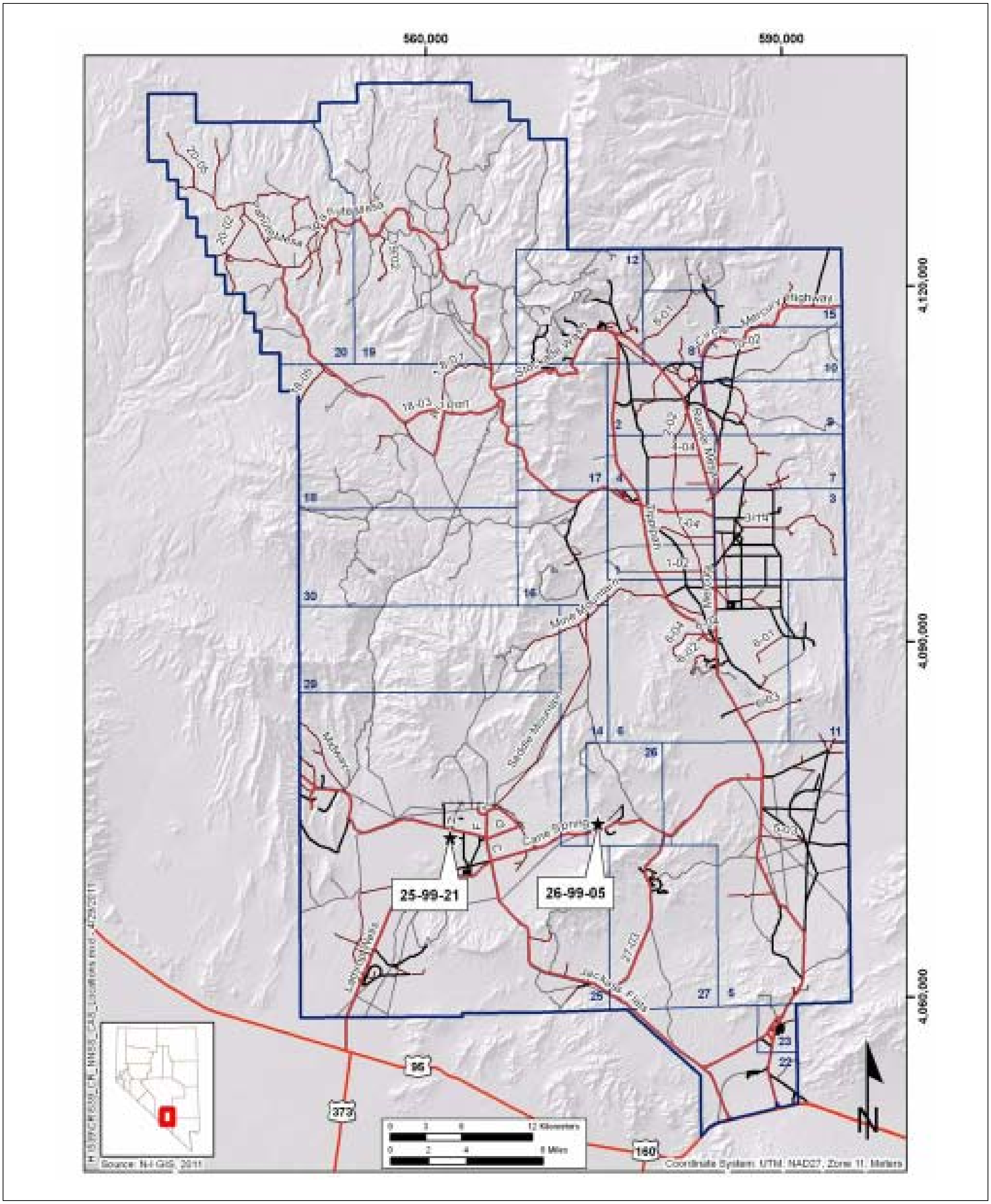

Figure 1-2
CAU 539 CAS Location Map

Corrective Action Site 25-99-21 consists of releases of radioactive material from nuclear rocket machinery transported on railroad cars to the soil/ballast surrounding and underlying the railroad tracks. The railroad in Area 25 interconnected the major facilities that supported the former Nuclear Rocket Development Station (NRDS) program area. The program conducted full-scale testing of reactors, engines, and rocket stages to evaluate the feasibility of developing nuclear reactors for the U.S. space program.

Corrective Action Site 26-99-05 consists of releases of radioactive material from nuclear rocket machinery transported on railroad cars to the soil/ballast surrounding and underlying the railroad tracks. The railroad in Area 26 interconnected the Pluto Facility and the Test Bunker in support of Project Pluto. Project Pluto was a program to demonstrate the feasibility of using a nuclear-powered ramjet engine to propel a supersonic low-altitude missile.

1.2 Scope

The corrective action of clean closure for CAS 26-99-05, Area 26 Railroad Tracks, was completed by demonstrating—through environmental soil sampling and analysis for internal dose estimates, thermoluminescent dosimeter (TLD) data for external dose estimates, and removal of potential source material (PSM)—that contaminants of concern (COCs) do not exist within the CAS.

The corrective action of closure in place with a use restriction (UR) and limited soil removal for CAS 25-99-21, Area 25 Railroad Tracks, was completed by demonstrating—through environmental soil sampling and analysis for internal dose estimates, TLD data for external dose estimates, and removal of PSM and lead-contaminated soil—that COCs exist within this CAS. Activities used to investigate both CASs included the following:

- Performing radiological surveys and field screening.
- Placing and collecting TLDs for laboratory analysis.
- Collecting environmental samples for laboratory analysis.
- Identifying, and removing where feasible, PSM.
- Collecting waste management samples.
- Collecting quality control (QC) samples.
- Justifying corrective actions and the technical rationale for implemented closure activities.
- Performing best management practices (BMPs), as required.
- For CAS 25-99-21, implementing a UR and posting the area.
- Documenting Notice of Completion and closure of CAU 539.

1.3 Closure Report Contents

This CR is divided into the following sections and appendices:

- Section 1.0, "Introduction," summarizes the purpose, scope, and contents of this CR.
- Section 2.0, "Closure Activities," summarizes the closure activities, deviations from the SAFER Plan, the actual schedule, and the site conditions following completion of corrective actions.
- Section 3.0, "Waste Disposition," discusses the wastes generated and entered into an approved waste management system as a result of the corrective action.
- Section 4.0, "Closure Verification Results," describes verification activities and results.
- Section 5.0, "Conclusions and Recommendations," provides the conclusions and recommendations, along with the rationale for their determination.
- Section 6.0, "References," provides a list of all referenced documents used in the preparation of this CR.
- Appendix A, *Data Quality Objectives as Developed in the* SAFER Plan, provides the DQOs as presented in Appendix B of the CAU 539 SAFER Plan.
- Appendix B, *Sample Location Coordinates*, presents the northing and easting coordinates for each TLD and sample location.
- Appendix C, *Sample Data*, provides tabular compilations of validated analytical results that provide a basis for the internal radiological dose estimates and TLD sample data that provide a basis for the external radiological dose estimates.
- Appendix D, *Confirmation Sampling Test Results*, provides a description of the project objectives, field closure and sampling activities, and closure results.
- Appendix E, *Waste Disposition Documentation*, documents disposal of items removed during closure activities.
- Appendix F, *Use Restrictions*, documents the URs.
- Appendix G, *Risk Evaluation*, presents the risk evaluation results.
- Appendix H, *Nevada Division of Environmental Protection* (NDEP) *Comments*, contains NDEP comments on the draft version of this document.

1.3.1 Applicable Programmatic Plans and Documents

To ensure all project objectives, health and safety requirements, and QC procedures were adhered to, all closure activities were performed in accordance with the SAFER Plan for CAU 539 (NNSA/NSO, 2010), FFACO (1996, as amended), and *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002).

1.3.2 Data Quality Objectives

This section contains a summary of the data quality objectives (DQO) process that is presented in Appendix A. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and design a data collection program that will satisfy these purposes.

The problem statement for CAU 539 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate corrective action alternatives (CAAs) and confirm closure of the two Railroad Tracks CASs in CAU 539." To address this problem, the resolution of two decision statements is required:

- Decision I: "Is any COC present in environmental media within the CAS at a concentration exceeding its corresponding final action level (FAL)?" For the judgmental sampling design, any analytical result for a contaminant of potential concern (COPC) above the FAL will result in that COPC being designated as a COC.
- Decision II: "If a COC is present, is sufficient information available to meet closure objectives?" Sufficient information is defined to include the following:
  - Identifying the volume of media containing any COC bounded by analytical sample results in lateral and vertical directions.
  - The information needed to characterize investigation-derived waste (IDW) for disposal.
  - The information needed to determine potential remediation waste types

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes that are present at a site (i.e., PSM) to release COCs into site environmental media.

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 contents to the surrounding media. The following were used as the criteria for determining whether a waste is PSM:

- A waste, regardless of concentrations 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 the waste could not result in soil contamination exceeding a FAL.
- If no assumption about the waste can be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:
  - For nonliquid waste, 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 nonliquid waste, 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 each contaminant in the waste divided by the mass of the waste and calculating the combined resulting dose using the RESRAD computer code (Murphy, 2004). If the resulting soil concentration exceeds the FAL, then the waste would be considered PSM.

1.3.3 Data Quality Assessment Summary

The data quality assessment (DQA) presented in Section 4.1 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 will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help ensure that DQO decisions are sound and defensible.

The DQA process, as presented in Section 4.1, 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.

Based on the results of the DQA presented in Section 4.1, the information generated during the investigation supports the conceptual site model (CSM) assumptions, and the data collected meet the DQOs and support their intended use in the decision-making process.

2.0 Closure Activities

The following sections summarize the CAU 539 closure activities and any deviations from the original scope of work. Detailed discussion and results of closure activities for individual CAU 539 CASs are presented in Appendix D of this document.

2.1 Description of Corrective Action Investigation Activities

The corrective action investigation (CAI) activities were conducted in accordance with the requirements set forth in the CAU 539 SAFER Plan (NNSA/NSO, 2010). Table 2-1 lists the CAI activities that were conducted at each of the CASs.

Table 2-1
Corrective Action Investigation Activities Conducted at Each CAS To Meet SAFER Plan Requirements for CAU 539

CAI Activities	CAS	
	25-99-21	26-99-05
Conducted surface radiological surveys along railroad tracks to identify biased locations for TLD placement.	X	X
Performed detailed radiological surveys at selected TLD transects.	X	X
Placed, collected, and analyzed TLDs for external dose measurements.	X	X
Collected soil samples from biased locations for internal dose measurements.	X	X
Field screened samples for alpha and beta/gamma radiation.	X	X
Identified and removed PSM where feasible.	X	X
Collected verification samples at PSM removal locations.	X	X
Performed radiological scans and swipes of PSM.	X	X
Inspected concrete-covered sections of railroad tracks.	X	--
Submitted select samples for offsite laboratory analysis.	X	X

-- = Not applicable

Soil samples and TLD measurements were collected to determine the presence of contamination. All soil samples were collected by hand excavation and field screened at specific locations for alpha and beta/gamma radiation. To facilitate site investigation, the releases for CAU 539 were classified into one of the following two categories:

- Radiological Releases: This release category is specific to the release of radioactive contaminants from railcars used to transport nuclear rocket/engine equipment. The primary locations for radiological contaminants are the railroad ballast and underlying soils up to 5 feet (ft) laterally on either side of the tracks.
- Nonradiological Releases: This release category is specific to all releases other than radiological releases from railcars. The primary location for nonradiological contaminants is in soil below and adjacent to the release (e.g., soil directly below lead bricks identified along the railroad).

A judgmental sampling scheme was implemented to collect *in situ* TLD measurements and soil samples as outlined in the SAFER Plan (NNSA/NSO, 2010). For radiological releases, TLD transect locations were based on results of radiological walkover surveys, whereas the locations selected for ballast and subsurface soil sample collection were based on the highest TLD external dose estimates. For nonradiological releases, judgmental sample locations were determined based on biasing criteria such as PSM. Judgmental sampling allows the methodical selection of sample locations that target the populations of interest (defined in the DQOs) rather than random locations.

Confidence in judgmental sampling scheme decisions was established qualitatively by the validation of the CSM and justification that sampling locations are the most likely locations to contain a COC, if a COC exists.

The potential internal dose at each sample location was determined based on the radionuclide analytical results from ballast and ballast/soil interface samples and the corresponding residual radioactive material guidelines (RRMGs) that were calculated using the RESRAD code (Yu et al., 2001) (see Appendix G, Attachment G-1). The RRMGs are the activity concentrations of individual radionuclides in surface soil that would cause an internal dose to a receptor equal to the radiological FAL. The internal dose from each of the radionuclides is then summed to produce the total potential internal dose.

The potential internal dose at each TLD location where soil samples were not collected was conservatively estimated using the potential external dose from the TLD and the ratio of internal dose to external dose from the location along the railroad with the maximum internal dose. This was done under the assumption that the internal dose at any CAU 539 location would constitute the same percentage of the total dose as at the location where the maximum internal dose was observed. Therefore, at each CAS, the ratio of the internal to external dose was determined at the sample location with the highest internal dose by dividing the internal dose by the external dose. This CAS-specific ratio was then multiplied by the external dose measured at each TLD-only location to estimate the internal dose.

The potential external dose at each TLD location was determined from the readings of a TLD placed at a height of 1 meter above the soil surface. The net external dose (the gross TLD dose reading minus the background dose) was divided by the number of hours the TLD was exposed to site contamination resulting in an hourly dose rate. That hourly dose rate was then multiplied by the number of hours per year that a site worker would be present at the site (i.e., the annual exposure duration) to establish the maximum potential annual external dose a site worker would receive. The appropriate annual exposure duration in hours is based on using the Industrial Area exposure scenario. Appendix G provides details on the risk evaluation and establishment of the FAL.

The calculated total effective dose (TED) (the sum of internal and external dose) for each sample location is an estimation of the true radiological dose (true TED). The TED is defined in Title 10 of the *Code of Federal Regulations* (CFR), Part 835 (CFR, 2011) as the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures). Because the average TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If an average TED were directly compared to the FAL, a significant difference between the true TED and the sample TED could lead to decision errors. To reduce the probability of a false negative decision error, a conservative estimate of the true TED (i.e., the 95 percent upper confidence limit [UCL]) is used to compare to the FAL. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED. The 95 percent UCL of the TED was calculated as the sum of the 95 percent UCL of the external dose and the average internal dose.

2.1.1 CAS 25-99-21 Closure Activities

Closure activities conducted at this CAS included conducting site walkover radiological surveys, visual inspections of identified features, field screening, collecting TLD measurements for external dose estimates, collecting soil samples for internal dose estimates, and collecting verification samples following removal of lead bricks (PSM). Except for lead bricks and high-activity debris identified as PSM, visual inspections and radiological surveys of features along the railroad tracks identified no other biasing factors to investigate for closure.

Fourteen lead bricks were identified as PSM at CAS 25-99-21. Following removal of lead bricks as PSM from eight locations and lead-contaminated soil from one location, a total of seven verification soil samples were collected from underlying soil and submitted for metals analysis (specifically lead). Total lead was detected above the preliminary action level (PAL) in soil collected from under lead bricks; however, the Tier 2 evaluation determined that lead was not above the FAL, so lead is not considered a COC. The Tier 2 evaluation is presented in Appendix G.

During the collection of ballast samples, pieces of debris with high alpha and beta/gamma readings were identified as PSM at or near several TLD locations (e.g., AT02, AT14, and AT16). These pieces of high-activity PSM were located on the ground surface, in the ballast matrix, and/or under the ballast. It was noted during sample collection and a review of walkover survey results that the ballast provides a shielding effect, thereby reducing detection ability of radiological instruments without removing ballast. Additionally, the nature of the debris makes visual identification difficult due to the color and size of the material blending into the ballast. Because of the nature of this high-activity PSM observed along the railroad tracks and the shielding effect provided by ballast, it cannot be determined whether all high-activity PSM has been identified.

A total of 20 TLD measurement locations were selected along the Area 25 railroad to obtain data to estimate the external dose component of the TED. Five of these locations were selected for sample collection biased towards the highest external dose estimates. Six ballast and six subsurface samples were collected from the five TLD locations and analyzed to calculate the estimated internal dose component of the TED. The TED was calculated using the external and internal dose estimates to determine whether exposure to surface and subsurface soils contaminated from radiological releases exceeded the FAL of 25 millirem per year (mrem/yr) for the Industrial Area scenario (25 mrem/IA-yr). Tables D.3-3 and D.3-4 in Appendix D present the estimated external dose and estimated internal dose, respectively.

The 95 percent UCL of the average TED results for each sample location at CAS 25-99-21 is presented in Table 2-2. Based on the comparison of the TED to the Tier 1 FAL (see Appendix G), four locations exceed the FAL of 25 mrem/IA-yr. The TED exceeding the FAL of 25 mrem/IA-yr, along with the detection of high-activity PSM not easily identifiable or removable, supports a corrective action of closure in place with limited soil removal and implementing an FFACO UR for this CAS. The FFACO UR, which is detailed in Appendix F, was implemented at this CAS and includes annual post-closure monitoring.

Table 2-2
Total Effective Dose (95 Percent UCL) at CAS 25-99-21, Area 25 Railroad Tracks, Sample Locations
(Page 1 of 2)

TLD Location	Sample Location	Industrial Area 95% UCL TED (mrem/IA-yr)
AT01	A01	**346.56**
AT02	A02	15.03
AT03	--	0.0
AT04	--	0.0
AT05	--	0.0
AT06	--	12.07
AT07	--	9.43
AT08	--	0.0
AT09	--	0.0
AT13	--	**36.87**
AT14	A04	**834.53**
AT15	A03	9.03
AT16	A09	**29.02**
AT17	--	0.0
AT18	--	0.0
AT19	--	0.0

Table 2-2
Total Effective Dose (95 Percent UCL) at CAS 25-99-21,
Area 25 Railroad Tracks, Sample Locations
(Page 2 of 2)

TLD Location	Sample Location	Industrial Area 95% UCL TED (mrem/IA-yr)
AT20	--	0.0
AT21	--	0.0
AT25	--	0.0
AT26	--	0.0

-- = No sample collected at the TLD location

Bolded values exceed the FAL.

2.1.2 CAS 26-99-05 Closure Activities

Closure activities at CAS 26-99-05 consisted of visual inspections, field screening, collecting TLD measurements for calculating external dose, collecting soil samples for calculating internal dose, removal of PSM (i.e., lead bricks), and collecting verification samples following removal of lead bricks. Based on visual inspections along the railroad, no other biasing factors were identified (i.e., staining).

Four lead bricks were identified and removed as PSM from three locations at CAS 26-99-05. A total of three verification soil samples were collected from underlying soil and submitted for metals analysis (specifically lead). Although total lead was reported at concentrations that exceeded the PAL, the Tier 2 evaluation (see Appendix G) demonstrated that the lead concentrations were not above the FAL, and therefore, lead is not considered a COC.

A total of five TLD measurement locations were selected along the Area 26 railroad to obtain data to calculate the external dose component of the TED. Two of the five TLD locations were selected for sample collection of the railroad ballast and underlying soil to calculate the internal dose component of the TED. The TLD locations selected for sample collection were biased towards the highest external dose estimates. Three ballast samples and two subsurface samples were collected from the two TLD locations. The TED was calculated using the external and internal dose estimates to determine whether exposure to surface and subsurface soils contaminated from radiological releases exceeded the FAL of 25 mrem/IA-yr. Tables D.4-3 and D.4-4 present the estimated external dose and internal dose, respectively.

The 95 percent UCL of the average TED results for each sample location is presented in Table 2-3. The comparison of the TED to the Tier 1 FAL (see Appendix G) showed that none of the sample locations exceed the Industrial Area scenario FAL (25 mrem/IA-yr). As PSM was removed and no other COCs were identified at this CAS, analytical data support the corrective action of clean closure for this CAS.

Table 2-3
Total Effective Dose (95 Percent UCL) at CAS 26-99-05, Area 26 Railroad Tracks, Sample Locations

TLD Location	Sample Location	Industrial Area 95% UCL TED (mrem/IA-yr)
BT01	--	0.0
BT02	B01	5.41
BT03	B02	4.64
BT07	--	0.0
BT08	--	0.0

2.2 Deviations from SAFER Plan as Approved

One deviation from the SAFER Plan requirements (NNSA/NSO, 2010) was applicable to both CASs. It involved the calculation of the external dose component and TED for exposure to subsurface soils. The SAFER Plan stated that the RESRAD computer code would be used to estimate both the external and internal doses for the subsurface using soil analytical results. Instead, it was decided that a 95 percent UCL external dose for the subsurface should be calculated by extrapolating the TLD measurement at each sample location to represent the potential exposure a receptor would receive if the ballast were removed. This extrapolation required that the ratio of the subsurface to surface internal doses be calculated for each sample location from analytical results and then that ratio be multiplied against the TLD measurement for that location to estimate the 95 percent UCL external dose. This external dose is then used to calculate the TED. This deviation is not considered significant because a higher external dose component is used to determine the TED and thus the resulting TED is more conservative and protective of human health and the environment.

Two minor deviations from the SAFER Plan requirements were identified for CAS 25-99-21 and are described below. Neither deviation, however, is considered to adversely impact the overall assessment or the need for implementing corrective actions at this CAS. Per the SAFER Plan, if fuel flecks were present in a ballast material sample, the flecks would be removed prior to submitting the sample for analysis. If fuel flecks were present in a soil sample collected from below the ballast, the soil sample would be split into two aliquots with one aliquot having fuel flecks removed prior to laboratory submittal. During the investigation, it was determined that removing fuel flecks from soil was not feasible, because the small particle size of the radioactive material was not visible. The inability to remove the small radioactive particles from the ballast and underlying soil samples for the internal dose component may result in a more conservative (i.e., higher) TED estimate.

The second minor deviation was applicable to the planned investigation points along the Area 25 concrete-covered railroad track. Two of the eight randomly selected locations along the concrete-covered track could not be accessed because the concrete was reinforced and/or thicker and could not be broken by hand tools. Because no contamination or other biasing factors were found under the concrete at the other six locations and the concrete was not breached at these inaccessible locations, the deviation is not considered significant.

2.3 Corrective Action Schedule as Completed

The CAI was conducted from November 29, 2010, through May 2, 2011. The closure-in-place remediation began on May 2, 2011, and was completed on June 14, 2011. This remediation consists of removing lead-contaminated soil and posting sections of CAS 25-99-21 with UR signs.

2.4 Site Plans/Survey Plat

Sample locations are shown in Figures D.3-1 through D.3-6 in Appendix D for CAS 25-99-21 and Figure D.4-1 in Appendix D for CAS 26-99-05. Use restriction maps are presented in Appendix F.

3.0 Waste Disposition

Wastes generated during the SAFER field activities include disposable personnel protective equipment (PPE), disposable sampling equipment, contaminated soil, lead bricks, and housekeeping waste. The types, amounts, and disposal of the wastes are detailed in the following subsections. Generated wastes such as PPE/sampling debris (plastic/glass) were characterized based on the associated soil samples and knowledge of the waste-generating process. Waste containers that were not sampled directly were characterized based on process knowledge and analytical results of the associated soil samples. Site controls were in place to prevent the introduction of hazardous constituents to these waste streams.

3.1 Waste Streams

The waste generated by site closure activities at CAU 539 was segregated into the following waste streams:

- Disposable PPE and sampling equipment, plastic sheeting, glass/plastic sample jars, aluminum foil, and other debris such as boxes
- Environmental media debris
- Potential source material (i.e., lead bricks and high-activity debris)

3.2 Waste Sampling

Waste containers that were not sampled directly were characterized based on process knowledge and analytical results of the corresponding soil samples. Waste requiring characterization was not generated at CAS 26-99-05. No waste streams at CAS 25-99-21 were sampled directly. However, verification sample 539A014 was reanalyzed for lead using the Toxicity Characteristic Leaching Procedure (TCLP) to assist in determining final disposition of one drum of waste soil. The comparison of results to regulatory disposal criteria is discussed in Section D.5.0.

3.3 Waste Disposal

This section summarizes the types and amounts of waste disposed of during the CAU 539 site closure activities:

- Most disposable PPE and sampling equipment waste generated during site closure activities was determined to be industrial solid waste based on observations and process knowledge. The waste was bagged, labeled, and staged in a designated industrial solid waste bin located at Building 23-153 to be disposed of at the NNSS Area 9 U10c industrial waste landfill.

- Four bags of disposable PPE and sampling equipment waste generated during site closure activities were determined to be low-level waste (LLW) based on field screening and process knowledge. The waste was bagged, labeled, and placed in the Building 23-153 radioactive materials area (RMA) for future disposal at the Area 5 Radioactive Waste Management Complex (RWMC).

- One drum of soil and debris generated at CAS 25-99-21 was characterized as LLW and transported to the Area 5 RWMC for final disposal.

- One drum of soil and debris generated at CAS 25-99-21 was characterized as mixed LLW (MLLW) and transferred to the Area 5 RWMC pending final disposal at an approved treatment, storage, and disposal facility (TSDF).

- A total of 18 lead bricks were removed as PSM from both CASs and staged at Building 23-153 for recycling through Toxco Materials Management Center. The scrap metal (lead) is considered nonregulated *Resource Conservation and Recovery Act* (RCRA) recyclable material.

4.0 Closure Verification Results

Closure verification results consist of the TED results and analytical results from biased verification samples which demonstrate that closure objectives were met. For clean closure, TED results and PSM verification results demonstrate that COCs do not exist within CAS 26-99-05. For the corrective action of closure in place, TED results demonstrate that the FAL was exceeded and COCs are present within CAS 25-99-21.

The CAU 539 SAFER Plan (NNSA/NSO, 2010) identified that the right type, quality, and quantity of data are needed to resolve the DQO decision statements. To verify that the dataset obtained as a result of this investigation supports the DQO decisions, a DQA was conducted. Section 4.1 provides a summary of the DQA, and Section 4.2 summarizes any URs for each CAS.

This section provides a summary of the TED results and verification data from the closure activities as detailed in Appendix D. Except as noted in the following CAS-specific sections, CAU 539 TLD and sampling locations were accessible, and sampling activities at planned locations were not restricted by buildings, storage areas, active operations, or aboveground and underground utilities. The following subsections provide a summary of the CAS-specific verification results as presented in Appendix D.

4.1 Data Quality Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 539 SAFER Plan (NNSA/NSO, 2010) 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 any deviations from the sampling design.

Step 2: Conduct a Preliminary Data Review—A preliminary data review should be performed by reviewing quality assurance (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 censored, determine the impact on DQO decision error.

Step 5: Draw Conclusions from the Data—Perform the calculations required for the test.

4.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A. 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 from the sampling design also are presented.

4.1.1.1 Decision I

The Decision I statement as presented in the CAU 539 SAFER Plan is as follows: "Is any COC present in environmental media within the CAS at a concentration exceeding its corresponding FAL?"

Decision I Rules

- If the population parameter of any COPC in the Decision I population of interest exceeds the corresponding FAL, then the contaminant is identified as a COC, and if practical, the contaminated material will be removed, or Decision II samples will be collected until an estimate of the extent of contaminated material has been made.
- If no COCs associated with a release from the CAS are detected, then further assessment of the CAS is not required, and the CAA of no further action will be selected.
- If a waste is present that, if released, has the potential to cause the further contamination of the site environmental media, then a corrective action will be determined, otherwise no further action will be necessary.

Population Parameter: For the radiological judgmental ballast and subsurface sampling results, the population parameter is the TED. The TED consists of external dose results from TLDs and the internal dose calculated from the soil samples using RESRAD. For nonradiological sampling results, the population parameter is the maximum observed sample result from each individual sample.

4.1.1.1.1 DQO Provisions to Limit False Negative Decision Error

A false negative decision error (where consequences are more severe) was controlled by meeting the following criteria:

1. Having a high degree of confidence that 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

The following methods (stipulated in the CAU 539 DQOs [NNSA/NSO, 2010]) were used in selecting sample locations:

1. Selection of transect locations to collect *in situ* TLD dose measurements used to calculate external dose to a receptor was accomplished by biasing locations to areas most likely to have radiological releases associated with the railroad. The selected TLD locations were identified through biasing factors outlined in the SAFER Plan and included visual observations, elevated

radiological survey results, and/or professional judgement. Once a transect was identified for TLD placement, additional scanning surveys were performed to determine the highest radioactivity readings along each transect for TLD placement.

2. Selection of ballast and subsurface sample locations used to calculate the internal dose to a receptor was accomplished by reviewing the estimated external doses calculated from the TLD data and selecting the TLD transect locations with the highest external dose. Once the TLD transect location was chosen, additional scanning surveys were performed near the TLD to bias the sample to the highest radiological screening result.

3. Selection of verification sample locations was based on the identification of lead bricks as PSM. Following removal of the lead bricks and limited volumes of associated soil, verification samples were collected at lead brick locations where PSM was in contact with soil to determine whether a COC exists.

4. Selection of sampling locations associated with professional judgment based on acceptable knowledge was accomplished by the following:

   - Source and location of release
   - Chemical nature and fate properties
   - Physical transport pathways and properties
   - Transport drivers

<u>Criterion 2</u>

All samples were analyzed using the analytical methods listed in Tables 3-4 and 3-5 of the SAFER Plan and for the chemical and radiological parameters listed in Table 3-1 and discussed in Section B.2.2.2 of the SAFER Plan (NNSA/NSO, 2010). Table 4-1 provides a reconciliation of samples analyzed to the planned analytical program.

Samples were submitted for all of the analytical methods specified in the analytical program specified in Section 3.1 of the SAFER Plan. Additionally, selected verification samples from CAS 25-99-21 collected initially for only RCRA metals were analyzed for gamma spectroscopy, isotopic uranium (U), and isotopic plutonium (Pu) analysis to provide waste characterization data and confirmation of the types of contaminants associated with elevated radiological readings near TLD location AT16.

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 SAFER Plan is that analytical detection limits will be less than the corresponding FAL. The

Table 4-1
CAU 539 Analyses Performed

CAS	Analytes							
	VOCs	SVOCs	Metals	Beryllium	Gamma Spectroscopy	Isotopic U	Isotopic Pu	Sr-90
25-99-21	--	--	S	RS	RS	RS	S	RS
26-99-05	--	--	S	RS	RS	RS	--	RS

RS = Required and submitted
S = Not required but submitted
-- = Not required and not submitted

Pu = Plutonium
Sr = Strontium
SVOC = Semivolatile organic compound
U = Uranium
VOC = Volatile organic compound

assessment of the CAU 539 sample results shows that all detection limits were less than the FAL, and therefore, the sensitivity acceptance criterion was met for all samples.

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, representativeness, completeness, and comparability, as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The DQI acceptance criteria are presented in Table 7-1 of the SAFER Plan (NNSA/NSO, 2010). As presented in the following subsections, these criteria were met for each of the DQIs.

Precision

The analytical criteria for precision were evaluated using the relative percent difference (RPD), absolute difference, or normalized difference. For the purpose of determining the data precision of chemical analyses, an RPD or absolute difference (when results are less than five times the reporting limit) between duplicate analyses was calculated. For radionuclides, the RPD was not calculated unless both the sample and its duplicate had concentrations of the target radionuclide exceeding five times their minimum detectable concentration (MDC). Otherwise, radionuclide duplicate results were evaluated using the normalized difference. Table 4-2 provides the chemical and radiological precision analysis results for all contaminants that were qualified for precision. The only chemical contaminant qualified for precision was barium, and no radionuclides were qualified for precision. Because the precision rates for all contaminants meet the acceptance criteria, the dataset is determined to be acceptable for the DQI of precision.

Table 4-2
Precision Measurements

Contaminant	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Barium	2	10	80

Accuracy

For the purpose of determining data accuracy of sample analyses, environmental soil samples were evaluated and incorporated into the accuracy calculation. The results qualified for accuracy were associated with matrix spike (MS) recoveries that were outside control limits and could potentially be reported at concentrations lower or higher than actual concentrations. There were no chemical or radiological data qualified for accuracy; therefore, the dataset is determined to be acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A was used to address sampling and analytical requirements for CAU 539. 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 and locations that bound COCs). The sampling locations identified in the Criterion 1 discussion meet this criterion. Therefore, the analytical data acquired during the CAU 539 CAI are considered representative of the population parameters.

Completeness

The CAU 539 SAFER Plan (NNSA/NSO, 2010) defines acceptance criteria for completeness to be 80 percent of CAS-specific nontarget contaminants identified in the SAFER Plan having valid results and 100 percent of target contaminants (including Decision II samples) having valid results. Also, the dataset must be sufficiently complete to be able to make the DQO decisions. Lead is identified as the target chemical contaminant, and the following are identified as target radiological contaminants: americium-241, cobalt-60, cesium (Cs)-137, niobium (Nb)-90, strontium (Sr)-90, U-235, and U-238.

There were no rejected data for CAU539; therefore, all data were 100 percent complete and meet the criteria for completeness.

<u>*Comparability*</u>

Field sampling, as described in the CAU 539 SAFER Plan (NNSA/NSO, 2010), was performed and documented in accordance with approved procedures that are in conformance with standard industry practices. Analytical methods and procedures approved by DOE were used to analyze, report, and validate the data. These methods and procedures are in conformance with applicable methods used in industry and government practices. Therefore, project datasets are considered comparable to other datasets generated using standard industry procedures, thereby meeting DQO requirements.

4.1.1.1.2 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 field blanks, trip blanks, laboratory control samples (LCSs), and method blanks, were used to determine whether a false positive analytical result may have occurred. This provision is evaluated during the validation process, and appropriate qualifications are applied to the data results when applicable.

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

4.1.1.2 Decision II

The Decision II statement as presented in the CAU 539 SAFER Plan is as follows: "If a COC is present, is sufficient information available to meet closure objectives?"

<u>Decision Rules</u>

- If the population parameter (the observed concentration of the TED or any COC) in the Decision II population of interest exceeds the corresponding FAL, then additional samples will be collected to complete the Decision II evaluation. If sufficient information is available to define the extent of contamination and confirm the closure objectives have been met, then further assessment of the CAS is not required. If sufficient information is not available to define the extent of contamination or confirm closure objectives have been met, then additional samples will be collected until the extent is defined.

- If the extent of the contamination is defined and additional remediation can be accomplished during the SAFER, then clean close the site by removing the contaminated media until all contamination has been removed. If the extent of contamination has been determined and additional remediation cannot be accomplished during the SAFER, then the contaminated area will be closed in place with appropriate URs and the extent of contamination defined.

- If valid analytical results are available for the waste characterization samples, then the decision will be that sufficient information exists to characterize the IDW and remediation waste for disposal, else collect additional waste characterization samples.

Population Parameter: The population parameter for Decision II data is an individual analytical result from a bounding sample or the observed concentration of each sample used to characterize the potential waste streams.

4.1.1.2.1 DQO Provisions to Limit False Negative Decision Error

A false negative decision error (where consequences are more severe) is controlled by meeting the following criteria:

1. Having a high degree of confidence that the sample locations selected will identify the extent of the COCs.

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.

4. Having a high degree of confidence that the potential waste streams are characterized.

Criterion 1

Rather than conduct Decision II sampling, it was determined to make the following conservative assumption: the TED exceeding the FAL for the Industrial Area scenario is present at any location along the railroad because of (1) the heterogeneous nature of the radiological contamination and (2) the presence of high-activity PSM that is not readily identifiable due to shielding by the ballast.

The assumptions documented in the CSM for locations of release points, transport mechanisms, and migration were applied across the entire length of railroad tracks at CAS 25-99-21 to determine the lateral and vertical extent of contamination rather than step-out soil samples and additional TLD measurements. The assumptions are validated by the visual observations and elevated radiological readings of high-activity PSM that were not contiguous and the heterogeneous external dose estimates at the various locations along the railroad.

An overview of the TLD locations with TED results at CAS 25-99-21 is shown in Figure D.3-1. The locations where the TED exceeds the FAL are TLD locations AT01, AT13, AT14, and AT16. The nature and extent of COCs for these locations are considered representative for all other locations of COCs along the railroad tracks at CAS 25-99-21.

One Decision II sample was collected at location A01 (TLD location AT01) at a depth of 6 to 9 inches (in.) below ground surface (bgs), and results show that the vertical extent of contamination decreases with depth. The nature and extent of COCs at depth for this location are considered representative for all other locations of COCs along the railroad tracks at CAS 25-99-21.

Criterion 2

The second criterion for extent (sensitivity) was accomplished for all analyses as presented under Criterion 2 for Decision I.

Criterion 3

To satisfy the third criterion for extent, the entire dataset, as well as individual sample results, was assessed against the DQIs of precision, accuracy, representativeness, comparability, and completeness, as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The DQI discussion is presented under Criterion 3 for Decision I.

4.1.1.2.2 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 field blanks, trip blanks, LCSs, and method blanks, were used to determine whether a false positive analytical result may have occurred. Nine QA/QC samples were submitted for laboratory analysis, and of the nine QA/QC samples submitted, no false positive analytical results were detected.

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

4.1.1.3 Sampling Design

The SAFER Plan made the following commitments for sampling:

1. Judgmental sampling will be conducted for radiological releases by a combination of soil sample collection and *in situ* TLD dose measurements.

   Result: The locations of TLD measurements and the ballast and subsurface samples were selected based on biasing factors, and all samples were collected.

2. Judgmental sampling will be conducted for nonradiological releases and at locations of potential contamination identified during the closure activities.

   Result: Locations for verification samples were selected based on the potential for contaminant releases from lead bricks as PSM.

4.1.2 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.

4.1.3 Select the Test and Identify Key Assumptions

The test for resolving DQO Decision I for the judgmental sampling design was the comparison of the maximum analyte result or TED from each CAS to the corresponding FAL. The test for ensuring compliance for DQO Decision II was the comparison of all COC analyte results and/or TED from each bounding sample to the corresponding FALs.

The key assumptions that could impact a DQO decision are listed in Table 4-3.

Table 4-3
Key Assumptions

Exposure Scenario	Site workers are exposed to COCs only through oral ingestion, inhalation, external exposure to radiation, or dermal contact with COCs absorbed into the soils (by absorption). Exposure to contamination is limited to industrial workers, construction/remediation workers, and military personnel conducting training.
Affected Media	Surface (i.e., ballast) and shallow subsurface soil underlying the ballast along and adjacent to the railroad tracks is assumed to be affected.
Locations of Contamination/Release Points	Release points are limited to the surface soils along the tracks. Additional release points associated with the high-activity PSM are assumed to exist along the railroad tracks but could not be identified during closure activities.
Transport Mechanisms	Surface transport may occur as a result of stormwater runoff.
Preferential Pathways	None.
Lateral and Vertical Extent of Contamination	Lateral and vertical extent of COCs is assumed to be within the spatial boundaries of each CAS. Contamination, if present, is expected to be contiguous to the release points. Groundwater contamination is not expected.
Groundwater Impacts	None.
Future Land Use	Industrial.
Other DQO Assumptions	All detected contaminants were adjacent to features and decreased with distance.

4.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 539 DQOs and Table 4-3 except as listed below:

- Exception: The lateral extent of contamination is assumed to be contiguous to the release points. However, investigation results revealed that the release points of high-activity PSM and elevated TEDs were not contiguous across the railroad. Soil contamination where it was associated high-activity PSM was contiguous to each release point.
- Impact: No impact on the CSM as the release points are consistent with the CSM.

All data collected during the CAI supported the CSM with the exceptions noted in this section. These exceptions did not invalidate the CSM presented in the SAFER Plan, nor did they necessitate revisions to the CSM.

4.1.4.1 Other DQO Commitments

The SAFER Plan made no other commitments for sampling.

4.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 539 CASs.

4.1.5.1 Decision Rules for Decision I

Decision Rule: If the concentration of any COPC in a target population exceeds the FAL for that COPC during the initial investigation, then that COPC is identified as a COC and Decision II sampling will be conducted.

Result: The following COCs were identified in CAS 25-99-21:

- The TED exceeded the dose specified for the Industrial Area scenario (25 mrem/IA-yr), and high-activity PSM above FALs remains in environmental media.

Decision Rule: If all COPC concentrations are less than the corresponding PALs, then the decision will be no further action.

Result: The TED did not exceed the FAL of 25 mrem/IA-yr, and no COCs were identified in verification samples following the removal of PSM at CAS 26-99-05; therefore, clean closure was identified as the recommended CAA for CAS 26-99-05.

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

Result: For CAS 26-99-05, lead bricks were identified as PSM and removed under a corrective action of clean closure. For CAS 25-99-21, high-activity debris and lead bricks were identified as PSM.

The lead bricks and a limited volume of contaminated soil were remediated, and verification samples show that no COCs associated with the lead bricks remain. A limited removal of high-activity PSM was conducted where the debris was encountered; however, it is assumed that additional high-activity PSM remains in the ballast and underlying soil. Therefore, closure in place with a UR was identified as the recommended corrective action for CAS 25-99-21.

4.1.5.2 Decision Rules for Decision II

Decision Rule: If the observed concentration of any COC in a Decision II sample exceeds the PALs, then additional samples will be collected to complete the determination of the extent.

Result: Rather than conduct Decision II sampling, it was determined to conservatively assume that the TED exceeding the FAL of 25 mrem/IA-yr is present at any location along the railroad. This assumption was made based on the heterogeneous nature of the radiological contamination and presence of high-activity PSM that is not readily identifiable due to shielding by the ballast. The assumptions documented in the CSM for release points, transport mechanisms, and migration pathways were applied across the entire length of the railroad tracks in CAS 25-99-21 to determine the lateral and vertical extent of contamination rather than step-out soil samples and additional TLD measurements. The assumptions are validated by the visual observations of high-activity PSM that were not contiguous and the heterogeneous external dose estimates at the various locations along the railroad.

Decision Rule: If all observed COC population parameters are less than the PALs, then the decision will be that the extent of contamination has been defined in the lateral or vertical direction or both.

Result: The extent of contamination (i.e., those areas where the TED exceeds the FAL) is defaulted to the entire length of the railroad within CAS 25-99-21, with migration limited laterally to less than 15 ft from either side of the railroad tracks and vertically to surface soils/ballast based on visual observations, field screening, and CSM assumptions.

4.2 Use Restrictions

The TED calculated for soil during the closure activities at CAS 26-99-05 was evaluated against the Industrial Area scenario FAL, and it was determined that no COCs were present. The PSM (i.e., lead bricks) was removed, and verification sample results determined that no COCs were present. A corrective action of clean closure was implemented, and no further corrective action is necessary at this CAS.

The TED calculated for soil during the closure activities at CAS 25-99-21 was evaluated against the Industrial Area scenario FAL, and high-activity PSM remains within the CAS; therefore, it was determined that COCs were present. The lead bricks and a limited contaminated soil removal was conducted, and verification sample results determined that no lead contamination remains at a level that causes concern. A corrective action of closure in place with a UR was implemented, and no further corrective action is necessary at this CAS.

Risk evaluations completed for CASs 25-99-21 and 26-99-05 are in Appendix G. Specific information and map locations relating to the UR imposed on CAS 25-99-21 are presented in Appendix F.

Use restriction signs for CAU 539 read as follows: “Warning. Surface radiological contamination up to 15 feet on each side of railroad track. FFACO Site CAU 539/CAS 25-99-21. No activities that may alter or modify the containment control or removal of materials are permitted in this area without U.S. Government permission. Before working in this area, contact Real Estate Services at 702-295-2528.”

4.2.1 CAS 25-99-21, Area 25 Railroad Tracks

The TED for radiological releases exceeds the FAL of 25 mrem/IA-yr at CAS 25-99-21. A conservative assumption was made that the entire length of the railroad may exceed the FAL at any location; therefore, a corrective action of closure in place with a UR was implemented. A total of 99 UR signs were mounted on permanent posts/poles and placed at selected locations within the CAS, focused mostly on road crossings and facility entrances. The UR for CAS 25-99-21 is in Appendix F.

5.0 Conclusions and Recommendations

Based on the results of the closure activities, no further closure activities are necessary for CAU 539.

The DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) provides the following recommendations:

- Clean closure is required at CAS 26-99-05. The presence of lead bricks as PSM was identified. The PSM was removed, and verification sample results show that no COCs remain at this CAS. Therefore, no further corrective action is required at this CAS.
- Closure in place with limited PSM removal is required at CAS 25-99-21. Lead bricks were identified and removed as PSM, along with a limited volume of contaminated soil. Verification sample results show that no lead remains above FALs at this CAS. High-activity debris identified as PSM remains in environmental media at this CAS.
- A UR is required at CAS 25-99-21. An FFACO UR will prohibit activities at this CAS that would result in exposures to site workers in excess of the decision-basis exposure duration without NDEP approval. The FFACO UR will be recorded in the NNSA/NSO Facility Information Management System with the coordinates that define the restricted area.
- A Notice of Completion is requested from NDEP for the closure of CAU 539.
- Corrective Action Unit 539 should be moved from Appendix III to Appendix IV of the FFACO, signifying closure.

6.0 References

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Appendix A

Data Quality Objectives as Developed in the SAFER Plan

Note: This appendix contains the DQOs presented in the SAFER Plan and consists of Appendix B of the SAFER Plan. Therefore, cross-references, page numbers, and header information in this appendix refer to the original document.

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Streamlined Approach for Environmental Restoration (SAFER) Plan for Corrective Action Unit 539: Areas 25 and 26 Railroad Tracks, Nevada Test Site, Nevada

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Appendix B

Data Quality Objective Process

B.1.0 Introduction

The DQO process described in this appendix is a seven-step strategic systematic planning method used to plan data collection activities and define performance criteria for the field investigation of CAU 539, CASs 25-99-21 (Area 25 Railroad Tracks) and 26-99-05 (Area 26 Railroad Tracks). The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to determine the appropriate corrective actions, to verify the adequacy of existing information, to provide sufficient data to implement the corrective actions, and to verify that closure was achieved.

The CAU 539 Areas 25 and 26 Railroad Tracks CAI will be based on the DQOs presented in this appendix as developed by representatives of NDEP and NNSA/NSO. The seven steps of the DQO process presented in Sections B.2.0 through B.8.0 were developed in accordance with *EPA Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006) and the CAS-specific information presented in Section B.2.0.

The DQO process presents a judgmental sampling approach. In general, the procedures used in the DQO process provide:

- A method to establish performance or acceptance criteria that serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study.
- Criteria that will be used to establish the final data collection design such as:
  - The nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated.
  - The decisions or estimates that need to be made and the order of priority for resolving them.
  - The type of data needed.
  - An analytic approach or decision rule that defines the logic for how the data will be used to draw conclusions from the study findings.
- Acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data.

- A data collection design that will generate data meeting the quantitative and qualitative criteria specified. A data collection design specifies the type, number, location, and physical quantity of samples and data, as well as the QA and QC activities that will ensure that sampling design and measurement errors are managed sufficiently to meet the performance or acceptance criteria specified in the DQOs.

B.2.0 Step 1 - State the Problem

Step 1 of the DQO process defines the problem that requires study, identifies the planning team, and develops a conceptual model of the environmental hazard to be investigated.

A modification to the FFACO was approved in May 2010 to transfer the two Railroad Tracks CASs from CAU 114 into CAU 539. The two CASs—CAS 25-99-21, Area 25 Railroad Tracks, and CAS 26-99-05, Area 26 Railroad Tracks—are addressed in this SAFER and consist of the following:

- Potential radiological releases to soil beneath and adjacent to the railroad tracks associated with historical operations of the railroad in Areas 25 and 26.
- Potential releases of organic and inorganic constituents to the surface soil adjacent to the railroad that may present an unacceptable risk to human health and the environment.

The problem statement for the CAU 539 Railroad Tracks CASs is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate CAAs and confirm closure of the two Railroad Tracks CASs in CAU 539."

B.2.1 Planning Team Members

The DQO planning team consists of representatives from NDEP and NNSA/NSO.

B.2.2 Conceptual Site Model

The CSM is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at any point in time. The CSM is a primary vehicle for communicating assumptions about release mechanisms, potential migration pathways, or specific constraints. It provides a summary of how and where contaminants are expected to move and what impacts such movement may have. It is the basis for assessing how contaminants could reach receptors both in the present and future. The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. Accurate CSMs are important as they serve as the basis for all subsequent inputs and decisions throughout the DQO process.

The CSM was developed for the CAU 539 Railroad Tracks CASs using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs.

The CSM consists of:

- Potential contaminant releases (radiological and chemical) along the railroad tracks, including media subsequently affected.
- Release mechanisms (the conditions associated with the release).
- Potential contaminant source characteristics, including contaminants suspected to be present and contaminant-specific properties.
- Site characteristics, including physical, topographical, and meteorological information.
- Migration pathways and transport mechanisms that describe the potential for migration and where the contamination may be transported.
- The locations of points of exposure where individuals or populations may come in contact with a COC associated with a CAS.
- Routes of exposure where contaminants may enter the receptor.

If additional elements that are outside the scope of the CSM are identified during the CAI, the situation will be reviewed and a recommendation will be made as to how to proceed. In such cases, NDEP and NNSA/NSO will be notified and given the opportunity to comment on, and concur with, the recommendation.

The applicability of the CSM to the CASs is summarized in Table B.2-1 and discussed below. Table B.2-1 provides information on CSM elements that will be used throughout the remaining steps of the DQO process. Figure B.2-1 represents site conditions applicable to the CSM and depicts the surface and shallow subsurface releases associated with the railroad tracks, lead bricks, and other potential releases related to normal operation of the railroad, such as hydrocarbon spills.

Table B.2-1
Conceptual Site Model Description of Elements for Each CAS in CAU 539

CAS Identifier	25-99-21	26-99-05
CAS Description	Area 25 Railroad Tracks	Area 26 Railroad Tracks
Site Status	The two railroads are inactive and abandoned. Portions of the railroad are located near currently active facilities (e.g., ETS-1) or facilities undergoing D&D (e.g., R-MAD).	
Exposure Scenario	Occasional Use Area	
Sources of Potential Soil Contamination	Release of fuel flecks and potentially other radioactive material to the ballast and soil beneath the two railroads. Other unspecified organic or inorganic (e.g., lead) releases from the use of the railroad.	
Location of Contamination/ Release Point	Surface and subsurface soil below the railroad tracks and 5 ft laterally of the tracks. Soil beneath and adjacent to the lead bricks.	
Amount Released	Unknown	
Affected Media	Surface and shallow subsurface soil along tracks.	
Potential Contaminants	Radionuclides (Am-241; Cs-137; Co-60; Eu-152, -154, and -155; Nb-94; Sr-90; U-234/235, and -238), Lead, Beryllium, SVOCs, VOCs	
Transport Mechanisms	Percolation of precipitation through subsurface media serves as the major driving force for migration of contaminants. Surface water runoff may provide for the transportation of some contaminants within or outside of the footprints of the CASs (e.g., Topopah Wash).	
Migration Pathways	Vertical transport expected to dominate over lateral transport due to small surface gradients. There will be a component of lateral migration due to the raised road bed.	
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.	
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COCs through oral ingestion, inhalation, dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials.	

B.2.2.1 Contaminant Release

Any contaminants released from CAU 539 Railroad Tracks CASs, regardless of physical or chemical characteristics, are expected to exist within the ballast and/or in the soil adjacent to the release in lateral and vertical directions. For both CASs, the primary locations for radiological contaminants are the ballast and underlying soils and surface and subsurface soil where ballast is not present and

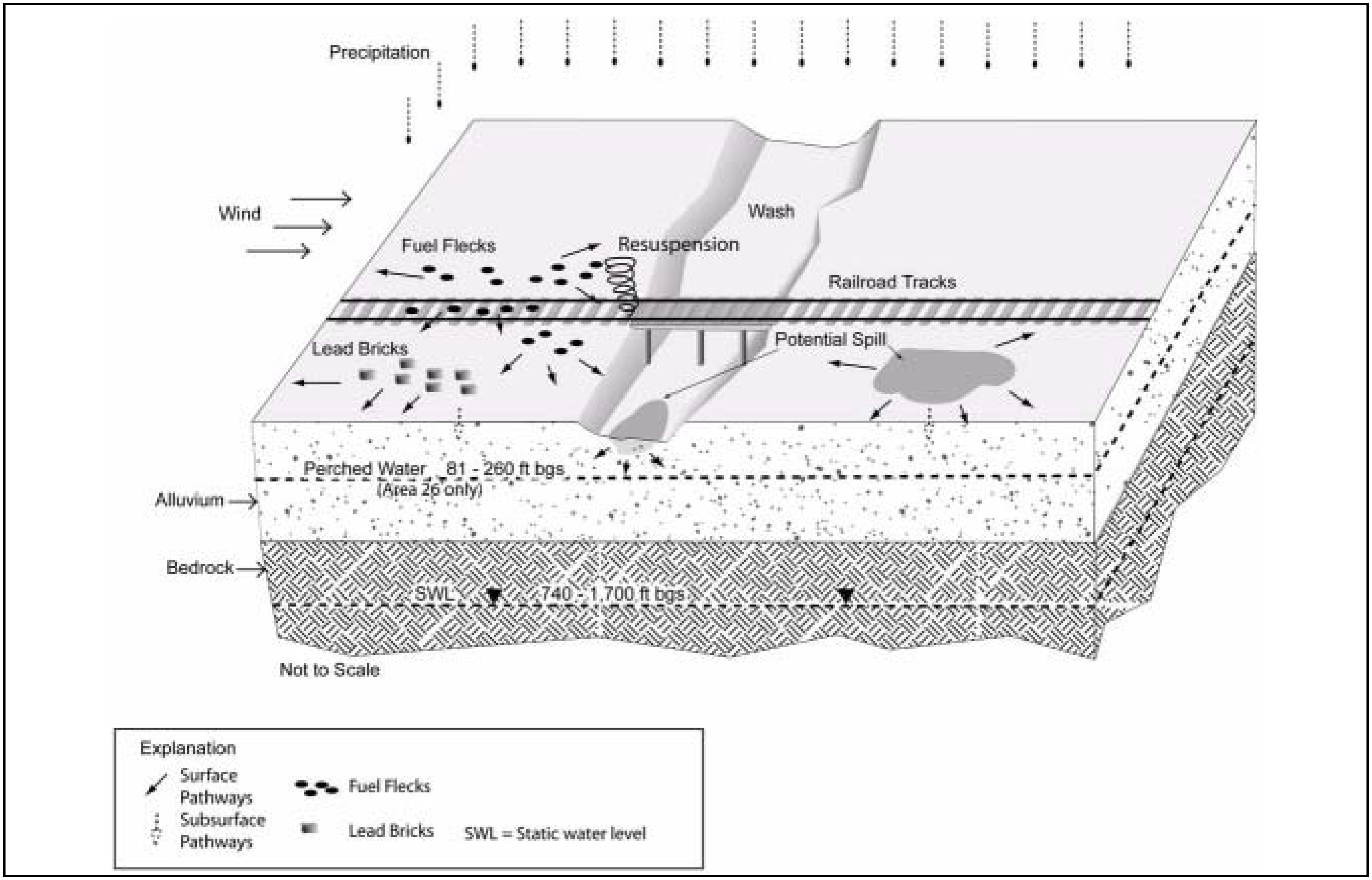

Figure B.2-1
Conceptual Site Model for CAU 539 CASs

5 ft laterally from the tracks in Areas 25 and 26. At the locations where lead bricks were discovered adjacent to the tracks, the primary location for contaminants to be released to the environment is in the soil below the bricks. At any potential spills or other releases, the primary location for contaminants to be released to the environment is in the soil below and adjacent to the release.

The CSM accounts for potential releases resulting from fuel flecks and potentially other radioactive materials that were shaken loose from the railcars carrying reactors, equipment, and other items related to testing activities between the various testing facilities. The CSM also accounts for potential releases resulting from the lead bricks, potential spills, and other releases related to railroad operations.

B.2.2.2 Potential Contaminants

The COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs. Because complete information regarding activities performed at the CAU 539 sites is not available, contaminants detected at similar NTS sites were included in the contaminant lists to reduce uncertainty. The list of COPCs is intended to encompass all of the contaminants that could potentially be present at each CAS.

The COPCs for both CASs include the following radionuclides associated with both fission and activation products typically associated with nuclear reactors and engines: Am-241; U-234/235 and -238; Eu-152, -154, and -155; Sr-90; Cs-137; Co-60; and Nb-94. Other radionuclides may be present at low-activity concentrations.

Nonradiological COPCs include beryllium, lead, VOCs, and SVOCs. The specific COPC is dependant upon the type of release identified. Lead is a COPC due to the identified presence of lead bricks within each CAS. Other potential releases involving organic constituents (e.g., diesel spill) may be present; VOCs and SVOCs are groups of compounds that would contain the organic COPCs. Beryllium is included in the list of COPCs because beryllium legacy sites are associated with R-MAD, E-MAD, TCA, TCC, and ETS-1 in Area 25, and the Pluto Facility in Area 26.

The COPCs will also include creosote on railroad ties and hydrocarbons related to the operation of the railroad cars.

The COPCs applicable to Decision I environmental samples from each of the CASs of CAU 539 are defined as the detectable constituents reported from the analyses stipulated in Table B.2-2. The radionuclides that will be reported from the gamma spectroscopy analysis have some naturally occurring radionuclides (e.g., K-40). These naturally occurring radionuclides are not considered COPCs.

Table B.2-2
Analytical Program[a]

Analyses	CAS 25-99-21	CAS 26-99-05
Organic COPCs		
SVOCs	X[b]	X[b]
VOCs	X[b]	X[b]
Inorganic COPCs		
RCRA Metals	X[b]	X[b]
Beryllium	X	X
Radionuclide COPCs		
Gamma Spectroscopy	X	X
Isotopic U	X	X
Sr-90	X	X

[a]The COPCs are the constituents reported from the analytical methods listed.
[b]Analytical method may be included dependant upon type of release investigated.

X = Required analytical method

During the review of site history documentation, process knowledge information, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs, some of the COPCs were identified as targeted contaminants at specific CASs. Targeted contaminants are those COPCs for which evidence in the available site and process information suggests that they may be reasonably suspected to be present at a given CAS. The targeted contaminants are required to meet more stringent completeness criteria than other COPCs, thus providing greater protection against a decision error (see Section B.7.1). Targeted contaminants for both CAU 539 CASs are identified in Table B.2-3.

Table B.2-3
Targeted Contaminants for CAU 539 Railroad Tracks CASs

CASs	Chemical Targeted Contaminant	Radiological Targeted Contaminants
25-99-21 and 26-99-05	Lead	Am-241, Co-60, Cs-137, Nb-94, Sr-90, U-235, U-238

B.2.2.3 Contaminant Characteristics

Contaminant characteristics include, but are not limited to, solubility, density, and adsorption potential. In general, contaminants with large particle size, low solubility, high affinity for media, and/or high density can be expected to be found relatively close to release points. Contaminants with small particle size, high solubility, low affinity for media, and/or low density are found further from release points or in low areas where evaporation of ponding will concentrate dissolved constituents.

B.2.2.4 Site Characteristics

Site characteristics are defined by the interaction of physical, topographical, and meteorological attributes and properties. Physical properties include permeability, porosity, hydraulic conductivity, degree of saturation, sorting, chemical composition, and organic content. Topographical and meteorological properties and attributes include slope stability; precipitation frequency and amounts; precipitation runoff pathways; drainage channels and ephemeral streams; and evapotranspiration potential. Migration pathways and transport mechanisms relevant to the present investigation are discussed in Section B.2.2.5.

Area 25: Jackass Flats lies within the Alkali Flat-Furnace Creek Ranch sub-basin. Depths to groundwater for the three water supply wells located within Area 25 are 1,041 ft, 928 ft, and 740 ft below ground surface (bgs) (USGS, 1995). The movement of groundwater within Jackass Flats is to the southwest, ultimately discharging into areas within the Amargosa River Valley (DRI, 1988; DOE, 1988).

Area 25 contains Jackass Flats, which is an intermontane valley bordered by highlands on all sides except for a large drainage outlet to the southwest. Elevations range from 3,400 to 5,600 ft above mean sea level (amsl). The Jackass Flats basin is underlain by alluvial, colluvial, and volcanic rocks of Cenozoic age. The alluvium and colluvium are above the saturated zone throughout most of

Jackass Flats. Paleozoic sedimentary rocks, limestone, and dolomite occur at greater depths (NNSA/NV, 2001).

Area 26: Area 26 is generally bounded on the southwest by the low drainage divide between Wahmonie Flat and Jackass Flats, on the northwest by Lookout Peak, on the northeast by small rugged hills that are unnamed, and on the south by Skull Mountain. Area 26 is located midway between Jackass Flats and Frenchman Flat. The portion of Area 26 of concern to CAU 539 Railroad CAI is an intermontane valley bordered by highlands on all sides except for drainage outlets to the southwest and southeast. Area 26 is located in the transition zone between the northern edge of the Mojave Desert and the southern portion of the Great Basin Desert. Elevations where Project Pluto facilities are present range from 4,200 to 4,400 ft amsl (NNSA/NV, 2001).

A perched water table occurs in a zone of highly fractured bedrock in Area 26. Static perched water levels range from 81 to 167 ft bgs. The perched water may extend to depths exceeding 261 ft bgs before encountering rocks with a low-fracture permeability. The regional water table is thought to be at a depth of approximately 1,700 ft bgs (NNSA/NV, 2001).

B.2.2.5 Migration Pathways and Transport Mechanisms

Migration pathways include the lateral migration of potential contaminants as a result of surface water runoff across surface soils/sediments and vertical migration of potential contaminants through subsurface soils due to percolation. Contamination, if present, is expected to be contiguous to the release points. The Area 25 Railroad Tracks location is dissected by numerous ephermal drainages of which Topopah Wash is the primary drainage in the area. Topopah Wash, originating in the Calico Hills, bisects Jackass Flats and also joins with the Amargosa River, further to the east (DRI, 1996). Contaminants released into Topopah Wash are subject to much higher transport mechanisms than contaminants released to other surface areas. Topopah Wash is generally dry but is subject to infrequent, potentially intense stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and horizontal transport of contaminants. In Area 26, although a minimal number of small drainages cross the railroad, there are no major/primary drainages present to provide a significant horizontal transport mechanism.

Infiltration and percolation of precipitation serves as a driving force for downward migration of contaminants. However, due to the low permeability of the alluvium throughout both areas, high potential evapotranspiration rates (annual potential evapotranspiration at the Area 3 Radiological Waste Management Site has been estimated at 62.6 inches [in.] [Shott et al., 1997]), and low precipitation rates (approximately 5.72 in. per year in Area 25 as measured from station 4JA [ARL/SORD, 2009], and approximately 7.71 in. per year in Area 26 at nearby Cane Spring [ARL/SORD, 2009]), percolation of infiltrated precipitation at the NTS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992). Environmental contamination is, therefore, expected to be limited to the area near release points. Other potential minor transport of contamination may include wind-borne material and material pushed along road crossings within release areas. Based on the particle size of fuel flecks associated with radiological releases from railroad cars, wind-borne transport of radioactive fuel flecks is expected to be minor.

B.2.2.6 Land-Use and Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion, inhalation, dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials, or irradiation by radioactive materials. The land-use and exposure scenarios for the CAU 539 Railroad Tracks CASs are listed in Table B.2-4. These are based on NTS current and future land use (DOE/NV, 1998). Portions of CASs 25-99-21 and 26-99-05 are located adjacent to and outside existing facilities and structures; however, these facilities are not expected to be used as assigned work stations for NTS site personnel. These sites, therefore, are classified as occasional work areas. Other abandoned portions of the railroads are at remote locations without any site improvements and where no regular work is performed. However, the possibility still exists that site workers could occupy any of these locations on an occasional and temporary basis, such as when a military or training exercise is being conducted (e.g., former Test Bunker facility). Therefore, these sites are classified as occasional work areas.

Table B.2-4
Land-Use and Exposure Scenarios

CAS	Record of Decision Land Use Zone	Exposure Scenario
25-99-21 and 26-99-05	Research Test and Experiment Zone This area is designated for small-scale research and development projects and demonstrations; pilot projects; outdoor tests; and experiments for the development, quality assurance, or reliability of material and equipment under controlled conditions. This zone includes compatible defense and nondefense research, development, and testing projects and activities.	Occasional Use Area Worker will be exposed to the site occasionally (up to 80 hours per year for 5 years). Site structures are not present for shelter and comfort of the worker.

B.3.0 Step 2 - Identify the Goal of the Study

Step 2 of the DQO process states how environmental data will be used in meeting objectives and solving the problem, identifies study questions or decision statement(s), and considers alternative outcomes or actions that can occur upon answering the question(s). Figure B.3-1 depicts the sequential flow of decision points and action alternatives required to fulfill the objectives of the SAFER process.

B.3.1 Decision Statements

The Decision I statement is: "Is any COC present in environmental media within the CAS at a concentration exceeding its corresponding FAL?" For a judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006). If a COC is detected, then Decision II must be resolved.

The Decision II statement is: "If a COC is present, is sufficient information available to meet the closure objectives?" Sufficient information is defined to include:

- Identifying the volume of media containing any COC bounded by analytical sample results in lateral and vertical directions.
- The information needed to characterize IDW for disposal.
- The information needed to determine potential remediation waste types.

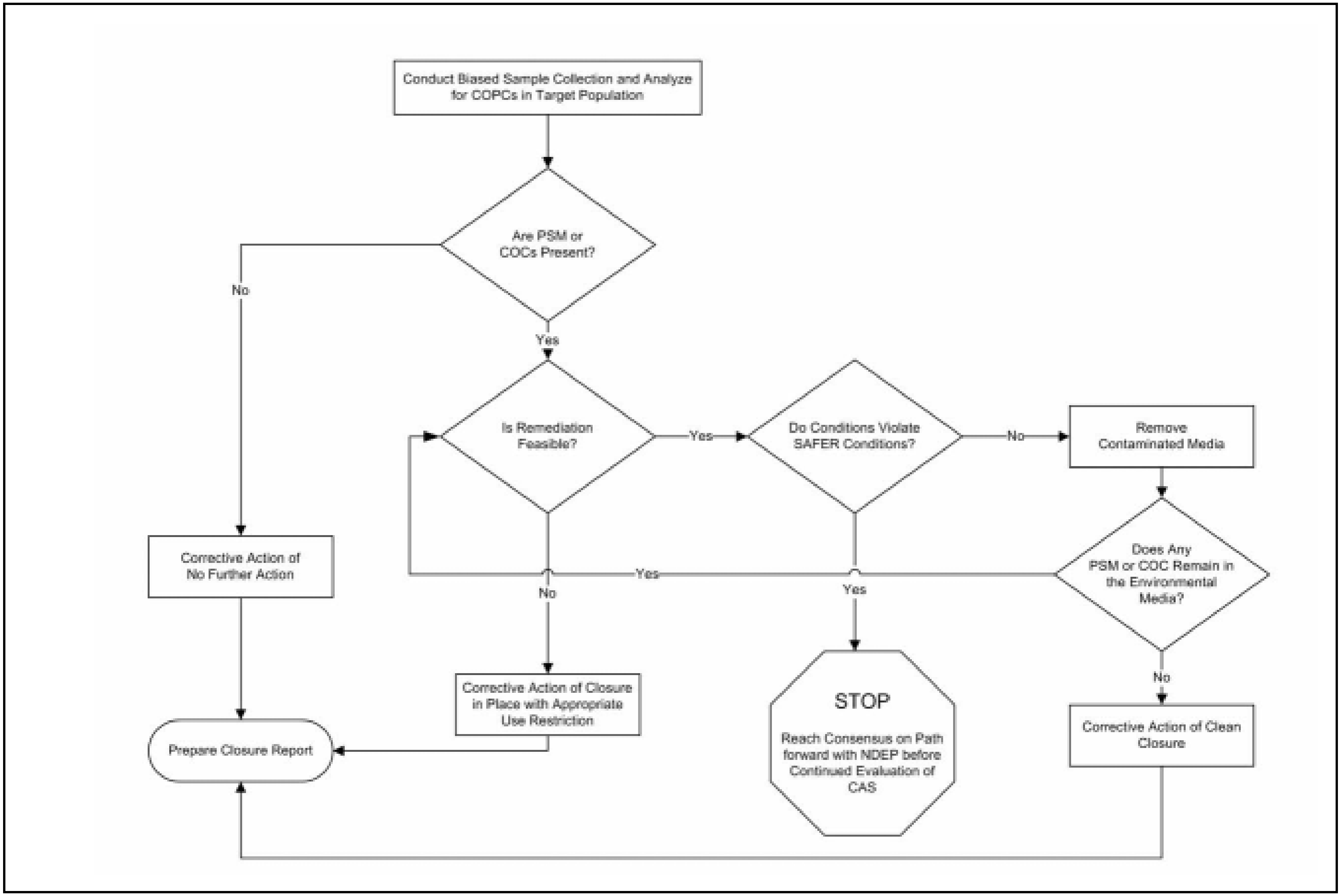

Figure B.3-1
SAFER Closure Decision Process for CAU 539 CASs

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes that are present at a site to impose COCs into site environmental media if the wastes were to be released. To evaluate the potential for site wastes to result in the introduction of a COC to the surrounding environmental media, the following conservative assumption was made:

- For nonliquid 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 sufficient information is not available to meet the closure objectives, then site conditions will be re-evaluated and additional samples will be collected (as long as the scope of the CAI is not exceeded and any CSM assumption has not been shown to be incorrect).

B.3.2 Alternative Actions to the Decisions

This section identifies actions that may be taken to solve the problem depending on the possible outcomes of the CAI.

B.3.2.1 Alternative Actions to Decision I

If no COC associated with a release from the CAS is detected, then further assessment of the CAS is not required, and the CAA of no further action will be selected. If a COC associated with a release from the CAS is detected, then additional sampling will be conducted to determine the extent of COC contamination.

B.3.2.2 Alternative Actions to Decision II

If sufficient information is available to define the extent of COC contamination and confirm that closure objectives were met, then further assessment of the CAS is not required. If sufficient information is not available to define the extent of contamination or confirm that closure objectives were met, then additional samples will be collected until the extent is defined.

If the extent of the contamination is defined and remediation can be accomplished during the SAFER, then clean close the site by removing the contaminated media until all COCs have been removed. If the collection of verification samples confirm that all the contaminated media have been removed, then the clean closure objectives will have been met. If the extent of contamination has been determined and additional remediation cannot be accomplished, then the contaminated area will be closed in place with appropriate URs.

B.4.0 Step 3 - Identify Information Inputs

Step 3 of the DQO process identifies the information needed, determines sources for information, and identifies sampling and analysis methods that will allow reliable comparisons with FALs.

B.4.1 Information Needs

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

- Samples must be collected in areas most likely to contain a COC (judgmental sampling) and areas most likely to exceed a 25-mrem/yr total effective dose (TED).
- The analytical methods and *in situ* measurements must be sufficient to detect a 25-mrem/yr dose for radiological releases.
- The analytical suite selected must be sufficient to identify any COCs present in the samples for nonradiological releases.

To resolve Decision II (determine whether sufficient information is available to confirm that closure objectives were met at each CAS), samples must be collected and analyzed to meet the following criteria:

- Samples must be collected in areas contiguous to the contamination but where contaminant concentrations are below FALs.
- Samples of the waste or environmental media must provide sufficient information to determine potential remediation waste types.
- The analytical suites selected must be sufficient to detect contaminants at concentrations equal to or less than their corresponding FALs.

B.4.2 Sources of Information

Information to satisfy Decision I and Decision II will be generated by collecting environmental samples using grab sampling, hand auguring, or other appropriate sampling methods, as well as collection of dose rate measurements using TLDs. The environmental samples will be submitted to analytical laboratories meeting the quality criteria stipulated in the Industrial Sites QAPP

(NNSA/NV, 2002a). Screening levels/nonvalidated data (e.g., radiological surveys) will be used to guide the detailed judgmental sampling; however, only validated data from analytical laboratories will be used to support DQO decisions. Sample collection and handling activities will follow standard procedures.

Radiological data collected will estimate the TED at each selected transect along the railroad. The TED will be determined by summing the internal and external dose components. For internal dose, sample results will be used to calculate internal dose using the Residual Radioactive (RESRAD) computer code (Yu et al., 2001). External dose will be determined by collecting *in situ* measurements using TLDs. Decision criteria are based on the maximum TED estimate at any given transect. Information on decreasing TED rate trends will be generated through soil sampling and calculating TED rates from Decision II samples, and correlating the dose with distance from point of release.

All waste characterization data must be sufficient to meet the quality requirements of the designated waste acceptance criteria. Waste disposal documentation, field surveys, and other appropriate information may also be used to ensure corrective actions were completed as planned.

B.4.2.1 Sample Locations

Design of the sampling approaches for the CAU 539 CASs must ensure that the data collected are sufficient for selection of the CAAs (EPA, 2002). To meet this objective, the samples collected from each site should be from locations that most likely contain a COC, if present. These sample locations, therefore, can be selected by means of biasing factors used in judgmental sampling (e.g., a stain likely containing a spilled substance). Because sufficient data are available to develop a judgmental sampling plan, this approach was used to select locations for sampling environmental media at the CASs. Biasing factors include areas of elevated radiological readings and piles of lead bricks.

B.4.2.1.1 Judgmental Approach for Sampling Location Selection

Decision I sample locations at CASs 25-99-21 and 26-99-05 will be determined based upon the likelihood of the soil containing a COC, if present at the CAS. These locations will be selected based on field-screening techniques, biasing factors, the CSM, and existing information. Analytical suites for Decision I samples will include all COPCs identified in Table B.2-2.

Field-survey techniques will be used to select appropriate sampling locations by providing semiquantitative data. Field screening may also be used for health and safety monitoring and to assist in making certain health and safety decisions. The following field-survey methods and biasing factors may be used to select biased sample locations at CAU 539 CASs:

- Walkover radiological surveys: A radiological gamma walkover survey was conducted in August and September 2009 using a hand-held TSA PRM470 scintillation radiation detector coupled with a Trimble global positioning system to identify any areas with elevated radiological readings. The survey was conducted along each track of the railroad. Any points of interest were also surveyed. The results of the survey show various levels of readings ranging from indistinguishable from background to elevated readings. Elevated radioactivity was detected in four primary areas along the railroad tracks: TCC, the posted radiological materials area near TCC, TCA, and R-MAD. All features and points of interest were documented. The information and the data generated during the survey are archived in the Geographic Information Systems (GIS).

- Radiological surveys will be conducted under any railroad trestles during the initial phase of the field effort. If these surveys show radiological contamination, the sample locations will be adjusted accordingly.

- Elevated radiation: *In situ* TLD measurements will be used to select soil sample locations with the highest elevated reading above surrounding background soil.

- Stains: Any discolored soil, material, or other surfaces.

- Drums, containers, equipment, or debris: Materials that may have been used at, or added to, a location and that may have contained or come in contact with hazardous or radioactive substances at some point during their use. Note that, during the initial site visits, drums full of railroad spikes and piles of lead bricks were observed.

- Preselected areas based on process knowledge of the site: Locations for which evidence, such as historical photographs, experience from previous investigations, or interviewee’s input, exists that a release of hazardous or radioactive substances may have occurred.

- Preselected areas based on process knowledge of the contaminant(s): Locations that may reasonably have received contamination, selected on the basis of the chemical and/or physical properties of the contaminant(s) in that environmental setting.

- Experience and data from investigations of similar sites that have radiologically contaminated soil.

- Visual indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination.

- Other biasing factors: Factors not previously defined for the CAI, but become evident once the investigation of the site is under way.

Decision II sample locations will be selected based on the CSM, biasing factors, and existing data. Analytical suites will include those parameters that exceeded FALs (i.e., COCs) in Decision I samples. Biasing factors to support Decision II sample locations include Decision I biasing factors plus available analytical results.

B.4.2.2 Analytical Methods

Analytical methods are available to provide the data needed to resolve the decision statements. The analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy) are provided in Tables 3-4 and 3-5.

B.5.0 Step 4 - Define the Boundaries of the Study

Step 4 of the DQO process defines the target population of interest and its relevant spatial boundaries, specifies temporal and other practical constraints associated with sample/data collection, and defines the sampling units on which decisions or estimates will be made.

B.5.1 Target Populations of Interest

The population of interest to resolve Decision I ("Is any COC present in environmental media within the CAS?") is any location within the CAS that contains contaminant concentrations above a FAL. In the case of radionuclides, the population of interest is any location where the TED exceeds the FAL. The populations of interest to resolve Decision II ("If a COC is present, is sufficient information available to evaluate potential CAAs?") are:

- Each one of a set of locations bounding contamination in lateral and vertical directions.
- IDW or environmental media that must be characterized for disposal.
- Remediation waste.

B.5.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination at each CAS, as shown in Table B.5-1. Contamination found beyond these boundaries may indicate a flaw in the CSM and may require re-evaluation of the CSM before the investigation could continue. Each CAS is considered geographically independent, and intrusive activities are not intended to extend into the boundaries of neighboring CASs or existing URs from previously investigated CAUs.

Table B.5-1
Spatial Boundaries of CAU 539 CASs

CAS	Spatial Boundaries
25-99-21 and 26-99-05	The lateral boundary for railroad releases is 1 mi (to allow for migration due to erosion); the vertical boundary (depth) is limited to 10 ft bgs.
	The boundary for the lead bricks is within 5 ft laterally from the bricks, and 10 ft bgs vertically.
	For other potential releases, the vertical boundary is limited to 10 ft bgs below the release point, and the horizontal boundary is 50 ft laterally from the release point.

B.5.3 Practical Constraints

Practical constraints that may affect the ability to investigate this site include military activities at the NTS, utilities, threatened or endangered animal and plants, unstable or steep terrain, and/or access restrictions.

B.5.4 Define the Sampling Units

The scale of decision making in Decision I is defined as the CAS. Any COC detected at any location within the CAS will cause the determination that the CAS is contaminated and needs further evaluation. The scale of decision making for Decision II is defined as a contiguous area contaminated with any COC originating from the CAS. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically.

B.6.0 Step 5 - Develop the Analytic Approach

Step 5 of the DQO process specifies appropriate population parameters for making decisions, defines action levels, and generates an "If … then … else" decision rule that defines the conditions under which possible alternative actions will be chosen. This step also specifies the parameters that characterize the population of interest, specifies the FALs, and confirms that the analytical detection limits are capable of detecting FALs.

B.6.1 Population Parameters

For chemical judgmental sampling results, the population parameter is the observed concentration of each contaminant from each individual analytical sample. Each sample result will be compared to the FALs to determine the appropriate resolution to Decision I and Decision II. For Decision I, a single sample result for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS.

For radiological judgmental ballast and subsurface sampling results, the population parameter is the TED. For ballast results, the TED is composed of external dose results from TLDs and the internal dose calculated from the soil samples using RESRAD (Yu et al., 2001). For subsurface sampling results, the TED is the internal and external doses calculated from the soil samples using RESRAD.

The Decision II population parameter is an individual analytical result from a bounding sample. For Decision II, a single bounding sample result for any contaminant exceeding a FAL would cause a determination that the contamination is not bounded.

B.6.2 Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation and, therefore, streamline the consideration of remedial alternatives. The 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 NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2009a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2009b) 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 (i.e., FALs) or to establish that corrective action is not necessary."

This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- Tier 1 evaluation - conducted by comparing sample results from source areas (highest concentrations) to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the SAFER Plan). 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 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 TPH concentrations 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 ASTM Method E1739 that consider site-, pathway-, and receptor-specific parameters.

The comparison of laboratory results to FALs and the evaluation of potential corrective actions will be included in the investigation report. The FALs will be defined (along with the basis for their definition) in the investigation report.

B.6.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the EPA *Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites* (EPA, 2009) for industrial soils. Background concentrations for RCRA metals will be used instead of SLs when natural background concentrations exceed the SL, as is often the case with arsenic on the NTS. Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established SLs, the protocol used by EPA Region 9 in establishing SLs (or similar) will be used to establish PALs. If used, this process will be documented in the investigation report.

B.6.2.2 Radionuclide PALs

The PALs for radiological contaminants (other than tritium) are based on the NCRP Report No. 129 recommended screening limits for construction, commercial, and industrial land-use scenarios (NCRP, 1999) scaled to 25-mrem/yr dose constraint (Murphy, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). These PALs are based on the construction, commercial, and industrial land-use scenarios provided in the NCRP Report and are appropriate for the NTS based on future land use scenarios as presented in Section B.2.2.6.

B.6.3 Decision Rules

The decision rules applicable to both Decision I and Decision II are:

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

The decision rules for Decision I are:

- If the population parameter of any COPC in the Decision I population of interest (defined in Step 4) exceeds the corresponding FAL, then that contaminant is identified as a COC, and if practicable, the contaminated material will be removed, or Decision II samples will be collected until an estimate of the extent of contaminated material has been made.

- If no COC associated with a release from the CAS is detected, then further assessment of the CAS is not required and the CAA of no further action will be selected.

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

The decision rules for Decision II are:

- If the population parameter (the observed concentration of any COC or the TED) in the Decision II population of interest (defined in Step 4) exceeds the corresponding FAL, then additional samples will be collected to complete the Decision II evaluation. If sufficient information is available to define the extent of COC contamination and confirm that closure objectives were met, then further assessment of the CAS is not required. If sufficient information is not available to define the extent of contamination or confirm that closure objectives were met, then additional samples will be collected until the extent is defined.

- If the extent of the contamination is defined and additional remediation can be accomplished during the SAFER, then clean close the site by removing the contaminated media until all contamination has been removed. If the extent of contamination has been determined and additional remediation cannot be accomplished during the SAFER, then the contaminated area will be closed in place with appropriate URs and the extent of contamination defined.

- If valid analytical results are available for the waste characterization samples defined in Section B.8.0, then the decision will be that sufficient information exists to characterize the IDW and remediation waste for disposal, else collect additional waste characterization samples.

B.7.0 Step 6 - Specify Performance or Acceptance Criteria

Step 6 of the DQO process defines the decision hypotheses, specifies controls against false rejection and false acceptance decision errors, examines consequences of making incorrect decisions from the test, and places acceptable limits on the likelihood of making decision errors.

B.7.1 Decision Hypotheses

The baseline condition (i.e., null hypothesis) and alternative condition for Decision I are:

- Baseline condition – A COC is present.
- Alternative condition – A COC is not present.

The baseline condition (i.e., null hypothesis) and alternative condition for Decision II are as follows:

- Baseline condition – The extent of a COC has not been defined.
- Alternative condition – The extent of a COC has been defined.

Decisions and/or criteria have false negative or false positive errors associated with their determination. The impact of these decision errors and the methods that will be used to control these errors are discussed in the following subsections. In general terms, confidence in DQO decisions based on judgmental sampling results will be established qualitatively by:

- Developing and achieving concurrence of CSMs (based on process knowledge) by stakeholder participants during the DQO process.
- Conducting validity testing of CSMs based on investigation results.
- Evaluating data quality based on DQI parameters.

B.7.2 False Negative Decision Error

The false negative decision error would mean deciding that a COC is not present when it actually is (Decision I), or deciding that the extent of a COC has been defined when it has not (Decision II). In both cases, the potential consequence is an increased risk to human health and the environment.

B.7.2.1 False Negative Decision Error for Judgmental Sampling

In judgmental sampling, the selection of the number and location of samples is based on knowledge of the feature or condition under investigation and on professional judgment (EPA, 2002). Judgmental sampling conclusions about the target population depend upon the validity and accuracy of professional judgment.

The false negative decision error (where consequences are more severe) for judgmental sampling designs is controlled by meeting these criteria:

- For Decision I, having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS. For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.
- Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.
- Having a high degree of confidence that the dataset is of sufficient quality and completeness.

To satisfy the first criterion, Decision I samples must be collected in areas most likely to be contaminated by COCs (supplemented by random samples where appropriate). Decision II samples must be collected in areas that represent the lateral and vertical extent of contamination (above FALs). The following characteristics must be considered to control decision errors for the first criterion:

- Source and location of release
- Chemical nature and fate properties
- Physical transport pathways and properties
- Hydrologic drivers

These characteristics were considered during the development of the CSMs and selection of sampling locations. The field survey methods and biasing factors listed in Section B.4.2.1 will be used to further ensure that appropriate sampling locations are selected to meet these criteria. Radiological survey instruments and field-screening equipment will be calibrated and checked in accordance with the manufacturer's instructions and approved procedures. The investigation report will present an assessment on the DQI of representativeness that samples were collected from those locations that best represent the populations of interest as defined in Section B.5.1.

To satisfy the second criterion, Decision I samples will be analyzed for the chemical and radiological parameters listed in Section 3.2 of this SAFER Plan. Decision II samples will be analyzed for those chemical and radiological parameters that identified unbounded COCs. The DQI of sensitivity will be assessed for all analytical results to ensure that all sample analyses had measurement sensitivities (detection limits) that were less than or equal to the corresponding FALs. If this criterion is not achieved, the affected data will be assessed (for usability and potential impacts on meeting site characterization objectives) in the investigation report.

To satisfy the third criterion, the entire dataset, as well as individual sample results, will be assessed against the DQIs of precision, accuracy, comparability, and completeness as defined in the Industrial Sites QAPP (NNSA/NV, 2002a) and in Section 7.2 of this SAFER Plan. The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as to assess the need to potentially "flag" (qualify) individual contaminant results when corresponding QC sample results are not within the established control limits for precision and accuracy. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the analyte performance criteria based on an assessment of the data. The DQI for completeness will be assessed to ensure that all data needs identified in the DQO have been met. The DQI of comparability will be assessed to ensure that all analytical methods used are equivalent to standard EPA methods so that results will be comparable to regulatory action levels that have been established using those procedures. Strict adherence to established procedures and QA/QC protocol protects against false negatives. Site-specific DQIs are discussed in more detail in Section 7.2 of this SAFER Plan.

To provide information for the assessment of the DQIs of precision and accuracy, the following QC samples will be collected as required by the Industrial Sites QAPP (NNSA/NV, 2002a):

- Field duplicates (minimum of 1 per matrix per 20 environmental samples)
- Laboratory QC samples (minimum of 1 per matrix per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)

B.7.3 False Positive Decision Error

The false positive decision error would mean deciding that a COC is present when it is not, or a COC is unbounded when it is not, resulting in increased costs for unnecessary sampling and analysis.

False positive results are typically attributed to laboratory and/or sampling/handling errors that could cause cross contamination. To control against cross contamination, decontamination of sampling equipment will be conducted in accordance with established and approved procedures, and only clean sample containers will be used. To determine whether a false positive analytical result may have occurred, the following QC samples will be collected as required by the Industrial Sites QAPP (NNSA/NV, 2002a):

- Trip blanks (one per sample cooler containing VOC environmental samples)
- Equipment blanks (one per sampling event for each type of decontamination procedure)
- Source blanks (one per source lot per sampling event)
- Field blanks (minimum of one per CAS, additional samples required if field conditions change)

B.8.0 Step 7 - Develop the Plan for Obtaining Data

Step 7 of the DQO process selects and documents a design that will yield data that will best achieve performance or acceptance criteria. A judgmental sampling scheme will be implemented to select sample locations and evaluate analytical results for CASs 25-99-21 and 26-99-05 in CAU 539. Sections B.8.1 and B.8.2 contain general and specific information about collecting Decision I and Decision II samples under judgmental sampling designs. These sections also provide CAS-specific sampling activities, including proposed TLD placement and/or sample locations, when applicable.

These CASs are combined for discussion of investigation activities because both CASs will be investigated in the same manner and both CASs have similar releases of fuel flecks and potentially other radioactive material to the soil surrounding the railroads from the transport of reactors and equipment between testing facilities. Lead bricks were also discovered along each railroad. Figure B.8-1 shows the current site conditions of the railroad in CAS 25-99-21, and Figure B.8-2 shows the current site conditions of the railroad in CAS 26-99-05.

Figure B.8-1
Current Site Conditions at CAS 25-99-21

Figure B.8-2
Current Site Conditions at CAS 26-99-05

B.8.1 Decision I Sampling

A judgmental sampling approach will be implemented for the Decision I investigation of the CAU 539 Railroad Tracks CASs. Because individual sample results, rather than an average concentration, will be used to compare to FALs at the CASs undergoing judgmental sampling, statistical methods to generate site characteristics will not be used. Adequate representativeness of the entire target population may not be a requirement to developing a sampling design. If good prior information is available on the target site of interest, then the sampling may be designed to collect samples only from areas known to have the highest concentration levels on the target site. If the observed concentrations from these samples are below the action level, then a decision can be made that the site contains safe levels of the contaminant without the samples being truly representative of the entire area (EPA, 2006).

All sample locations will be selected to satisfy the DQI of representativeness in that samples collected from selected locations will best represent the populations of interest as defined in Section B.5.1. To meet this criterion for judgmentally sampled sites, a biased sampling strategy will be used for

Decision I samples to target areas with the highest potential for contamination, if it is present anywhere in the CAS. Sample locations will be determined based on process knowledge, previously acquired data, or the field-screening and biasing factors listed in Section B.4.2.1. If biasing factors are present in soils below locations where Decision I samples were removed, additional Decision I soil samples will be collected at depth intervals selected by the Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present. The Site Supervisor has the discretion to modify the judgmental sample locations, but only if the modified locations meet the decision needs and criteria stipulated in this DQO.

B.8.1.1 Decision I Radiological Sampling Approach

The following subsections describe, in general order, the Decision I radiological sampling approach for both CAU 539 Railroad Tracks CASs. Radiological data collected will estimate the TED at selected transects along the railroad that represent the maximum dose to receptors. The TED will be determined by summing the internal and external dose components. Analytical results from soil samples will be used to calculate internal dose using RESRAD computer code (Yu et al., 2001). External dose will be determined by collecting *in situ* measurements using TLDs.

Internal dose is the combination of doses resulted from ingestion and inhalation of radioactive material (Yu et al., 2001). For the CAU 539 Railroad Tracks CASs, there is no ingestion pathway by food and water consumption because of the designated land-use scenarios (DOE/NV, 1998). That leaves only soil ingestion and inhalation as the potential pathway for internal dose to the receptor.

The primary determining factor for soil ingestion and inhalation is the direct contact with the contaminated soils. Particle size and solubility also need to be considered while conducting the dose assessment for soil ingestion and inhalation (Yu et al., 2001).

The configuration and location of the Railroad Tracks CASs precludes any constant direct worker contact with potentially contaminated soils. The PSM (fuel flecks) has physically settled inside the environmental media (e.g., ballast), and resuspension of those flecks would have to be caused by intrusive activities. Coupled with the extremely low solubility of the fuel flecks and low precipitation on the NTS, the migration potential is significantly limited.

The effects of nuclear fuel particles, released to the environment, on humans have been assessed in a few epidemiological and theoretical studies. These studies are based on occupational exposure and exposure to uranium fuel particles released from the Chernobyl accident. A study of nuclear fuel particle resuspension as a result of anthropogenic activities has shown that the concentration of large particles (12 to 20 micrometers [μm]) in air increased by more than an order of magnitude than the concentration of fine particles (2 to 4 μm) (Garger et al., 1998). This trend of increased concentration in air for larger particles as a result of anthropogenic activities has been reported for other radioactive aerosols (Kim et al., 2006). As discussed, the fuel flecks (i.e., the PSM) have settled into the environmental media (soil and ballast) and, as a result, there is an extremely low potential for the fuel flecks to be re-suspended into the air as a result of non-anthropogenic activities. Therefore, it is highly improbable to have fine fuel-fleck material pose an inhalation issue.

Studies of the solubility of nuclear fuel particles from the Chernobyl reactor indicated that the dissolution rate constant decreased (for all nuclides) with increasing particle size. The decreasing inhalation dose with size and increasing dose with lower solubility may counterbalance each other for fission products (Garger et al., 2004).

Ingestion of insoluble particles, such as nuclear fuel compounds, does not pose significant radiological health effect. Uranium oxide (e.g., UO_2, UO_3) particles are not absorbed to any significant extent. Fission products are also absorbed poorly in their elemental form, and they are almost metabolically inert when fused in a uranium matrix (Lang et al., 1995). Under the designated land-use scenario, the significance from short-term intrusive activities particle resuspension at the Railroad Tracks CASs on the inhalation and soil ingestion dose is negligible.

Decision criteria are based on the maximum TED estimate at any given transect. Information on decreasing TED rate trends will be generated through soil sampling and calculating TED rates from Decision II samples, and correlating the dose with distance from point of release.

B.8.1.1.1 Collection of In Situ TLD Dose Measurements

To collect *in situ* dose measurements and provide a biasing factor for soil sample selection, TLDs will be placed at transects perpendicular to the railroad tracks. A total of 25 transects will be selected for TLD placement with 20 transects along the Area 25 Railroad Tracks and 5 transects along the

Area 26 Railroad Tracks. The selection criteria for placement of the TLDs include: (1) highest radiological readings from the gamma walkover survey conducted in August and September 2009; (2) areas with road crossings, switches, or trestles that could increase vibrations of railcars; and (3) culverts and/or bridges that could increase vibrations of railcars.

The TLD transect locations for CAS 25-99-21 are shown in Figure B.8-3. Based on the TLD dose measurements, a minimum of five transects will be selected for surface and subsurface soil sampling. Locations will be selected in areas most likely to be contaminated based on the conceptual model and other biasing factors outlined in Step 3 of the DQO process (e.g., field screening). The soil beneath and adjacent to the lead bricks at CAS 25-99-21 will be sampled during Decision I activities.

The five TLD transect locations for CAS 26-99-05 are shown in Figure B.8-4. Based on the TLD dose measurements, a minimum of two transects will be selected for surface and subsurface soil sampling. Locations will be selected in areas most likely to be contaminated based on the conceptual model and other biasing factors outlined in Step 3 of the DQO process (e.g., field screening). The soil beneath and adjacent to the lead bricks at CAS 26-99-05 will be sampled during Decision I activities.

Each selected transect will be further surveyed with handheld radiological instruments across the railroad tracks and on both sides of the railroad grade to determine locations of maximum radiological screening values. A maximum of four TLDs will be placed at locations along the transect. Figure B.8-5 is a conceptual diagram depicting where TLDs may be located within a transect. The TLDs will be placed at a height of 1 meter and remain in place for approximately 94 days so that an external dose representative of an exposure period of one industrial worker year (2,250 hours) can be determined. For the concrete-covered railroad tracks north of TCC, at least one of the eight randomly selected inspection locations falling within the posted radioactive material area will have a TLD measurement collected.

B.8.1.1.2 Ballast Samples

To provide data for calculating internal dose, ballast/soil samples will be collected at the TLD locations on transects indicating the highest external dose measurements. In Area 25, a minimum of five transects will be selected for biased sample collection, and a minimum of two transects will be selected in Area 26. One sample location within each transect will be selected based on the highest individual TLD reading within that transect. The sample will be collected from the ballast material as follows:

- Collect ballast from the surface to the ballast/native soil interface.
- Sieve the ballast to remove size fractions greater than 0.25 in.
- Spread out the sieved ballast on a pan and field-screen with radiological instruments so that radioactive fuel flecks can be identified and removed.
- After removal of the fuel flecks, the soil will be collected in sample bottles for analysis. The fuel flecks within the ballast will be monitored by the TLDs, and not removing them from the ballast could double the dose results.

Sufficient ballast will be collected to generate enough fine materials for the sample. The fine material represents the inhalation and ingestible fraction required for an internal dose to a receptor. Figure B.8-5 is a conceptual diagram depicting the surface sample profile within a transect.

B.8.1.1.3 Subsurface Samples

To investigate the potential for vertical migration of COPCs through the ballast and provide exposure data for receptors conducting intrusive work on the railroad ballast, subsurface soil samples will be collected at the same location as the surface samples. The subsurface samples will be collected from the top of the ballast/native soil interface to 6 in. below the interface. If radioactive fuel flecks are present within the soil matrix, the sample will be split into two aliquots. One aliquot will be collected and analyzed, leaving the fuel flecks within the soil matrix to represent the internal dose (inhalable and ingestible fraction). The other aliquot will be field-screened with radiological instruments to identify and remove radioactive fuel flecks before collection and analysis of the soil. Figure B.8-5 is a conceptual diagram depicting where the subsurface sample profile may be located within a transect.

B.8.1.1.4 Concrete-Covered Railroad Tracks Samples

During a preliminary site walkover, one section of the Area 25 Railroad Tracks, north of the TCC, was identified where concrete was poured between the tracks directly upon the ballast and railroad ties. Although not documented, the manner and appearance of the poured concrete suggests the concrete may have been used as a walking platform for railroad workers rather than to cover

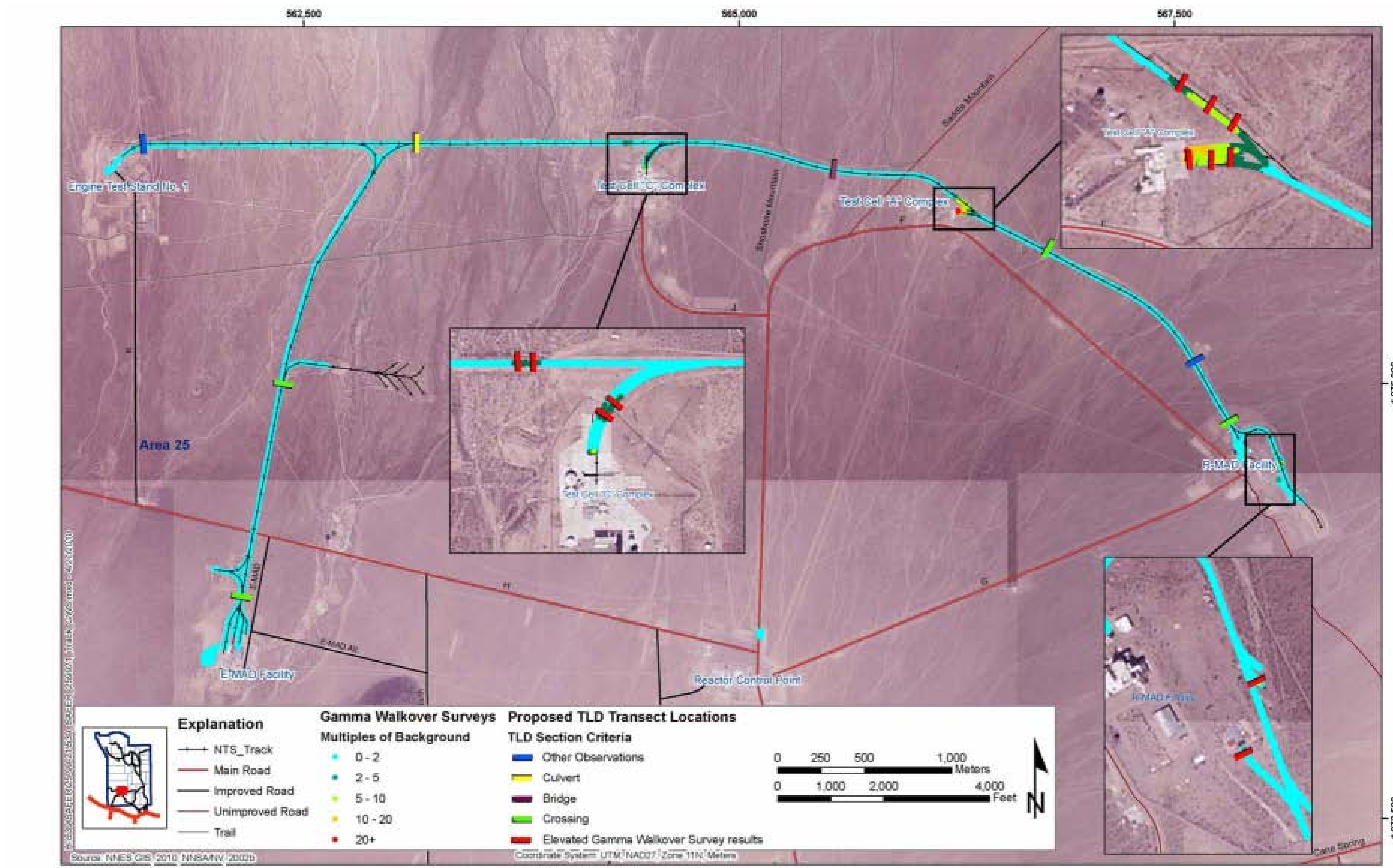

Figure B.8-3
Proposed TLD Locations at CAS 25-99-21

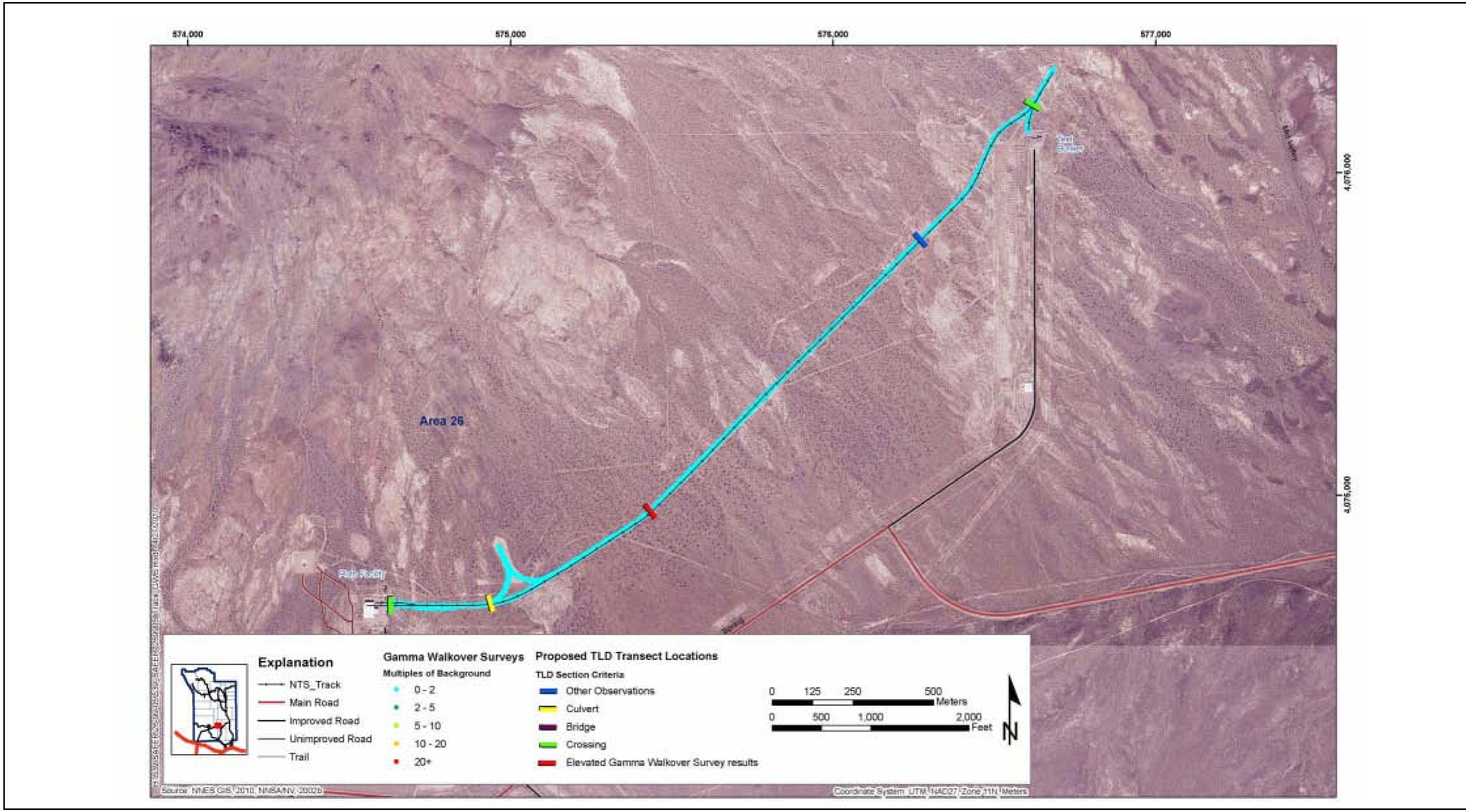

Figure B.8-4
Proposed TLD Locations at CAS 26-99-05

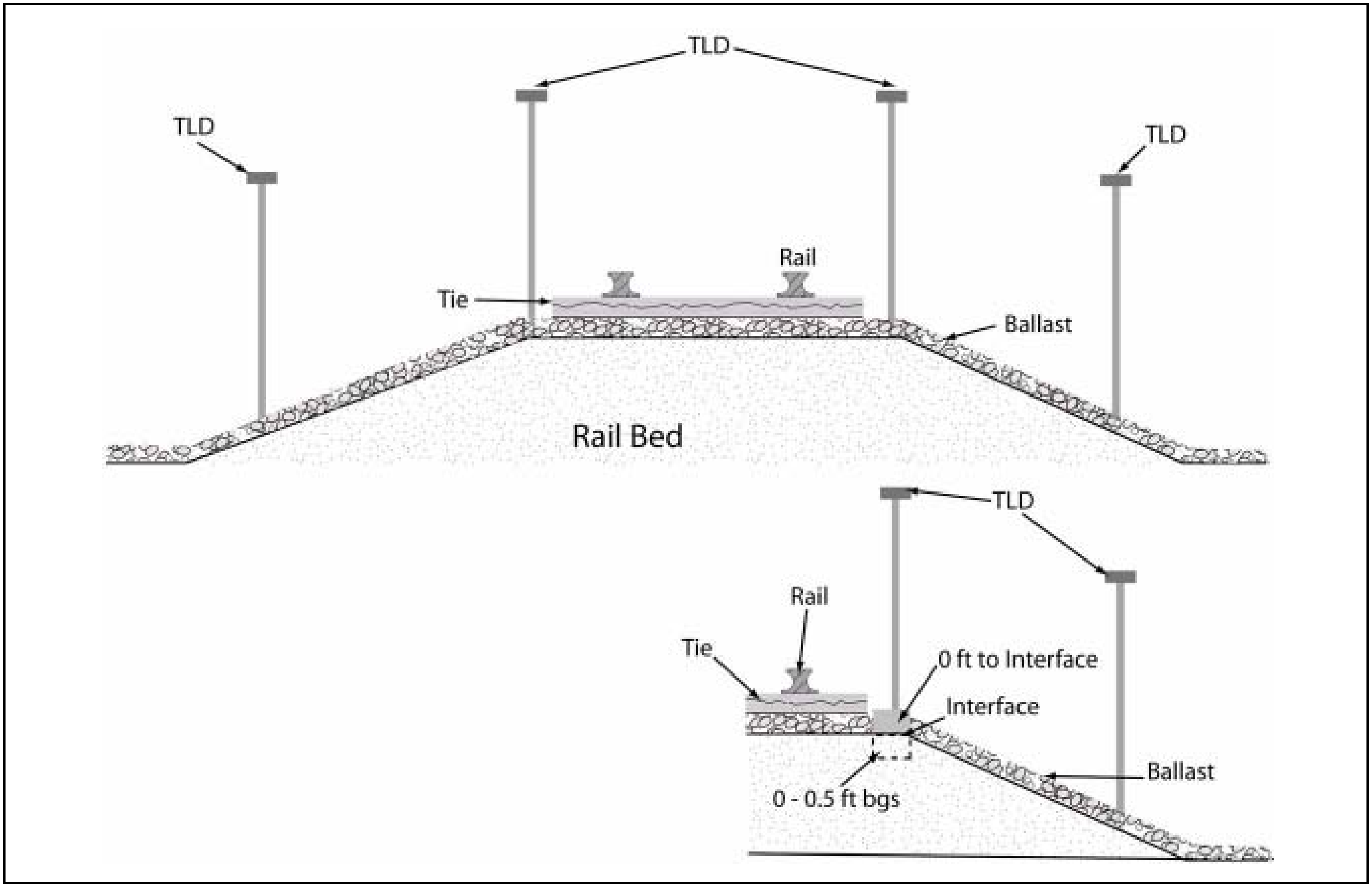

Figure B.8-5
Conceptual Diagram of TLD Placement and Sample Profiles

radiological contamination. However, these concrete-covered sections will be inspected to determine whether Decision I samples need to be collected. For each identified section of concrete-covered track, the following Decision I activities will be implemented:

- The total length of concrete-covered track will be measured.
- Eight randomly selected locations along the total length of concrete-covered track will be inspected for biasing factors.
- At each randomly selected location, the concrete will be broken, and the underlying 12 in. of ballast/soil will be field-screened with radiological instruments.
- If elevated radiological readings (greater than background plus two standard deviations) are detected, then a soil sample will be collected. If no elevated radiological readings are detected, then no sample will be collected.
- During investigation, any other biasing factors (e.g., staining) that may warrant additional sampling will be noted.

B.8.1.2 Decision I Nonradiological Sampling Approach

Nonradiological soil samples will be collected along the railroad tracks if biasing factors are identified (e.g., lead bricks, staining). Additional soil samples may be collected based on the site walkover observations and visual inspection of soils underlying the ballast at select TLD transects, crossings, roads, and the concrete-covered railroad tracks.

Sampling at the lead brick locations will consist of collecting one soil sample beneath the lead bricks. The lead bricks will be removed and placed in a waste drum. A shovel full of soil directly under the lead brick(s) will be placed in another waste drum and managed as “Hazardous Waste Pending Analysis” and potentially “Rad Waste Pending Analysis.” One confirmatory soil sample will then be collected.

For other potential releases, the location and depth of soil sample collection will be based on biasing factors (e.g., area of darkest stained soil or directly below release point if known).

B.8.2 Decision II Radiological and Nonradiological Sampling

To meet the DQI of representativeness for Decision II samples (i.e., Decision II sample locations represent the population of interest as defined in Section B.5.1), judgmental sampling locations at each CAS will be selected based on the outer boundary sample locations where COCs were detected, the CSM, and other field-screening and biasing factors listed in Section B.4.2. In general, sample locations will be arranged in a triangular pattern around the Decision I location or area at distances based on site conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, Decision II samples will be collected from incremental step-outs. A clean sample (i.e., COCs less than FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination in that direction. The number, location, and spacing of step-outs may be modified by the Site Supervisor, as warranted by site conditions.

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Appendix B

Sample Location Coordinates

B.1.0 Sample Location Coordinates

One TLD was staged at each transect location in both Areas 25 and 26. The Global Positioning System (GPS) coordinates from the TLD locations define the ballast and ballast/soil sample locations where collected. The GPS coordinates for all environmental TLD locations are presented in Tables B.1-1 and B.1-2. The GPS coordinates for the background TLD locations are presented in Tables B.1-3 and B.1-4. The GPS coordinates for all ballast, ballast/soil, and PSM verification sample locations are listed in Tables B.1-5 and B.1-6.

Table B.1-1
Sample Location Coordinates for Environmental TLDs at CAS 25-99-21, Area 25 Railroad Tracks

TLD Location	Easting	Northing
AT01	568,100.5	4,074,443.3
AT02	568,118.8	4,074,533.8
AT03	567,832.7	4,074,740.4
AT04	567,619.7	4,075,106.2
AT05	566,789.3	4,075,742.7
AT06	566,375.5	4,075,963.6
AT07	566,207.6	4,076,093.8
AT08	565,564.5	4,076,219.3
AT09	565,284.8	4,076,287.9
AT13	564,475.5	4,076,305.4
AT14	564,492.9	4,076,313.3
AT15	564,473.0	4,076,379.2
AT16	564,354.4	4,076,376.9
AT17	564,246.3	4,076,380.8
AT18	562,375.4	4,075,008.2
AT19	561,588.9	4,076,367.9
AT20	562,256.8	4,076,372.9
AT21	563,146.0	4,076,374.4
AT25	562,042.8	4,073,918.0
AT26	562,148.0	4,073,800.5

Table B.1-2
Sample Location Coordinates for Environmental TLDs at CAS 26-99-05, Area 26 Railroad Tracks

TLD Location	Easting	Northing
BT01	576,638.2	4,076,232.8
BT02	576,253.7	4,075,777.9
BT03	575,566.3	4,075,083.2
BT07	575,000.2	4,074,681.2
BT08	574,767.1	4,074,657.1

Table B.1-3
Sample Location Coordinates for Background TLDs at CAS 25-99-21, Area 25 Railroad Tracks

TLD Location	Easting	Northing
AT10	565,313.2	4,076,311.4
AT11	565,269.3	4,076,326.8
AT12	565,248.4	4,076,259.6
AT22	562,238.7	4,074,381.4
AT23	562,230.1	4,074,357.6
AT24	562,282.0	4,074,370.1

Table B.1-4
Sample Location Coordinates for Background TLDs at CAS 26-99-05, Area 26 Railroad Tracks

TLD Location	Easting	Northing
BT04	575,421.2	4,074,976.7
BT05	575,461.4	4,074,932.4
BT06	575,426.7	4,074,887.6

Table B.1-5
Sample Location Coordinates for Grab Samples at CAS 25-99-21, Area 25 Railroad Tracks

Sample Location	Sample Number	Easting	Northing
A01	539A001	568,099.8	4,074,444.7
	539A002	568,099.8	4,074,444.7
	539A003	568,099.8	4,074,444.7
	539A004	568,099.8	4,074,444.7
A02	539A005	568,118.5	4,074,535.6
	539A006	568,118.5	4,074,535.6
A03	539A007	564,473.9	4,076,378.5
	539A008	564,473.9	4,076,378.5
	539A009	564,473.9	4,076,378.5
A04	539A010	564,495.4	4,076,312.0
	539A011	564,495.4	4,076,312.0
A05	539A012	564,351.9	4,076,376.9
A06	539A013	564,351.4	4,076,377.2
A07	539A014	564,350.2	4,076,378.4
	539A020	564,350.2	4,076,378.4
A08	539A015	564,247.0	4,076,380.5
A09	539A016	564,354.6	4,076,376.4
	539A017	564,354.6	4,076,376.4
A10	539A018	564,664.9	4,076,379.7
A11	539A019	564,136.9	4,076,377.9

Table B.1-6
Sample Location Coordinates for Grab Samples at CAS 26-99-05, Area 26 Railroad Tracks

Sample Location	Sample Number	Easting	Northing
B01	539B001	576,253.7	4,075,777.9
	539B002	576,253.7	4,075,777.9
	539B003	576,253.7	4,075,777.9
B02	539B004	575,566.3	4,075,083.2
	539B005	575,566.3	4,075,083.2
B03	539B006	574,676.7	4,074,659.1
B04	539B007	574,632.1	4,074,658.8
B05	539B008	574,626.8	4,074,658.6

Appendix C

Sample Data

C.1.0 Sample Data for CAS 25-99-21

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the TLD transect locations at CAS 25-99-21, Area 25 Railroad Tracks, that were detected above MDCs are presented in Tables C.1-1 and C.1-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Internal dose estimates in millirem per Industrial Area year for individual samples within each TLD transect location in Area 25 are presented in Table C.1-3.

Results for the TLDs staged at CAU 539 in Area 25 are presented in Tables C.1-4 and C.1-5. These data are the direct radiation measurements from each of the three TLD elements used in the evaluation of the radiological release (i.e., the data have not been corrected for background). Table C.1-4 presents the TLD element data for the environmental TLDs. Table C.1-5 presents the TLD element data for the field background TLDs.

Table C.1-1
Gamma Spectroscopy Sample Results Detected above MDCs at CAS 25-99-21, Area 25 Railroad Tracks
(Page 1 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)			
			Ac-228	Cs-137	Nb-94	Th-234
539A01	539A001	0–2	1.51	18.2	0.38	--
	539A002	2–6	1.75	22.7	0.27	--
	539A003	2–6	1.78	38.3	0.77	--
	539A004	6–9	1.2	7	--	--
539A02	539A005	0–2	1.7	3.57	--	--
	539A006	2–6	1.93	17.4	--	--
539A03	539A007	0–2	1.99	7.59	--	--
	539A008	0–2	2.02	2.33	--	--
	539A009	2–6	2.19	0.427	--	--
539A04	539A010	0–2	1.58	15.8	--	--
	539A011	2–6	1.67	54.3	--	--

Table C.1-1
Gamma Spectroscopy Sample Results Detected above MDCs at CAS 25-99-21, Area 25 Railroad Tracks
(Page 2 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)			
			Ac-228	Cs-137	Nb-94	Th-234
539A05	539A012	0–6	1.49	3.34	--	--
539A06	539A013	0–6	--	2.89	--	--
539A09	539A016	0–2	1.34	6.54	--	109 (J)
	539A017	2–6	1.27	1.09	--	32.1 (J)

J = Estimated result
-- = Not detected above MDCs

Ac = Actinium
pCi/g = Picocuries per gram
Th = Thorium

Table C.1-2
Isotopic Sample Results Detected above MDCs at CAS 25-99-21, Area 25 Railroad Tracks
(Page 1 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)				
			Pu-239/240	Sr-90	U-234	U-235	U-238
539A01	539A001	0–2	--	0.57	1.97	--	0.94
	539A002	2–6	--	1,000	1.99	--	0.83
	539A003	2–6	--	2.98	13.4	0.52	0.91
	539A004	6–9	--	--	2.24	0.152	0.97
539A02	539A005	0–2	--	1.44	7.2	0.282	0.95
	539A006	2–6	--	5.1	23.1	0.71	0.94
539A03	539A007	0–2	--	--	0.76	0.068	0.75
	539A008	0–2	--	0.53	0.87	0.058	0.79
	539A009	2–6	--	--	0.89	--	0.76
539A04	539A010	0–2	--	2.6	1.77	0.071	0.8
	539A011	2–6	--	1,250	10.5	0.36	0.7
539A05	539A012	0–6	--	--	2,040	75	8.1

Table C.1-2
Isotopic Sample Results Detected above MDCs
at CAS 25-99-21, Area 25 Railroad Tracks
(Page 2 of 2)

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)				
			Pu-239/240	Sr-90	U-234	U-235	U-238
539A06	539A013	0–6	0.121	--	3,210	104	14.2
539A09	539A016	0–2	--	--	4,270	120	18.5
	539A017	2–6	--	--	700	24.1	3.9

-- = Not detected above MDCs

Table C.1-3
Internal Dose Estimates at CAS 25-99-21,
Area 25 Railroad Tracks, TLD Transects

TLD Location	Sample (mrem/IA-yr)	
	Ballast	Subsurface
AT01	0.02	0.45
AT02	0.03	0.06
AT14	0.02	0.57
AT15	0.03	0.03
AT16	5.74	0.99

Table C.1-4
TLD Results for CAS 25-99-21, Area 25 Railroad Tracks

TLD Location	Element (mrem/IA-yr)		
	2	3	4
AT01	49.6	44.5	44.6
AT02	39.5	39.1	37.1
AT03	27.3	26.0	25.2
AT04	29.4	30.4	26.6
AT05	33.4	32.1	30.1
AT06	40.6	39.7	38.1
AT07	39.0	38.0	37.1
AT08	31.0	31.8	31.8
AT09	32.7	32.7	30.6
AT13	57.2	53.6	50.6
AT14	67.6	64.2	63.2
AT15	38.9	33.9	30.8
AT16	52.2	42.2	39.0
AT17	30.7	33.0	30.3
AT18	27.1	26.6	27.0
AT19	33.0	32.3	31.1
AT20	29.7	27.7	26.8
AT21	30.3	30.5	28.7
AT25	26.3	29.6	25.4
AT26	28.8	28.8	26.2

Table C.1-5
Background TLD Results for CAS 25-99-21, Area 25 Railroad Tracks

TLD Location	Element (mrem/IA-yr)		
	2	3	4
AT10	32.8	32.7	30.8
AT11	35.1	35.2	32.2
AT12	37.1	35.5	35.7
AT22	29.1	28.9	27.5
AT23	28.5	28.2	25.8
AT24	29.5	30.6	26.4

C.2.0 Sample Data for CAS 26-99-05

Analytical results for gamma-emitting and isotopic radionuclide environmental samples collected at the TLD transect locations at CAS 26-99-05, Area 26 Railroad Tracks, that were detected above MDCs are presented in Tables C.2-1 and C.2-2. Because individual radionuclide results were not used for decisions, these results are presented in this appendix for completeness.

Internal dose estimates in millirem per Industrial Area year for individual samples within each TLD transect location in Area 26 are presented in Table C.2-3.

Results for the TLDs staged at CAU 539 in Area 26 are presented in Tables C.2-4 and C.2-5. These data are the direct radiation measurements from each of the three TLD elements used in the evaluation of the radiological release (i.e., the data have not been corrected for background). Table C.2-4 presents the TLD element data for the environmental TLDs. Table C.2-5 presents the TLD element data for the field background TLDs.

Table C.2-1
Gamma Spectroscopy Sample Results Detected above MDCs at CAS 26-99-05, Area 26 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	COPC (pCi/g)
			Ac-228
B01	539B001	0–1	1.71
	539B002	1–4	1.93
	539B003	1–4	2.07
B02	539B004	0–2	1.57
	539B005	2–6	2.03

Table C.2-2
Isotopic Sample Results Detected above MDCs at CAS 26-99-05, Area 26 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)		
			U-234	U-235	U-238
B01	539B001	0–1	0.86	0.055	0.92
	539B002	1–4	0.96	--	0.89
	539B003	1–4	0.93	0.066	0.91
B02	539B004	0–2	0.9	--	0.81
	539B005	2–6	0.87	--	0.84

-- = Not detected above MDCs

Table C.2-3
Internal Dose Estimates at CAS 26-99-05, Area 26 Railroad Tracks TLD Transects

TLD Location	Sample (mrem/IA-yr)	
	Ballast	Subsurface
BT02	0.02	0.03
BT03	0.02	0.02

Table C.2-4
TLD Results for CAS 26-99-05, Area 26 Railroad Tracks

TLD Location	Element (mrem/IA-yr)		
	2	3	4
BT01	28.2	28.1	25.2
BT02	32.5	31.6	29.9
BT03	31.7	31.4	29.8
BT07	29.9	28.4	25.7
BT08	27.1	27.7	25.8

Table C.2-5
Background TLD Results for CAS 26-99-05, Area 26 Railroad Tracks

TLD Location	Element (mrem/IA-yr)		
	2	3	4
BT04	34.5	31.8	29.8
BT05	33.5	32.5	29.9
BT06	33.4	32.2	30.5

Appendix D

Confirmation Sampling Test Results

D.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 539. Corrective Action Unit 539 is located in Areas 25 and 26 of the NNSS (Figure 1-2) and comprises the two CASs listed below:

- CAS 25-99-21, Area 25 Railroad Tracks
- CAS 26-99-05, Area 26 Railroad Tracks

The investigation approach for the portions of the Areas 25 and 26 railroad tracks that were included in the CAU 539 investigation are detailed in Table 2-1 of the CAU 539 SAFER Plan.

The Area 25 Railroad Tracks CAS is located in the former program area known as the NRDS in Area 25. The railroad is approximately 9 mi long and connected to the testing facilities within the former NRDS system in Area 25. The CAS consists of suspected releases of radioactive material from nuclear rocket machinery transported on railroad cars to the soil/ballast surrounding the railroad tracks. This railroad track system has been inactive and abandoned since 1973.

The Area 26 Railroad Tracks CAS is approximately 2 mi long and connected the Pluto Facility and the Test Bunker in Area 26 in support of Project Pluto. The CAS consists of suspected releases of radioactive material from nuclear-powered machinery transported on railroad cars to the soil/ballast surrounding the railroad tracks. This railroad track system has been inactive and abandoned since 1964.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 539 SAFER Plan (NNSA/NSO, 2010c).

D.1.1 Project Objectives

The primary objective of the investigation was to provide sufficient information to validate the assumptions used to select the corrective actions and to verify that closure objectives were met for each CAS in CAU 539. This objective was achieved by determining the nature and extent of COCs and by implementing corrective actions.

The selection of soil and/or waste characterization sample locations was based on site conditions and the strategy developed during the DQO process as presented in the CAU 539 SAFER Plan (Appendix A).

D.1.2 Contents

This appendix contains information and data in sufficient detail to justify that no further corrective action is required at CAU 539. The contents of this appendix are as follows:

- Section D.1.0 describes the investigation background, objectives, and content.
- Section D.2.0 provides an investigation overview.
- Sections D.3.0 and D.4.0 provide CAS-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section D.5.0 summarizes waste management activities.
- Section D.6.0 discusses the QA and QC procedures followed and results of the QA/QC activities.
- Section D.7.0 is a summary of the investigation results.
- Section D.8.0 lists the cited references.

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

D.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 539 CAI were conducted from November 29, 2010, through May 2, 2011. Table D.2-1 lists the CAI activities that were conducted at each of the CASs.

Table D.2-1
Corrective Action Investigation Activities Conducted at Each CAS To Meet SAFER Plan Requirements for CAU 539

CAI Activities	CAS	
	25-99-21	26-99-05
Conducted surface radiological surveys along railroad tracks to identify biased locations for TLD placement.	X	X
Performed detailed radiological surveys at selected TLD transects.	X	X
Placed, collected, and analyzed TLDs for external dose measurements.	X	X
Collected soil samples from biased locations for internal dose measurements.	X	X
Field screened samples for alpha and beta/gamma radiation.	X	X
Identified and removed PSM where feasible.	X	X
Collected verification samples at PSM removal locations.	X	X
Performed radiological scans and swipes of PSM.	X	X
Inspected concrete-covered sections of railroad tracks.	X	--
Submitted select samples for offsite laboratory analysis.	X	X

-- = Not applicable

The investigation and sampling program was managed in accordance with the requirements set forth in the CAU 539 SAFER Plan (NNSA/NSO, 2010c). Samples were collected and documented following approved protocols and procedures. Quality control samples (e.g., duplicate samples) were collected as required by the Industrial Sites QAPP (NNSA/NV, 2002a) and the CAU 539 SAFER Plan (NNSA/NSO, 2010c). During field activities, waste minimization practices were followed according to approved procedures, including segregation of waste by waste stream.

Weather conditions at the site varied to include sun, moderate to low temperatures, above average rainfall, intermittent cloudiness, and light to strong winds. There were no delays to site activities due to inclement weather conditions.

The CASs were investigated by conducting radiological surface screening and walkover surveys, sampling potential contaminant sources, collecting external dose measurements with TLDs, and sampling ballast/subsurface soil. All soil samples were collected by hand excavation. The ballast/soil samples were field screened at specific locations for alpha and beta/gamma radiation. The results were compared against screening levels to guide in the CAS-specific investigations. Field screening was also for health and safety controls and to meet transportation requirements.

Except as noted in the following CAS-specific sections, CAU 539 Decision I sampling locations were accessible, and sampling activities at planned locations were not restricted. Decision II step-out sample locations were not required.

Sections D.2.1 through D.2.4 provide the investigation methodology and laboratory analytical information.

D.2.1 Sample Locations

Investigation locations selected for sampling were based on results of the radiological walkover surveys, TLD *in situ* measurements, identified PSM, and process knowledge as provided in the CAU 539 SAFER Plan (NNSA/NSO, 2010c). Sampling points for each site were selected based on the approach provided in the SAFER Plan. The planned biased sample locations are discussed in text and represented on figures in the SAFER Plan. Actual environmental sample locations are shown on the figures included in Sections D.3.0 and D.4.0. Some locations were modified slightly from planned positions due to field conditions and observations. Sample locations were surveyed with a GPS instrument. Appendix B presents sample location coordinates in a tabular format.

D.2.2 Investigation Activities

The investigation activities were performed at CAU 539 as discussed in the CAU 539 SAFER Plan (NNSA/NSO, 2010c). The technical approach consisted of the activities listed in Table D.2-1. The investigation strategy allowed the nature and extent of contamination associated with each CAS to be established. The following sections describe the specific investigation activities that took place at CAU 539.

D.2.2.1 Radiological Surveys

Radiological walkover surveys were performed at both CASs to identify the presence, nature, and extent of radiological contaminants at levels of radioactivity statistically distinguishable from background activity (more than twice background levels). Count-rate data were collected with a TSA Systems PRM-470G model plastic scintillator for gamma. Count-rate and position data were collected and recorded at 1-second intervals via a Trimble Systems GeoXT GPS unit. Personnel performed the survey by walking along the outer edge of each rail atop the railroad grade, or where rails previously existed if removed, with the radiation detector held at a height of approximately 18 in. above the ground surface. Supplemental surveys using a beta and low-energy gamma 44-21 plastic scintillator were performed at selected drainages and washes to determine whether migration occurred from the railroad tracks.

The radiological walkover survey data served as the basis for identifying specific locations for TLD placement (i.e., highest gamma readings).

D.2.2.2 Field Screening

Field-screening activities for alpha and beta/gamma radiation were performed as specified in the CAU 539 SAFER Plan (NNSA/NSO, 2010c). Site-specific field-screening levels (FSLs) for alpha and beta/gamma radiation were defined as the mean background activity level plus two times the standard deviation of readings from 10 background locations selected near each CAS. The radiation FSLs are instrument-specific and were established for each instrument and CAS before use.

Alpha and beta/gamma radiation screening was performed at each CAS using an NE Technology Electra fitted with a DP6 dual-alpha and beta/gamma radiation scintillation probe. The CAS-specific sections of this document identify the CASs where field screening was conducted and how the FSLs were used to aid in the selection of samples to submit for analysis.

D.2.2.3 Surface and Subsurface Soil Sampling

Ballast and subsurface (ballast/soil interface) samples were collected using “scoop and trowel” (surface hand-grab sampling). Ballast sample locations were based on the TLDs indicating the highest external dose measurements. All sample locations were initially field screened for alpha and beta/gamma radiation before the start of sampling. To assess internal dose to a receptor, ballast (surface) soil samples were typically collected from 0.0 to 2.0 in. bgs, which typified the ballast thickness along the railroad grade. To assess whether contaminants have migrated downward through the ballast into the underlying soil, soil samples were collected immediately below the ballast to a depth of 6.0 in. bgs. Subsurface soil samples were collected as a continuation at surface soil sample locations where field-screening results (FSRs) and analytical results indicated contamination.

All ballast was sieved to remove size fractions greater than 0.25 in. The sieved ballast/soil was then spread out on a pan and field screened for alpha and beta/gamma radiation to not only determine the presence/absence of radioactive fuel flecks, but also serve as a health and safety control to protect the sampling team. To reduce the possibility of doubling the dose results, detectable and visible fuel flecks identified in the ballast sample were to be removed; however, based on the small particle size, the removal was not possible (see Section D.3.1.6 for deviations). Labeled sample containers were then filled with remaining soil for laboratory analysis.

In addition to the ballast and ballast/soil interface samples, verification sample locations were identified where lead bricks and limited volumes of associated soil were removed as PSM. Samples were collected by hand from the soil immediately beneath and in contact with the lead bricks (0.0–6.0 in. bgs) to determine whether lead remains in the environment above action levels.

D.2.2.4 Internal Dose Estimates

Internal dose was estimated using the radionuclide analytical results from ballast and subsurface (ballast/soil interface) samples and the corresponding RRMG (see Appendix G, Attachment G-1). The internal dose RRMG concentration for a particular radionuclide is that concentration in surface soil that would cause an internal dose to a receptor of 25 mrem/yr (under the appropriate exposure scenario) independent of any other radionuclides (i.e., assuming that no other radionuclides contribute to the dose). The internal dose RRMG for each detectable radionuclide (in picocuries per gram of soil) was derived using the RESRAD computer code (Yu et al., 2001) using the Industrial Area exposure scenario.

The total internal dose corresponding to each soil sample was calculated by adding the dose contribution from each radionuclide. For each sample, the radionuclide-specific analytical result was divided by its corresponding internal RRMG to yield a fraction of the 25-mrem/yr dose. The fractions for all radionuclides detected in a soil sample were summed to yield a total fraction for that sample. The sum of fractions was then multiplied by 25 to yield an internal dose estimate (in millirem per year) at that sample location. Because a judgmental sample design was utilized at each sample location, statistical inferences could not be calculated, and the internal dose at each location was established as the maximum dose measured from any depth sample.

For TLD locations where soil samples were not collected, the internal dose was estimated using the external dose measurement from the TLD and the internal to external dose ratio from the surface sample location with the maximum internal dose measurement (sample location A09). The internal dose for each of these TLD-only locations was calculated by multiplying this ratio by the external dose value specific to the location.

D.2.2.5 External Dose Estimates

Thermolunimescent dosimeters (specifically, Panasonic UD-814 TLDs) were placed at selected transects along each set of railroad tracks in Areas 25 and 26 with the objective of collecting *in situ* measurements to determine the external radiological dose for exposure to surface contaminants. The TLDs were placed at transects perpendicular to the railroad tracks based on selection criteria that included highest radiological readings from gamma walkover surveys and areas that could increase vibration of railcars such as road crossing, switches, culverts, and bridges/trestles. Each selected transect was further surveyed with handheld radiological instruments (e.g., PRM-470) across the tracks and on both sides of the railroad grade to determine locations of maximum radiological survey values. All TLDs were placed at a height of approximately 1 meter to be consistent with the NNSS Environmental Monitoring Program. Once retrieved from the field locations, the TLDs were analyzed using automated TLD readers. Automated TLD readers are calibrated and maintained by the NNSS management and operating contractor. Details of the environmental monitoring TLD program and TLD QC are presented in Section D.6.5.

Each TLD used at CAU 539 contains four individual elements. Each of these elements is considered a separate, independent measurement of external dose. External dose at each TLD location is determined using the readings from TLD elements 2, 3, and 4. Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose for the purpose of this investigation; therefore, Element 1 was not included in the external dose calculation. Measurements from control and background TLDs were subtracted from the raw TLD element data. The control, or rack, background TLDs measured the amount of dose received by the TLDs before being deployed in the field. The rack background TLDs were staged at Building 23-153 in the same area where the environmental TLDs were stored prior to emplacement at CAU 539. The field background TLDs measured the amount of dose received by TLDs in areas unaffected by the CAS releases. Overall background dose was 29 mrem/IA-yr at CAS 26-99-05 and 32.8 mrem/IA-yr at CAS 25-99-21.

After subtracting the control and field background TLD readings, the TLD value was then divided by the number of hours the TLD was exposed to site contamination, resulting in a net hourly rate dose rate. The hourly dose rate was then multiplied by the number of hours per year that a site worker would be present at the site (i.e., the annual exposure duration of 2,250 hours assumed for the Industrial Area scenario) to establish the maximum potential annual external dose a site worker could receive. The TLD results for CASs 25-99-21 and 26-99-05 are discussed in Sections D.3.2 and D.4.2, respectively.

At locations where the subsurface internal dose was greater than the surface internal dose, it was conservatively assumed that the external dose would also be greater than that measured by the TLD if the subsurface contamination were to be exposed at some time in the future. This potential greater external dose was estimated by increasing the TLD-measured dose by the same proportion as the subsurface-to-surface internal dose increase. This was done by dividing the subsurface internal dose by the surface internal dose (yielding a ratio greater than 1) and multiplying the TLD-measured external dose (the average or 95 percent UCL) by this ratio (thus increasing the external dose estimate).

D.2.2.6 Total Effective Dose

The TED represents the sum of the internal dose (calculated from soil sample results) and the external dose (calculated from TLD measurements) for each sample location. The average TED calculated from sample results is an estimate of the true (unknown) TED. It is uncertain how well the average TED represents the true TED. If an average TED were directly compared to the FAL, a significant difference between the true TED and the sample TED could lead to decision errors. To reduce the operability of a false negative decision error, a conservative estimate of the true TED (i.e., the 95 percent UCL) is used to compare to the FAL. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED. The 95 percent UCL of the TED was calculated as the sum of the 95 percent UCL of the external dose and the average internal dose.

D.2.2.7 Waste Characterization Sampling

Characterization of IDW and remediation waste was performed to support recommendations for disposal of these items and determine whether the waste in question at these CASs could be acting as a source of potential soil contamination. Investigation methods included visual inspection and radiological surveys of lead bricks removed for recycling and a review of analytical results from environmental soil samples associated with the soil waste stream. No specific waste characterization samples were collected from the soil waste streams. Section D.5.0 provides additional details on characterization of CAU 539 waste steams.

D.2.3 Laboratory Analytical Information

Radiological and chemical analyses 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 D.2-2. 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.

Validated analytical data for CAU 539 have been compiled and evaluated to determine the presence of COCs and define the extent of contamination, if present. The validated results of the radiochemical analyses were evaluated for only those radionuclides that contribute to an internal dose (see Appendix G). The analytical results for each CAS are presented in Sections D.3.0 and D.4.0.

The analytical parameters are CAS-specific and were selected through the application of site process knowledge according to the DQOs.

Table D.2-2
Laboratory Analyses and Methods, CAU 539 Investigation Samples[a]

Analysis	Analytical Method[b]
Total Metals	Aqueous - EPA SW-846[c] 6010/6020/7470 Non-aqueous - EPA SW-846[c] 6010/6020/7471
TCLP Metals	Non-aqueous - EPA SW-846[c] 1311/6010/7470
Total Beryllium	Non-aqueous - EPA SW-846[c] 6010/6020
Isotopic U	Aqueous/Non-aqueous - DOE EML HASL-300[d] U-02-RC
Isotopic Pu	Aqueous - DOE EML HASL-300[d] Pu-10-RC Non-aqueous - DOE EML HASL-300[d] Pu-02-RC
Gamma Spectroscopy	Aqueous - EPA 901.1[e] Non-aqueous - DOE EML HASL-300[d], Ga-01-R
Sr-90	Aqueous - EPA 905.0[e] Non-aqueous - DOE EML HASL-300[d] Sr-02-RC

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

ASTM = ASTM International
EML = Environmental Measurements Laboratory
EPA = U.S. Environmental Protection Agency
HASL = Health and Safety Laboratory
N-I = Navarro-Intera, LLC
NIOSH = National Institute for Occupational Safety and Health

D.2.4 Comparison to Action Levels

The PALs-to-FALs comparison for radiological releases is 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 539 release. As such, it is dependant upon the cumulative annual hours of exposure to site contamination. The PALs were established in the SAFER Plan (NNSA/NSO, 2010c) 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 that a site worker would be exposed to site contamination for 10 hours per day for 225 days per year). The FALs were established in Appendix G based on the Industrial Area scenario.

Results for radiological releases and other releases (i.e., PSM) are presented in Sections D.3.2 and D.4.2. Radiological results are reported as doses that are comparable to the dose-based FAL.

Results that are equal to or greater than FALs are identified by bold text in the CAS-specific result tables in Sections D.3.0 and D.4.0.

A COC is defined as any contaminant present in environmental media exceeding a FAL. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006). If COCs are present, corrective actions must be considered for the CAS.

A corrective action may also be necessary 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 contents to the surrounding media. The following were used as the criteria for determining whether a waste is PSM:

- A waste, regardless of concentrations 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 nonliquid waste, 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 nonliquid waste, 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 each contaminant in the waste divided by the mass of the waste and calculating the combined resulting dose using the RESRAD computer code (Murphy, 2004). If the resulting soil concentration exceeds the FAL, then the waste would be considered PSM.

D.3.0 CAS 25-99-21, Area 25 Railroad Tracks, Investigation Results

Corrective Action Site 25-99-21, Area 25 Railroad Tracks, is located in Area 25 of the NNSS (Figure D.3-1). This CAS consists of approximately 9 mi of track that was used to transport nuclear rocket machinery to and from NRDS testing facilities via railcars. These activities may have released radioactive materials to the soil/ballast surrounding the railroad tracks. The portions of the railroad tracks identified in Table 2-1 of the SAFER Plan were identified for investigation. Several portions of the railroad tracks were investigated and closed during previous CAU investigation and were excluded from CAU 539 (NNSA/NSO, 2010c). Additional detail is provided in the SAFER Plan.

D.3.1 SAFER Activities

A total of 20 characterization samples (including one field duplicate [FD]) were collected during investigation activities at CAS 25-99-21. The sample IDs, locations, types, and analyses are listed in Table D.3-1. A total of 26 TLDs (representing a total of 78 elements) at 26 locations (6 field background locations and 20 field locations) were used to calculate the external dose to site workers. For each TLD, its location, serial number, date placed, date removed, and purpose are listed in Table D.3-2. The specific CAI activities conducted to satisfy the SAFER Plan requirements at this CAS are described in the following sections.

D.3.1.1 Radiological Surveys

A radiological walkover survey was conducted along the railroad tracks at CAS 25-99-21, and results were presented in the SAFER Plan. The survey identified elevated radiological count rates in the ballast/surface soil near several of the former NRDS facilities, and the results were used to select locations for establishing TLD transects and collecting soil samples.

Additional scanning surveys were performed at selected transects to determine the highest radioactivity readings along each transect to determine TLD placement. A similar survey was performed to determine the ballast/soil sample location at each selected TLD transect.

Table D.3-1
Samples Collected at CAS 25-99-21, Area 25 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	Matrix	Purpose	Gamma	Metals	Beryllium	Plutonium	Strontium	Uranium
A01	539A001	0–2	Soil	Environmental	X	--	X	X	X	X
	539A002	2–6	Soil	Environmental	X	--	X	X	X	X
	539A003	2–6	Soil	Environmental	X	--	X	X	X	X
	539A004	6–9	Soil	Environmental	X	--	--	X	X	X
A02	539A005	0–2	Soil	Environmental	X	--	X	X	X	X
	539A006	2–6	Soil	Environmental	X	--	X	X	X	X
A03	539A007	0–2	Soil	Environmental	X	--	X	X	X	X
	539A008	0–2	Soil	FD of #539A007	X	--	X	X	X	X
	539A009	2–6	Soil	Environmental	X	--	X	X	X	X
A04	539A010	0–2	Soil	Environmental	X	--	X	X	X	X
	539A011	2–6	Soil	Environmental	X	--	X	X	X	X
A05	539A012	0–6	Soil	Environmental	X	X	--	X	--	X
A06	539A013	0–6	Soil	Environmental	X	X	--	X	--	X
A07	539A014	0–6	Soil	Environmental	--	X	--	--	--	--
	539A020	0–6	Soil	Environmental	--	X	--	--	--	--
A08	539A015	0–6	Soil	Environmental	--	X	--	--	--	--
A09	539A016	0–2	Soil	Environmental	X	--	X	X	X	X
	539A017	2–6	Soil	Environmental	X	--	X	X	X	X
A10	539A018	0–1	Soil	Environmental	--	X	X	--	--	--
A11	539A019	0–1	Soil	Environmental	--	X	X	--	--	--

X = Analyzed
-- = Not required

Table D.3-2
TLDs at CAS 25-99-21, Area 25 Railroad Tracks

TLD Location	TLD Serial Number	Date Placed	Date Removed	Purpose
AT01	3549	06/18/2010	09/24/2010	Field
AT02	3643	06/18/2010	09/24/2010	Field
AT03	3847	06/18/2010	09/24/2010	Field
AT04	3835	06/18/2010	09/24/2010	Field
AT05	3320	06/18/2010	09/24/2010	Field
AT06	4029	06/18/2010	09/24/2010	Field
AT07	3737	06/18/2010	09/24/2010	Field
AT08	3565	06/18/2010	09/24/2010	Field
AT09	3595	06/18/2010	09/24/2010	Field
AT10	2066	06/18/2010	09/24/2010	Background
AT11	3297	06/18/2010	09/24/2010	Background
AT12	1395	06/18/2010	09/24/2010	Background
AT13	3760	06/18/2010	09/24/2010	Field
AT14	1300	06/18/2010	09/24/2010	Field
AT15	4289	06/18/2010	09/24/2010	Field
AT16	1806	06/18/2010	09/24/2010	Field
AT17	1646	06/18/2010	09/24/2010	Field
AT18	3727	06/18/2010	09/24/2010	Field
AT19	1933	06/18/2010	09/24/2010	Field
AT20	3726	06/18/2010	09/24/2010	Field
AT21	1191	06/18/2010	09/24/2010	Field
AT22	1480	06/21/2010	09/24/2010	Background
AT23	3892	06/21/2010	09/24/2010	Background
AT24	4247	06/21/2010	09/24/2010	Background
AT25	2059	06/21/2010	09/24/2010	Field
AT26	3926	06/21/2010	09/24/2010	Field

Additional radiological walkover surveys were conducted at selected areas along the Area 25 railroad tracks where ballast had washed out and within drainages associated with trestles and culverts. These additional radiological walkover surveys were conducted to investigate the potential for migration of contaminants and identify biasing factors for additional soil sampling. Surveys were performed at three ballast wash-out locations, one culvert drainage, and one trestle drainage. No elevated radioactivity was identified beyond the expected 15-ft lateral direction from the tracks, and no other biasing factors were discovered; therefore, no biased samples were identified.

Results for the swipe collection survey conducted on the lead bricks found along the section of track north and northwest of the Test Cell C Facility indicate 6 of the 14 lead bricks (RR1LB–RR6LB) have removable radioactive contamination.

D.3.1.2 Visual Inspections

Features associated with railroad tracks and items identified as PSM were inspected within the CAS during both the initial gamma walkover survey and subsequent site visits to place and collect TLDs. These features consisted of switches, culverts, piles of railroad ties, lead bricks, and debris such as drums of railroad spikes. Three drums (two containing railroad spikes) were inspected, and no biasing factors were found. A 503-ft section of concrete-covered railroad track was identified north of the Test Cell C Facility. In accordance with the SAFER Plan, the concrete was breached at six of the eight planned locations, inspected for biasing factors, and screened for radioactivity. No biasing factors were identified under the concrete; therefore, no sample collection was performed. Visual inspections identified 8 locations as containing a total of 14 lead bricks. Six of these locations were identified as requiring soil sample collection. No other PSM or biasing factors (e.g., staining) were identified in the areas inspected along the railroad tracks.

D.3.1.3 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were exceeded in eight samples. Beta/gamma radiation FSLs were exceeded in 11 samples. In general, the soil samples underlying the ballast samples had higher FSRs.

D.3.1.4 Sample Collection

Sample collection at CAS 25-99-21 consisted of collecting TLD measurements for calculating external dose, soil samples for calculating internal dose, and verification samples following removal of PSM. Figure D.3-1 shows all the TLD locations in Area 25. Figures D.3-2 through D.3-6 provide details on investigation locations along specific portions of the railroad tracks.

D.3.1.4.1 TLD Samples

The 26 TLDs listed in Table D.3-2 and shown at the locations on Figures D.3-1 through D.3-6 were used to measure external dose. The TLDs at TLD locations AT10 through AT12 (Figure D.3-5) and AT22 through AT24 (Figure D.3-2) were placed at field background locations. Soil samples were collected at TLD locations AT01, AT02, AT14, AT15, and AT16.

The selected TLD locations were identified through biasing factors outlined in the SAFER Plan and included visual observations, elevated radiological survey results, and/or professional judgement. Of the six proposed locations inside the Test Cell A Facility, four were determined unnecessary as the portion of the tracks inside the facility would be characterized under CAU 375 and were presumed to exceed the action level of 25 mrem/IA-yr. Therefore, it was deemed appropriate to move four of the TLD transects to other locations for a more comprehensive study.

D.3.1.5 Soil Samples

For the determination of internal dose for radiological releases, five TLD locations were selected for soil sample collection based on highest TLD measurements and biasing factors such as radiological survey data and concrete-covered track. Six ballast (surface) samples (including one FD) were collected from 0 to 2 in. bgs at locations A01 through A04 and A09 (TLD locations AT01, AT02, AT14, AT15, and AT16). Six subsurface samples were collected from the soil directly below the ballast to a depth of 6 in. bgs at the same TLD locations to provide information on the migration of COCs and exposure data for receptors conducting intrusive work. Visual observations and field screening during ballast sample collection show that sample locations A02, A04, and A09 (TLD locations AT02, AT14, and AT16) are associated with the presence of large pieces of high-activity PSM (greater than 0.75 in. in length) either at or near the sample location. Although field screening

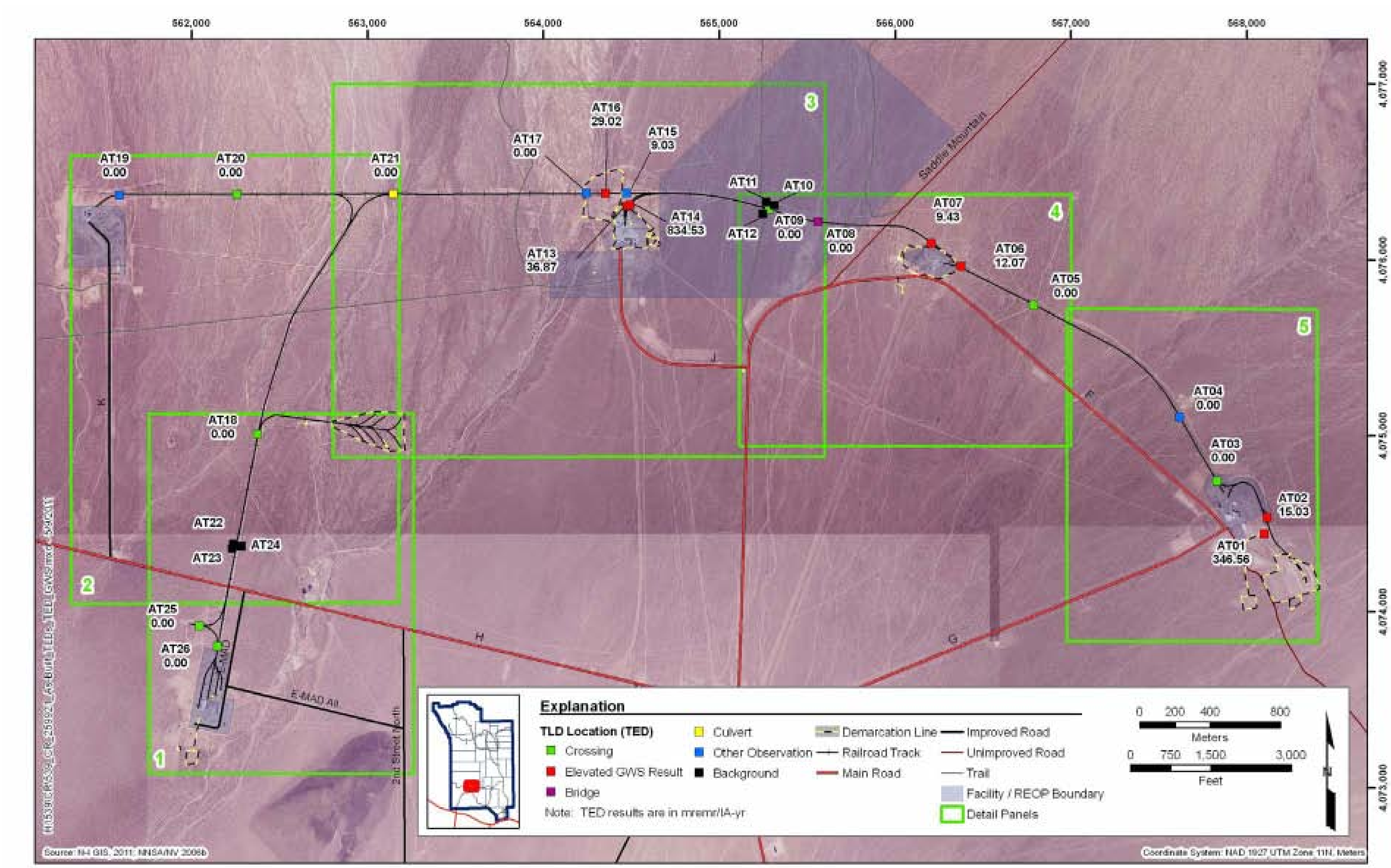

Figure D.3-1
CAS 25-99-21, Area 25 Railroad Tracks, TED Results at TLD Locations

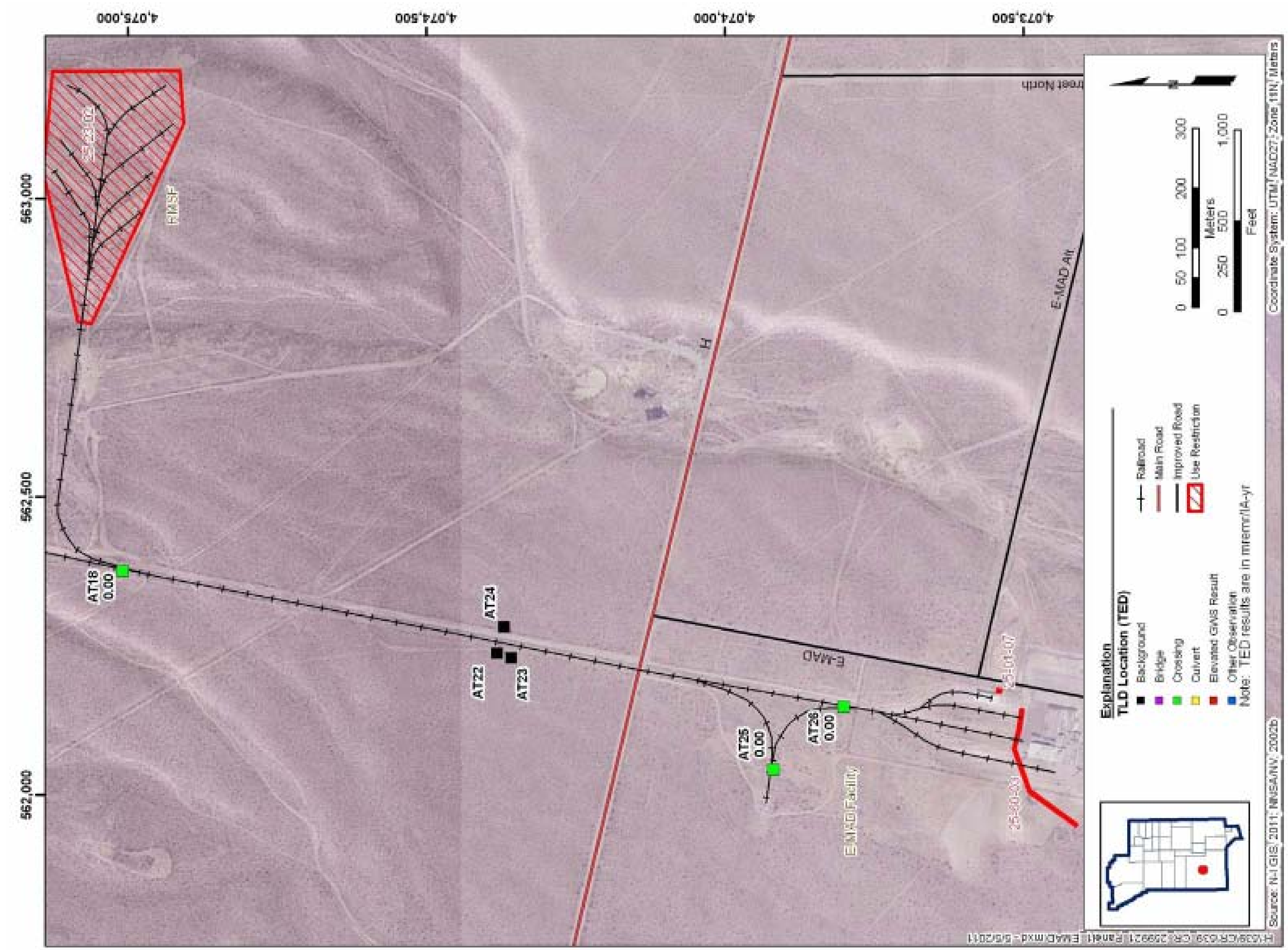

Figure D.3-2
Panel 1 Engine Maintenance, Assembly, and Disassembly Facility Sample Locations at CAS 25-99-21, Area 25 Railroad Tracks

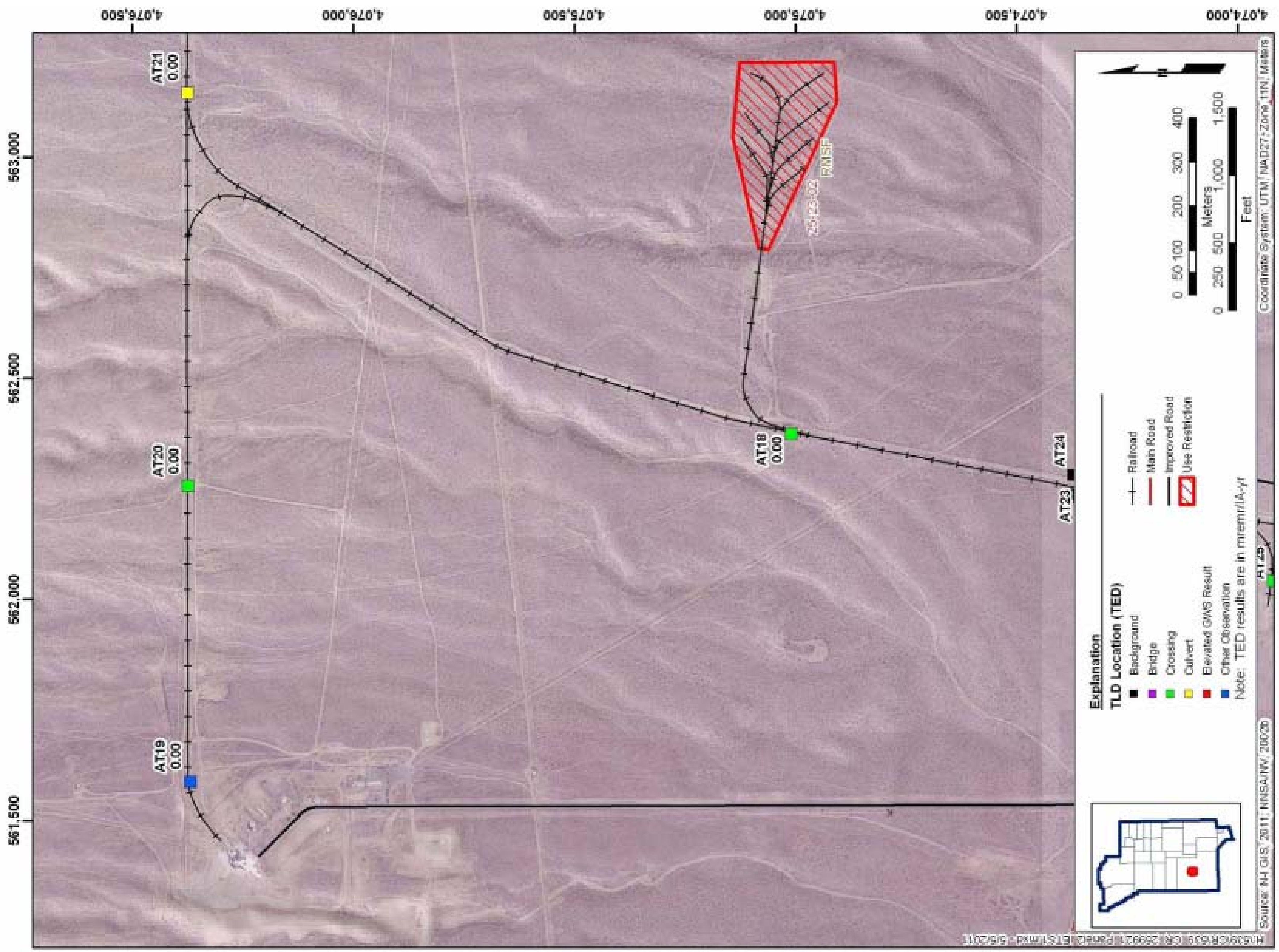

Figure D.3-3
Panel 2 Engine Test Stand No. 1 Facility Sample Locations at CAS 25-99-21, Area 25 Railroad Tracks

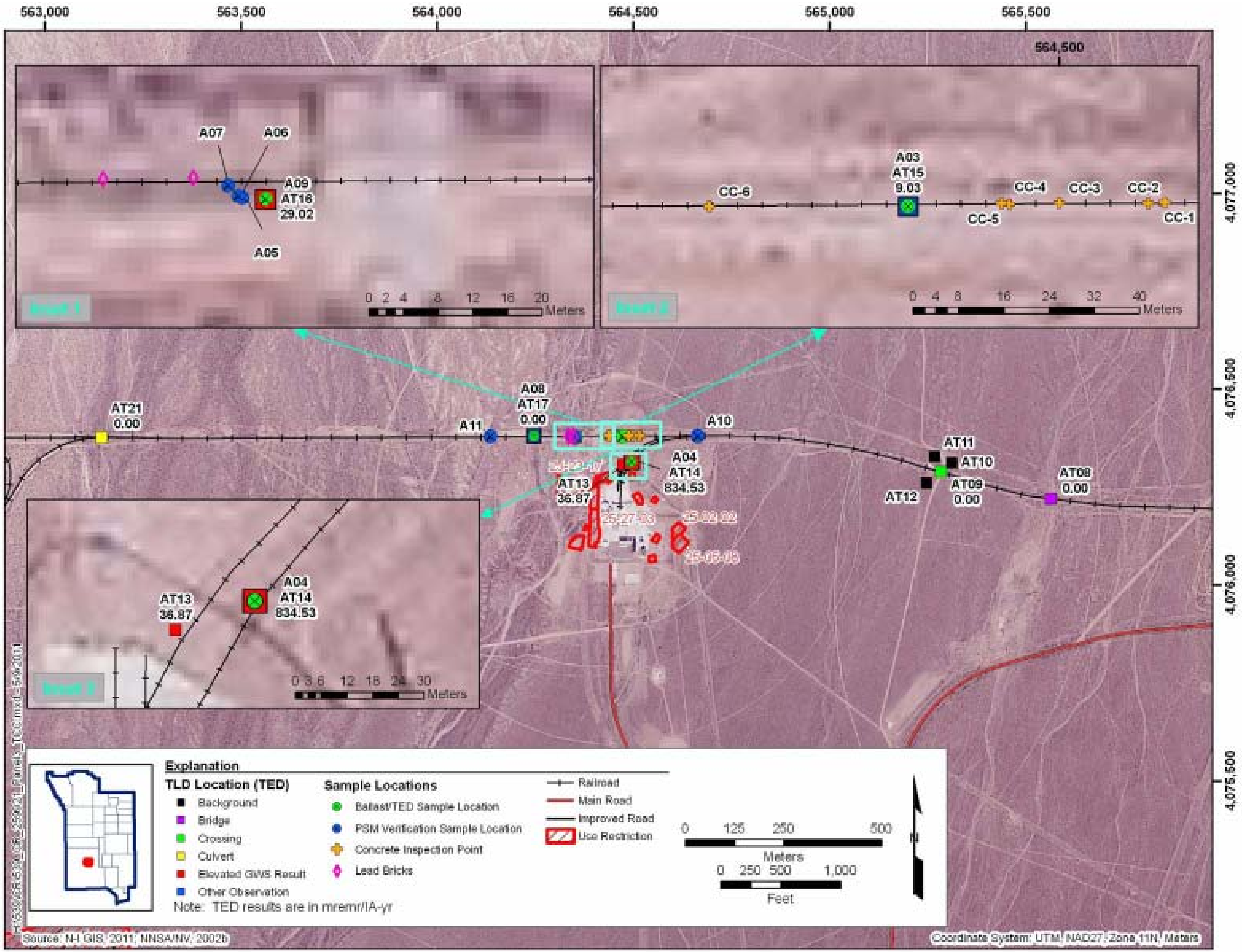

Figure D.3-4
Panel 3 Test Cell C Facility Sample Locations at CAS 25-99-21, Area 25 Railroad Tracks

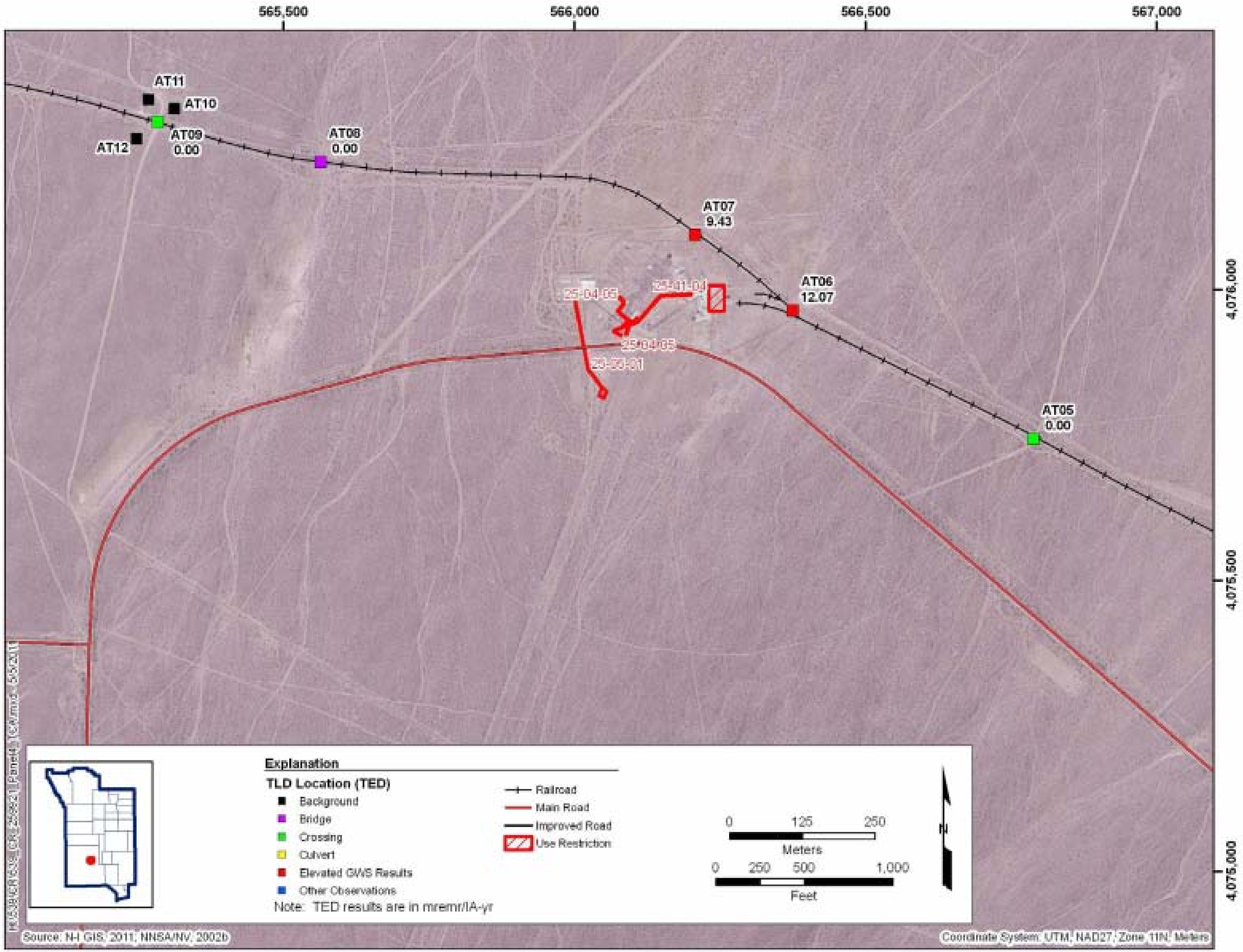

Figure D.3-5
Panel 4 Test Cell A Facility Sample Locations at CAS 25-99-21, Area 25 Railroad Tracks

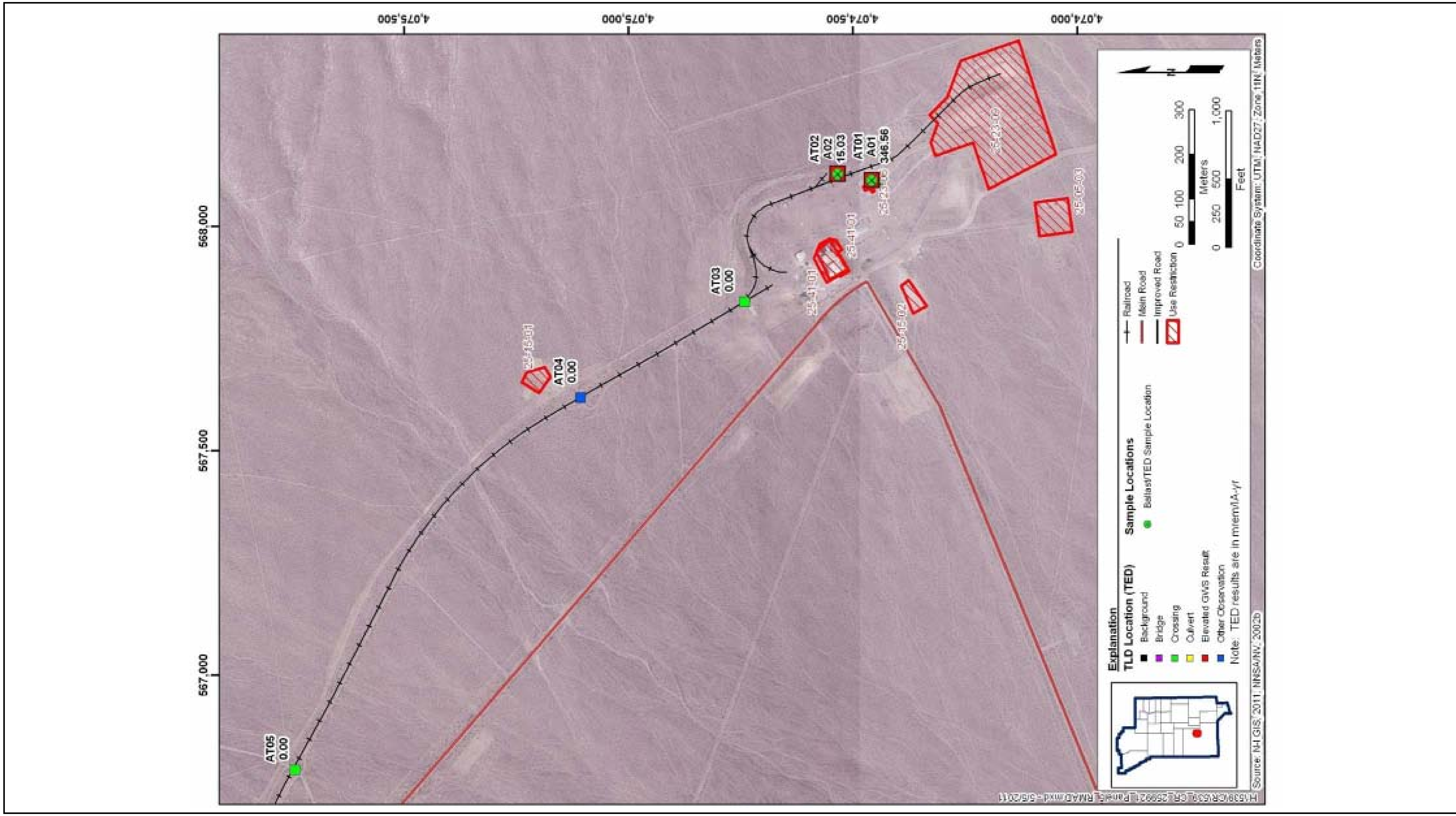

Figure D.3-6
Panel 5 Reactor Maintenance, Assembly, and Disassembly Facility Sample Locations at CAS 25-99-21, Area 25 Railroad Tracks

indicated the presence of high-activity PSM at sample location A01, it was not visually identified during sampling. The sample locations are shown on Figures D.3-4 and D.3-6.

Eight locations along the railroad tracks at CAS 25-99-21 were identified as containing lead bricks as PSM. Following the removal of the lead bricks as PSM and a limited volume of associated soil, a total of seven verification soil samples (539A012–D015, 539A018–D020) were collected from the lead brick locations and submitted for metals analysis (i.e., lead) to determine whether the PSM remains (Figure D.3-4). Two of the lead bricks were not in contact with soil; therefore, no verification sample was required. In addition to the lead (metals) analysis, samples 539A012 and 539A013 were also submitted for radionuclide analysis to assess soil conditions associated with the TLD external dose at TLD location AT16.

One Decision II sample was collected from 6 to 9 in. bgs at sample location A01 to assess vertical extent of potential contaminants. During the course of the investigation, visual observations and field screening indicated that elevated radioactivity is limited to the top 6 in. and primarily associated with the large pieces of high-activity PSM and/or weathered particles of the PSM. Observations during the investigation noted that these pieces of high-activity PSM are easily shielded by soil and showed limited mobility.

D.3.1.6 Deviations

One deviation from the SAFER Plan requirements (NNSA/NSO, 2010c) was applicable to both CASs. It involved the calculation of the external dose component and TED for exposure to subsurface soils. The SAFER Plan stated that the RESRAD computer code would be used to estimate both the external and internal doses for the subsurface using soil analytical results. Instead, it was decided that a 95 percent UCL external dose for the subsurface should be calculated by extrapolating the TLD measurement at each sample location to represent the potential exposure a receptor would receive if the ballast were removed. This extrapolation required that the ratio of the subsurface to surface internal doses be calculated for each sample location from analytical results and then that ratio be multiplied against the TLD measurement for that location to estimate the 95 percent UCL external dose. This external dose is then used to calculate the TED. This deviation is not considered significant because a higher external dose component is used to determine the TED and thus the resulting TED is more conservative and protective of human health and the environment.

Per the SAFER Plan, if fuel flecks were present in a ballast material sample, the flecks would be removed prior to submitting the sample for analysis. If fuel flecks were present in a soil sample collected from below the ballast, the soil sample would be split into two aliquots with one aliquot having fuel flecks removed prior to laboratory submittal. It was determined during the investigation that removing fuel flecks from soil was not feasible because the radioactive material has a small particle size and thus was not visible. The inability to remove the small radioactive particles from the ballast and underlying soil samples for internal dose component may result in a more conservative (i.e., higher) TED estimate.

A minor deviation occurred in relation to the planned investigation points along the concrete-covered railroad track. Two of the eight randomly selected locations along the concrete-covered track could not be accessed because the concrete was reinforced and/or thicker and could not be broken by hand tools. Because no contamination or other biasing factors were found under the concrete at the other six locations and the concrete was not breached at these inaccessible locations, the deviation is not considered significant.

D.3.2 Investigation Results

The following sections provide the analytical and computational results for soil and TLD samples collected at CAS 25-99-21. Soil and TLD sample collection activities were completed as outlined in the SAFER Plan (NNSA/NSO, 2010c). Investigation samples were analyzed for the COPCs specified in the SAFER Plan, which included beryllium, gamma-emitting radionuclides, isotopic U, Sr-90, and RCRA metals. The RCRA metals analysis was added for specific PSM verification samples. Isotopic Pu was added as a parameter for a limited number of Area 25 soil samples based on the presence of high-activity PSM encountered. Table D.3-1 lists the sample-specific analytical suite for CAS 25-99-21.

The radiological results are reported as doses that are comparable to the dose-based FALs as established in Appendix G except for those results associated with lead brick verification samples. Results that are equal to or greater than FALs are identified by bold text in the result tables.
A minimum number of soil samples does not apply for the calculation of TED because probabilistic soil sampling was not implemented for the CAU 539 CAI. The 95 percent UCL of the average TED was calculated using the average internal dose and 95 percent UCL external dose.

External dose estimates for TLD locations are summarized in Section D.3.2.1. Internal dose estimates for each sample location are summarized in Section D.3.2.2. The TEDs for each TLD transect location are summarized in Section D.3.2.3.

For verification soil samples collected following removal of lead bricks as PSM, the analytical results with concentrations exceeding MDCs are summarized in Section D.3.2.4. An evaluation was conducted on all contaminants detected above MDCs by comparing individual concentrations or activity results against the FALs. Establishment of the FALs is presented in Appendix G.

D.3.2.1 External Radiological Dose Estimates

External dose estimates were derived from the TLDs staged at each sample location. The external dose for each TLD location was calculated for the Industrial Area exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use Area exposure scenarios. The standard deviation, number of elements, and 95 percent UCL of the average external dose for each exposure scenario are presented in Table D.3-3.

Table D.3-3
CAS 25-99-21, Area 25 Railroad Tracks,
95 Percent UCL External Dose for Each Exposure Scenario
(Page 1 of 2)

TLD Location	Standard Deviation	Number of Elements	Minimum Sample Size[a]	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
AT01	2.90	3	1.7	**346.54**	2.74	0.65
AT02	1.28	3	1.4	15.00	1.18	0.28
AT03	1.07	3	1.4	0.00	0.00	0.00
AT04	1.99	3	1.5	0.00	0.00	0.00
AT05	1.69	3	1.5	0.00	0.00	0.00
AT06	1.25	3	1.4	8.80	1.31	0.31
AT07	0.96	3	1.4	6.86	1.02	0.24
AT08	0.50	3	1.4	0.00	0.00	0.00
AT09	1.22	3	1.4	0.00	0.00	0.00
AT13	3.30	3	1.8	**26.57**	3.97	0.94
AT14	2.31	3	1.6	**834.50**	5.39	1.28
AT15	4.10	3	2.0	9.00	1.29	0.31

Table D.3-3
CAS 25-99-21, Area 25 Railroad Tracks,
95 Percent UCL External Dose for Each Exposure Scenario
(Page 2 of 2)

TLD Location	Standard Deviation	Number of Elements	Minimum Sample Size[a]	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
AT16	6.88	3	3.2	23.28	3.48	0.83
AT17	1.45	3	1.4	0.00	0.00	0.00
AT18	0.31	3	1.4	0.00	0.00	0.00
AT19	0.97	3	1.4	0.00	0.00	0.00
AT20	1.47	3	1.4	0.00	0.00	0.00
AT21	1.00	3	1.4	0.00	0.00	0.00
AT25	2.22	3	1.5	0.00	0.00	0.00
AT26	1.48	3	1.4	0.00	0.00	0.00

[a]The minimum sample size is based on the Industrial Area scenario.
Bold indicates the values exceeding the FALs.
mrem/OU-yr = Millirem per Occasional Use Area per year
mrem/RW-yr = Millirem per Remote Work Area per year

D.3.2.2 Internal Radiological Dose Estimates

Estimates for the internal dose that a receptor would receive at both the ballast and subsurface sample locations were determined as described in Section D.2.2.4 and shown in Table D.3-4. As shown in Table D.3-4, the maximum internal dose at the surface (ballast) and subsurface was at sample location A09 (TLD location AT16). For TLD locations where ballast samples were not collected (15 of the 20 TLD locations), the internal to external dose ratio from the sample location with the maximum amount of internal dose was used to estimate internal dose at those TLD-only locations. The internal to external dose ratios are provided in Table D.3-5 and show that the highest ratio was at sample location A09 at 0.491. The analytical results for the individual radionuclides for each sample and the corresponding calculated internal dose estimates are presented in Appendix C.

Table D.3-4
CAS 25-99-21, Area 25 Railroad Tracks, Average Internal Dose

TLD Location	Sample Location	Number of Samples	Industrial Area (mrem/IA-yr)	Number of Samples	Industrial Area (mrem/IA-yr)
		Surface		Subsurface	
AT01	A01	1	0.02	3	0.45
AT02	A02	1	0.03	1	0.06
AT15	A03	2	0.03	1	0.03
AT14	A04	1	0.02	1	0.57
AT16	A09	1	5.74	1	0.99

Table D.3-5
CAS 25-99-21, Area 25 Railroad Tracks, Ratio of Calculated Internal Dose to External Dose at Each Sample Point

TLD Location	Sample Location	Average Internal Dose	95% UCL External Dose	95% UCL Total Dose	Internal Dose to External Dose Ratio
		(mrem/IA-yr)			
AT01	A01	0.02	346.54	346.56	0.0
AT02	A02	0.03	15.00	15.03	0.003
AT15	A03	0.03	9.00	9.03	0.014
AT14	A04	0.02	834.50	834.53	0.0
AT16	A09	5.74	23.28	29.02	0.491

D.3.2.3 Total Effective Dose

The TED for each ballast sample was calculated by summing the external dose values from TLDs and the internal dose values from ballast analytical results. Values for the average TED for the Industrial Area exposure scenario are presented in Table D.3-6. The TED exceeds the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/IA-yr) at TLD locations AT01, AT13, AT14, and AT16 (Figures D.3-4 and D.3-6).

Future dose at this site is conservatively estimated by considering only radioactive decay mechanisms and ignoring dispersion (erosion and transport mechanisms). It is estimated assuming that dose will continually decrease and that the area exceeding the FAL will continually decrease. However, based on the long half-lives of the radionuclides present at the site (e.g., U-235), TED will not significantly decay in the next 1,000 years.

Table D.3-6
Total Effective Dose (95 Percent UCL) at CAS 25-99-21, Area 25 Railroad Tracks, Sample Locations

TLD Location	Sample Location	Industrial Area 95% UCL TED (mrem/IA-yr)
AT01	A01	**346.56**
AT02	A02	15.03
AT03	--	0.0
AT04	--	0.0
AT05	--	0.0
AT06	--	12.07
AT07	--	9.43
AT08	--	0.0
AT09	--	0.0
AT13	--	**36.87**
AT14	A04	**834.53**
AT15	A03	9.03
AT16	A09	**29.02**
AT17	--	0.0
AT18	--	0.0
AT19	--	0.0
AT20	--	0.0
AT21	--	0.0
AT25	--	0.0
AT26	--	0.0

-- = No sample collected at the TLD location
Bold indicates the values exceeding the FAL.

D.3.2.4 Nonradiological Releases

The following sections discuss the analytical results for verification samples collected after removing lead bricks as PSM and beryllium analyses submitted for both radiological and nonradiological releases.

D.3.2.4.1 RCRA Metals and Beryllium

Analytical results for RCRA metals and beryllium in soil samples collected at this CAS that were detected above MDCs are presented in Table D.3-7. Lead was detected at concentrations exceeding the PAL at several locations where lead bricks were removed as PSM. Lead was moved to a Tier 2 evaluation to determine the site-specific FAL, which is presented in Appendix G. The Tier 2 FAL of 1,202 mg/kg was exceeded at only one lead brick location (sample location A07). Additional soil was removed from this location, and a second verification sample was collected (sample number 539A020). The results from verification sample 539A020 show that lead is below the Tier 2 FAL. Based on the additional soil removal and verification sampling, lead is not considered a COC at this CAS. For all other metals, the FALs were established at the PAL concentrations.

D.3.2.4.2 Gamma-Emitting Radionuclides

Analytical results for gamma-emitting radionuclides in verification soil samples collected at this CAS that were detected above MDCs are presented in Table D.3-8. None of the radionuclides exceeded the PAL; therefore, the FALs were established at the PAL concentrations.

D.3.2.4.3 Plutonium and Uranium Isotopes

Analytical results for isotopic Pu and isotopic U in verification soil samples collected at this CAS that were detected above MDCs are presented in Table D.3-9. No isotopic Pu concentrations exceeded the PALs; therefore, the FALs were established at the PAL concentrations. The U-234 and U-235 concentrations exceeded the PALs. However, because the TED for radiological releases exceed the FAL at this CAS, the FALs for verification samples were established at the PAL concentrations.

Table D.3-7
Sample Results for Metals Detected above MDCs at CAS 25-99-21, Area 25 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)						
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury
FALs			**23[a]**	**190,000[b]**	**2,000[b]**	**800[b]**	**N/A**	**800[b]**	**34[b]**
A04	539A010	0–2	N/A	N/A	0.29	N/A	N/A	N/A	N/A
	539A011	2–6	N/A	N/A	0.28	N/A	N/A	N/A	N/A
A05	539A012	0–6	1.9	95 (J)	N/A	0.041 (J-)	3.2	360	0.039
A06	539A013	0–6	2.3	80	N/A	0.7	4.9	160	0.015 (J-)
A07	539A014	0–6	1.9	64	N/A	--	4	**1,300**	0.027 (J-)
	539A020	0–6	2	76 (J)	N/A	0.061	2.9	54	N/A
A08	539A015	0–6	3.6	76	N/A	0.044 (J-)	3.4	**850**	0.04
A09	539A016	0–2	N/A	N/A	7.3	N/A	N/A	N/A	N/A
	539A017	2–6	N/A	N/A	1.5	N/A	N/A	N/A	N/A
A10	539A018	0–1	2.6	98	0.36	--	3.8	480	0.02 (J-)
A11	539A019	0–1	3.1	84	0.37	0.18 (J-)	4.6	**1,100**	0.027 (J-)

[a]Based on background concentrations for metals (NBMG, 1998; Moore, 1999)
[b]Based on EPA Region 9 screening levels (EPA, 2010)

J = Estimated result
J- = Result is an estimated quantity, but may be biased low.
N/A = Not applicable
-- = Not detected above MDCs

Bold indicates the values exceeding the FALs.

mg/kg = Milligrams per kilogram

Table D.3-8
Sample Results for Gamma-Emitting Radionuclides Detected above MDCs at CAS 25-99-21, Area 25 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)	
			Ac-228[a]	Cs-137[b]
FALs			**5**	**12.2**
539A05	539A012	0–6	1.49	3.34
539A06	539A013	0–6	--	2.89

[a]Taken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, and thallium-208, as found in Chapter IV of DOE Order 5400.5, Change 2, *Radiation Protection of the Public and the Environment* (DOE, 1993).
[b]Taken from the construction, commercial, industrial land use scenario in Table 2-1 of the National Council on Radiation Protection and Measurements Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source were scaled to a 25-millirem-per-year dose.

-- = Not detected above MDCs

Table D.3-9
Sample Results for Isotopes Detected above MDCs at CAS 25-99-21, Area 25 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	COPCs (pCi/g)			
			Pu-239/240	U-234	U-235	U-238
FALs			**12.7[a]**	**143[a]**	**17.6[a]**	**105[a]**
539A05	539A012	0–6	--	**2,040**	**75**	8.1
539A06	539A013	0–6	0.121	**3,210**	**104**	14.2

[a]Taken from the construction, commercial, industrial land use scenario in Table 2-1 of the National Council on Radiation Protection and Measurements Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review Factors Relevant to Site-Specific Studies* (NCRP, 1999). The values provided in this source were scaled to a 25-millirem-per-year dose.

-- = Not detected above MDCs

Bold indicates the values exceeding the FALs.

D.3.3 Nature and Extent of Contamination

The TED calculated at three surface locations at CAS 25-99-21 exceeded the FAL of 25 mrem/IA-yr. The nature of radiological contamination is consistent with releases from activities related to the railroad. In addition, observations made during the investigation identified several locations containing high-activity PSM that is not easily detected by radiological surveys due to shielding effects of the ballast. Based on observations, analytical results, and identification of high-activity PSM, it is determined that the extent of contamination is limited to the surface (less than 1 ft bgs) and less than 15 ft laterally away from the railroad tracks.

The analytical results for verification samples collected at lead brick locations indicate no COCs remain above Tier 2 FALs.

D.3.4 Revised Conceptual Site Model

The SAFER Plan requirements were met at this CAS, and no revisions were necessary to the CSM.

D.4.0 CAS 26-99-05, Area 26 Railroad Tracks, Investigation Results

Corrective Action Site 26-99-05, Area 26 Railroad Tracks, is located in Area 26 of the NNSS (Figure 1-2). This CAS consists of approximately 2 mi of track that was used to transport nuclear-powered machinery to and from Project Pluto facilities via railcars. These activities may have released radioactive materials to the soil/ballast surrounding the railroad tracks. The portions of the railroad tracks identified in Table 2-1 of the SAFER Plan were identified for investigation. Additional detail is provided in the SAFER Plan.

D.4.1 SAFER Activities

A total of eight characterization samples (including one FD) were collected during investigation activities at CAS 26-99-05. The sample IDs, locations, types, and analyses are listed in Table D.4-1. A total of 8 TLDs (representing a total of 24 elements) at 8 locations (3 field background locations and 5 field locations) were used to calculate the external dose to site workers. For each TLD, its location, serial number, date placed, date removed, and purpose are listed in Table D.4-2. The specific CAI activities conducted to satisfy the SAFER Plan requirements at this CAS are described in the following sections.

D.4.1.1 Visual Inspections

Features associated with the railroad tracks and/or identified as PSM were identified within the CAS during both the initial gamma walkover survey and subsequent site visits to place and collect TLDs. These features consisted of switches, culverts, debris, and lead bricks. All the features were accessed and inspected.

During previous radiological walkover surveys, several locations were identified as containing debris and/or lead bricks. Upon inspection, three locations were identified as containing lead bricks. No other PSM or biasing factors (e.g., staining) were identified for additional sample locations. Other than the three lead brick locations, no additional biased sample locations were identified.

Table D.4-1
Samples Collected at CAS 26-99-05, Area 26 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	Matrix	Purpose	Gamma	Metals	Beryllium	Strontium	Uranium
B01	539B001	0–1	Soil	Environmental	X	--	X	X	X
	539B002	1–4	Soil	Environmental	X	--	X	X	X
	539B003	1–4	Soil	FD of #539B002	X	--	X	X	X
B02	539B004	0–2	Soil	Environmental	X	--	X	X	X
	539B005	2–6	Soil	Environmental	X	--	X	X	X
B03	539B006	0–1	Soil	Environmental	--	X	X	--	--
B04	539B007	0–1	Soil	Environmental	--	X	X	--	--
B05	539B008	0–1	Soil	Environmental	--	X	X	--	--

X = Analyzed
-- = Not required

Table D.4-2
TLDs at CAS 26-99-05, Area 26 Railroad Tracks

TLD Location	TLD Serial Number	Date Placed	Date Removed	Purpose
BT01	1537	06/21/2010	09/24/2010	Field
BT02	3821	06/21/2010	09/24/2010	Field
BT03	1699	06/21/2010	09/24/2010	Field
BT04	1803	06/21/2010	09/24/2010	Background
BT05	3381	06/21/2010	09/24/2010	Background
BT06	1960	06/21/2010	09/24/2010	Background
BT07	3879	06/21/2010	09/24/2010	Field
BT08	1474	06/21/2010	09/24/2010	Field

D.4.1.2 Radiological Surveys

A radiological walkover survey was conducted along the railroad tracks from the Pluto Facility to the Test Bunker at CAS 26-99-05. The survey results were used to select locations for establishing TLD transects and collecting soil samples. Additional scanning surveys were performed at the selected transects to determine the highest radioactivity readings for TLD placement. A similar survey was performed to determine ballast/soil sample locations at each selected TLD transect.

Results for the direct scan and swipe collection survey conducted on the lead bricks indicate none of the lead bricks had removable contamination.

D.4.1.3 Field Screening

Investigation samples were field screened for alpha and beta/gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. Gross alpha radiation FSLs were not exceeded. Beta/gamma radiation FSLs were exceeded in five samples.

D.4.1.4 Sample Collection

Sample collection at CAS 26-99-05 consisted of collecting TLD measurements for calculating external dose, soil samples for calculating internal dose, and verification samples following removal of PSM (i.e., lead bricks).

D.4.1.4.1 TLD Samples

The eight TLDs listed in Table D.4-2 and shown at the locations in Figure D.4-1 were used to measure external dose. The selected TLD locations were identified through biasing factors outlined in the SAFER Plan and included visual observations, elevated radiological survey results, and/or professional judgement. The TLDs at TLD locations BT04, BT05, and BT06 were placed at field background locations. Soil samples were collected at TLD locations BT02 and BT03.

D.4.1.4.2 Soil Samples

For the determination of internal dose for radiological releases, two TLD locations (BT02 and BT03) were selected for soil sample collection based on biasing factors and highest TLD dose

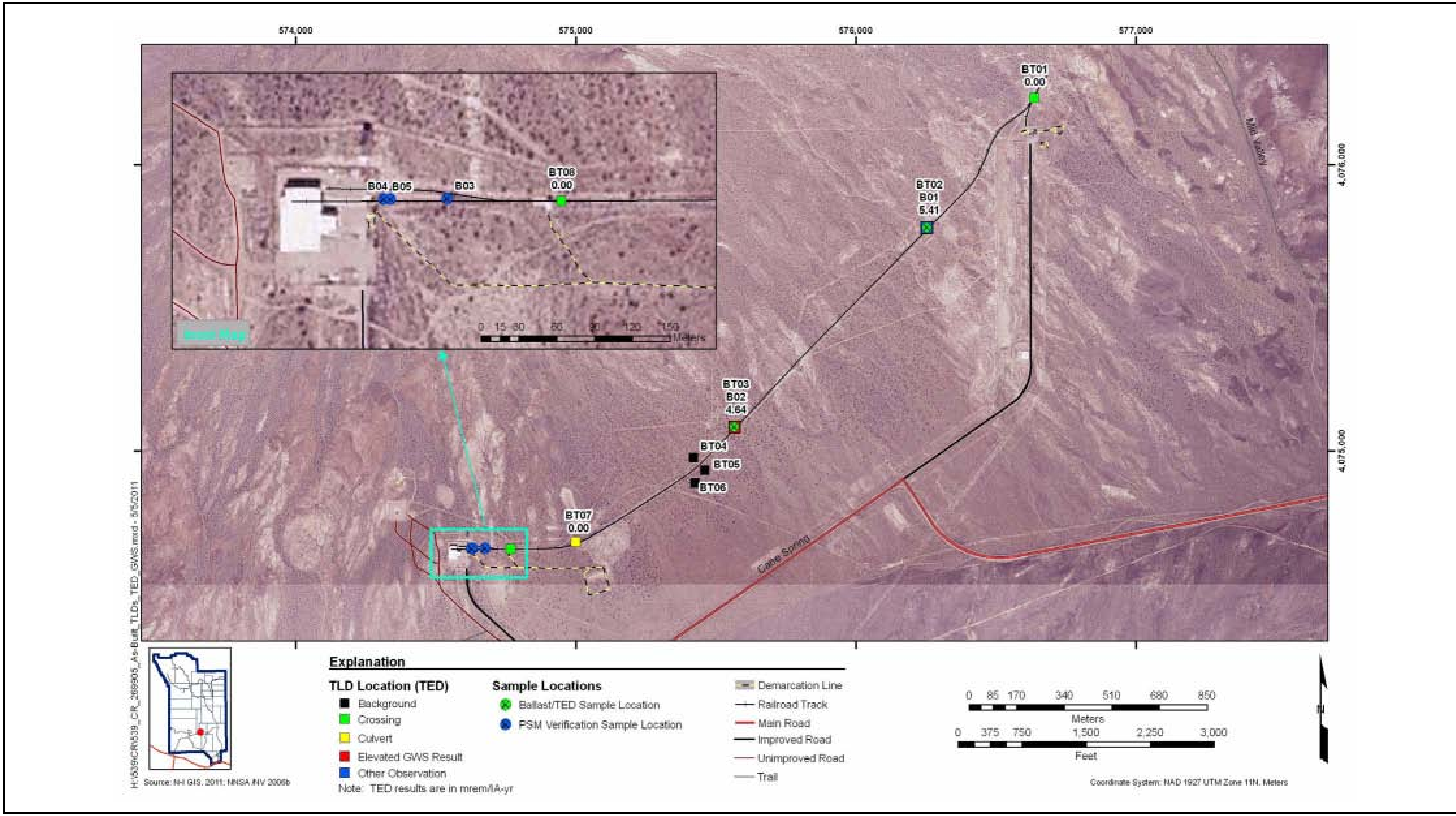

Figure D.4-1
CAS 26-99-05, Area 26 Railroad Tracks, TED Results at TLD Locations

measurements. Ballast soil samples 539B001 and 539B004 were collected from 0 to 2 in. bgs at sample locations B01 and B02 (TLD locations BT02 and BT03), respectively. Three subsurface soil samples 539B002, 539B003 (FD), and 539B005 were collected directly below the ballast from 2 to 6 in. bgs at the same TLD locations to provide information on the migration of COCs and exposure data for receptors conducting intrusive work. The biased sample locations are shown in Figure D.4-1.

Four lead bricks were identified as PSM at three locations (sample locations B03 through B05) along the railroad tracks near the Pluto Facility fence line. Following removal of the lead bricks, three verification samples (sample numbers 539B006 through 539B008) were collected from soil directly beneath the lead bricks. The biased sample locations are shown in Figure D.4-1.

No Decision II or waste characterization sampling activities were required.

D.4.1.5 Deviations

Investigation samples were collected as outlined in the CAU 539 SAFER Plan (NNSA/NSO, 2010c) and submitted for laboratory analysis. One deviation from the SAFER Plan requirements (NNSA/NSO, 2010c) was applicable to both CASs. It involved the calculation of the external dose component and TED for exposure to subsurface soils. The SAFER Plan stated that the RESRAD computer code would be used to estimate both the external and internal doses for the subsurface using soil analytical results. Instead, it was decided that a 95 percent UCL external dose for the subsurface should be calculated by extrapolating the TLD measurement at each sample location to represent the potential exposure a receptor would receive if the ballast were removed. This extrapolation required that the ratio of the subsurface to surface internal doses be calculated for each sample location from analytical results and then that ratio be multiplied against the TLD measurement for that location to estimate the 95 percent UCL external dose. This external dose is then used to calculate the TED. This deviation is not considered significant because a higher external dose component is used to determine the TED and thus the resulting TED is more conservative and protective of human health and the environment.

D.4.2 Investigation Results

The following sections provide the analytical and computational results for soil and TLD samples collected at CAS 26-99-05. Soil and TLD samples were collected as outlined in the SAFER Plan (NNSA/NSO, 2010c). Investigation samples were analyzed for the COPCs specified in the SAFER Plan, which included beryllium, gamma-emitting radionuclides, isotopic U, and Sr-90. The RCRA metals analysis was added for specific PSM verification samples. Table D.4-1 lists the sample-specific analytical suite for CAS 26-99-05.

The radiological results are reported as doses that are comparable to the dose-based FALs as established in Appendix G. Results that are equal to or greater than FALs are identified by bold text in the result tables. A minimum number of soil samples does not apply for the calculation of TED because probabilistic soil sampling was not implemented for the CAU 539 CAI. The 95 percent UCL of the average TED was calculated using the average internal dose and 95 percent UCL external dose.

External dose estimates for TLD locations are summarized in Section D.4.2.1. Internal dose estimates for each sample location are summarized in Section D.4.2.2. The TEDs for each TLD transect location are summarized in Section D.4.2.3.

Analytical results with concentrations exceeding MDCs for verification soil samples for nonradiological releases are summarized in Section D.4.2.4. An evaluation was conducted on all contaminants detected above MDCs by comparing individual concentration or activity results against the FALs. Establishment of the FALs is presented in Appendix G.

D.4.2.1 External Radiological Dose Estimates

The external dose estimates at each sample location were derived from the TLDs staged at each sample location. The external dose for each TLD location was calculated for the Industrial Area exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use Area exposure scenarios. The minimum sample size was met for all TLD locations. The standard deviation, number of elements, and 95 percent UCL of the average external dose for each exposure scenario are presented in Table D.4-3.

Table D.4-3
CAS 26-99-05, Area 26 Railroad Tracks,
95 Percent UCL External Dose for Each Exposure Scenario

TLD Location	Standard Deviation	Number of Elements	Minimum Sample Size[a]	Industrial Area (mrem/IA-yr)	Remote Worker Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
BT01	1.74	3	1.5	0.00	0.00	0.00
BT02	1.30	3	1.4	5.39	0.68	0.16
BT03	1.01	3	1.4	4.62	0.55	0.13
BT07	2.10	3	1.5	0.00	0.00	0.00
BT08	0.96	3	1.4	0.00	0.00	0.00

[a]The minimum sample size is based on the Industrial Area scenario.

D.4.2.2 Internal Radiological Dose Estimates

Estimates for the internal dose that a receptor would receive at each ballast (surface) and subsurface sample location were determined as described in Section D.2.2.4 and shown in Table D.4-4. For TLD locations where soil samples were not collected (three of the five TLD locations), the internal to external dose ratio from the sample location with the maximum amount of internal dose was used to estimate internal dose at those TLD-only locations. The internal to external dose ratios for each sample location are shown in Table D.4-5. As shown in Table D.4-4, the maximum internal dose at the surface (ballast) was the same for both locations. The maximum internal dose at the subsurface was at sample location B01 (TLD location BT02). The internal to external dose ratio was 0.008 for both locations (Table D.4-5). The analytical results for the individual radionuclides for each sample and the corresponding calculated internal dose estimates are presented in Appendix C.

D.4.2.3 Total Effective Dose

The TED for each ballast sample was calculated by summing the external dose values from TLDs and the internal dose values from ballast analytical results. Values for the 95 percent UCL of the average TED for each exposure scenario are presented in Table D.4-6. The 95 percent UCL of the average TED did not exceed the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/IA-yr) at any location.

Table D.4-4
CAS 26-99-05, Area 26 Railroad Tracks, Average Internal Dose

TLD Location	Sample Location	Surface		Subsurface	
		Number of Samples	Industrial Area (mrem/IA-yr)	Number of Samples	Industrial Area (mrem/IA-yr)
BT02	B01	1	0.02	2	0.03
BT03	B02	1	0.02	1	0.02

Table D.4-5
CAS 26-99-05, Area 26 Railroad Tracks,
Ratio of Calculated Internal Dose to External Dose at Each Sample Point

TLD Location	Sample Location	Average Internal Dose	95% UCL External Dose	95% UCL Total Dose	Internal Dose to External Dose Ratio
		(mrem/IA-yr)			
BT02	B01	0.02	5.39	5.41	0.008
BT03	B02	0.02	4.62	4.64	0.008

Table D.4-6
Total Effective Dose (95 Percent UCL) at CAS 26-99-05,
Area 26 Railroad Tracks, Sample Locations

TLD Location	Industrial Area
	95% UCL TED (mrem/IA-yr)
BT01	0.0
BT02	5.41
BT03	4.64
BT07	0.0
BT08	0.0

D.4.2.4 Nonradiological Releases

The following sections discuss the analytical results for verification samples collected after removing lead bricks as PSM and beryllium analyses submitted for all types of releases.

D.4.2.4.1 RCRA Metals and Beryllium

Analytical results for RCRA metals and beryllium in soil samples collected at this CAS that were detected above MDCs are presented in Table D.4-7. Lead was detected at concentrations exceeding the PAL at locations were lead bricks were removed as PSM. Lead was moved to a Tier 2 evaluation to determine the site-specific FAL, which is presented in Appendix G. Lead did not exceed the Tier 2 FAL of 1,202 mg/kg; therefore, lead is not considered a COC at this CAS. For all other metals, the FALs were established at the PAL concentrations.

Table D.4-7
Sample Results for Metals Detected above MDCs
at CAS 26-99-05, Area 26 Railroad Tracks

Sample Location	Sample Number	Depth (in. bgs)	COPCs (mg/kg)						
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury
FALs			**23[a]**	**190,000[b]**	**2,000[b]**	**800[b]**	**N/A**	**800[b]**	**34[b]**
B01	539B001	0–1	N/A	N/A	0.39	N/A	N/A	N/A	N/A
	539B002	1–4	N/A	N/A	0.43	N/A	N/A	N/A	N/A
	539B003	1–4	N/A	N/A	0.4	N/A	N/A	N/A	N/A
B02	539B004	0–2	N/A	N/A	0.41	N/A	N/A	N/A	N/A
	539B005	2–6	N/A	N/A	0.38	N/A	N/A	N/A	N/A
B03	539B006	0–1	5.4	180	0.41	0.21 (J-)	6.6	**890**	0.022 (J-)
B04	539B007	0–1	8.3	930	0.51	0.46 (J-)	15	160	0.032 (J-)
B05	539B008	0–1	7.6	450	0.43	7.6	6	300	0.027 (J-)

[a]Based on background concentrations for metals (NBMG, 1998; Moore, 1999)
[b]Based on EPA Region 9 screening levels (EPA, 2010)

J- = Result is an estimated quantity, but may be biased low.
N/A = Not applicable

Bold indicates the values exceeding the FALs.

D.4.3 Nature and Extent of Contamination

Based on the analytical results for soil samples collected within CAS 26-99-05, no COCs were identified. Potential source material in the form of lead bricks was removed.

D.4.4 Revised Conceptual Site Model

The SAFER Plan requirements were met at this CAS, and no revisions were necessary to the CSM.

D.5.0 Waste Management

The following sections describe the waste generated during SAFER activities and their final disposition. For regulated waste, waste management areas were established and managed as specified in the CAU 539 SAFER Plan. All waste was managed in accordance with applicable state and federal regulations, DOE Orders, and the CAU 539 SAFER Plan. A summary of the wastes generated, managed, and dispositioned for CAU 539 is provided in Table D.5-1. Investigation activities did not require waste characterization samples to be collected.

Sanitary waste included office and lunch trash and was disposed of in designated sanitary waste bins allocated for disposal at the NNSS landfill.

D.5.1 Waste Streams

Waste generated during the CAU 539 investigation was segregated into the following waste streams: IDW, lead bricks as well as recyclable material, and remediation waste.

D.5.1.1 Investigation-Derived Waste

Investigation-derived waste generated during the field activities for CAU 539 included disposable PPE, disposable sampling equipment, and contaminated tools. The IDW, which was collected daily, was segregated and field screened as generated in accordance with the radiological release limits of Table 4-2 of the *Nevada Test Site Radiological Control Manual* (NNSA/NSO, 2010b). The IDW meeting the limits of Table 4-2 based on screening results was managed as industrial solid waste and transferred to a designated industrial waste bin at Building 23-153 for disposal at the NNSS Area 9 U10c industrial waste landfill. The IDW exceeding the limits of Table 4-2 based on field screening and/or process knowledge was bagged, labeled, and placed in the Building 23-153 RMA for future disposition as LLW at the Area 5 RWMC.

Waste minimization techniques were effectively integrated into the field activities to reduce the amount of waste generated. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste. Decontamination activities were planned and executed in a manner that eliminated rinsate to be managed.

Table D.5-1
Waste Summary for CAU 539

Waste Type	Description	Waste Characterization				Waste Disposition			
		Hazardous	Hydrocarbon	PCBs	Radioactive	Disposal Facility	Waste Volume	Disposal Date	Disposal Document[a]
IDW	Sampling Equipment and PPE	No	No	No	No	NNSS, U10c Landfill	5 yd^3	Pending	Load Verification Form[b]
	LLW—Sampling Equipment and PPE	No	No	No	Yes	NNSS, RWMC	5 yd^3	Pending	Certificate of Disposal[c]
Remediation Waste	LLW Soil Drum 539A01	No	No	No	Yes	NNSS, RWMC	1.3 ft^3	TBD	Certificate of Disposal
	MLLW Soil Drum 539A02	Yes	No	No	Yes	Offsite TSDF	1.3 ft^3	TBD	Onsite Manifest
Recyclable Material	Lead Bricks	No	No	No	No	Toxco, Inc.	18 each	N/A	Certificate of Recycle

[a]Copies of waste disposal documents are located in Appendix E of this document.

[b]Industrial waste staged at Building 23-153 is disposed at the end of the year.

[c]Low-level waste-IDW is consolidated with other LLW in cargo container # 566007 staged at Building 23-153 and is scheduled for disposal after completely full per NDEP approval (Murphy, 2011).

ft^3 = Cubic foot
PCB = Polychlorinated biphenyl
TBD = To be determined
yd^3 = Cubic yard

D.5.1.2 Lead Bricks as Recyclable Material

A total of 18 lead bricks were removed from both CASs and staged at Building 23-153 for future recycling through Toxco Materials Management Center in Oak Ridge, Tennessee. The lead bricks are considered scrap metal and are excluded from management as a RCRA hazardous waste in accordance with 40 CFR 261.4(a)(13) if reused or recycled in its present chemical form (CFR, 2010). The bricks will be shipped off site when enough recyclable material is accumulated to make off site shipment economical. It is anticipated this material will be shipped offsite by the end of the fiscal year 2011. A photograph of some of the lead bricks removed from CAS 25-99-21 is shown in Figure D.5-1.

Figure D.5-1
Lead Bricks at CAS 25-99-21, Area 25 Railroad Tracks before Removal

D.5.1.3 Remediation Waste

Remediation waste generated at CAU 539 includes the following waste streams:

- One drum of soil and debris generated at CAS 25-99-21, is characterized as LLW, and was transported at the NNSS RWMC in Area 5 for final disposal in accordance with the requirements contained in the NNSS Waste Acceptance Criteria (NNSA/NSO, 2010a).

- One drum of soil and debris generated from removing lead-contaminated soil is characterized as MLLW and was transferred to the Area 5 mixed waste storage unit to await offsite disposal.

The load verification and shipping documentation for CAU 539 are provided in Appendix E.

D.5.2 Waste Characterization

Waste characterization and disposal were based on process knowledge, radiological field surveys, and site environmental samples. Characterization and disposal for all waste streams were completed in accordance with federal regulations, state regulations, and DOE Orders, and the waste acceptance criteria of the applicable disposal site. One direct sample of the lead contaminated soil at sample location A07 (sample number 539A014) was reanalyzed for TCLP-lead. The TCLP-lead result was 22 milligrams per liter (mg/L), which is above the RCRA regulatory limit of 5 mg/L.

D.6.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 539 CAI. The following sections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in Section 4.1.

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, 2002a).

D.6.1 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 539 were evaluated for data quality in a tiered process described in Sections D.6.1.1 through D.6.1.3. 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.

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

D.6.1.1 Tier I Evaluation

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

- 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.

D.6.1.2 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 duplicate (MSD) percent recoveries (%R) and 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:

- 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, 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.

D.6.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 5 percent of the sample analytical data was performed by TLI Solutions, Inc. of 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; and
  - data package for completeness.
- Determine sample results qualifiers through the evaluation of (but not limited to)
  - tracers and QC sample results (e.g., duplicates, LCSs, blanks, MSs) evaluated and used to determine sample results qualifiers;
  - sample preservation, sample preparation/extraction and run logs, sample storage, and holding time;
  - instrument and detector tuning;
  - initial and continuing calibrations;
  - calibration verification (initial, continuing, second source);

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

D.6.2 Field QC Samples

Field QC samples consisted of two full laboratory QC samples and two FDs collected and submitted for analysis by the laboratory analytical methods shown in Table D.2-2. The QC samples were assigned individual sample numbers and sent to the laboratory "blind." Five additional samples were selected by the laboratory to be analyzed as laboratory duplicates and MSs.

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

D.6.2.1 Laboratory QC Samples

Analyses of preparation blanks (PBs), MSs, LCSs, and duplicates were performed on each sample delivery group (SDG) in which inorganic analyses were requested. 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.

The laboratory included a PB, LCS, and a laboratory duplicate sample with each batch of field samples analyzed for radionuclides.

D.6.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

D.6.4 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. These laboratory nonconformances have been accounted for and resolved during the data qualification process.

D.6.5 TLD Data Validation

The use of a TLD to determine an individual's external exposure is the standard in radiation safety and serves as the "legal dose of record" when other measurements are not available. Specifically, 10 CFR 835.402 (CFR, 2011) stipulates that personal dosimeters shall be provided to monitor individual exposures and that the monitoring program using dosimeters shall be accredited in accordance with a DOE Laboratory Accreditation Program, as was the case for the TLDs used at CAU 539.

The TLDs were exposed at the CAU 539 sample locations for exposure durations ranging from 2,280 to 2,352 hours. The measured does from each TLD was then scaled based on the exposure duration defined for the Industrial Area exposure scenario (i.e., 2,250 hours).

D.7.0 Summary

Radionuclide and inorganic contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 539. Assessment of the data generated from investigation activities indicates that the TED estimate for CAS 25-99-21 exceeded the FAL of 25 mrem/IA-yr for radiological releases. The following summarizes the results for each CAS.

CAS 25-99-21, Area 25 Railroad Tracks

The TED for radiological releases was compared to and exceeded the FAL of 25 mrem/yr. Based on field observations, the locations exceeding the Industrial Area scenario FAL are associated with the identification of high-activity PSM that is likely contributing to the external dose of the TED. The analytical results combined with radiological walkover surveys indicate that migration of the high-activity PSM is limited laterally to less than 15 ft and decreases with distance from the railroad tracks. Based on the presence of the high-activity PSM and the exceedances of the Industrial Area scenario FAL, a corrective action of closure in place with a UR is recommended for this CAS. Verification samples collected from soil after the removal of lead bricks indicate no COC above FALs are present in the soil.

CAS 26-99-05, Area 26 Railroad Tracks

Based on the observations made, the radiological surveys conducted, and the analytical results of the environmental samples collected at this CAS, no radiological contamination has been released to the soil at this CAS. Verification samples collected after the removal of lead bricks indicate no COC above FALs are present in the soil. Therefore, clean closure was completed, and no further action is required at this CAS.

D.8.0 References

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Appendix E

Waste Disposition Documentation

(2 Pages)

NTS On-Site HazMat Transfer - Published

Tracking No: DPM11TRC **Mesa Number:**

Carrier: NSTEC
Vehicle: G620445D
Driver: JOSEPH WARD

Depart: 22-JUN-2011 Arrival: 22-JUN-2011

From: ROBERT ZION
NSTEC
BASE CAMP
MERCURY, NV 89023

Area: 25
Bldg: TEST CELL C
Phone: 702-295-4594
Mobile: 702-486-4231

To: LOUIS GREGORY
NSTEC
BASE CAMP
TRU PAD
MERCURY, NV 89023
Area: 05
Bldg: 024
Phone: 702-295-2799
Mobile: 702/595-9414

Entered By: THERESA HALE Date Entered: 20-JUN-2011
Modified By: THERESA HALE Date Modified: 21-JUN-2011

Shipped Material(s)	Package(s)	Unit(s)	Guide No.
RQ, UN/NA 2910, RADIOACTIVE MATERIAL, EXCEPTED PACKAGE, LIMITED QUANTITY OF MATERIAL, 7 WASTE (D008), RADIONUCLIDES:SR-90, U-234, U-235, U-238 PHYSICAL FORM:SOLID CHEMICAL FORM:OXIDE PACKAGE ACTIVITY:PACKAGE # 639A02, 5.312E+08 BQ CATEGORY:FISSILE EXCEPTED, EXCLUSIVE USE SHIPMENT, ON-SITE TRANSFER	1 DRUM, METAL	70.00 POUND(S) (GROSS)	161

Emergency Response Number
702-295-0311

Secondary Emergency Response Contact And/Or Comments
STEFAN DUKE 702-630-0423

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

EMERGENCY RESPONSE

By Phone
702-295-0311

By Radio
'MAYDAY - MAYDAY - MAYDAY'

In the event of an incident involving Hazardous Material:

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

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

Authorized Signature: /s/ Signature on File Date: 6/22/11 Time: 0930

Received by: /s/ Signature on File Date: 6/22/11 Time: 1140

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

Appendix F

Use Restrictions

F.1.0 Use Restrictions

The following sections document the UR completed for CAU 539 at CAS 25-99-21.

F.1.1 CAS 25-99-21 Use Restriction

Attachment F-1 of this appendix provides details of the UR and figures of the UR boundary.

The UR signs state the following information:

WARNING

**SURFACE RADIOLOGICAL CONTAMINATION
UP TO 15 FEET ON EACH SIDE
OF RAILROAD TRACK**

FFACO Site CAU 539/CAS 25-99-21
No activities that may alter or modify the containment control or removal of materials are permitted in this area without U.S. Government permission.

Before working in this area,
Contact Real Estate Services at 702-295-2528

Attachment F-1

Use Restriction

(12 Pages)

Use Restriction Information

CAU Number/Description: CAU 539, Areas 25 and 26 Railroad Tracks
Applicable CAS Number/Description: CAS 25-99-21, Area 25 Railroad Tracks

Contact (Federal Sub-Project Director/Sub-Project): Kevin Cabble Industrial Sites Subproject Manager

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
See Attachment 1 (table for 83 UR points)		

Depth: Surface to 5 feet below ground surface

Survey Method (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: The FFACO UR was implemented to protect site workers from inadvertent exposure to radiological contaminants. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 67 hours of exposure to the surface location with the maximum detected radioactivity. Also, radiological contaminated debris was identified on, within, and/or underlying the railroad ballast (surface gravel). This contaminated soil and debris, if exposed through surface disturbance or excavation, could cause a site woker to receive a dose exceeding 25 mrem/yr. The analytical results and locations of all samples collected are presented in the Closure Report for CAU 539.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 539 CAS 25-99-21, Area 25 Railroad Tracks			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Total Effective Dose (TED)	834.5	25	mrem/2,250 hours

Site Controls: The UR area encompasses the entire set of railroad tracks in Area 25 (excluding road crossings but including sections where railroad ties and/or rails were removed) up to 15 feet laterally on both sides of the railroad centerline where contamination exceeds the FAL of 25 mrem in 2,250 hours (the Industrial Area annual exposure scenario). To permit vehicle travel, the UR area excludes existing road crossings over the tracks and parallel access roads along the railroad track. It is established at the coordinates referenced above and depicted in the attached figures. Site controls include warning signs placed along both sides of tracks, at every existing road crossing, and at facility boundary fence lines where tracks enter facilities. Warning signs will be placed in a manner that will result in informing workers who travel on the roads adjacent to the railroad and that cross the railroad.

Administrative Use Restriction Physical Description*: N/A

Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
Southeast (N/A)	N/A	N/A

Depth: N/A

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

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

Use Restriction Information

Basis for Administrative UR(s):

Summary Statement: N/A

Contaminants Table:

Maximum Concentration of Contaminants for CAU 539 CAS 25-99-21, Area 25 Railroad Tracks			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
N/A	N/A	N/A	N/A

Site Controls: N/A

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

Description: The UR must be entered into the NNSA/NSO Facility Information Management System (FIMS) and the FFACO database.

Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure the signs are in place and readable and to verify no evidence of intrusion to the surface soils.

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

Comments: Radiologically contaminated Potential Source Material (PSM) is located on, within, and/or below the railroad ballast (i.e., surface gravel/soil covering the railroad grade). The removal of the ballast and the PSM contained within the ballast was not feasible due to volume of ballast along the approximately 9 miles of railroad tracks included in this CAS and the unknown/unidentified locations of the contaminated PSM. Personnel are restricted from removing any materials and/or performing any type of work or activity that may disturb the surface soils/ballast. Should any portion of the railroad track be identified for future work, permission to conduct activities within this area requries notification of the NDEP. The nature of the UR area allows for portions of the track to be investigated for radiological contaminants and potentially removed from the UR upon notification of the NDEP.

Submitted By: /s/ Kevin Cabble **Date:** 6-14-11

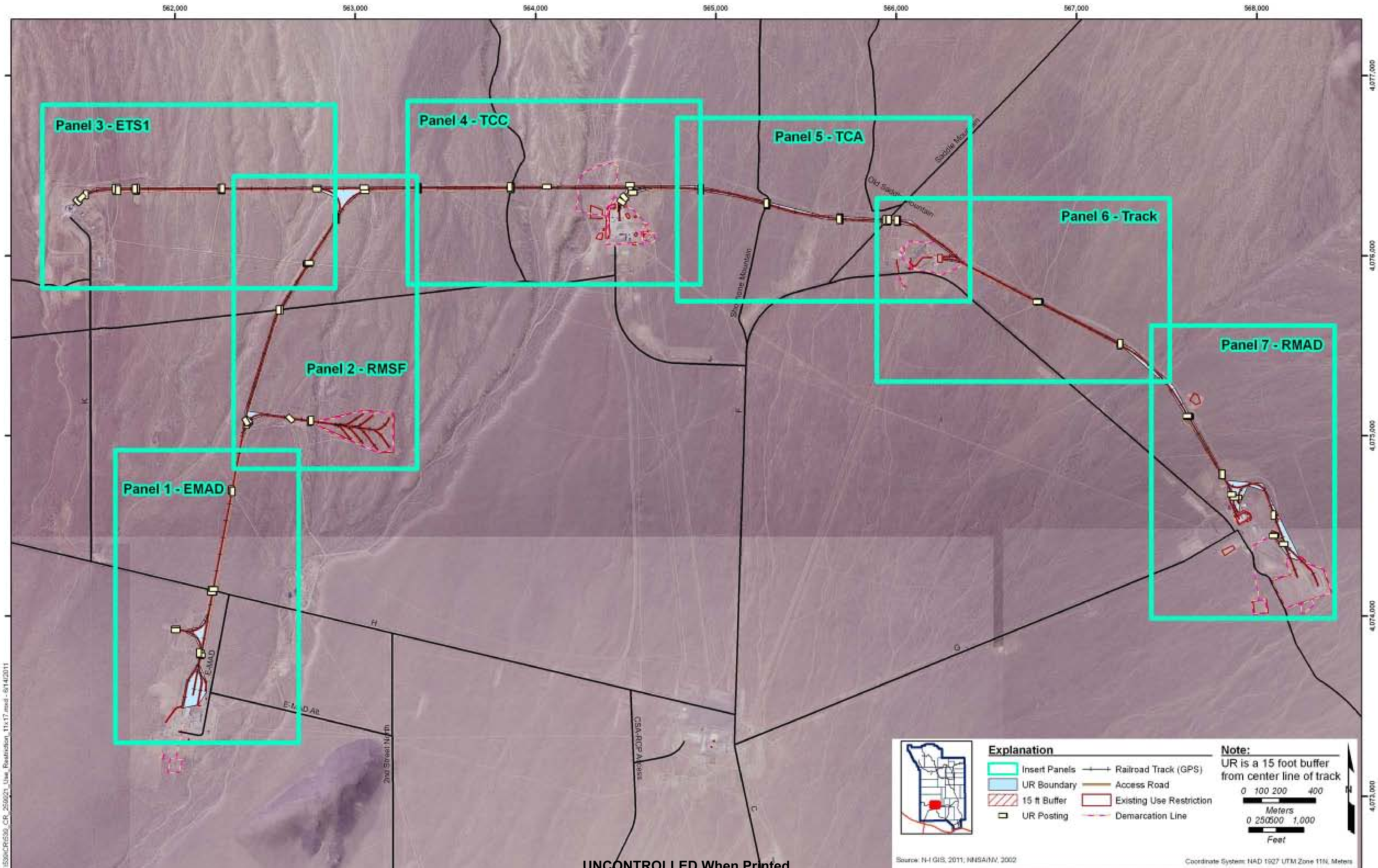
Note: Effective upon acceptance of closure documents by NDEP

Attachment 1 - FFACO Use Restriction Physical Description:
Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points (Southeast)	Northing	Easting
7	568,240.7	4,074,320.7
8	568,230.0	4,074,310.5
9	568,187.6	4,074,325.5
10	568,179.3	4,074,322.8
11	568,089.0	4,074,442.1
12	568,100.0	4,074,448.7
13	568,147.7	4,074,409.6
14	568,041.8	4,074,694.2
15	567,950.4	4,074,725.1
16	567,907.0	4,074,625.9
17	567,900.9	4,074,570.4
18	567,883.2	4,074,556.0
19	567,845.9	4,074,637.8
20	567,836.8	4,074,725.1
21	567,504.6	4,075,278.2
22	567,256.0	4,075,495.2
23	566,355.4	4,075,962.0
24	566,259.8	4,075,977.7
25	566,258.4	4,075,997.2
26	566,312.7	4,076,004.4
27	566,101.0	4,076,162.1
28	566,003.5	4,076,184.3
29	565,817.2	4,076,192.0
30	565,603.0	4,076,203.8
31	565,424.6	4,076,239.7
32	565,139.8	4,076,321.3
33	564,893.5	4,076,365.9
34	564,655.1	4,076,375.5
35	564,539.4	4,076,345.9
36	564,483.6	4,076,291.9
37	564,468.3	4,076,300.2
38	564,506.9	4,076,371.6
39	563,110.1	4,076,369.8
40	563,015.8	4,076,338.2
41	562,947.2	4,076,278.1
42	562,568.1	4,075,665.0
43	562,406.1	4,075,137.6
44	562,792.7	4,075,082.1
45	562,791.5	4,075,073.0
46	562,489.7	4,075,113.8
47	562,421.8	4,075,089.9
48	562,381.0	4,075,012.8
49	562,191.7	4,074,017.0
50	562,137.0	4,073,730.0

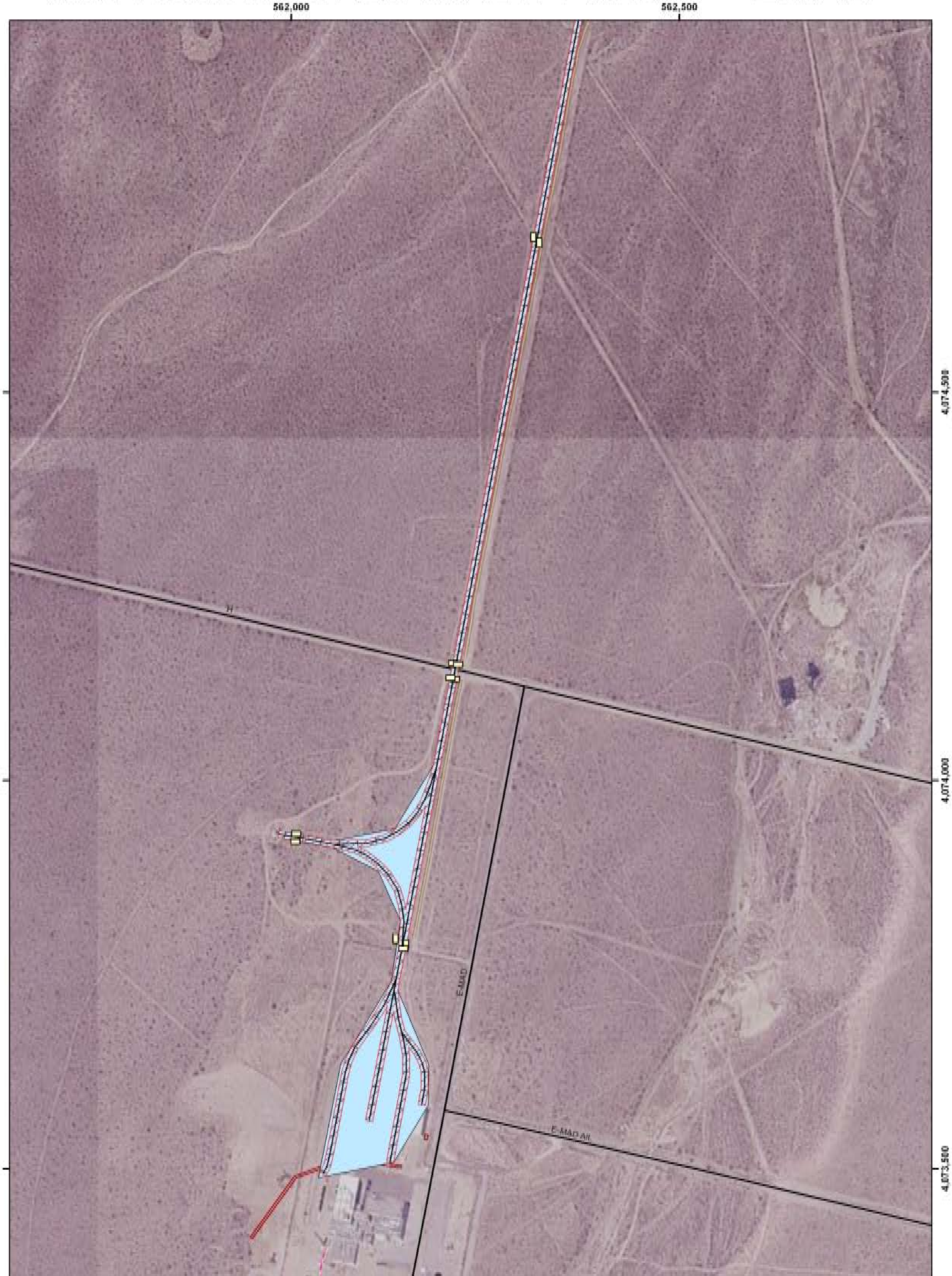
Attachment 1 - FFACO Use Restriction Physical Description: Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points (Southeast)	Northing	Easting
51	562,177.1	4,073,633.5
52	562,176.3	4,073,581.8
53	562,131.6	4,073,508.3
54	562,035.0	4,073,488.5
55	562,063.7	4,073,634.9
56	562,128.5	4,073,741.6
57	562,140.4	4,073,819.4
58	562,111.8	4,073,883.3
59	562,053.4	4,073,913.5
60	561,982.8	4,073,926.3
61	561,984.3	4,073,935.3
62	562,054.9	4,073,922.6
63	562,133.8	4,073,938.2
64	562,182.7	4,074,019.1
65	562,372.0	4,075,014.8
66	562,372.1	4,075,015.2
67	562,389.9	4,075,141.1
68	562,556.6	4,075,671.9
69	562,889.6	4,076,204.6
70	562,891.6	4,076,321.8
71	562,792.7	4,076,368.2
72	561,618.4	4,076,363.5
73	561,565.1	4,076,356.8
74	561,508.3	4,076,334.3
75	561,462.3	4,076,298.3
76	561,450.6	4,076,310.7
77	561,501.8	4,076,341.2
78	561,562.5	4,076,376.0
79	564,878.5	4,076,388.3
80	565,092.6	4,076,347.6
81	565,583.4	4,076,225.2
82	566,080.2	4,076,195.2
83	566,080.2	4,076,195.2
0	566,080.2	4,076,195.2
1	566,309.3	4,076,025.5
2	566,375.4	4,075,961.6
3	567,310.6	4,075,482.8
4	567,537.5	4,075,279.0
5	567,831.8	4,074,751.9
6	568,031.7	4,074,735.9



H:\5309\CR\530_CR_250\21_Use_Restriction_11x17.mxd - 8/14/2011

Use Restriction 25-99-21: Panel 1 - EMAD



Explanation

- UR Posting
- Railroad Track (GPS)
- 15 ft Buffer
- UR Boundary
- Access Road
- NNSS Road
- Demarcation Line
- Existing Use Restriction

Note:
UR is a 15 foot buffer from center line of track

0 50 100 200
Meters

0 250 500 1,000
Feet

N

Source: N-I GIS, 2011, NNSA/NV, 2002

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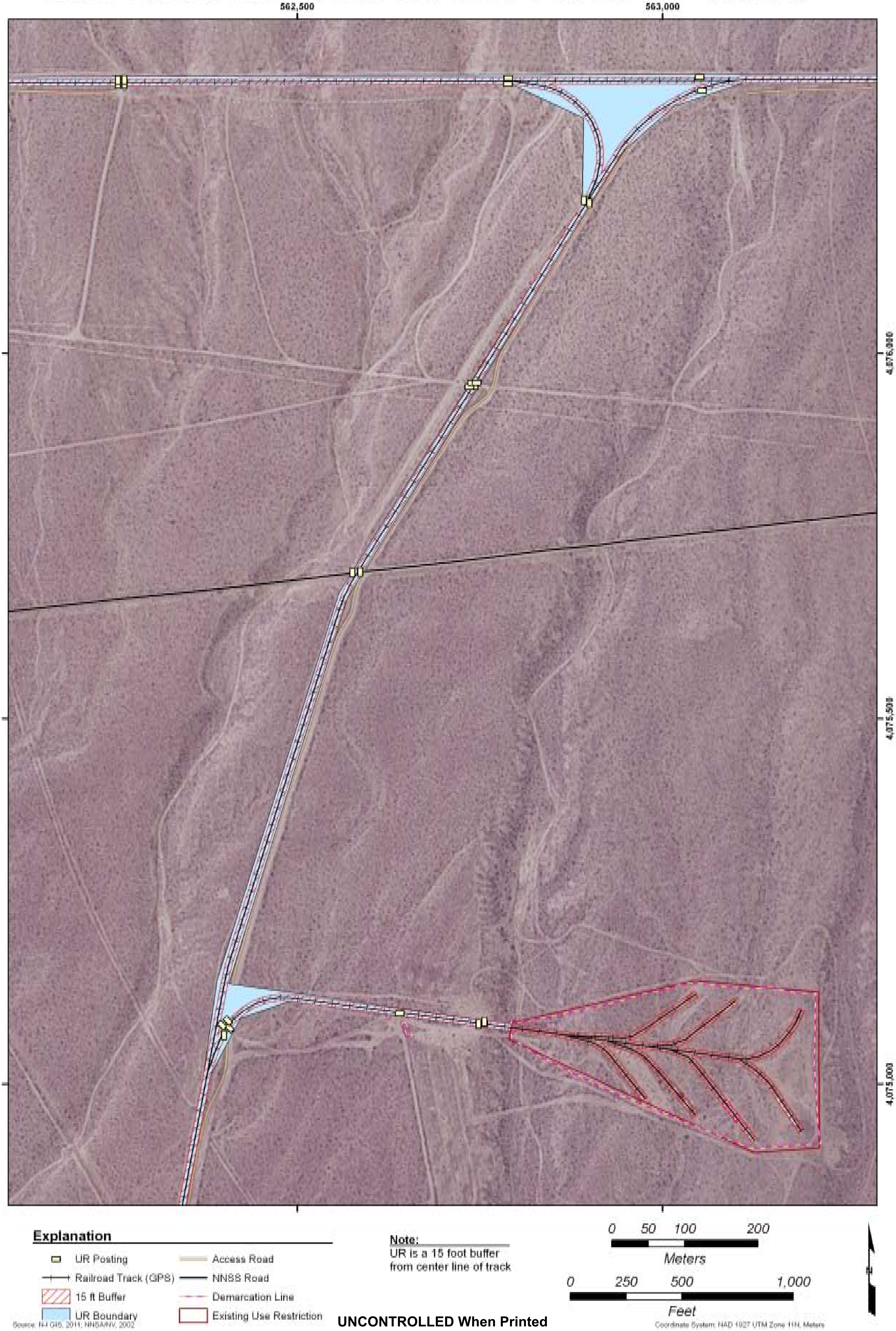
Coordinate System: NAD 1927 UTM Zone 11N, Meters

Use Restriction 25-99-21: Panel 2 - RMSF



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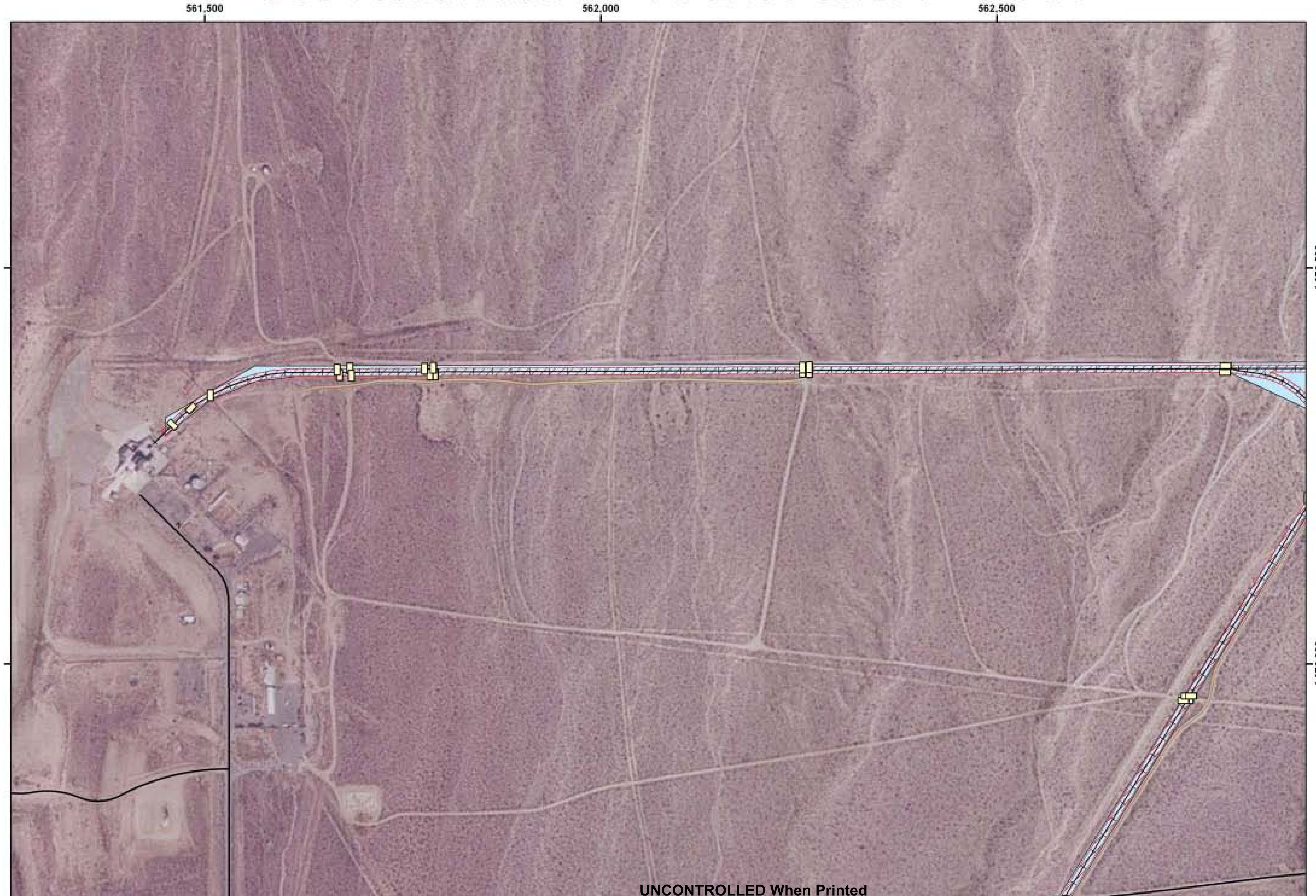
Use Restriction 25-99-21: Panel 3 - ETS1



Explanation

- UR Posting
- Railroad Track (GPS)
- 15 ft Buffer
- UR Boundary
- Access Road
- NNSS Road
- Demarcation Line
- Existing Use Restriction

Note:
UR is a 15 foot buffer from center line of track

N

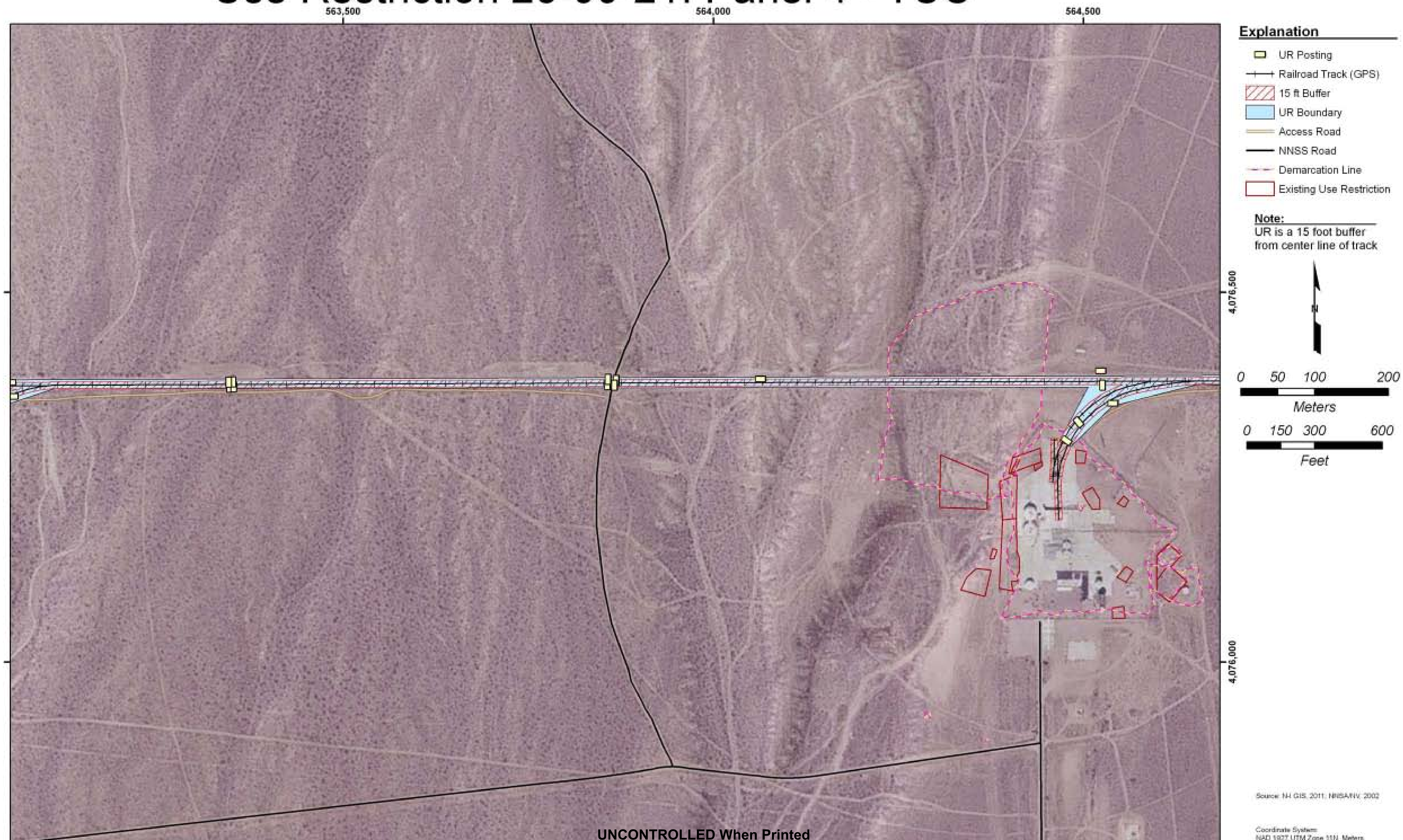
0 50 100 200
Meters

0 150 300 600
Feet

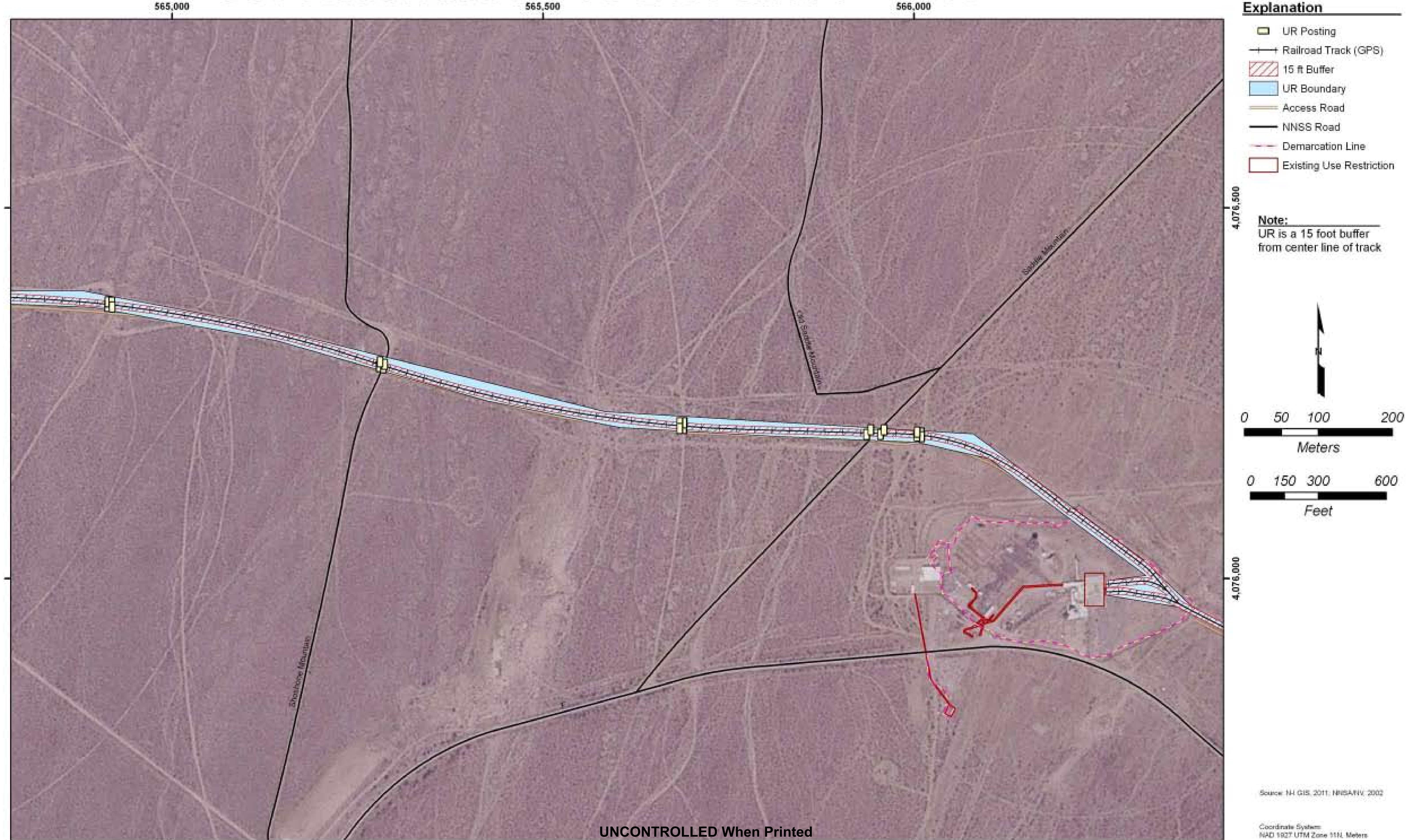
Source: N-I GIS, 2011; NNSA/NV, 2002

Coordinate System: NAD 1927 UTM Zone 11N, Meters

Use Restriction 25-99-21: Panel 4 - TCC



Use Restriction 25-99-21: Panel 5 - TCA



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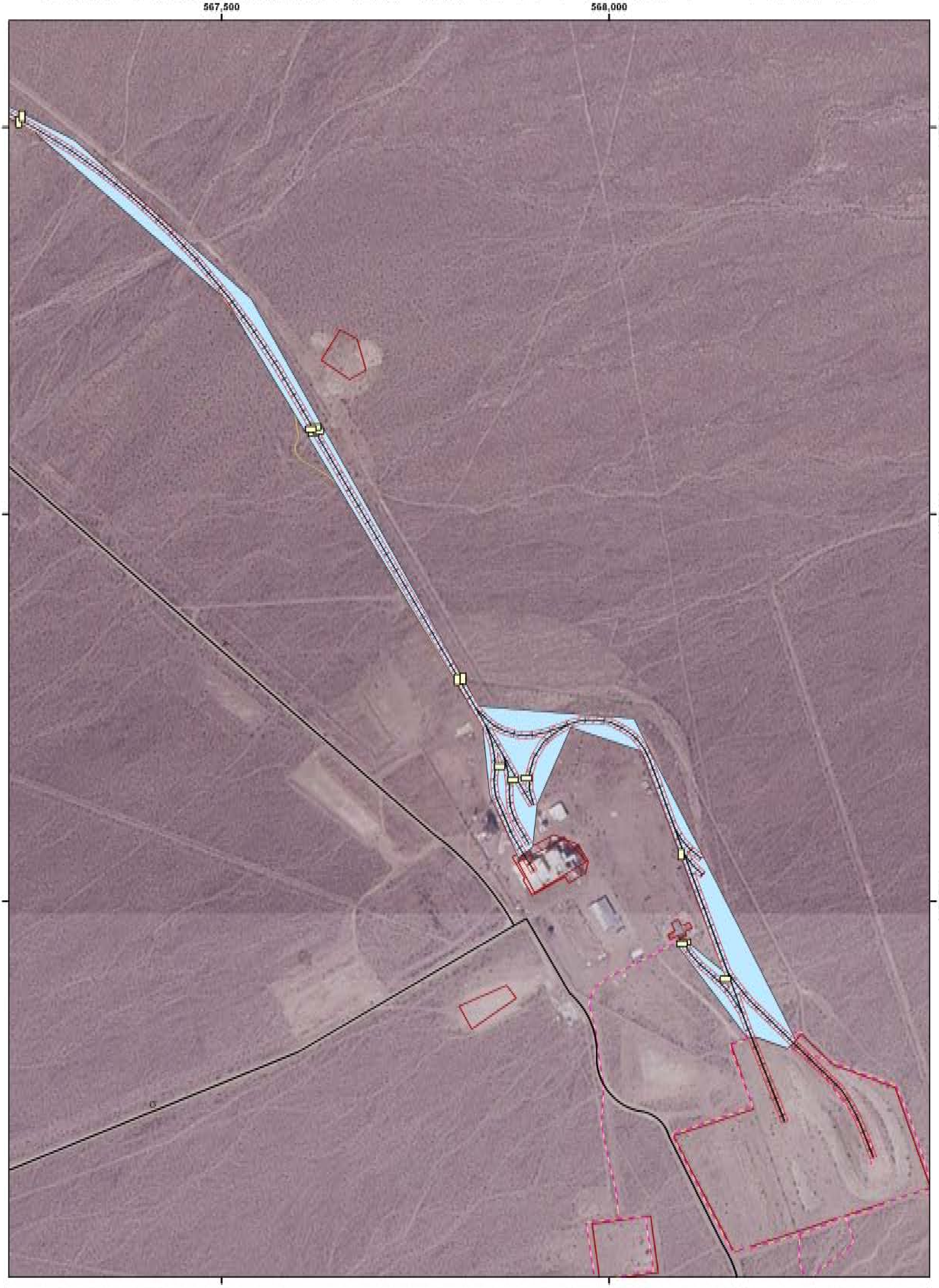
Use Restriction 25-99-21: Panel 6 - Track

Use Restriction 25-99-21: Panel 7 - RMAD



Explanation

- UR Posting
- Railroad Track (GPS)
- 15 ft Buffer
- UR Boundary
- Access Road
- NNSS Road
- Demarcation Line
- Existing Use Restriction

Source: N-I GIS, 2011; NNSA/NV, 2002

Note:
UR is a 15 foot buffer from center line of track

0 50 100 200
Meters

0 250 500 1,000
Feet

Coordinate System: NAD 1927 UTM Zone 11N, Meters

UNCONTROLLED When Printed

Appendix G

Risk Evaluation

G.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) and summarized in Figure G.1-1. This process conforms with *Nevada Administrative Code* (NAC) Section 445A.227 (NAC, 2008a), which lists the requirements for sites with soil contamination. For the evaluation of corrective actions, NAC Section 445A.22705 (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 (i.e., FALs) or to establish that corrective action is not necessary."

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) compared to action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 539 SAFER Plan [NNSA/NSO, 2010]). 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—A Tier 2 evaluation is 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—A Tier 3 evaluation is 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.

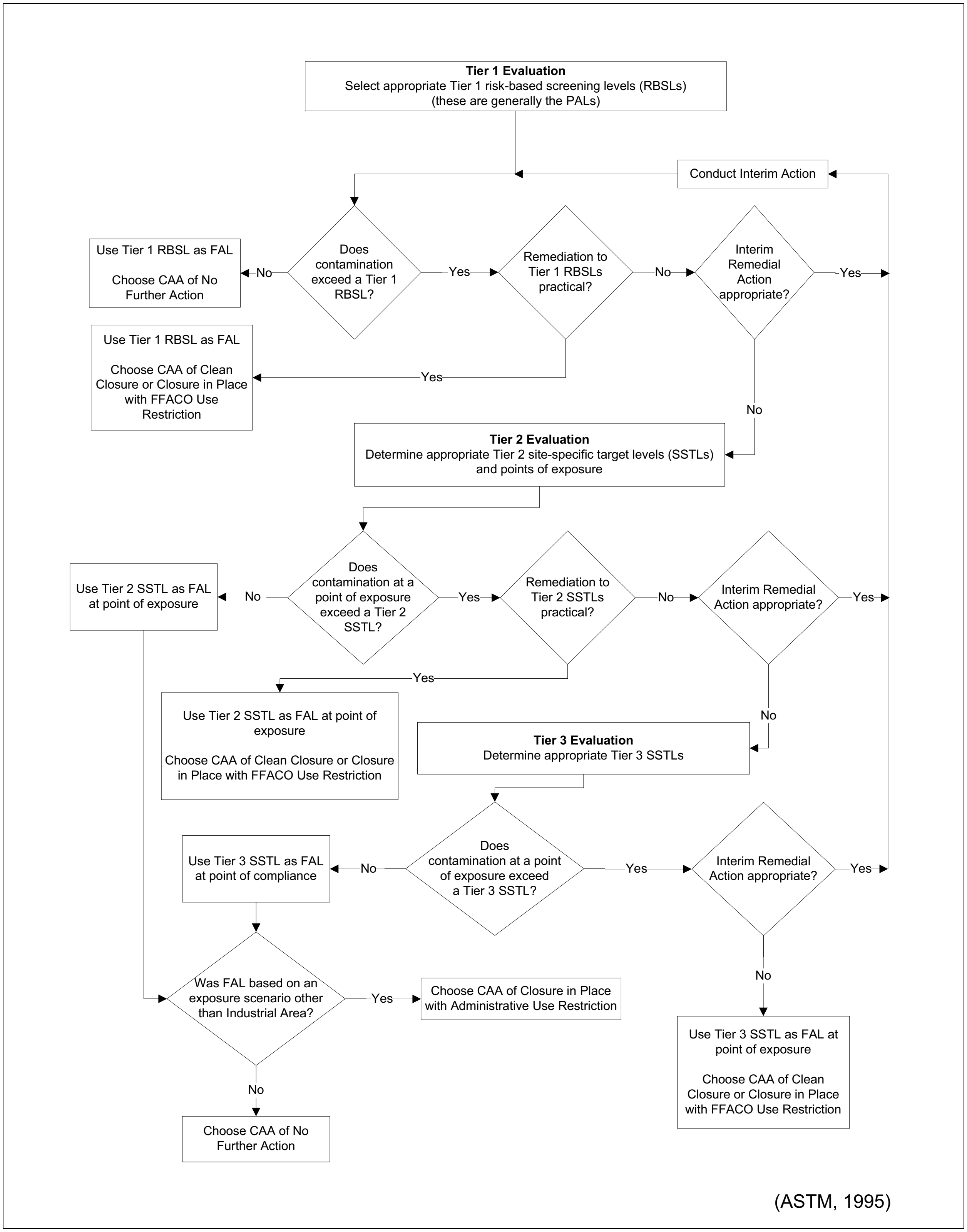


Figure G.1-1
Risk-Based Corrective Action Decision Process

G.1.1 A. Scenario

Corrective Action Unit 539 comprises the following two CASs within Areas 25 and 26 of the NNSS:

- 25-99-21, Area 25 Railroad Tracks
- 26-99-05, Area 26 Railroad Tracks

The Area 25 Railroad Tracks (CAS 25-99-21) is approximately 9 mi in length and has been inactive since 1973. The Area 26 Railroad Tracks (CAS 26-99-05) is approximately 2 mi in length and has been inactive since 1964. The railroad tracks in both Areas 25 and 26 are in various states of disrepair. Additional information relating to the site history, planning, and scope of the closure is presented in the SAFER Plan (NNSA/NSO, 2010).

Corrective Action Site 25-99-21 consists of releases of radioactive material from nuclear rocket machinery transported on railroad cars to the soil/ballast surrounding and underlying the railroad tracks. The railroad tracks interconnected the major facilities that supported the former NRDS program area. The program conducted full-scale testing of reactors, engines, and rocket stages to evaluate the feasibility of developing nuclear reactors for the U.S. space program.

Corrective Action Site 26-99-05 consists of releases of radioactive material from nuclear rocket machinery transported on railroad cars to the soil/ballast surrounding and underlying the railroad tracks. The railroad tracks interconnected the Pluto Facility and the Test Bunker in support of Project Pluto. Project Pluto was a program to demonstrate the feasibility of using a nuclear-powered ramjet engine to propel a supersonic low-altitude missile.

G.1.2 B. Site Assessment

The CAI at CAS 25-99-21, Area 25 Railroad Tracks, involved radiological walkover surveys, visual inspections, and field screening of selected portions of the railroad tracks; collection of *in situ* TLD measurements; collection of ballast and ballast/soil interface samples; and removal of PSM (i.e., lead bricks). Verification soil samples were collected from underlying soil at the lead brick PSM locations, and results indicate lead concentrations in soil were above the Tier 1 risk-based screening level (RBSL). The TED for radiological releases at this CAS exceeded the FAL established in this appendix based on the Industrial Area scenario (25 mrem/IA-yr) at four locations. The source, release point, and nature and extent of the COCs are consistent with the CSM presented in the SAFER Plan (NNSA/NSO, 2010).

The CAI at CAS 26-99-05, Area 26 Railroad Tracks, involved radiological walkover surveys, collection of *in situ* TLD measurements, collection of ballast and ballast/soil interface samples, and removal of PSM (i.e., lead bricks). Verification soil samples were collected from underlying soil at the PSM locations, and results indicate lead concentrations in soil were above the Tier 1 RBSL. The TED for radiological releases at this CAS did not exceed the FAL established in this appendix based on the Industrial Area scenario (25 mrem/IA-yr). The source, release point, and nature and extent of the COCs are consistent with the CSM presented in the SAFER Plan (NNSA/NSO, 2010).

G.1.3 C. Site Classification and Initial Response Action

The four major site classifications listed in Table 1 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, neither CAS presents an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at the CAU 539 CASs. Because PSM was identified at CAS 26-99-05, this CAS is determined to be a Classification 2 site as defined by ASTM Method E1739 (ASTM, 1995) and poses short-term threats. At CAS 25-99-21, due to the presence of high-activity PSM and contamination exceeding the FAL of 25 mrem/IA-yr, this site has been determined to be a Classification 2 site as defined by ASTM Method E1739.

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

Tier 1 RBSLs are defined as the PALs established during the DQO process and listed in the SAFER Plan (NNSA/NSO, 2010). The PALs for radionuclides are based on a dose of 25 mrem/yr using the Industrial Area exposure scenario. This represents a very conservative estimate of risk, is preliminary in nature, and is used for site screening purposes. Although the PALs are not intended to be used as FALs, FALs may be defined as the Tier 1 RBSL (i.e., PAL) value if implementing a correction action based on the Tier 1 RBSL would be appropriate. The Industrial Area exposure scenario assumes that a full-time industrial worker is present at a particular location for his entire career (10 hours per day, 225 days per year, for 25 years). The Tier 1 RBSL based on 25-mrem/yr dose for the primary radiological releases 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 other releases are the following PALs as defined in the SAFER Plan:

- The EPA *Regions 3, 6, and 9 Regional Screening Levels for Chemical Contaminants at Superfund Sites* (EPA, 2009) for industrial soils.
- 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 screening levels, a protocol similar to EPA Region 9 will be used to establish an action level; otherwise, an established screening level from another EPA region may be chosen.
- The PALs for radioactive contaminants are based on the screening limits recommended in the National Council on Radiation Protection and Measurements (NCRP) Report No. 129 for construction, commercial, industrial land use scenarios (NCRP, 1999) scaled to the dose constraint of 25 mrem/yr (Appenzeller-Wing, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).

The PALs were developed based on the Industrial Area exposure scenario. Because the CAU 539 CASs have a greater potential for future re-use, the use of the Industrial Area scenario PALs is appropriate.

G.1.5 E. Exposure Pathway Evaluation

The DQOs stated that site workers would only be exposed to COCs through oral ingestion or inhalation of dermal contact (absorption) with 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 within the site boundaries. The limited migration demonstrated by the analytical results, elapsed time since the suspected release, and depth to groundwater supports the selection and evaluation of only surface and shallow subsurface contact as the complete exposure pathways. Ingestion of groundwater is not considered to be a complete exposure pathway.

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

The TED calculated based on the Industrial Area scenario for all sample locations related to radiological releases that exceed the Tier 1 RBSL (i.e., PAL) are listed in Table G.1-1. Based on the conservative assumption that a site worker would be exposed to the maximum dose measured at any sampled location, the site worker would receive a 25-mrem dose at TLD location AT14 in CAS 25-99-21, Area 25 Railroad Tracks, with an exposure time of 67 hours. Note that no sample location along the CAS 26-99-05 railroad tracks exceeded the Tier 1 RBSL.

Table G.1-1
Locations Where TED Exceeds the Tier 1 RBSL at CAU 539

CAS	TLD Location	TED (mrem/IA-yr)	
		Average	95% UCL
25-99-21	AT01	**254.29**	**346.56**
	AT13	**31.30**	**36.87**
	AT14	**744.31**	**834.53**
	AT16	17.42	**29.02**

Bold indicates the values exceeding 25 mrem/yr.

Lead bricks were identified as PSM and removed from both CASs. Verification soil samples were collected from the underlying soil after removing the PSM. The analytical results from the lead brick verification samples were less than the corresponding Tier 1 action levels (i.e., PALs) except for those listed in Table G.1-2. Verification samples 539A012 and 539A013 at CAS 25-99-21 were submitted for radiological analysis to provide additional information on the nature of contamination near TLD location AT16 and not representative of the PSM.

Table G.1-2
Contaminants of Potential Concern Detected above PALs

CAS	Sample Number	Lead
PAL		800 mg/kg
25-99-21	539A014	1,300
	539A015	850
	539A019	1,100
26-99-05	539B006	890

G.1.7 G. Evaluation of Tier 1 Results

The TED for radiological releases at CAS 26-99-05 did not exceed the Tier 1 RBSL at any sample location. For radiological releases at CAS 25-99-21, the TED exceeded the Tier 1 RBSL.

For all contaminants not listed in Table G.1-2, the FALs were established as the Tier 1 RBSLs. It was determined that no further action is required for these contaminants at both CASs.

G.1.8 H. Tier 1 Remedial Action Evaluation

TED Evaluation for Radiological Releases

For CAS 25-99-21, NNSA/NSO determined that remediation to the Tier 1 RBSL is appropriate because there is a potential for industrial activities in Area 25 to increase in the future. Therefore, the Tier 1 RBSL of 25 mrem/IA-yr is established as the FAL for radiological releases, and a corrective action will be required at CAS 25-99-21.

It was determined by NNSA/NSO that remediation of lead in both CASs 25-99-21 and 26-99-05 was not practical. Therefore, a Tier 2 SSTL will be calculated for lead at both CASs.

G.1.9 I. Tier 2 Evaluation

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

G.1.10 J. Development of Tier 2 SSTLs

Development of Lead SSTLs

The EPA's risk assessment for lead is unique because a reference dose (RfD) value for lead is not available. Because the toxicokinetics (the absorption, distribution, metabolism, and excretion of toxins in the body) of lead are well understood, lead is regulated based on blood lead concentration (PbB). The EPA and the Centers for Disease Control and Prevention (CDC) have determined that childhood PbBs at or above 10 micrograms per deciliter (µg/dL) of blood present risks to children's health. The EPA risk reduction goal for contaminated sites is to limit the probability of a child's PbB exceeding 10 µg/dL to 5 percent or less after cleanup. The EPA's Adult Lead Methodology (ALM) has been developed to estimate the PbB of pregnant women and their developing fetuses who might be exposed to nonresidential lead-contaminated soils (EPA, 2003).

In the commercial/industrial setting, the most sensitive receptor is the fetus of a worker who has a nonresidential exposure to lead. Based on the available scientific data, a fetus is more sensitive to the adverse effects of lead than an adult (NRC, 1993). The EPA assumes that cleanup levels that are protective of a fetus will also afford protection for male or female adult workers. The ALM was developed to calculate cleanup goals such that there would be no more than a 5 percent probability that fetuses exposed to lead would exceed a PbB of 10 µg/dL of blood. This same approach also appears to be protective for lead's effect on blood pressure in adult males.

Therefore, the ALM was used to develop an SSTL of 1,202 mg/kg for the lead contamination at CASs 25-99-21 and 26-99-05.

G.1.11 K. Comparison of Site Conditions with Tier 2 SSTLs

The Tier 2 action levels are typically compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Points of exposure are defined as those locations or areas at which an individual or population may come in contact with a COC originating from a CAS. For CAU 539, the Tier 2 action levels were compared to maximum contaminant concentrations from each lead brick verification sample location.

As shown in Table G.1-2, the maximum concentrations for lead from CASs 25-99-21 and 26-99-05 were less than the corresponding Tier 2 action level of 1,202 mg/kg, except for one sample (539A014) at sample location A07 in CAS 25-99-21. After a soil removal action at this sample location, verification sample 539A020 was collected. Final results show that no lead remains above the Tier 2 SSTL. The FAL for lead was established as the Tier 2 SSTL.

G.1.12 L. Tier 2 Remedial Action Evaluation

The results of verification sample 539A020 show that remaining concentrations of lead are below the Tier 2 FAL and do not pose an unacceptable risk from a health standpoint. Therefore, no further corrective action is necessary at both CASs.

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

G.2.0 Recommendations

Due to the presence of lead bricks as PSM at both CASs 25-99-21 and 26-99-05, corrective action was necessary. At CAS 26-99-05, four lead bricks were removed, and verification samples from underlying soil were collected. The verification sample results show that no COCs remain in the soil; therefore, no further corrective action is necessary. At CAS 25-99-21, 14 lead bricks were removed, and verification samples from underlying soil were collected. Because one location exceeded the FAL for lead, additional contaminated soil was removed and a second verification sample was collected. The results of the second verification sample show that no lead remains in the soil above FALs; therefore, no further corrective action is necessary for lead contaminants.

Because the TED values for surface soils at four locations within CAS 25-99-21 exceed the corresponding FALs (using the Industrial Area exposure scenario) and high-activity PSM is present in this CAS, it was determined that surface soil contamination related to radiological releases at this CAS warrants corrective action. Surface contamination is assumed to exist within the entire length of the railroad track in Area 25.

A corrective action of closure in place with a UR is recommended for CAS 25-99-21 for the areas encompassed by the Tier 1 FAL corrective action boundaries based on the extent of the contamination and the infeasibility of removing ballast containing high-activity PSM from the railroad tracks. The UR boundary encompasses the entire length of the railroad track, including inside facility fencelines and up to 15 ft laterally from the center line of the tracks. Specific areas excluded from the UR include existing road crossings and portions of the parallel access roads that may come within the 15-ft lateral boundary. The railroad tracks located inside the Radioactive Material Storage Facility (CAU 168) and the Contaminated Waste Dump #1 (CAU 143) are also excluded from the UR because they were outside the scope of CAU 539. The FFACO UR area along the Area 25 railroad tracks will be posted with signs at each facility boundary, all existing road crossings, and at selected locations between road crossings/facilities.

The corrective action of closure in place with a UR for CAS 25-99-21 is based on the assumptions 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 in such a way that these assumptions are no longer valid, additional evaluation may be necessary.

The FFACO UR is recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. The UR is included in Appendix F.

G.3.0 References

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

NAC, see *Nevada Administrative Code.*

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Attachment G-1

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at CAU 539: Areas 25 and 26 Railroad Tracks Nevada National Security Site, Nevada

(10 Pages)

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 539, Areas 25 and 26 Railroad Tracks Nevada National Security Site, Nevada

Introduction

This attachment 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 (N-I), 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 <u>do</u> 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 <u>not</u> 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 5400.5 (DOE, 1993). 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. $$\left(\frac{2250 \text{ hrs on-site}}{8760 \text{ hrs in a year}}\right) 0.6666 \text{ indoors} = 0.1712$$ 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^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

CFR, see *Code of Federal Regulations*.

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DOE, see U.S. Department of Energy.

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U.S. Department of Energy. 1993. *Radiation Protection of the Public and the Environment,* DOE Order 5400.5, Change 2. Washington, DC.

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

Appendix H

Nevada Division of Environmental Protection Comments

(2 Pages)

1. Document Title/Number: Draft Closure Report for Corrective Action Unit 539: Areas 25 and 26 Railroad Tracks, Nevada National Security Site, Nevada	2. Document Date: May 2011
3. Revision Number: 0	4. Originator/Organization: Navarro-Intera
5. Responsible DOE NNSA/NSO Subproject Mgr.: Kevin J. Cabble	6. Date Comments Due: 5/23/2011
7. Review Criteria: Full	
8. Reviewer/Organization Phone No.: Jeff MacDougall, NDEP, 486-2850, Ext. 233	9. Reviewer's Signature:

<table>
<tr><th>10. Comment Number/Location</th><th>11. Type[a]</th><th>12. Comment</th><th>13. Comment Response</th><th>14. Accept/Reject</th></tr>
<tr><td>1) Section 2.1.1, Pages 12 and 13</td><td>Mandatory</td><td>Provide discussion pertaining to the proposed use restriction (UR) for this CAS. Specifically, discuss whether or not the UR will be designated and if post-closure monitoring/inspection will apply.</td><td>The following text was added to the last paragraph of Section 2.1.1 on page 13: "The FFACO UR, which is detailed in Appendix F, was implemented at this CAS and includes annual post-closure monitoring. "</td><td>Accept</td></tr>
<tr><td>2) Section 2.2, Page 15</td><td>Mandatory</td><td>Include additional discussion explaining why NSO decided to extrapolate TLD measurements (versus using RESRAD codes) for the purposes of calculating external dose for the subsurface. It has been indicated that this yields a more conservative TED - explain in detail why the results (calculated by extrapolating measurements) are more conservative and/or accurate than those obtained using RESRAD codes</td><td>As the dose to a receptor from site radioactivity is primarily due to surface radiation and the inhalation/ingestion of surface contamination, the evaluation of subsurface contamination is based on the assumption that the subsurface contamination would at some future time be exposed at the soil surface. The external radiation levels from this future surface material (currently subsurface) cannot be measured directly with TLDs without exposing the subsurface soil by removing the overlying soil. Therefore, subsurface equivalent TLD external doses were estimated by increasing the surface TLD external dose by the same proportional increase of subsurface internal dose over the surface internal dose.

The analytical results from subsurface samples could also have been used to calculate subsurface equivalent external doses using the RESRAD code. However, it was determined that this would be less accurate than scaling direct measurements of external dose. As shown in the following table, scaling the surface TLD measurement to a subsurface equivalent external dose provides a more conservative estimate of external dose than using the RESRAD calculated external dose or the surface TLD measurement of external dose.

<table>
<tr><th>Sample Location</th><th>TLD Location</th><th>Surface TLD External Dose Measurement</th><th>Subsurface Scaled TLD External Dose</th><th>RESRAD External Dose Calculation</th></tr>
<tr><td>A01</td><td>AT01</td><td>13.5</td><td>254</td><td>10.75</td></tr>
<tr><td>A02</td><td>AT02</td><td>5.8</td><td>10.9</td><td>6.14</td></tr>
<tr><td>A03</td><td>AT15</td><td>1.7</td><td>1.9</td><td>0.24</td></tr>
<tr><td>A04</td><td>AT14</td><td>32.2</td><td>744</td><td>22.74</td></tr>
</table>
</td><td>Accept</td></tr>
</table>

[a]Comment Types: M = Mandatory, S = Suggested.
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10. Comment Number/Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept/Reject
3) Section 2.2, Page 16	Mandatory	As a deviation, soil samples were analyzed without removing fuel flecks - explain the potential effect that these sample results (of soils containing fuel flecks) may have had on the decision for closure in place (i.e., if soil sample results were significantly impacted due to the presence of fuel flecks, would the decision for closure strategy change, or be affected?).	The sample results containing fuel flecks did not impact the need for implementing the corrective action of closure in place because the 95 percent UCL external dose estimate at TLD locations AT13 and AT14 exceeded the FAL without adding the contribution of internal dose to the TED. Therefore, the potential effect of estimating internal dose using those sample results containing fuel flecks is a more conservative TED estimate at the remaining TLD locations at CAS 25-99-21.	Accept

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