UNCONTROLLED

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 309
CAU Description: Area 12 Muckpiles
CAU Owner: Industrial Sites - Environmental Restoration (ER)

ROTC No. DOE/NV--1099-ROTC 1 **Page** 1 of 21

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 12/15/2021

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

Tiffany Gamero
Requestor Name

Long-Term Monitoring Activity Lead
Requestor Title

Description of Change:

1. This ROTC replaces the Use Restriction (UR) information listed in the documentation for CAU 309.

   UR forms have been updated to list all UR requirements, including but not limited to: post-closure site controls (signs, fencing, etc.), inspection and maintenance requirements, and Geographic Information Systems (GIS) coordinate information. The UR requirements and form(s) included in this ROTC represent the current corrective action requirements for each Corrective Action Site (CAS) in this CAU and supersede information concerning corrective action and post-closure requirements in existing documentation.
2. The UR boundary coordinate values changed due to conversion from North American Datum (NAD) 1927 to NAD 1983.
3. The FFACO UR for Corrective Action Sites (CASs) 12-06-09, 12-08-02, and 12-28-01 was separated into URs for each CAS.

Justification:

1. Some changes in the UR requirements from those found in closure documents have been subsequently modified in letters, memos, and inspection reports. This has resulted in difficulty in determining current post-closure requirements. A review of the post-closure requirements for this CAU has been conducted to ensure that all requirements have been identified and documented on the new UR form. The new UR form was developed to be inclusive of all requirements for long-term monitoring and standardize information contained in the URs consistent with current protocols.
2. UR boundary coordinates need to be in one standardized coordinate system.
3. Current protocol is to have separate URs for each CAS. The separate UR boundaries were determined from the CAU 309 CADD/CR.

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 309
CAU Description: Area 12 Muckpiles
CAU Owner: Industrial Sites - Environmental Restoration (ER)

ROTC No. DOE/NV--1099-ROTC 1 **Page** 2 of 21

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 12/15/2021

Description of Change:

4. Removed requirements for specific sign locations.

5. The UR for CAS 12-28-01 was changed to an Administrative UR.

Justification:

4. Signs will be posted and maintained to meet the requirement that signs are present and legible.
5. The UR was changed to an Administrative UR based on results from the CADD/CR which show that contamination does not exceed final action levels (FALs). However, contaminants are present at concentrations that exceed industrial action levels and warrant an Administrative UR.

Schedule Impacts:

No impacts to schedule.

ROTC applies to the following document(s):

- U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2005. Corrective Action Decision Document/Closure Report for Corrective Action Unit 309: Area 12 Muckpiles, Nevada Test Site, Nevada, Rev. 0, DOE/NV--1099. Las Vegas, NV.

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 309
CAU Description: Area 12 Muckpiles
CAU Owner: Industrial Sites - Environmental Restoration (ER)

ROTC No. DOE/NV--1099-ROTC 1 **Page** 3 of 21

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 12/15/2021

Approvals:

Tiffany A. Gamero Digitally signed by Tiffany A. Gamero Date: 2022.01.12 11:30:23 -08'00' Date _____

Tiffany Gamero
Activity Lead
Environmental Management (EM) Nevada Program

WILHELM WILBORN Digitally signed by WILHELM WILBORN Date: 2022.01.12 12:51:37 -08'00' Date _____

Bill Wilborn
Deputy Program Manager, Operations
Environmental Management (EM) Nevada Program

Christine Andres Digitally signed by Christine Andres Date: 2022.02.04 14:34:53 -08'00' Date _____

Christine Andres
Chief, Bureau of Federal Facilities
Nevada Division of Environmental Protection (NDEP)

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

General Information

Use Restriction (UR) Type(s): FFACO Only

Corrective Action Unit (CAU) Number & Description: 309 - Area 12 Muckpiles

Corrective Action Site (CAS) Number & Description: 12-06-09 - Muckpile

CAU/CAS Owner: Industrial Sites - ER

Note: CAS previously shared UR Form with CASs 12-08-02 and 12-28-01.

Section I. *Federal Facility Agreement and Consent Order* (FFACO) UR

Basis for FFACO UR

Summary Statement: This FFACO UR is established to protect workers from inadvertent exposure to Radiological and Chemical contaminants that were released at this site. Radiological and Chemical contaminants are assumed to be present that exceed final action levels.

FFACO UR Physical Description

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

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
FFACO Boundary	1	574,661	4,119,396
	2	574,341	4,119,396
	3	574,341	4,119,503
	4	574,661	4,119,503
	5	574,661	4,119,396

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

Boundary Applies to: Both Surface and Subsurface

Starting Depth: 0 **Ending Depth:** 30

Depth Unit: Meters

Survey Source: GPS

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

FFACO UR Requirements

Site Controls:

This FFACO UR is recorded as described in **Section IV. Recordation Requirements** to restrict activities within the area by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

Control	Criteria
Signage	Present and legible.

Inspection Frequency: Annual

Additional Considerations:

Consideration	Criteria
None	None

Requirements Comments:

Section II. Administrative UR

An Administrative UR is not identified for this site.

Section III. Supporting Documentation

UR Source Document(s)

ROTC 1 for CAU 309 CADD/CR (DOE/NV--1099), dated 12/15/2021.

ERRATA Sheet for CAU 309 CADD/CR (DOE/NV--1099), dated 01/09/2006.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2005. Corrective Action Decision Document/Closure Report for Corrective Action Unit 309: Area 12 Muckpiles, Nevada Test Site, Nevada, Rev. 0, DOE/NV--1099. Las Vegas, NV.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Attachments

- FFACO UR Boundary Map (UTM, Zone 11, NAD 83 meters)
- Supplemental Information Figure (UTM, Zone 11, NAD 83 meters)

Section IV. Recordation Requirements

Recordation:

The above UR(s) are recorded in the:

- FFACO Database
- NNSA M&O Contractor GIS
- EM Nevada Program CAU/CAS Files

Section V. EM Nevada Program Approval

Tiffany A. Gamero Digitally signed by Tiffany A. Gamero Date: 2022.01.12 11:31:48 -08'00'

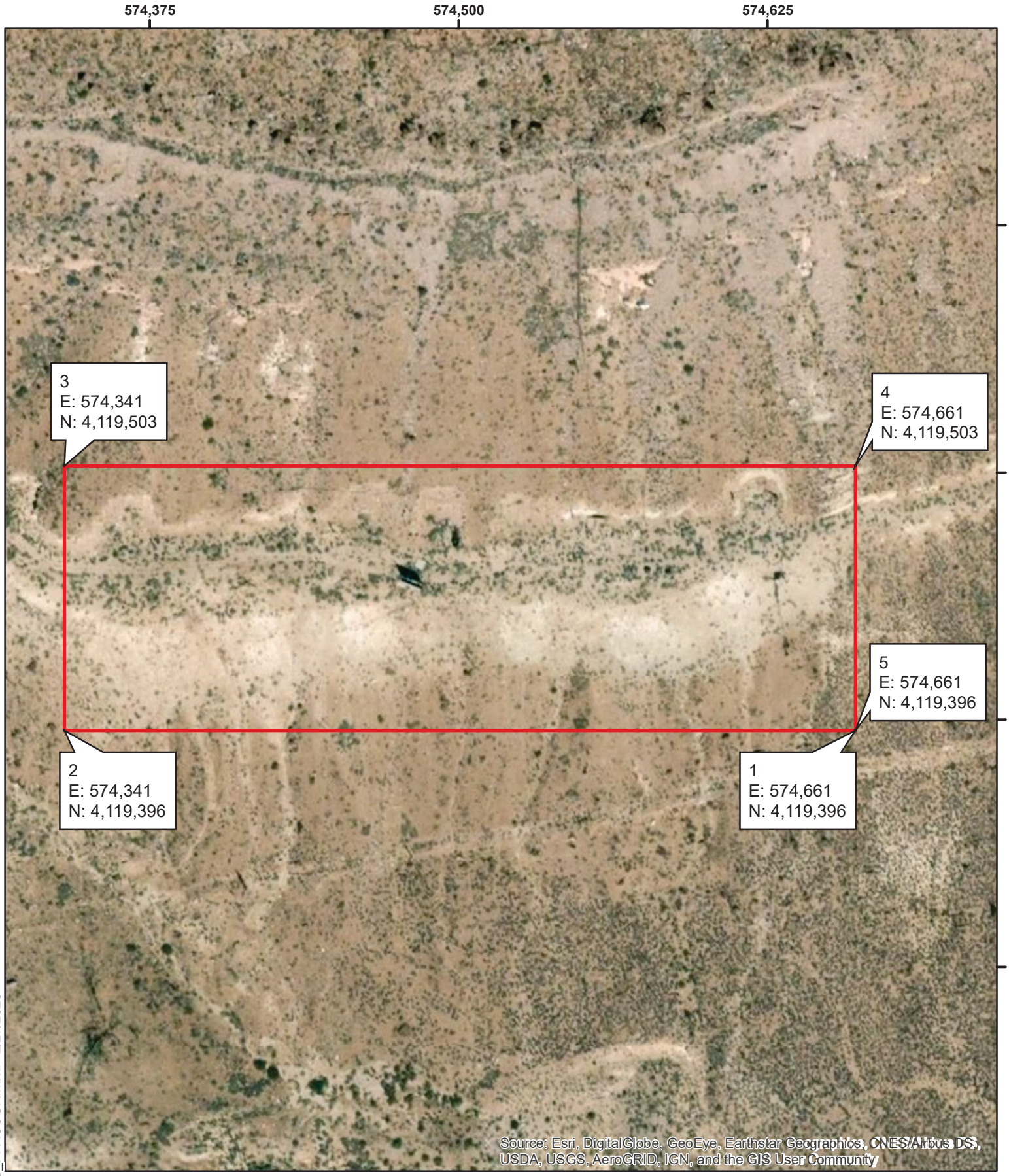
Date: _____

Tiffany Gamero

Activity Lead

EM Nevada Program

UR is effective upon acceptance by NDEP.



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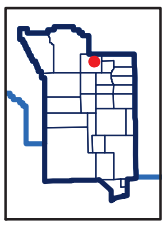

CAU 309, CAS 12-06-09
Muckpile
FFACO UR Boundary

Explanation

FFACO UR

0 20 40 80 Meters

0 50 100 200 Feet

N

Source: Navarro GIS, 2020

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Supplemental Information Figure

The attached supplemental information figure(s) are included to capture site feature information that was available in previous iterations of this Use Restriction (UR) to prevent loss of that information.

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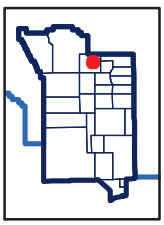


CAU 309, CAS 12-06-09
Muckpile
Supplemental Information
General Location of Site Features

Explanation

- FFACO UR
- Admin UR
- Light Duty Road
- Trail

0 70 140 280 Meters

0 175 350 700 Feet

N

Source: Navarro GIS, 2021

Coordinate System: NAD 1983 UTM Zone 11N, Meter

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

General Information

Use Restriction (UR) Type(s): FFACO Only

Corrective Action Unit (CAU) Number & Description: 309 - Area 12 Muckpiles

Corrective Action Site (CAS) Number & Description: 12-08-02 - Contaminated Waste Dump (CWD)

CAU/CAS Owner: Industrial Sites - ER

Note: CAS previously shared UR Form with CASs 12-06-09 and 12-28-01.

Section I. *Federal Facility Agreement and Consent Order* (FFACO) UR

Basis for FFACO UR

Summary Statement: This FFACO UR is established to protect workers from inadvertent exposure to Radiological and Chemical contaminants that were released at this site. Radiological and Chemical contaminants are assumed to be present that exceed final action levels.

FFACO UR Physical Description

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

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
FFACO Boundary	1	574,856	4,119,478
	2	574,763	4,119,478
	3	574,763	4,119,548
	4	574,856	4,119,548
	5	574,856	4,119,478

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

Boundary Applies to: Both Surface and Subsurface

Starting Depth: 0 **Ending Depth:** 30

Depth Unit: Meters

Survey Source: GPS

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

FFACO UR Requirements

Site Controls:

This FFACO UR is recorded as described in **Section IV. Recordation Requirements** to restrict activities within the area by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

Control	Criteria
Signage	Present and legible.

Inspection Frequency: Annual

Additional Considerations:

Consideration	Criteria
None	None

Requirements Comments:

Section II. Administrative UR

An Administrative UR is not identified for this site.

Section III. Supporting Documentation

UR Source Document(s)

ROTC 1 for CAU 309 CADD/CR (DOE/NV--1099), dated 12/15/2021.

ERRATA Sheet for CAU 309 CADD/CR (DOE/NV--1099), dated 01/09/2006.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2005. Corrective Action Decision Document/Closure Report for Corrective Action Unit 309: Area 12 Muckpiles, Nevada Test Site, Nevada, Rev. 0, DOE/NV--1099. Las Vegas, NV.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Attachments

- FFACO UR Boundary Map (UTM, Zone 11, NAD 83 meters)
- Supplemental Information Figure (UTM, Zone 11, NAD 83 meters)

Section IV. Recordation Requirements

Recordation:

The above UR(s) are recorded in the:

- FFACO Database
- NNSA M&O Contractor GIS
- EM Nevada Program CAU/CAS Files

Section V. EM Nevada Program Approval

Tiffany A. Gamero Digitally signed by Tiffany A. Gamero Date: 2022.01.12 11:33:33 -08'00'

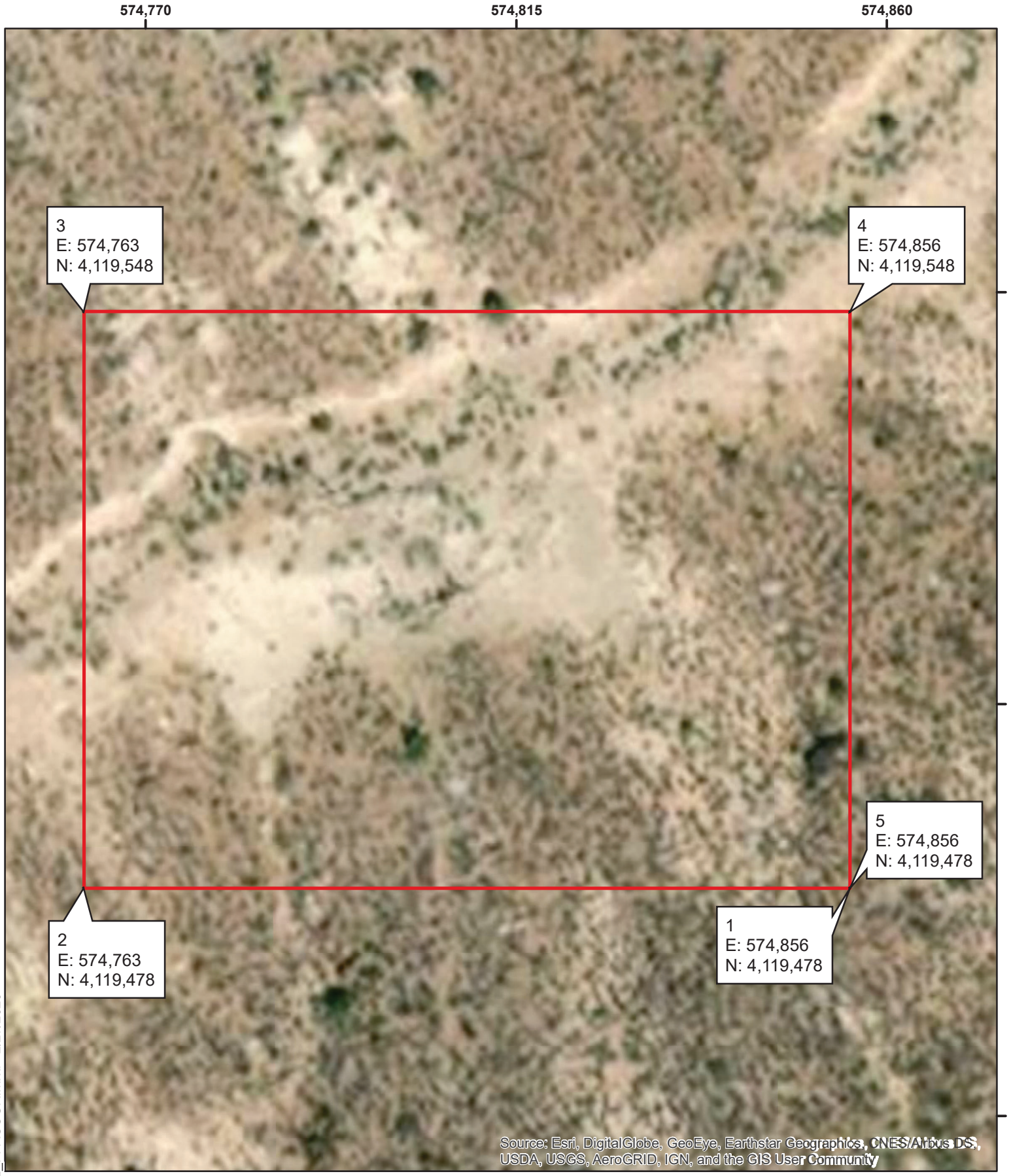
Date: _____

Tiffany Gamero

Activity Lead

EM Nevada Program

UR is effective upon acceptance by NDEP.



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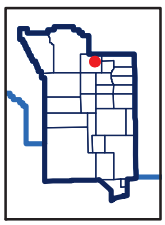

CAU 309, CAS 12-08-02
Contaminated Waste Dump (CWD)
FFACO UR Boundary

Explanation

FFACO UR

0 5 10 20 Meters

0 20 40 80 Feet

N

Source: Navarro GIS, 2020

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Supplemental Information Figure

The attached supplemental information figure(s) are included to capture site feature information that was available in previous iterations of this Use Restriction (UR) to prevent loss of that information.

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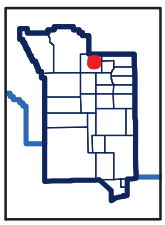


CAU 309, CAS 12-08-02
Contaminated Waste Dump (CWD)
Supplemental Information
General Location of Site Features

Explanation

- FFACO UR
- Admin UR
- Light Duty Road
- Trail

0 70 140 280 Meters

0 175 350 700 Feet

N

Source: Navarro GIS, 2021

Coordinate System: NAD 1983 UTM Zone 11N, Meter

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

General Information

Use Restriction (UR) Type(s):	Administrative Only
Corrective Action Unit (CAU) Number & Description:	309 - Area 12 Muckpiles
Corrective Action Site (CAS) Number & Description:	12-28-01 - I, J, and K-Tunnel Debris
CAU/CAS Owner:	Industrial Sites - ER
Note:	CAS previously shared UR Form with CASs 12-06-09 and 12-08-02.

Section I. *Federal Facility Agreement and Consent Order* (FFACO) UR

An FFACO UR is not identified for this site.

Section II. Administrative UR

Basis for Administrative UR

Summary Statement: This Administrative UR is established to protect workers should future land use result in increased exposure to site contaminants. Radiological and Chemical contaminants released at this site are assumed to be present that exceed final action levels under the Industrial Area (2,000 hours per year) exposure scenario.

Administrative UR Physical Description

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

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
Admin UR	1	574,406	4,119,098
	2	574,291	4,119,098
	3	574,291	4,119,149
	4	574,406	4,119,149
	5	574,406	4,119,098

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Boundary Applies to: Both Surface and Subsurface

Starting Depth: 0 **Ending Depth:** 2

Depth Unit: Meters

Survey Source: GPS

Administrative UR Requirements

Administrative URs do not require onsite postings or other physical barriers, and they do not require periodic inspections or maintenance.

Site Controls:

This Administrative UR is recorded as described in **Section IV. Recordation Requirements** to restrict activities within the area defined by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

Section III. Supporting Documentation

UR Source Document(s)

ROTC 1 for CAU 309 CADD/CR (DOE/NV--1099), dated 12/15/2021.

ERRATA Sheet for CAU 309 CADD/CR (DOE/NV--1099), dated 01/09/2006.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2005. Corrective Action Decision Document/Closure Report for Corrective Action Unit 309: Area 12 Muckpiles, Nevada Test Site, Nevada, Rev. 0, DOE/NV--1099. Las Vegas, NV.

Attachments

- FFACO UR Boundary Map (UTM, Zone 11, NAD 83 meters)
- Supplemental Information Figure (UTM, Zone 11, NAD 83 meters)

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Section IV. Recordation Requirements

Recordation:

The above UR(s) are recorded in the:

- FFACO Database
- NNSA M&O Contractor GIS
- EM Nevada Program CAU/CAS Files

Section V. EM Nevada Program Approval

Tiffany A. Gamero Digitally signed by Tiffany A. Gamero Date: 2022.01.12 11:35:47 -08'00'

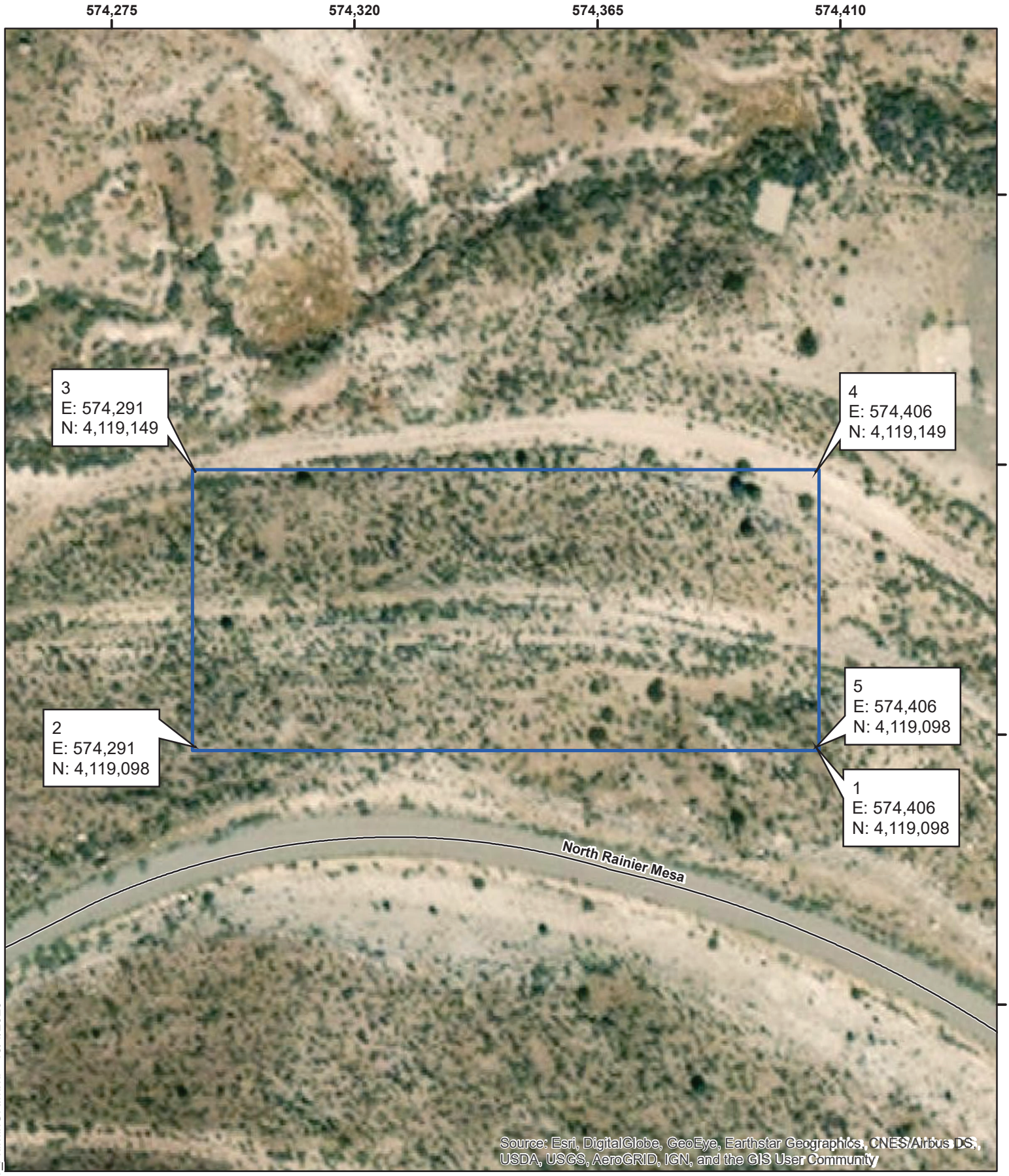
Date: _____

Tiffany Gamero

Activity Lead

EM Nevada Program

UR is effective upon acceptance by NDEP.



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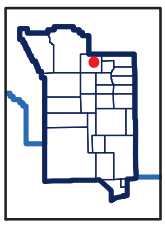

CAU 309, CAS 12-28-01
I, J, and K-Tunnel Debris
Administrative UR Boundary

Explanation

- Administrative UR
- Light Duty Road

0 10 20 40 Meters

0 25 50 100 Feet

N

Source: Navarro GIS, 2020

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Supplemental Information Figure

The attached supplemental information figure(s) are included to capture site feature information that was available in previous iterations of this Use Restriction (UR) to prevent loss of that information.

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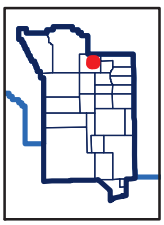

CAU 309, CAS 12-28-01
I, J, and K-Tunnel Debris
Supplemental Information
General Location of Site Features

Explanation

- FFACO UR
- Admin UR
- Light Duty Road
- Trail

0 70 140 280 Meters

0 175 350 700 Feet

N

Source: Navarro GIS, 2021

Coordinate System: NAD 1983 UTM Zone 11N, Meter

UNCONTROLLED

ERRATA SHEET

The Following Corrections and Clarifications Apply to: Corrective Action Decision Document/Closure Report for Corrective Action Unit 309: Area 12 Muckpiles, Nevada Test Site, Nevada

DOE Document Number: DOE/NV--1099

Revision: 0

Original Document Issuance Date: December 2005

This errata sheet was issued under cover letter from DOE on: January 9, 2006

The signature is omitted from the CAU Use Restriction Information form on page D-2 of D-3. Replace with the attached signed form.

Use Restrictions

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 Closure Report or other CAU 309 documentation, unless appropriate concurrence is obtained in advance.

Comments: This Use Restriction is for the surface and subsurface disturbances. CASs 12-06-09 and 12-08-02 are restricted from the surface to the bottom of the muckpiles, estimated to be not greater than 100 ft bgs. The restricted area is identified by signs that are placed on existing fencing going around the muckpiles at the access road to the muckpiles from the west and east. Two additional signs are at the lower power line road also from the west and east. At CAS 12-28-01 signs are attached to the existing fencing surrounding the contamination area. Annual post-closure inspections will be conducted to ensure postings are in place, intact, and readable. Maintenance or replacement of the existing road and utilities can be conducted without prior approval from NDEP. See the Corrective Action Decision Document/Closure Report for additional information on the condition of the site.

Submitted By: /s/ Signature on file **Date:** 1/4/06

cc with copy of survey map (paper and digital (.dgn) formats):
CAU Files (2 copies)

The use restriction signs will state the following information:

WARNING
Surface and Subsurface Contamination
FFACO Site CAU 309/CAS XX-XX-XX
Area 12 Muckpiles
No activities that may alter or modify the containment control are permitted without U.S. Government permission.
Before working in this area,
Contact Real Estate Services at 295-2528

Nevada
Environmental
Restoration
Project

DOE/NV--1099

National Nuclear Security Administration

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 309: Area 12 Muckpiles Nevada Test Site, Nevada

Controlled Copy No.: UNCONTROLLED
Revision No.: 0

December 2005

Approved for public release; further dissemination unlimited.

Environmental Restoration
Division

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

Available for public sale, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800.553.6847
Fax: 703.605.6900
Email: *orders@ntis.gov*
Online ordering: *http://www.ntis.gov/ordering.htm*

Available electronically at *http://www.osti.gov/bridge*

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U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Phone: 865.576.8401
Fax: 865.576.5728
Email: *reports@adonis.osti.gov*

DOE/NV--1099

CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 309: AREA 12 MUCKPILES, NEVADA TEST SITE, NEVADA

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

Controlled Copy No.: UNCONTROLLED

Revision No.: 0

December 2005

CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT
FOR
CORRECTIVE ACTION UNIT 309:
AREA 12, MUCKPILES,
NEVADA TEST SITE, NEVADA

Approved by: Approved Signature Date: 12/19/2005

Kevin Cabble, Acting Project Manager
Industrial Sites Project

Approved by: Approved Signature Date: 12/19/2005

Janet Appenzeller-Wing, Acting Division Director
Environmental Restoration Division

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List of Tables *(Continued)*

List of Acronyms and Abbreviations

Am	Americium
amsl	Above mean sea level
ASTM	American Society for Testing and Materials
BAP	Benzo(a)pyrene
bgs	Below ground surface
BMP	Best management practice
CA	Contaminated area
CADD/CR	Corrective Action Decision Document/Closure Report
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CLP	Contract Laboratory Program
cm	Centimeter
cm^3/cm^3	Cubic centimeters per cubic centimeter
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
Cs	Cesium
CSM	Conceptual site model
CWD	Contaminated waste dump
day/yr	Days per year
DOE	U.S. Department of Energy
DQA	Data quality assessment

List of Acronyms and Abbreviations *(Continued)*

DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FID	Flame-ionization detector
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
ft bgs	Feet below ground surface
gal	Gallon
GPS	Global positioning system
GRO	Gasoline-range organics
H&S	Health and safety
HWAA	Hazardous waste accumulation area
ID	Identification
IDW	Investigation-derived waste
in.	Inch
Iso-Pu	Isotopic plutonium
Iso-U	Isotopic uranium
kg/day	Kilograms per day
kg/year	Kilograms per year
LCS	Laboratory control sample

List of Acronyms and Abbreviations *(Continued)*

LLW	Low-level waste
MDC	Minimum detectable concentration
mg/kg	Milligrams per kilogram
mi	Mile
MS/MSD	Matrix spike/matrix spike duplicate
mrem/yr	Millirem per year
NA	Not applicable
NAC	Nevada Administrative Code
NAD	North American Datum
ND	Nondetect
NDEP	Nevada Division of Environmental Protection
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute for Standards and Technology
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
PAL	Preliminary action level
PB	Preparation blank
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
POC	Performance objective criteria
PPE	Personal protective equipment
ppm	Parts per million
PRG	Preliminary Remediation Goal
Pu	Plutonium
QA	Quality assurance
QA/QC	Quality assurance/quality control

List of Acronyms and Abbreviations *(Continued)*

QAPP	Quality Assurance Project Plan
QC	Quality control
RadCon	Radiological Control
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
RESRAD	Residual radioactive
ROTC	Record of Technical Change
RPD	Relative percent difference
RSL	Remote Sensing Laboratory
SCL	Sample collection log
SDG	Sample delivery group
SNJV	Stoller-Navarro Joint Venture
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
TCE	Trichloroethene
TPH	Total petroleum hydrocarbons
TPH-DRO	Total petroleum hydrocarbons-diesel range organics
U	Uranium
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
WM	Waste management
µg/kg	Micrograms per kilogram
%R	Percent recovery

Executive Summary

This Corrective Action Decision Document/Closure Report has been prepared for Corrective Action Unit 309, Area 12 Muckpiles, at the Nevada Test Site, Nevada, according to the *Federal Facility Agreement and Consent Order* (1996). Corrective Action Unit (CAU) 309 is comprised of three corrective action sites (CASs):

- CAS 12-06-09, Muckpile
- CAS 12-08-02, Contaminated Waste Dump
- CAS 12-28-01, I, J, and K-Tunnel Debris

The purpose of this Corrective Action Decision Document/Closure Report for CAU 309 is to provide justification and documentation supporting the recommendation for closure with no further corrective action, by placing use restrictions at all three CASs. This closure alternative was identified and agreed to by the decision-maker during the planning process for this CAU. To achieve this, corrective action investigation (CAI) activities were performed from June 9 through June 29, 2005, as set forth in the Corrective Action Investigation Plan (CAIP) for CAU 309: Area 12 Muckpiles (NNSA/NSO, 2004).

Because of the steep slopes and safety issues associated with sampling on the muckpiles, the typical approach for the investigation was modified. This modification included the incorporation of the sampling results from previous muckpile investigation in lieu of both sampling on the steep slopes and sampling into the underlying native soil. Soil samples were collected from the areas of the muckpile that were safely accessible and the combined data set was used to determine the acceptability of the proposed corrective action. Therefore, the two CAU 309 muckpiles (CASs 12-06-09 and 12-08-02) were assigned radiological and chemical contamination values based on the historical data and the limited data collected from the safely accessible areas of the two muckpiles during this corrective action investigation. This modification was discussed with and approved by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) and the Nevada Division of Environmental Protection during the planning process for the corrective action investigation. The purpose of the CAI was to fulfill the following data needs as defined during the data quality objective (DQO) process:

- Determine whether contaminants of concern (COCs) are present.
- If COCs are present, determine their nature and extent.

- Provide sufficient information and data to complete appropriate corrective actions.

The CAU 309 dataset from the investigation and historical data was evaluated based on the data quality indicator parameters. This evaluation demonstrated the quality and acceptability of the dataset for use in fulfilling the DQO data needs.

Analytes detected during the CAI and historical investigations at other muckpiles were evaluated against final action levels (FALs) established in this document. Tier 2 FALs were calculated for the radionuclides cobalt (Co)-60, cesium (Cs)-137, americium (Am)-241, plutonium (Pu)-238, Pu-239, and europium (Eu)-152. The Tier 2 FALs for the radionuclides were calculated using site-specific information on the detected radionuclides and other site-specific physical characteristics using the Residual Radioactive (RESRAD) code (version 6.21). This calculation determined the activities of all detected radionuclides that, together, would sum to an exposed dose of 25 millirem per year to a site receptor (based on their relative abundances at each CAS). The evaluation for the radionuclides determined that the FALs were exceeded for Cs-137 and Pu-239 at CAS 12-08-02 and for Cs-137 at CAS 12-28-01. Inadvertent contact with these contaminants could pose an unacceptable risk to human health and the environment unless restrictions for future land use are imposed.

The DQO data needs were met, and the data accurately represent the radiological and chemical risk present at CAU 309. It was determined that the recommended corrective action of closure in place with use restriction is appropriate for the three CASs at CAU 309.

Based on the field investigation, the following contaminants were determined to be present at concentrations exceeding their corresponding FALs:

- Cs-137 and Pu-239 at CAS 12-08-02
- Cs-137 at CAS 12-28-01

The strategy of using data from previously investigated muckpiles as discussed in the CAIP was used to identify Cs-137, Pu-239 and the additional COCs arsenic, lead, total petroleum hydrocarbons, diesel-range organics, and Co-60. These COCs are assumed to be present within the two muckpiles (CASs 12-06-09 and 12-08-02) only and not the native soils beneath the muckpiles. These assigned COCs from previously investigated muckpiles do not apply at CAS 12-28-01.

Based on the data evaluation and risk evaluation, the DQO data needs presented in the CAIP were met, and the data accurately represent the radiological and chemical risk present at CAU 309. Based on the results of the data evaluation it was determined that the corrective action proposed in the CAIP (Close in Place with a Use Restriction) will effectively control exposure to future land users. Therefore, the NNSA/NSO provides the following recommendations:

- Close in place COCs at CASs 12-06-09, 12-08-02, and 12-28-01 with use restrictions.
- No further corrective action for CAU 309.
- No corrective action plan.
- A Notice of Completion to the NNSA/NSO is requested from the Nevada Division of Environmental Protection for closure of CAU 309.
- Move CAU 309 from Appendix III to Appendix IV of the *Federal Facility Agreement and Consent Order*.

1.0 Introduction

This Corrective Action Decision Document/Closure Report (CADD/CR) has been prepared for Corrective Action Unit (CAU) 309, Area 12 Muckpiles, Nevada Test Site (NTS), Nevada. The corrective actions proposed in this document are according to the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada, U.S. Department of Energy (DOE), and the U.S. Department of Defense (FFACO, 1996). The NTS is approximately 65 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1).

Corrective Action Unit 309 is comprised of the three Corrective Action Sites (CASs) (Figure 1-1) listed below:

- CAS 12-06-09, Muckpile
- CAS 12-08-02, Contaminated Waste Dump (CWD)
- CAS 12-28-01, I-, J-, and K-Tunnel Debris

Corrective Action Sites 12-06-09 and 12-08-02 will be collectively referred to as muckpiles in this document. Corrective Action Site 12-28-01 will be referred to as the fallout plume because of the extensive lateral area of debris and fallout contamination resulting from the containment failures of the J- and K-Tunnels.

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 309: Area 12 Muckpiles, Nevada Test Site (NTS), Nevada.* (NNSA/NSO, 2004).

1.1 Purpose

This CADD/CR provides justification for the closure of CAU 309 without further corrective action. This justification is based on process knowledge and the results of the investigative activities conducted according to the CAIP (NNSA/NSO, 2004), which provides information relating to the history, planning, and scope of the investigation. Therefore, this information will not be repeated in this CADD/CR.

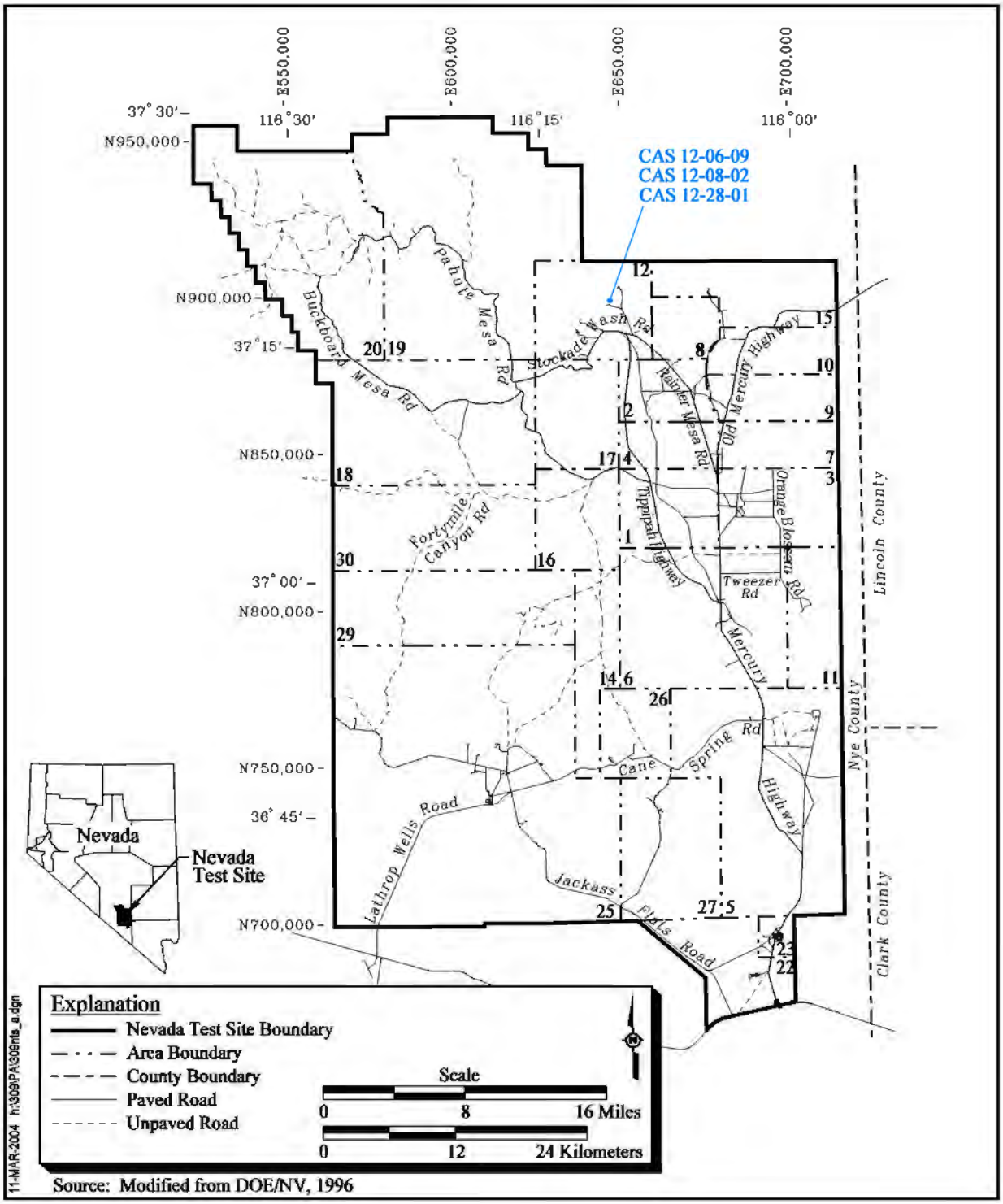

Figure 1-1
NTS Location Map Showing CAU 309 CASs

Corrective Action Unit 309, Area 12 Muckpiles consists of three inactive sites located in the central portion of Area 12. These three inactive sites consist of two muckpiles, and a blowout plume, and were used to support nuclear testing conducted in the Rainier Mesa area during the 1960s.

1.2 Scope

The scope of this CADD/CR is to justify and recommend that no further corrective action is required at CAU 309, Area 12 Muckpiles. To achieve this scope, the following actions were implemented:

- Evaluation of current site conditions, including the nature and extent of contaminants of concern (COCs).
- Closed in place with use restriction was implemented to prevent exposure of industrial and construction workers to unacceptable risks.

1.3 Corrective Action Decision Document/Closure Report Contents

This CADD/CR is divided into the following sections and appendices:

Section 1.0 – Introduction: Summarizes the purpose, scope, and contents of this CADD/CR.

Section 2.0 – Corrective Action Investigation (CAI) Summary: Summarizes the investigation field activities, the results of the investigation, the need for corrective action, and a summary of the results of the data quality objective (DQO) assessment.

Section 3.0 – Recommendation: States why no further action is required.

Section 4.0 – References: Provides a list of all referenced documents used in the preparation of this CADD/CR.

Appendix A – *Corrective Action Investigation Results for CAU 309:* Provides a description of the project objectives, field investigation and sampling activities, investigation results, waste management (WM), and quality assurance (QA). Section A.3.0 provides specific information regarding field activities, sampling methods, and laboratory analytical results from the investigation.

Appendix B – *Data Assessment for CAU 309:* Provides a data quality assessment (DQA) that reconciles DQO assumptions and requirements to the investigation results.

Appendix C – *Risk Assessment for CAU 309:* Presents an evaluation of risk associated with the recommended no further action.

Appendix D – *Closure Activity Summary for CAU 309:* Provides details on the completed closure activities and includes the required verification activities and supporting documentation for CAU 309.

Appendix E – *Sample Location Coordinates for CAU 309:* Provides investigation sample locations coordinates.

1.3.1 Applicable Programmatic Plans and Documents

To ensure all project objectives, health and safety (H&S) requirements, and quality control (QC) procedures were adhered to, and investigation activities were performed according to the following documents:

- Corrective Action Investigation Plan for CAU 309, Area 12 Muckpiles (NNSA/NSO, 2004)
- Record of Technical Change (ROTC) No. 1 for the CAIP for CAU 309, Area 12 Muckpiles
- Industrial Sites Quality Assurance Project Plan (QAPP) (NNSA/NV, 2002)
- *Federal Facility Agreement and Consent Order* (1996)
- Approved standard quality practices and detailed operating procedures

1.3.2 Data Quality Assessment Summary

The DQOs identified in the CAIP are as follows:

- Determine whether COCs are present.
- If COCs are present, determine their nature and extent. Obtain sufficient information to evaluate potential corrective action alternatives.

The data quality indicators (DQIs) discussed in Appendix B were achieved and DQOs established in the CAIP were met.

2.0 Corrective Action Investigation Summary

The following sections summarize the investigation activities, investigation results, and justification for no further corrective action at CAU 309. Detailed investigation activities and results for individual CAU 309 CASs are presented in Appendix A of this document.

2.1 Investigation Activities

Corrective action investigation activities were performed as set forth in the CAU 309 CAIP (NNSA/NSO, 2004) and conducted from June 9 through June 29, 2005.

Because of the steep slopes and safety issues associated with sampling on the muckpiles, the typical approach for the investigation was modified. This modification included the incorporation of the sampling results from previous muckpile investigation in lieu of both sampling on the steep slopes and sampling into the underlying native soil. Soil samples were collected from the areas of the muckpile that were safely accessible and the combined data set was used to determine the acceptability of the proposed corrective action. Therefore, the two CAU 309 muckpiles (CASs 12-06-09 and 12-08-02) were assigned radiological and chemical contamination values based on the historical data and the limited data collected from the safely accessible areas of the two muckpiles during this corrective action investigation. This modification was discussed with and approved by NNSA/NSO and NDEP during the planning process for the corrective action investigation. Therefore arsenic, lead, total petroleum hydrocarbon, diesel-range organics (TPH-DRO), Cs-137, Co-60, and Pu-239 are considered to be COCs at the two muckpiles (CASs 12-06-09 and 12-08-02).

The purpose of the CAU 309 CAI was to address the decision statements in the project-specific DQOs by:

- Determining whether COCs are present in the soils associated with CAU 309.
- Determining the lateral and vertical extent of identified COCs.
- Ensuring adequate data have been collected to close the sites under the Nevada Division of Environmental Protection (NDEP), *Resource Conservations and Recovery Act* (RCRA) (CFR, 2003a), *Toxic Substance Control Act* (CFR, 2003b), and DOE requirements.

The scope of the CAI included the following activities:

- Performing radiological surveys (i.e., aerial, walkover, static, scanning, and swipe collection).
- Field screening soil samples for volatile organic compounds (VOCs) and total alpha and beta/gamma radiation, and conducting on-site analysis for gamma-emitting radionuclides.
- Collecting environmental samples for laboratory analyses to determine the presence of COCs and to define the vertical and lateral extent of COCs, if present.
- Collecting QC samples for laboratory analyses to ensure that the data generated from the analysis of investigation samples meet the requirements of the DQIs.

A judgmental (nonprobabilistic) sampling scheme was implemented to select sample locations and evaluate analytical results, as outlined in the CAIP. Judgmental sampling allows for the methodical selection of sample locations that target the populations of interest (defined in the DQOs) rather than non-selective random locations.

Because individual sample results (rather than average concentrations) were used to compare to action levels, statistical methods to generate site characteristics (averages) were not necessary. Section 0.4.4 of the U.S. Environmental Protection Agency (EPA) *Data Quality Objectives Process for Hazardous Waste Site Investigations* (EPA QA/G-4HW) guidance states that the use of statistical methods may not be warranted by program guidelines or site-specific sampling objectives (EPA, 2000). The need for statistical methods is dependent upon the decisions being made. Section 7.1 of the EPA QA/G-4HW guidance states that a nonprobabilistic (judgmental) sampling design is developed when there is sufficient information on the contamination sources and history to develop a valid conceptual site model (CSM) and to select specific sampling locations. This design was used to confirm the existence of contamination at specific locations and provide information (such as extent of contamination) about specific areas of the site.

Confidence was established qualitatively in judgmental sampling results by the validation of the CSM developed and concurred to by stakeholder participants (DOE, National Nuclear Security Administration Nevada Site Office [NNSA/NSO] and NDEP) during the DQO process, investigation results, and the DQA.

Waste characterization activities were conducted to gather sufficient information and data to support waste disposal decisions. Information regarding waste characterization is presented in Section A.7.0 of Appendix A.

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

2.1.1 Muckpile (CAS 12-06-09)

This CAS consists of a muckpile and debris located on the hillside in front of the I-, J-, and K-Tunnels on the eastern slopes of Rainier Mesa in Area 12. The muckpile includes mining debris (muck) generated during the excavation, construction, and operation of the I-, J-, and K-Tunnels. Debris on the muckpile consists of scattered wood, twisted and rusted metal, metal tank, cables, railroad tracks, and pipes.

The following sections summarize the radiological surveys, visual inspections, field screening, and sample collection activities conducted at CAS 12-06-09.

2.1.1.1 Radiological Surveys

A radiological walk-over survey was performed on January 21, 2004, at the CAS 12-06-09 muckpile and surrounding areas in front of K-Tunnel down to the CAS 12-08-02 CWD. The maximum gamma radiation emission rate was 8,492 counts per second (cps), which is approximately 26.5 times greater than the mean undisturbed background gamma radiation emission rate. The highest gamma emission rates in the survey area were seen at the CWD in the northeast corner of the survey area, in front of K-Tunnel re-entry portal, inside a posted contamination area. The results of this survey are included in the CAIP (NNSA/NSO, 2004).

A low-altitude, aerial radiological survey was conducted for the NNSA/NSO by the Remote Sensing Laboratory (RSL), located in Las Vegas, Nevada, and maintained and operated by Bechtel Nevada. The survey was performed using a helicopter in late 2004 and early 2005 covering all the CASs within CAU 309. The flight was conducted at an altitude of approximately 50 feet (ft). Results of the helicopter survey were used to select biased soil sampling locations and are discussed in Section A.2.2.2 and shown in Figure A.3.1.

There were no swipe surveys performed on debris at CAS 12-06-09.

2.1.1.2 Visual Inspection

Visual inspections were conducted of the corrugated metal tank and associated piping, and of the soil potentially impacted by the effluent end of the discharge pipe by waste process operations conducted at this CAS. A soil sample was collected and analyzed from beneath the effluent pipe discharge from the corrugated above-ground tank. The tank appears to have been a water tank and was observed to be empty. Photographs were taken to document this observation.

Visual inspections were conducted to identify biasing factors (i.e., staining, elevated radiation levels, odor) on the muckpile and surrounding areas including debris piles. Several of the proposed sampling locations were moved and several additional biased samples were identified other than those proposed in the CAIP.

Observations and changes were made as follows:

- Location A01 was moved so that the lowest area of the contamination area just outside the J-Tunnel portal could be sampled.
- Location A04 was moved to the front of the K-Tunnel portal within the contamination area posting.
- Location A11 was moved inside the contamination area to sample the soil beneath the effluent pipe discharge from the corrugated above ground tank.
- Location A23 was moved to the center of a drainage ditch.
- Location A29 was added to the sampling locations to capture any potential contaminant pathway from drainage of the hillside across the valley and adjacent to the J-Tunnel blowout.
- Locations A30 and A32 were selected within ditches to capture any potential contaminants that may have been migrating from the CAU 309 CASs or the T-Tunnel CAU.
- Location A31 was selected within the main wash of P-Tunnel.

2.1.1.3 Field Screening

Investigation samples were field screened for VOCs, total alpha and beta/gamma radiation, and gamma radiation. The field-screening results (FSRs) were compared to field-screening levels (FSLs) to guide subsequent sampling decisions where appropriate. The VOC headspace FSRs were not exceeded in samples collected at this CAS. Gross alpha and/or total beta/gamma radiation FSLs were exceeded in 31 samples. Samples were also analyzed for gamma radiation via a gamma spectrometer. Gamma spectroscopy results were compared to the FSLs. Eight samples had FSRs exceeding the FSLs. The FSRs showed consistency with the results of the RSL flyover survey.

2.1.1.4 Sample Collection

Decision I and Decision II environmental sampling activities included the collection of biased surface and subsurface soil and muck samples on and surrounding the muckpiles (Figure A.3-1), along the downslope side of the muckpiles, and extent locations at the southeast boundary of the CAU footprint.

A total of forty-two environmental samples including three field duplicate (FD) were collected from thirty-two locations on and around the muckpiles. Surface samples (0.0 to 0.5 ft below ground surface [bgs]) were collected from all sample locations. At seven of these locations, subsurface samples were collected at depths ranging from 1.5 to 4.0 ft bgs. A soil sample was collected directly below the effluent end of the pipe beneath the discharge from the corrugated above ground tank.

No samples were collected at this CAS for the purpose of waste characterization and disposal determination.

2.1.1.5 Conceptual Site Model Validation

A CSM was developed to represent the release mechanisms and potential migration pathways for contaminant releases at CAU 309 CASs. The CSM and associated discussion for this CAS are provided in the CAIP.

The CSM for the muckpiles contains an assumption that the CAU 309 muckpiles are comparable to previously investigated NTS muckpiles and contain COCs identified during those investigations.

Based on previously investigated muckpiles, COCs at CAS 12-06-09 include arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239.

The contamination pattern of the COCs at the CAS 12-06-09 muckpile are consistent with the CSM in that the COCs are limited in vertical and lateral migration to the boundary of the muckpile. There was no evidence of contamination during the CAI that was not consistent with the CSM.

Process knowledge from previous muckpile investigations shows the native material underlying these muckpiles has been largely uncontaminated. Lateral migration of contaminants is considered a primary migration pathway and an important transport mechanism due to erosion and the steep slopes of the area. The CAU 309 CASs have very steep surface gradients and are located in drainage channels; therefore, the predominant migration pathway shown in the CSM is expected to be lateral migration over soils and talus material. Based on the CAI, there is no evidence of lateral migration of the COCs at the CAS 12-06-09 muckpile.

The migration pathway and release mechanism information gathered during the CAI was consistent with the CSM, and all information gathered during the CAI supports and validates the CSM as presented in the CAIP.

2.1.2 Contaminated Waste Dump (CAS 12-08-02)

This CAS consists of a muckpile and debris and is located on the hillside southeast of the front of the re-entry tunnel for K-Tunnel. During re-entry mining operations, potentially contaminated muck was removed from the tunnel and deposited on the muckpile. Debris on the muckpile consists of rusted and twisted metal, wood, cables, a lighting fixture, lead bricks and railroad tracks still attached to their wooden supports. Much of the debris was observed to be buried. The muckpile is posted with a, "Caution Contamination Area" sign. Similar debris is also located off the muckpile, close to the mountainside and K-Tunnel re-entry portal. Included in this debris is a wooden toilet that is tipped on its side. The collection reservoir consists of a 55-gallon (gal) drum, which was observed to be empty. It was photographed, and there is no staining visible beneath the drum.

The following sections summarize the radiological surveys, visual inspections, field screening, and sample collection activities conducted at CAS 12-06-09.

2.1.2.1 Radiological Survey

See Section A.2.2.2 for information regarding the low-altitude, aerial radiological survey conducted by RSL, and Section A.3.1.2 for information regarding the radiological walk-over survey that was performed by Stoller-Navarro Joint Venture (SNJV) personnel on January 21, 2004, at CAS 12-06-09 muckpile and CAS 12-08-02 CWD.

Results for the swipe collection survey conducted on the lead bricks that were removed from inside the contamination area indicate no removable alpha or beta/gamma contamination above release limits specified in the Radiological Control (RadCon) Manual (see Table A.4-8). Additional swipe surveys were conducted on equipment that was used inside the contaminated area (CA) at the muckpile. No removable contamination was detected above release limits.

2.1.2.2 Visual Inspection

Prior to intrusive activities, the site was visually inspected and photo documented. The visual inspection focused on biasing factors such as staining or ditches and drainages off the muckpile which could provide a preferential pathway for the transport of contaminants. A 55-gallon drum has been historically used as the collection reservoir for a portable toilet. The 55-gallon drum was observed to be empty and photographs were taken to document this observation.

The visual inspection resulted in several sampling locations being moved. Specifically, observations and changes were made as follows:

- Location B01 was moved due to a bedrock outcrop at this location; inside the contamination area fencing just outside the K-Tunnel re-entry portal.
- Location B10 was moved upslope on the muckpile to the area with the highest radiological field screening within the contamination area posting fence.
- Location B12 was moved to the center of a drainage ditch.
- Location B20 was moved due to solid rock.

The walkover visual inspections did not identify any additional sample locations based on biasing factors (i.e., staining). No additional biased sample locations were identified.

2.1.2.3 Field Screening

Investigation samples were field screened for VOCs, total alpha and beta/gamma radiation, and gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. The VOC headspace FSRs were not exceeded in samples collected at this CAS. Gross alpha and/or total beta/gamma radiation FSLs were exceeded in 9 samples. Samples were also analyzed for gamma radiation via the Gamma spectrometer in Building 153. Gamma spectroscopy results were compared to the FSLs. Five samples had FSRs exceeding the FSLs. The field screening results showed consistency with results of the RSL flyover survey.

2.1.2.4 Sample Collection

Decision I and Decision II environmental sampling activities included the collection of biased surface and subsurface soil and muck samples on and surrounding the muckpiles, below the base of the muckpile, and locations to the south and east downgradient of the muckpile (Figure A.3-1).

A total of 23 characterization samples (including 1 FD) were collected during investigation activities at CAS 12-08-02. Environmental samples were collected from the soil and muck at the muckpile from the surface interval from 0 to 0.5 ft bgs. Subsurface samples were not collected at this CAS due to hazardous working conditions including the possibility of airborn contaminants, and a very steep and unstable ground surface. A soil sample was not collected below or within the 55-gal portable toilet drum, because the tank was observed to be void of sampling material, and had no staining present in the soil.

Samples were collected at this CAS for the purpose of waste characterization and disposal determination of lead bricks that were removed from this CAS. The analytical results for waste characterization samples are discussed in Section A.6.0. Per the CAIP, lead brick removal would be completed for bricks laying on the ground surface. Twenty bricks were removed and additional lead bricks were observed partially buried or beneath the bricks removed. After discussions with NNSA/NSO and NDEP representatives, it was agreed that only the twenty bricks found at the surface would be removed and all others would remain on the muckpile because of safety concerns with removal (airborn contamination and unstable ground).

2.1.2.5 Conceptual Site Model Validation

A CSM was developed to represent the release mechanisms and potential migration pathways for contaminant releases at CAU 309 CASs. The CSM and associated discussion for this CAS are provided in the CAIP.

The CSM for the muckpiles is based on an assumption that the CAU 309 muckpiles are contaminated at levels comparable to previously investigated NTS muckpiles and contain COCs identified during those investigations and include arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239.

The contamination pattern of the COCs at CAS 12-08-02 muckpile are consistent with the CSM in that the COCs are limited in vertical and lateral extent to the boundary of the muckpile.

Process knowledge from previous muckpile investigations shows the native material underlying these muckpiles has been largely uncontaminated. Lateral migration of contaminants is considered a primary migration pathway and an important transport mechanism due to erosion and the steep slopes of the area. The CAU 309 CASs have very steep surface gradients and are located in drainage channels; therefore, the predominant migration pathway shown in the CSM is lateral migration over soils and talus material. Based on the CAI, there is no evidence of lateral migration of the COCs at the CAS 12-08-02 muckpile.

The migration pathway and release mechanism information gathered during the CAI were consistent with the CSM and all information gathered during the CAI support and validate the CSM as presented in the CAIP.

2.1.3 I-, J-, and K-Tunnel Debris, (CAS 12-28-01)

This CAS is defined as the debris ejected during the Des Moines and Platte Tests and the associated contamination that is not covered in the two muckpiles CASs. This site consists of debris scattered south of the I-, J-, and K-Tunnel muckpiles and extends down the hillside, across the valley, and onto the adjacent hillside to the south. The CAS also covers contamination associated with "ventings" along fractures and various boreholes on the mesa top and face. The operational history is also similar to the other two CASs except that T-Tunnel Ponds and other support facilities constructed in impacted areas after the release may have redistributed some contaminants. The T-Tunnel ponds are

located in the posted area at the bottom of the canyon. These ponds are covered in CAU 478, CAS 12-23-01, and are excluded from further investigation in CAU 309.

The following sections summarize the radiological surveys, visual inspections, field screening, and sample collection activities conducted at CAS 12-28-01.

2.1.3.1 Radiological Survey

A low-altitude, aerial radiological survey was conducted for the NNSA/NSO by the RSL. The survey was performed using a helicopter in late 2004 and early 2005 covering all the CASs within CAU 309 at an altitude of approximately 50 ft. Results of the helicopter survey were used to select biased soil sampling locations and identify the extent of the radiological contamination within the survey area. The analytical results of the soil samples showed a good correlation with the data from the helicopter survey and supported the delineation of the surficial contamination. Results of the helicopter survey are in Section A.2.2.2 and shown in Figure A.3-1.

Results for the swipe collection survey conducted on the debris that were ejected from the J-Tunnel blowout from inside the contamination area, across the valley, indicated no removable alpha or beta/gamma contamination. Some of the miscellaneous debris included the portal door and I-beams.

2.1.3.2 Visual Inspection

Prior to intrusive activities, the site was visually inspected and photo documented. The visual inspection focused on biasing factors such as staining or ditches and drainages off the fallout plume that could provide a preferential pathway for the transport of contaminants.

The visual inspection resulted in several sampling locations being moved. Specifically, observations and changes were made as follows:

- Location C05 was moved due to a steep embankment.
- Location C07 was moved to beneath a wooden debris pile.
- Location C08 was moved from outside to inside the CA fence boundary.

- Location C10 was moved so a soil sample could be collected from directly beneath a debris pile that included I-beams and various metal debris.
- Location C12 was moved so a soil sample could be collected from directly beneath a debris pile.

The visual inspection resulted in adding several new locations. Locations C27 through C30 were added to the sampling due to observation of trinity glass and having the highest radiological field screening within the CA posting fence. Location C31 was added to the center of locations C27 through C30 and contained trinity glass. Location C32 was added to capture potential contaminants from a drainage near a cement yard, and location C33 was added to capture potential contaminants from a drainage near an equipment yard. (Figure A.3-1)

No staining was observed during site walkovers, and no additional biased sample locations were identified except for those above.

2.1.3.3 Field Screening

Investigation samples were field screened for VOCs, total alpha and beta/gamma radiation, and gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. The VOC headspace FSRs were not exceeded in samples collected at this CAS. Gross alpha and/or total beta/gamma radiation FSLs were exceeded in 37 samples. Samples were also analyzed for gamma radiation via a gamma spectrometer. Gamma spectroscopy results were compared to the FSLs. Seven samples had FSRs exceeding the FSLs. Due to high FSRs, locations C27 through C30 were added to the sampling locations. The FSRs showed consistency with the results of the RSL flyover survey.

2.1.3.4 Sample Collection

Decision I and Decision II environmental sampling activities included the collection of biased surface and subsurface soil samples on and surrounding the fallout plume, on top of the mesa, and extent locations to the south and east downgradient of the fallout plume.

A total of 53 characterization environmental samples (including 4 FD) were collected during investigation activities at CAS 12-28-01.

Decision I and Decision II environmental sampling activities included the collection of biased surface and subsurface soil samples within and surrounding the blowout plume (Figure A.3-1), on the mesa top, and extent locations to the south and east downgradient of the blowout plume.

Environmental samples were collected from the soil at the blowout plume from the surface interval (from 0 to 0.5 ft bgs). Subsurface samples were collected at this CAS from intervals ranging from 0.75 - 1.5 ft bgs. Soil samples were collected below debris piles of wooden and metal debris; however, no staining was evident in the soil. Photographs were taken to document these observations and are retained in the project files.

No samples were collected at this CAS for waste characterization and disposal determination.

2.1.3.5 Conceptual Site Model Validation

A CSM was developed to represent the release mechanisms and potential migration pathways for contaminant releases at CAU 309 CASs. The CSM and associated discussion for this CAS is provided in the CAIP.

Because there are no muckpiles associated with this CAS, the COCs from previous NTS muckpile investigations do not apply. Based on field observations and analytical results of the environmental samples collected at this CAS, the only COC identified is Cs-137. Contamination is present at concentrations exceeding the FALs in the surface soil at sample locations C03, C04, C06, C27, and C31. These five locations are within the posted CA fencing located across the valley from J-tunnel where the portal door was found. The contaminated soil is laterally bounded as demonstrated by the sample results of nearby locations C05, C07, C08, and C09 (also within the posted CA fencing) and contamination is vertically restricted to the surficial soils as evident at locations C06 and C27, where Cs-137 concentrations decreased approximately double at depths of 1 ft bgs.

The contamination pattern of the COCs at the CAS 12-28-01 are consistent with the CSM in that the COCs are limited in vertical migration. Lateral migration of contaminants was thought be an important transport mechanism due to erosion and the steep slopes of the area. Data obtained during the CAI did not show lateral migration. There was no evidence of contamination during the CAI that was not consistent with the CSM.

The migration pathway and release mechanism information gathered during the CAI were consistent with the CSM (and information gathered during the CAI support) and validate the CSM as presented in the CAIP.

2.2 Results

The summary of data from the CAI provided previously in Section 2.2.1 defines the areas within the CAU 309 CASs where the contaminants of potential concern (COPCs) exceeded the FALs and extent of all identified COCs. Section 2.2.2 summarizes the assessment made in Appendix B, which demonstrates that the investigation results satisfy the DQO data requirements.

2.2.1 Summary of Analytical Data

Chemical and radiological results for investigation samples collected at each of the CASs are summarized in Section 2.2.1.1 through Section 2.2.1.3. The preliminary action levels (PALs) for the CAU 309 investigation were determined during the DQO process and are discussed in Section 3.3 of the CAIP (NNSA/NSO, 2004). Final action levels are presented in Section 2.3.1, and details about the methods used during this investigation and a comparison of environmental sample results to the FALs are presented in Appendix A.

2.2.1.1 Muckpile (CAS 12-06-09)

The muckpile at CAS 12-06-09 is considered contaminated with chemical and radiological contamination based on the results of previous investigations of muckpiles at NTS. Therefore arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239 are considered to be COCs for the CAS 12-06-09 muckpile.

During the CAI, one surface sample, 309A019 at location A08, exceeded the FAL of 100 milligrams per kilogram (mg/kg) for TPH-DRO. Therefore, TPH-DRO is considered a COC.

Cesium-137 was detected at concentrations that exceeded the PAL (12.2 picocuries per gram [pCi/g]) in 15 of the 42 environmental soil samples collected from 32 locations. Americium-241 was detected at concentration exceeding the PAL (12.7 pCi/g) in 11 of the 42 environmental samples at 11 locations. Concentrations of Pu-238, and Pu-239 also exceed the PALs. Cesium-137, Am-241,

Pu-238, and Pu-239 were moved onto a Tier 2 evaluation in which the Residual Radioactive (RESRAD) code was used to determine the site-specific FALs for these radionuclides and are presented in Appendix C. Although the CAI sample results for these radionuclide were below the site-specific FALs, Cs-137 and Pu-239 were retained as COCs based on the results from previous muckpile investigations.

All concentrations of the other reported parameters were compared to and were less than the FALs for samples collected during the CAI.

All chemical and radiological COCs were bounded within the footprint of the muckpile, as samples taken below the base of the muckpile (see locations A03 and A-14 through A28) and extent samples taken further down the washes (see locations A 29, A30, A31, A32, C32, and C33), were found not to be contaminated with COCs.

The maximum concentration of each detected contaminant at this CAS is listed in Table 2-1.

Table 2-1
Maximum Concentration of Detected Contaminants for CAS 12-06-09 Muckpile
(Page 1 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Benzo(a)Anthracene	230	209A019RR1	0 - 0.5	A08	2,100	µg/kg
Benzo(b)Fluoranthene	30	309A035	0 - 0.5	A10	2,100	µg/kg
Benzoic Acid	1,500	309A018	0 - 0.5	A19	100,000,000	µg/kg
Bis(2-Ethylhexyl)Phthalate	140	309A018	0 - 0.5	A19	120,000	µg/kg
Diethyl Phthalate	90	309A018	0 - 0.5	A19	100,000,000	µg/kg
Fluoranthene	27	309A035	0 - 0.5	A10	22,000,000	µg/kg
Pyrene	490	309A019RR1	0 - 0.5	A08	29,000,000	µg/kg
Diesel Range Organics	3,100	309A019	0 - 0.5	A08	100	mg/kg
Arsenic	4.3	309A001	0 - 0.5	A29	23	mg/kg
Barium	3,800	309A004	0 - 0.5	A31	67,000	mg/kg
Beryllium	1.4	309A039	0 - 0.5	A01	1,900	mg/kg
Cadmium	0.41	309A038	0 - 0.5	A11	450	mg/kg
Chromium	6.9	309A017	0 - 0.5	A16	450	mg/kg
Lead	59	309A011	0 - 0.5	A24	750	mg/kg
Mercury	0.029	309A011	0 - 0.5	A29	310	mg/kg
Actinium-228	2.91	309A010	0 - 0.5	A22	15	pCi/g

Table 2-1
Maximum Concentration of Detected Contaminants for CAS 12-06-09 Muckpile
(Page 2 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Bismuth-212	3.7	309A018	0 - 0.5	A19	15	pCi/g
Bismuth-214	2.2	309A036	1.5 - 2	A10	15	pCi/g
Cesium-137	150	309A011	0 - 0.5	A24	196.7	pCi/g
Cobalt-60	0.7	309A034	0 - 0.5	A05	2.7	pCi/g
Europium-152	4	309A034	0 - 0.5	A05	5.7	pCi/g
Lead-212	3.29	309A026	3 - 4	A07	15	pCi/g
Lead-214	2.05	309A036	1.5 - 2	A10	15	pCi/g
Thallium-228	1.07	309A039	0 - 0.5	A01	15	pCi/g
Americium-241	161	309A034	0 - 0.5	A05	893.6	pCi/g
Plutonium-238	53.6	309A034	0 - 0.5	A05	1,075	pCi/g
Plutonium-239	670	309A034	0 - 0.5	A05	968.7	pCi/g
Strontium-90	3.93	309A020	0 - 0.5	A20	838	pCi/g
Uranium-234	4.72	309A034	0 - 0.5	A05	143	pCi/g
Uranium-235	0.208	309A010	0 - 0.5	A22	17.5	pCi/g
Uranium-238	1.96	309A020	0 - 0.5	A20	105	pCi/g

FAL = Final action level
ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
pCi/g = Picocuries per gram
µg/kg = Micrograms per kilogram

2.2.1.2 Contaminated Waste Dump (CAS 12-08-02)

The muckpile at CAS 12-08-02 is considered contaminated with chemical and radiological contamination based on the results of previous investigations of muckpiles at NTS. Therefore arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239 are considered to be COCs for the CAS 12-08-02 muckpile.

All gamma-emitting radionuclide concentrations except Co-60, Cs-137, Am-241, and europium (Eu)-152 did not exceed their respective PALs; therefore, for these radionuclides, the PALs are identified as the FALs. Cobalt-60 was detected at concentrations exceeding the PAL of 2.68 pCi/g in one sample at location B10. Cesium-137 was detected at concentrations that exceeded the PAL (12.2 pCi/g) in 8 of the 23 environmental soil samples at 6 locations. Americium-241 exceeded the PAL (12.7 pCi/g) in 6 of the 23 environmental samples at 4 locations. Europium-152 was reported at

concentration that exceeded the PAL in 2 samples at location B10. Plutonium-238 was detected in 4 samples from 3 locations at concentrations that exceeded the PAL of 13 pCi/g. Plutonium-239 was detected in 11 samples from 8 locations that exceeded the PAL of 12.2 pCi/g. These radionuclides for which concentrations exceeded their respective PALs, were moved onto a Tier 2 evaluation in which the RESRAD code was used to determine the site-specific FALs for these radionuclides. The calculation of the FALs are presented in Appendix C. Based on the results of the Tier 2 evaluation, Cs-137 had a reported concentration at one location (B10) that exceeded the FAL of 196.7 pCi/g, and Pu-239 also exceeded the FAL of 968.7 pCi/g in sample 309B004 at location B10 with a concentration of 1,860 pCi/g. Based on CAI sampling results, Cs-137 and Pu-139 are considered a COCs for the CWD.

Therefore arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239 are considered to be COCs for the CAS 12-08-02 muckpile. The maximum concentration of each detected contaminant at this CAS is listed in Table 2-2.

Table 2-2
Maximum Concentration of Detected Contaminants
for CAS 12-08-02, Contaminated Waste Dump
(Page 1 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Styrene	1.1	309B022	0 - 0.5	B19	1,700,000	µg/kg
Bis(2-Ethylhexyl)Phthalate	95	309B015	0 - 0.5	B14	120,000	µg/kg
Diesel Range Organics	12	309B006	0 - 0.5	B02	100	mg/kg
Arsenic	4.7	309B019	0 - 0.5	B16	23	mg/kg
Barium	150	309B014	0 - 0.5	B11	67,000	mg/kg
Beryllium	1.3	309B022	0 - 0.5	B19	1,900	mg/kg
Cadmium	0.99	309B004	0 - 0.5	B10	450	mg/kg
Chromium	7.8	309B022	0 - 0.5	B19	450	mg/kg
Lead	400	309B004	0 - 0.5	B10	750	mg/kg
Mercury	0.079	309B016	0 - 0.5	B20	310	mg/kg
Actinium-228	3.04	309B002	0 - 0.5	B05	5	pCi/g
Americium-241	576	309B004	0 - 0.5	B10	893.6	pCi/g
Bismuth-212	3.5	309B016	0 - 0.5	B20	5	pCi/g
Bismuth-214	1.84	309B004	0 - 0.5	B10	5	pCi/g
Cesium-137	241	309B004	0 - 0.5	B10	196.7	pCi/g

Table 2-2
Maximum Concentration of Detected Contaminants
for CAS 12-08-02, Contaminated Waste Dump
(Page 2 of 2)

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Cobalt-60	2.73	309B004	0 - 0.5	B10	43.9	pCi/g
Europium-152	17.4	309B004	0 - 0.5	B10	97.4	pCi/g
Europium-154	3.25	309B004	0 - 0.5	B10	5.4	pCi/g
Lead-212	3.08	309B023	0 - 0.5	B10	5	pCi/g
Lead-214	2.12	309B004	0 - 0.5	B10	5	pCi/g
Thallium-208	0.98	309B023	0 - 0.5	B10	5	pCi/g
Plutonium-238	166	309B004	0 - 0.5	B10	1,075	pCi/g
Plutonium-239	1,860	309B004	0 - 0.5	B10	968.7	pCi/g
Strontium-90	34.4	309B004	0 - 0.5	B10	838	pCi/g
Uranium-234	16.6	309B004	0 - 0.5	B10	143	pCi/g
Uranium-235	0.137	309B013	0 - 0.5	B12	17.5	pCi/g
Uranium-238	1.71	309B003	0 - 0.5	B04	105	pCi/g

FAL = Final action level
ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
pCi/g = Picocuries per gram
µg/kg = Micrograms per kilogram

2.2.1.3 I-, J-, and K-Tunnel Debris (CAS 12-28-01)

None of the gamma-emitting radionuclide concentrations except Am-241 and Cs-137 exceeded their respective PALs, therefore, for these radionuclides the PALs are identified as the FALs. Americium-241 exceeded the PAL (12.7 pCi/g) in 21 of the 53 environmental samples at 19 locations ranging from 12.4 to 150 pCi/g. Cesium-137 was detected at concentrations that exceeded the PAL (12.2 pCi/g) in 36 of the 53 environmental soil samples at 29 locations ranging in concentration from 12.2 to 330 pCi/g. Plutonium-238 was detected in 10 of the 53 environmental samples at 10 surface sample locations at concentrations that exceeded the PAL of 13 pCi/g. Plutonium-239, the most widespread radionuclide, was detected in 36 samples from 25 locations that exceeded the PAL of 12.2 pCi/g. These radionuclides were moved onto a Tier 2 evaluation in which the RESRAD code was used to determine the site-specific FALs for these radionuclides. The calculation of the FALs are presented in Appendix C. Based on the results of the Tier 2 evaluation, only Cs-137 had reported concentrations that exceeded the FAL of 196.7 pCi/g in 5 samples at 5 locations. Sample 309C010A

at location C03 had the highest concentration of Cs-137 at 330 pCi/g. All five exceedances were in the surface interval. Based on this evaluation, Cs-137 is considered a COC for CAS 12-28-01. The maximum concentration of each detected contaminant at this CAS is listed in Table 2-3.

Table 2-3
Maximum Concentration of Detected Contaminants
for CAS 12-28-01, I-, J-, and K-Tunnel Debris

Constituent	Maximum Result	Sample Number	Depth (ft bgs)	Location	FAL	Units
Beryllium	0.98	309C005	0 - 0.5	19	1,900	mg/kg
Lead	37	309C005	0 - 0.5	19	750	mg/kg
Actinium-228	2.86	309C036	0 - 0.5	C25	5	pCi/g
Aluminum-26	0.109	309C004A	0 - 0.5	C12	2.32	pCi/g
Americium-241	150	309C028	0 - 0.5	C31	893.6	pCi/g
Bismuth-212	2.97	309C031	0 - 0.5	C20	15	pCi/g
Bismuth-214	1.98	309C002	0 - 0.5	23	15	pCi/g
Cesium-137	330	C309C010A	0 - 0.5	C03	196.7	pCi/g
Cobalt-60	0.64	309C028	0 - 0.5	C31	2.7	pCi/g
Europium-152	3.95	309C028	0 - 0.5	C31	5.7	pCi/g
Europium-154	0.74	309C026	0 - 0.5	C08	135	pCi/g
Lead-212	3.45	309C037	0 - 0.5	C26	15	pCi/g
Lead-214	2.14	309C002	0 - 0.5	23	15	pCi/g
Thallium-208	1.08	309C033	0 - 0.5	C22	15	pCi/g
Plutonium-238	37.4	309C012A	0 - 0.5	C27	1,075	pCi/g
Plutonium-239	385	309C012A	0 - 0.5	C27	968.7	pCi/g
Strontium-90	17.5	309C010A	0 - 0.5	C03	838	pCi/g
Uranium-234	4	309C010A	0 - 0.5	C03	143	pCi/g
Uranium-235	0.146	309C010A	0 - 0.5	C03	17.6	pCi/g
Uranium-238	1.52	309C002A	0 - 0.5	C11	105	pCi/g

FAL = Final action level
ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
pCi/g = Picocuries per gram
µg/kg = Micrograms per kilogram

2.2.2 Data Assessment Summary

The DQA is presented in Appendix B and includes an evaluation of the 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 to ensure that DQO decisions are sound and defensible.

The DQA process as presented in Appendix B is comprised 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

Sample locations that support the presence and/or extent of contamination at each CAS are shown in Appendix A. Based on the results of the DQA presented in Appendix B, the DQO requirements have been met and the close in place corrective action alternative was selected as the closure alternative at CAU 309, Area 12 Muckpiles. The DQA also determined that information generated during the investigation supports the CSM assumptions and the data collected supports the intended use in the decision-making process.

2.3 Justification for No Further Action

No further action is justified based on an evaluation of risk to ensure protection of the public and the environment according to *Nevada Administrative Code* (NAC) 445A (NAC, 2003), feasibility, and cost effectiveness. The corrective actions were determined from DQO decision statements based on a comparison of the analyte concentrations detected in CAI soil samples to the FALs defined in Section 2.3.1. Because the extent of the COCs is limited and the CAI demonstrated that there has been no lateral migration of COCs, the corrective action close in place with administrative controls is justified at all three CASs. Appendix C presents an evaluation of risk associated with the recommended closure alternative.

2.3.1 Final Action Levels

The CAU 309 FALs are risk-based cleanup goals that, if met, will ensure that each release site will not pose an unacceptable risk to human health and the environment and that conditions at each site are in compliance with all applicable laws and regulations. The process described in this section to define or determine the FALs conforms with NAC Section 445A.227, which lists the requirements

for sites with soil contamination. For the evaluation of corrective actions, NAC Section 445A.22705 requires the use of American Society for Testing and Metals (ASTM) Method E1739-95 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 procedure (ASTM, 1995) defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses as follows:

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

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

Alternatively, the Tier 2 risk-based corrective action process SSTLs may be compared to the predicted concentration or activity of the contaminant at the point of exposure based on attenuation from the source using relatively simplistic mathematical models. Points of exposure are defined as those locations at which an individual or population may come in contact with a COC originating from a CAS. If a Tier 2 evaluation is conducted, the calculations used to derive the SSTLs and the contaminant attenuation calculations will be provided as an appendix to the investigation report. If remediation to Tier 2 SSTLs is not practicable, a Tier 3 evaluation may be conducted.

Tier 3 Evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in ASTM Method E1739-95 that consider site-, pathway-, and receptor-specific parameters. Tier 3 evaluation is much more complex than Tiers 1 and 2, because it may include additional site characterization, probabilistic evaluations, and sophisticated

chemical fate/transport models. The Tier 3 SSTLs are then compared to the upper 95 percent confidence limit of the mean of sample results from reasonable point(s) of exposure (as opposed to individual sample results as is done in Tier 2). Contaminant concentrations exceeding Tier 3 SSTLs require corrective action. If a Tier 3 evaluation is conducted, the calculations used to derive the SSTLs and the upper confidence limit of the means will be provided as an appendix to the investigation report.

A Tier 1 evaluation was conducted for all COPCs to determine whether contaminant levels satisfy the criteria for a quick regulatory closure or warrant a more site-specific assessment. This was accomplished by comparing individual source area contaminant concentration results to the Tier 1 action levels (the PALs established in the CAIP).

There was only one constituent detected at CAU 309 for which a PAL was not established. P-isopropyltoluene did not have a PAL, so the surrogate chemical isopropylbenzene was used, based on structural similarity; it has a PAL of 2,000 parts per million (ppm). The difference between the two chemicals is a carbon atom. Isopropyltoluene is more reactive, because the additional carbon affords an additional reaction site.

The constituents detected at the CAU 309 CASs that exceeded Tier 1 action levels were:

- TPH-DRO at CAS 12-06-09
- Co-60 at CAS 12-08-02
- Cs-137 at CASs 12-06-09, 12-08-02, and 12-28-01
- Am-241 at CASs 12-06-09, 12-08-02, and 12-28-01
- Pu-238 at CASs 12-06-09 and 12-08-02
- Pu-239 at CASs 12-06-09, 12-08-02, and 12-28-01
- Eu-152 at CAS 12-08-02.

The concentrations of all constituents at CASs not listed above were below Tier 1 action levels (except for the COCs from previously investigated muckpiles) and the corresponding PALs were established as the Tier 1 final action levels. Of the constituents at CASs that exceeded Tier 1 action levels, all were passed on to a Tier 2 evaluation.

The Tier 2 evaluation of TPH-DRO at CASs 12-06-09 was not performed due to the assumption that TPH-DRO is already present within the muckpiles as specified in the CAIP from previous muckpile investigations.

The Tier 2 evaluation for Co-60, Cs-137, Am-241, Pu-238, Pu-239, and Eu-152 compared the analytical results for these radionuclides at the CASs listed above to the Tier 2 action levels. The Tier 2 action levels were calculated using site-specific information on the detected radionuclides and other site-specific physical characteristics using the RESRAD code (version 6.21). This calculation determined the necessary activities of all detected radionuclides that, together, would sum to an exposed dose of 25 millirem (mrem) per year to a site receptor (based on relative abundance). These calculated activities were then established as the FALs for each radionuclide at each CAS that exceeded a Tier 1 action level. Additional details of the Tier 2 evaluations are provided in Appendix C.

The FALs for all CAU 309 COPCs detected above PALs are shown in Table 2-4.

Table 2-4
Definition of Final Action Levels for CAU 309 Contaminants of Potential Concern

COPCs	Tier 1 Based FALs	Tier 2 Based FALs	Tier 3 Based FALs
VOCs	PALs	NA	NA
SVOCs	PALs	NA	NA
PCBs	PALs	NA	NA
RCRA metals plus beryllium	PALs	NA	NA
TPH (DRO and GRO)	PALs	NA	NA
Radionuclides	PALs for all radionuclides at CASs for which Tier-2 based FALs were not calculated	RESRAD[a]-derived values for Co-60 at CAS 12-08-02	NA
		RESRAD[a]-derived values for Cs-137 at CASs 12-06-09, 12-08-02, and 12-28-01	NA
		RESRAD[a]-derived values for Am-241 at CASs 12-06-09, 12-08-02, and 12-28-01	NA
		RESRAD[a]-derived values for Pu-238 at CASs 12-06-09 and 12-08-02	
		RESRAD[a]-derived values for Pu-239 at CASs 12-06-09, 12-08-02, and 12-28-01	
		RESRAD[a]-derived values for Eu-152 at CAS 12-08-02	

[a]RESRAD code, version 6.21 (Yu, et al., 2001). See Tables 2-1 through 2-7 for the individual FALs.
Am = Americium
Cs = Cesium
DRO = Diesel-range organics
FAL = Final action level
GRO = Gasoline-range organics
NA = Not applicable
PAL = Preliminary action level
PCB = Polychlorinated biphenyl
Pu = Plutonium
RCRA = *Resource Conservation and Recovery Act*
RESRAD - Residual Radioactive
SVOC = Semivolatile organic compound
TPH = Total petroleum hydrocarbons
VOC = Volatile organic compound
µg/kg = Micrograms per kilogram

3.0 Recommendation

Assessment of the data generated from investigation activities indicates the FALs were exceeded for radionuclides in 6 surface soil samples from 6 locations at CAS 12-08-02, and at CAS 12-28-01. In addition, per the CAU 309 CAIP, the muckpiles at CASs 12-06-09 and 12-08-02 are considered to be contaminated at the highest concentrations of contaminants identified above FALs during previous (historical) investigations of muckpiles at NTS. Based on previously investigated muckpiles, COCs at the muckpile CASs 12-06-09 and 12-08-02 include arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239.

Although COCs were identified at each CAS (see Section 2.2) a use restriction notification shall be put in place for each CAS at CAU 309 that will prevent exposure of the COCs to NTS workers and the public. On a conservative basis, the muckpiles would each be use restricted from the surface to a depth of approximately 100 ft bgs. A use restriction at CAS 12-28-01 will include the volume of soil within the existing contamination area fencing from the surface to 5 ft bgs. The future use of CAU 309 would be restricted from any activity that would alter or modify the containment controls unless concurrence was obtained from NDEP. Because removal of the contaminants within the muckpiles is not feasible, the close in place with administrative controls corrective action alternative is appropriate. It will prevent inadvertent contact with the COCs, and meets all applicable state and federal regulations for closure of the site.

Maintenance or replacement of fencing can be conducted without prior approval from NDEP. An annual post-closure inspection is associated with the use restrictions to certify that markers and postings are in place, intact, and readable. Results of these inspections will be provided in the annual Post Closure Inspection and Monitoring Report. Signage will be placed around existing fencing to designate restricted areas. Specific use-restricted areas to be are provided in Appendix D.

The NNSA/NSO requests that NDEP issue a Notice of Completion for this CAU and approval to move the CAU from Appendix III to Appendix IV of the FFACO.

4.0 References

ASTM, see American Society for Testing and Materials.

American Society for Testing and Materials. 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites/American Society for Testing and Materials*, ASTM E 1739-95 (Reapproved 2002). Philadelphia, PA.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2003a. Title 40 CFR Parts 260 - 282, "Hazardous Waste Management." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2003b. Title 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Prohibitions." Washington, DC: U.S. Government Printing Office.

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

EPA, see U.S. Environmental Protection Agency.

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

Federal Facility Agreement and Consent Order. 1996 (as amended). Agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense.

NAC, see *Nevada Administrative Code*.

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

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Appendix A

Corrective Action Investigation Results for CAU 309

A.1.0 Introduction

This appendix presents the corrective action investigation activities and analytical results for CAU 309. Corrective Action Unit 309 is located in Area 12 of the NTS (Figure 1-1 of the main document) and is comprised of the three CASs listed below:

- CAS 12-06-09, Muckpile
- CAS 12-08-02, CWD
- CAS 12-28-01, I-, J-, and K-Tunnel Debris

Corrective Action Sites 12-06-09 and 12-08-02 will be collectively referred to as muckpiles in this document. Corrective Action Site 12-28-01 will be referred to as the fallout plume because of the extensive lateral area of debris and fallout contamination resulting from the containment failures of the J- and K-Tunnels.

Corrective Action Site 12-06-09 consists of a muckpile and debris located on the hillside in front of the I-, J-, and K-Tunnels on the eastern slopes of Rainier Mesa in Area 12. The muckpile includes mining debris (i.e., muck) and debris generated during the excavation and construction of the I-, J-, and K-Tunnels. Corrective Action Site 12-08-02 (CWD) consists of a muckpile and debris and is located on the hillside in front of the re-entry tunnel for K-Tunnel.

For the purpose of this investigation, CAS 12-28-01 is defined as debris ejected during containment failures during the Des Moines and Platte Tests in 1962 and the associated contamination not covered in the two muckpile CASs. This site consists of debris scattered south of the I-, J-, and K-Tunnel muckpiles and extends down the hillside, across the valley and onto the adjacent hillside to the south.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 309 CAIP (NNSA/NSO, 2004).

A.1.1 Project Objectives

The primary objective of the investigation was to provide sufficient information and data to document completion of appropriate corrective actions for each CAS in CAU 309. This objective was achieved

by identifying the absence or presence of COPCs, the nature of the COCs (i.e., COPCs at concentrations above FALs), and the vertical and lateral extent of the COCs.

The selection of soil and/or waste characterization sample locations was based on site conditions, and the strategy developed during the DQO process as outlined in the CAU 309 CAIP. The sampling strategy involved judgemental sample locations based on the results of an aerial radiological survey performed by RSL using a helicopter in late 2004 and early 2005.

A.1.2 Content

This appendix describes the investigation and presents the results in sufficient detail to support the selection of corrective action alternatives and a recommendation that no further action is necessary for the CASs in CAU 309. The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and content.
- Section A.2.0 provides an investigation overview.
- Section A.3.0 through Section A.5.0 provide CAS-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.6.0 summarizes waste management activities.
- Section A.7.0 discusses the QA and QC processes followed and the results of QA/QC activities.
- Section A.8.0 provides a summary of the investigation results.
- Section A.9.0 lists the cited references for the report.

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

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 309 CAI were conducted from June 9 through June 29, 2005. Table A.2-1 lists the CAI activities that were conducted at each of the CASs.

Table A.2-1
Corrective Action Investigation Activities Conducted at Each Corrective Action Site To Meet Corrective Action Investigation Plan Requirements for CAU 309

Corrective Action Investigation Activities	Corrective Action Site		
	12-06-09	12-08-02	12-28-01
Inspected and verified the CAS components identified in the Corrective Action Investigation Plan.	X	X	X
Aerial land area radiological surveys were conducted by RSL.	X	X	X
Performed site walkovers to identify biased sampling locations.	X	X	X
Performed swipe sampling for removable radioactivity using a hand-held survey instrument and/or a gamma scintillator.		X	X
Collected Decision I and II biased soil samples.	X	X	X
Field screened selected samples for VOCs using a hand-held survey instrument.	X	X	X
Field screened samples for total alpha and beta/gamma radiation using a hand-held survey instrument.	X	X	X
Analyzed samples for gamma radiation using a high-purity germanium gamma spectrometer.	X	X	X
Collected swipe samples from lead bricks and metal debris for waste characterization to support disposal recommendations and determine whether the waste could be a potential source of contamination for the environment (i.e., soil).	X	X	X
Collected required quality control samples.	X	X	X
Submitted samples for off-site laboratory analysis.	X	X	X
Collected GPS coordinates for sample locations and points of interest.	X	X	X

The investigation and sampling program was managed according to the requirements set forth in the CAU 309 CAIP (NNSA/NSO, 2004). Field activities were performed in compliance with the Industrial Sites Field Work Permit for CAU 309 that was developed According to the approved *Industrial Sites Health and Safety Plan* (SNJV, 2004) that is consistent with the DOE Integrated Safety Management System. Samples were collected and documented following approved protocols and procedures indicated in the CAU 309 CAIP. Quality control samples (e.g., field blanks, equipment rinsate blanks, trip blanks, and duplicate samples) were collected as required by the

Industrial Sites QAPP (NNSA/NV, 2002) and the CAU 309 CAIP (NNSA/NSO, 2004). 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 high temperatures), average rainfall, intermittent cloudiness, and light to strong winds. Rain suspended site operations due to lightning in the vicinity. Strong wind gusts were experienced during the investigation but did not delay site operations due to the lack of airborne debris at the site.

The CASs were investigated by using aerial and walkover radiological survey data, and sampling potential contaminant sources, surface and subsurface soils. Surface soil samples were collected by hand using disposable scoops. Shallow subsurface soil samples were collected using hand augering or other appropriate hand tool. The soil samples were field screened at specific locations for VOCs, total alpha and beta/gamma radiation, and gamma-emitting radionuclides. The results were compared against screening levels to guide in the CAS-specific investigations. Swipe samples of various media (e.g., lead bricks, metal debris) were collected to support both environmental and waste characterization. Samples were shipped to off-site laboratories to be analyzed for appropriate chemical and radiological parameters identified in the CAIP. These readings were also used to guide sampling decisions, and health and safety controls, and to meet transportation and laboratory requirements.

Except as noted in the following CAS-specific sections, CAU 309 Decision I sampling locations were accessible and sampling activities at planned locations were not restricted. Decision II step-out sample locations were accessible and remained within anticipated spatial boundaries.

Section A.2.1 through Section A.2.6 provide the investigation methodology, site geology and hydrology, and laboratory analytical information. Additional activity-specific details for the individual CASs are presented in Section A.3.0 through Section A.5.0.

A.2.1 Sample Locations

Investigation locations selected for sampling were based on interpretation of existing aerial (helicopter) and walkover radiological surveys, aerial and land photographs, interviews with former and current site employees, information obtained during site visits, and site conditions as provided in

the CAU 309 CAIP. Sampling locations for each site were selected based on the approach provided in the CAIP. The planned biased sample locations were estimated and are discussed in text and represented on figures in the CAIP. Actual environmental sample locations were biased by selecting locations and the corresponding global positioning system (GPS) coordinates obtained from computer software programs that displayed aerial photographs and radiological results from flyover surveys. Actual environmental sample locations are shown on the figures included in Section A.3.0 through Section A.5.0. Some locations initially identified were modified due to field conditions and observations but did not adversely impact the DQOs as identified in the CAIP. Step-out sampling locations below the muckpiles and extent samples in the south and east boundary of the site were collected in advance of analytical results to avoid remobilizing to the site. If sample locations were moved from the planned locations, they were surveyed with a GPS instrument at the time of collection. Sample locations and additional points of interest associated with each CAS have been plotted based on the coordinates collected by the GPS instrument and are provided in Appendix E.

A.2.2 Investigation Activities

The investigation activities performed at CAU 309 were based on field investigation activities discussed in the CAU 309 CAIP (NNSA/NSO, 2004). The technical approach consisted of the activities listed in Table A.2-1. The investigation strategy allowed the nature and extent of contamination associated with each CAS to be established.

Due to the steep slopes and safety issues with sampling on the muckpiles, the typical approach for the investigation was modified, as set forth in the CAIP, to incorporate the results of previous muckpile investigations in lieu of both sampling on the steep slopes and sampling into the underlying native soil. Therefore, the two muckpiles (CASs 12-06-09 and 12-08-02) in CAU 309 were assigned radiological and chemical contamination values (COCs) based on historical data. Therefore arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239 are considered to be COCs at the two muckpiles (CASs 12-06-09 and 12-08-02).

The following sections describe the specific investigation activities that took place at CAU 309.

A.2.2.1 Radiological Surveys

Radiological surveys (i.e., scanning, static, and swipe collection) were performed at all the CASs during the CAI. Radiological surveys were performed to identify the presence, the nature, and the extent of radiological contaminants at activities statistically greater than background. A radiological walkover survey was conducted at CASs 12-06-09 and 12-08-02 in January, 2004, using a handheld plastic scintillation detector in conjunction with a GPS receiver and datalogger. Results are discussed in the CAS-specific sections. To conduct radiological static surveys to detect total alpha and beta/gamma radiation, a handheld instrument was held within an inch over the sample for one minute. To support unrestricted release determinations per the *NV/YMP Radiological Control Manual* (DOE/NV, 2000), radiological surveys were performed at the appropriate CASs using an NE Technology Electra with dual-alpha and beta/gamma radiation scintillation probe. Swipe samples were also collected for identification of removable contamination on lead bricks, metal and wood debris, personal protective equipment (PPE), and sampling equipment. The swipe samples collected did not show removable contamination above regulatory limits.

A.2.2.2 Site Flyover Radiological Survey

A low-altitude, aerial radiological survey was conducted for the NNSA/NSO by the RSL. The survey was performed in late 2004 and early 2005 using a helicopter and covering all the CASs within CAU 309. The flight was conducted at an altitude of approximately 50 ft. Results of the helicopter survey were used to select biased soil sampling locations and identify the extent of the radiological contamination within the survey area. The analytical results of the soil samples showed a good correlation with the data from the helicopter survey and supported the delineation of the surficial contamination (Figure A.3-1).

A.2.2.3 Radiological Extent Maps

Aerial radiological survey data was obtained from the Bechtel Nevada RSL. The obtained aerial data sets contained gamma count per second data for Cs-137 and Am-241. The data was collected per RSL procedures and provided to SNJV in a spreadsheet. The RSL aerial data was reviewed and surface soil sample locations were identified based on the review. The surface soil sample locations were chosen based on the RSL contour delineations. Sample locations were chosen such that sufficient data would be collected to correlate each aerial contour to a surface soil sample. Surface

soil sampling data was correlated initially with the RSL aerial data for the isotopes that are easy to detect (e.g., Cs-137 and Am-241). The Cs-137 and Am-241 CAI surface data correlated well with RSL aerial data. The correlated data sets were then graphically displayed using a krigging interpolation algorithm in the ArcMap environment. The remaining isotopes identified during the CAI were then correlated to their respective surrogate (e.g., Am-241 is the surrogate for Pu isotopes and Cs-137 is the surrogate for gamma and beta emitting isotopes) and graphically displayed using the same krigging algorithm. The graphical maps delineating the extent of the surficial contamination are shown in Figures A.2-1 through A.2-4.

The Cs-137 map correlated extremely well with the RSL aerial data and represents the areas of radiological surface contamination at or in excess of the Cs-137 PAL of 12.2 pCi/g.

The Pu-239 map was generated off of the Am-241 data set. The reasoning for this is that Am-241 is detected easily due to it's 59.5 kev photon emission. The RSL detector system only detects photons. The CAI collected data was used to establish the Am-241 to Pu-239 ratio. This ratio was then used to generate the Pu-239 map. As can be seen by the map the only region exceeding the Pu-239 FAL of 968 pCi/g is the contaminated waste dump. The Pu-239 PAL map is not presented since the RSL aerial data detection limit for Am-241 is relatively high. If the correlated Pu-239 map were to be displayed against the PAL the entire area would be highlighted. This is not a true representation of the area and is an artifact of the correlation and detection limit.

The Am-241 map correlated well with the RSL aerial data. There is a lot of noise (blue areas on the map). This noise is due to the Am-241 12.7 pCi/g PAL is at or below the detection limit of the RSL aerial system.

Instead of providing isotope specific maps a sum of fractions map was generated based on the FAL for each isotope of concern identified during the CAI. The calculation is the sum of the ratios of the isotope specific values to the corresponding isotope specific FAL. Contours have been generated at cutoff values of .25, .5, 1.0, 1.19, and 1.5. The areas of concern are the areas that encompass the 1.0 contour value. These areas represent the sum of fractions calculation in which all of the CAI identified isotopes would generate a condition of equal to or greater than unity. This is a very conservative calculation and is the map of interest in determining the extent of surficial radiological contamination and use restrictions.

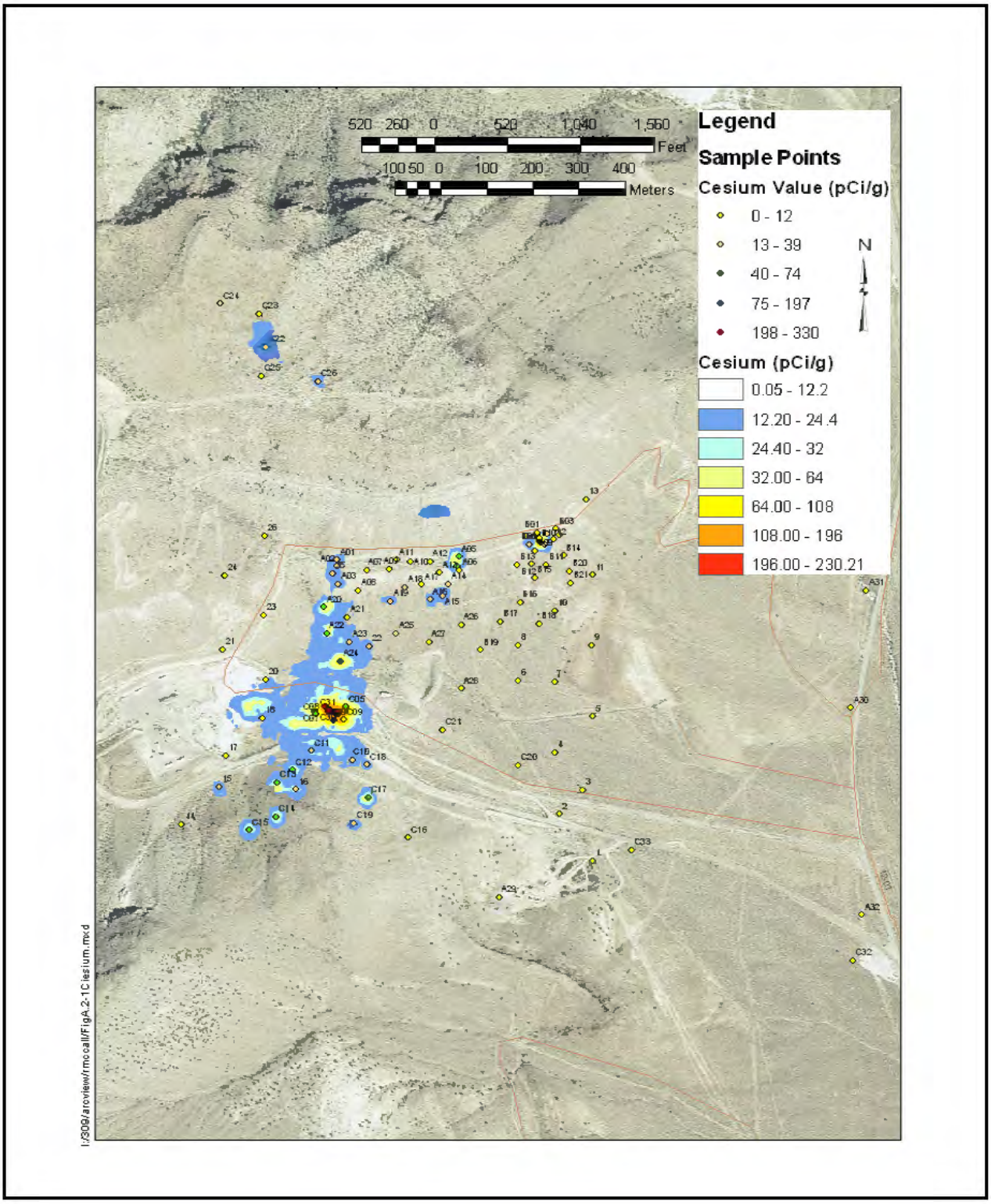

Figure A.2-1
Cesium-137 Map for CAU 309

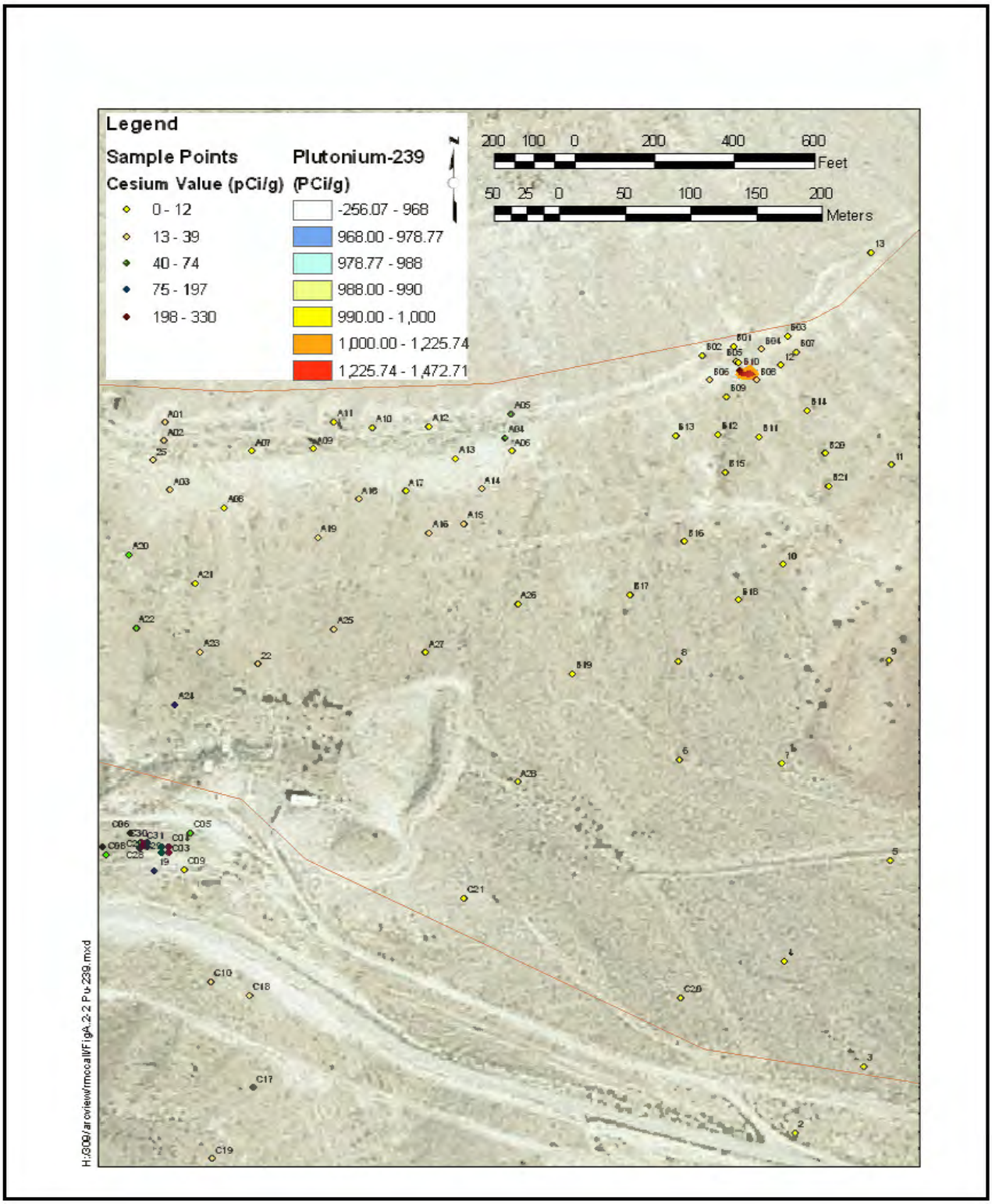

Figure A.2-2
Plutonium-239 Map for CAU 309

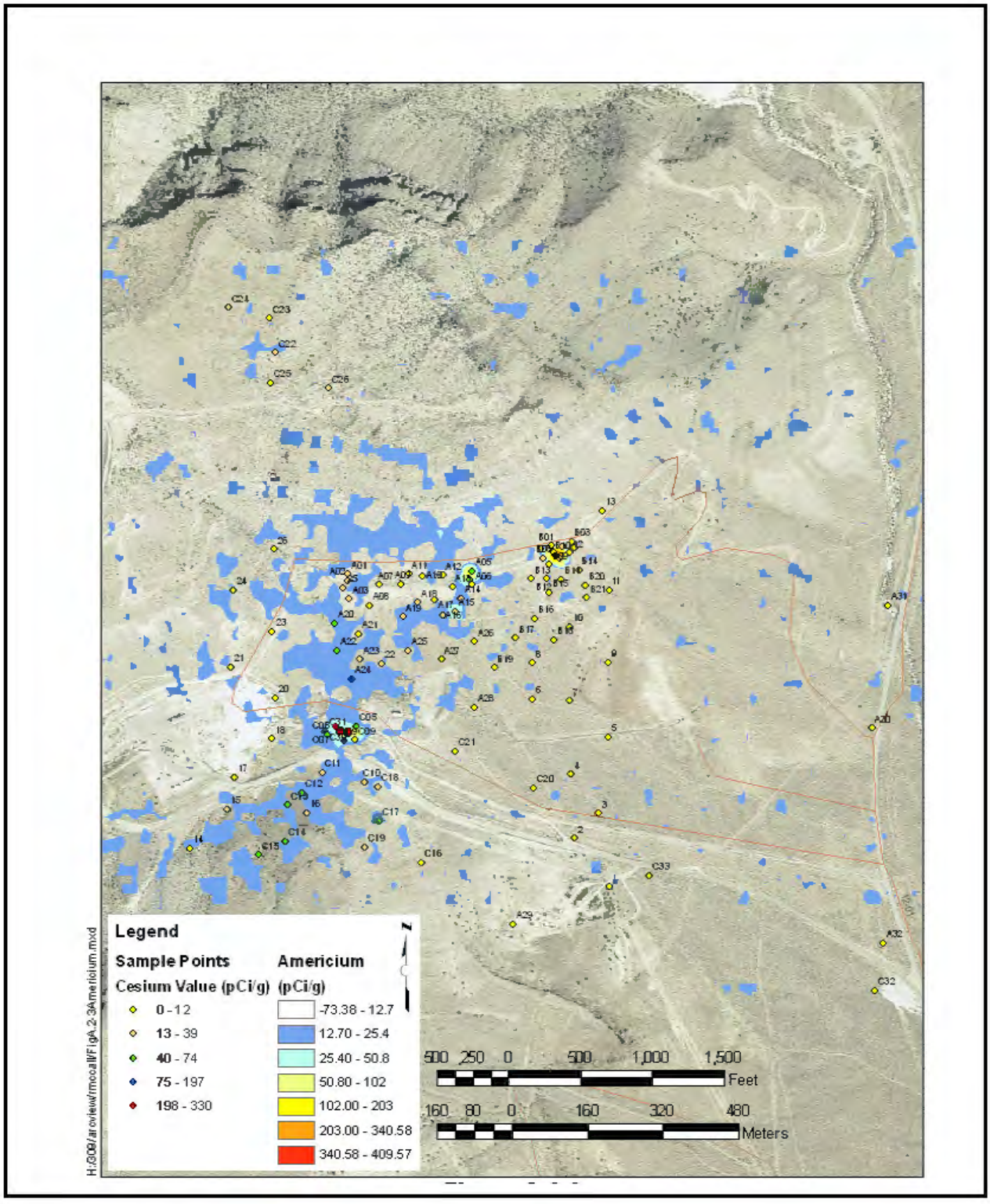

Figure A.2-3
Americium-241 Map for CAU 309

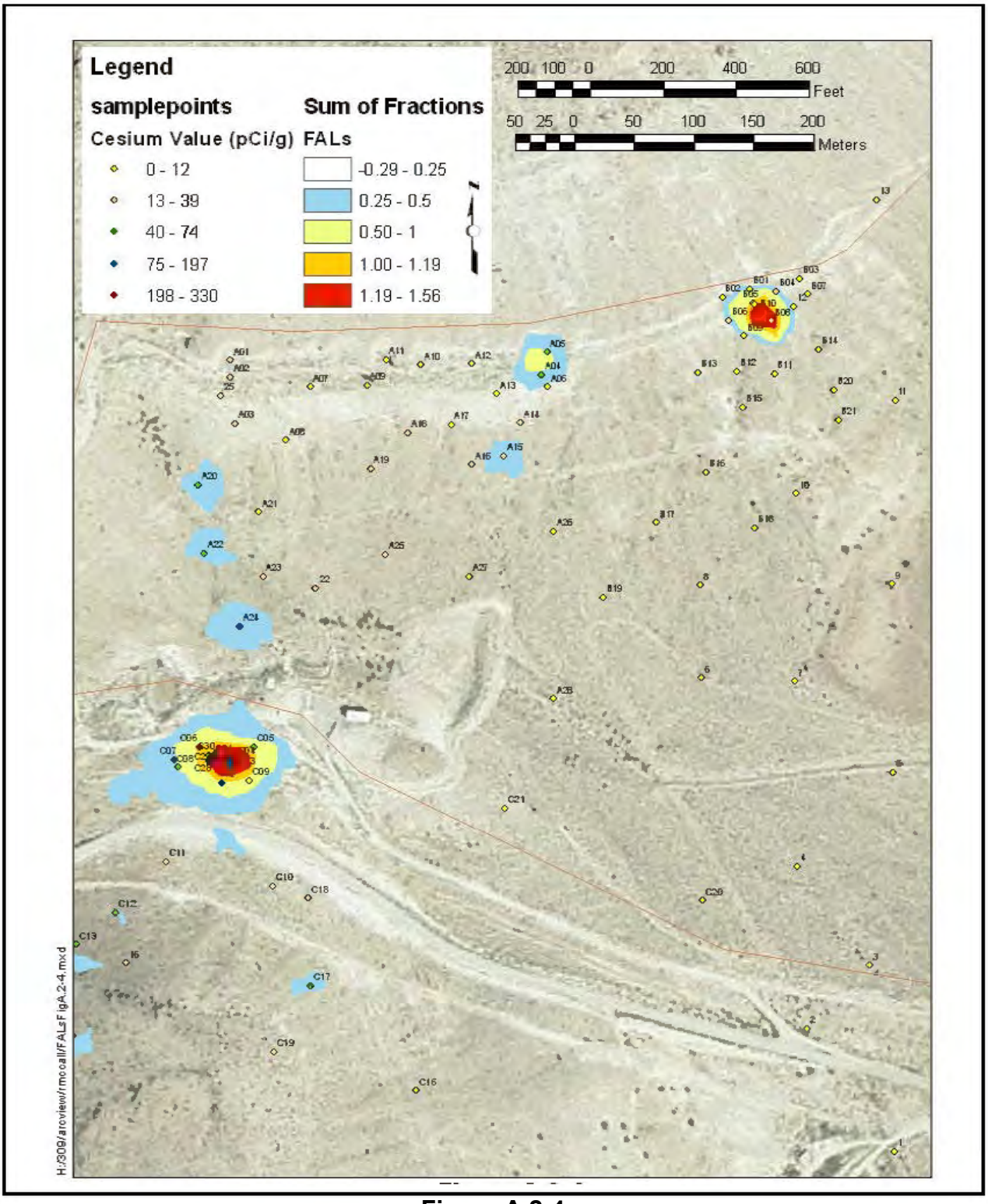

Figure A.2-4
Sum of Fractions Map for CAU 309

A.2.2.4 Field Screening

Field-screening activities for VOCs, total alpha and beta/gamma radiation, and gamma-emitting radionuclides were performed during the CAI. The FSL for VOC headspace was established at 20 ppm or 2.5 times background, whichever was greater. The TPH screening was not performed due to the lack of biasing factors to indicate TPH presence. Site-specific FSLs for total 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.

All field screening for VOCs was conducted using an flame-ionization detection (FID). The VOC field screening was conducted at all CASs. Total alpha and beta/gamma radiation screening was performed at each CAS using an NE Technology Electra or E-600 fitted with a DP6 dual-alpha and beta/gamma radiation scintillation probe. Field screening for gamma radiation at all the CASs was conducted using a high-purity germanium gamma spectrometer located in Building 23-153 in Mercury, Nevada.

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 sample locations. Field-screening results are recorded on SCLs and retained in the project files.

A.2.2.5 Surface and Subsurface Soil Sampling

Soil samples were collected using disposable scoops (surface hand-grab sampling) and hand auger (shallow subsurface). Field screening was conducted during sample collection at selected locations and after sample collections at all locations to both guide the investigation and serve as a health and safety control to protect the sampling team. Labeled sample containers were filled according to the following sequence: total VOCs sample containers were filled with soil directly from the sample location, followed by the collection of soil for VOC field screening using headspace analysis. Additional soil was placed into a plastic bag then transported to the sampling table and placed in a stainless-steel bowl, homogenized, and field screened for total alpha and beta/gamma radiation. Sample containers for the analysis of gamma radiation and TPH-DRO were then filled from the homogenized soil, and all remaining sample containers were also filled. Excess soil was returned to

its original location and the intermediate sample containers (e.g., plastic bags) appropriately disposed (based on field-screening and/or analytical results).

Surface soil samples were collected from 0.0 to 0.5 ft bgs at biased locations focusing on results of the helicopter radiological survey, stained soil, and aboveground features (i.e., metal debris). Subsurface soil samples were collected as a continuation at surface soil sample locations at selected locations. Subsurface soil samples were collected from depths ranging from 0.75 to 4 ft bgs.

A.2.2.6 Waste Characterization Sampling

Characterization of CAS-specific components, objects, materials, and waste was performed to support recommendations for disposal of these items during anticipated closure activities and to determine whether the waste in question at these CASs could be acting as a source of potential soil contamination. Investigation methods included visual inspection, radiological surveys, and direct swipe sampling of the metal debris. Waste characterization activities were intended to gather adequate information and data about the CAS to support decisions regarding the disposal of materials located within each CAS.

Samples were analyzed according to the procedures specified in the CAU 309 CAIP. The specific analyses for each CAS are listed in CAS-specific sections, and the analytical results are compared to the federal limits for hazardous waste, NDEP hydrocarbon action limit, landfill acceptance criteria, and the limits in the NTS performance objective criteria (POC) (BN, 1995). The POC limits have been established for NTS hazardous waste generators to ensure that all hazardous waste being shipped off-site contains no "added radioactivity."

Specific waste characterization sampling and analysis was conducted on potential waste streams as follows:

- Swipe samples collected from metal debris at CASs 12-06-02 and 12-28-01.
- Swipe samples collected from lead bricks at CAS 12-08-02.

A.2.2.7 Sample Location Documentation

A Trimble Pathfinder ProXRSTM GPS instrument was used for navigating to the pre-determined sample locations and for determining the sample location coordinates that were moved in the field

due to biasing factors and for CAS points of interest. Appendix E presents this data in a tabular format.

A.2.3 Laboratory Analytical Information

Radiological and chemical analyses were performed by Paragon Analytics, Inc., of Fort Collins, Colorado. The analytical suites and laboratory analytical methods used to analyze investigation samples are listed in Table A.2-2. Organic and inorganic analytical results are reported in this appendix if they were detected above the minimum detectable concentrations (MDCs) established in Table 3-2 of the CAU 309 CAIP (NNSA/NSO, 2004). Radionuclide analytical results are reported in this appendix if they are detected at or above MDCs established in Table 3-3 of the CAIP. The complete laboratory data packages are available in the project files.

Validated analytical data for CAU 309 investigation samples have been compiled and evaluated to confirm the presence of contamination and define the extent of contamination, if present. The analytical results for each CAS are presented in Section A.3.0 through Section A.5.0.

The analytical parameters are CAS-specific and were selected through the application of site process knowledge according to the EPA's *Guidance for the Data Quality Objectives Process* (EPA, 1994). Samples collected during step-out sampling were only analyzed for the COPCs that exceeded FALs in the original samples. Soil samples for the analysis of geotechnical and hydrological properties were collected at locations representative of these properties for each CAS. Bioassessment soil samples were not collected because FSRs and observations did not indicate the need for bioremediation.

A.2.4 Comparison to Action Levels

Analytical results from the soil samples with concentrations exceeding MDCs are summarized in (Section A.3.0 through Section A.5.0). An evaluation was conducted on all constituents detected above MDCs by comparing individual concentration or activity results against the PAL established in the CAIP. If the constituent concentrations were below their respective PALs, then the PALs were established as the corresponding FALs for supporting the Decisions I and II. If the reported concentrations exceeded the respective PALs, a Tier 2 evaluation was conducted to identify the FALs. This process is detailed in Appendix C.

Table A.2-2
Laboratory Analytical Parameters and Methods, CAU 309 Investigation Samples[a]

Analytical Parameter	Analytical Method
Total volatile organic compounds	Water and Soil - SW-846 8260B[b]
Total semivolatile organic compounds	Water and Soil - SW-846 8270C[b]
Total petroleum hydrocarbons (diesel-range organics)	Water and Soil - SW-846 8015B (modified)[b]
Total RCRA metals[c], plus beryllium	Water - SW-846 6010B[b], 7470A[b] Soil - SW-846 6010B[b], 7471A[b]
Total polychlorinated biphenyls	Water and Soil - SW-846 8082[b]
Gamma spectroscopy	Water and Soil - PAI 713R8[d] and 739R8[d]
Isotopic Uranium	Water and Soil - PAI 714R8[e], 721R10[e], 773R8[e], 778R8[e], and 776R8[e]
Isotopic Plutonium	Water and Soil - PAI 714R8[f], 721R10[f], 773R8[f], 778R8[f], and 776R8[f]
Isotopic Americium	Water and Soil - PAI 714R8[f], 721R10[f], 773R8[f], 778R8[f], and 776R8[f]
Strontium-90	Water and Solid - PAI 724R8[g] and 707R7[g]

[a]Investigation samples include both environmental and waste characterization samples and associated quality control samples.
[b]U.S. Environmental Protection Agency (EPA) *Test Methods for Evaluating Solid Waste*, *Physical/Chemical Methods*, 3rd Edition, Parts 1-4, SW-846 CD ROM (EPA, 1996).
[c]Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver
[d]PAI Standard Operating Procedures (SOP) (PAI, 1999-2003) are a variant of and incorporate all the intentions of EPA Procedure 901.1 and DOE/Environmental Measurements Laboratory Procedure 4.5.2.3.
[e]PAI SOPs (PAI, 1999-2003) are principally similar to the DOE/Environmental Measurements Laboratory Procedure U-2.
[f]PAI SOPs (PAI, 1999-2003) are principally similar to the DOE/EML Procedures Pu-02 for soil and Pu-10 for water.
[g]PAI SOPs (PAI, 1999-2003) are principally similar to DOE/EML Procedure Sr-02 for soil and similar to EPA Procedure 905.0 for water.
[h]PAI SOPs (PAI, 1999-2003) are principally similar to EPA Procedure 900.0.
[i]PAI SOPs (PAI, 1999-2003) are similar to EPA Procedure 906.0.

NIOSH = National Institute of Occupational Safety and Health
PAI = Paragon Analytics, Incorporated
RCRA = *Resource Conservation and Recovery Act*
TCLP = Toxicity Characteristic Leaching Procedure

Chemicals and radionuclides detected in samples at concentrations greater than FALs are identified as COCs. If COCs are present, corrective actions must be considered for the CAS. The FALs for the CAU 309 investigation are defined for each CAS in Section 2.3.1. Results that are equal to or greater than FALs are identified by bold text in the CAS-specific results tables (Sections A.3.0 through A.5.0).

A.2.5 Geology

Regional native surface soil consists of poorly graded, moderately consolidated, alluvial silty sands with gravel, and some cobble-sized volcanic detritus. Subsurface soil ranged from gravelly sands with fines to well-graded sands of volcanic detritus. The percentage of organic matter in the soil is low and decreases with depth beyond the native soil interface.

A general field description for each sample was recorded on SCLs. A more detailed description of the regional geology for Area 12 of the NTS is provided in the CAU 309 CAIP (NNSA/NSO, 2004).

A.2.6 Hydrology

The CAU 309 CASs are located on a south facing slope along the eastern side of the Rainier Mesa within Area 12 of the NTS. The steep terrain of CAU 309 would result in overland flow being the preferential migration pathway instead of vertical infiltration from precipitation events. Two dry washes that join downslope from the CASs provide channels that collect surface runoff from the three muckpiles. All stream flow is ephemeral, occurring only during precipitation events. Surface topography at the CAU 309 CASs ranges from gently to moderately sloping to very steep cliff faces on the mesa. No saturated zones (e.g., perched water, contaminant saturation) were found in the subsurface adjacent to or below the CASs, nor were saturated intervals identified during sampling activities. Due to the depth to groundwater and climatic conditions, groundwater at CAU 309 is not expected to have been impacted by COPCs.

Rainier Mesa serves as part of a drainage divide that separates westerly surface drainage to the Fortymile Canyon from the easterly surface drainage to Yucca Flat (DRI, 1987). Drainage from CAU 309 is towards the southeast into Yucca Flat. Within the subsurface, the regional zone of saturation occurs in the Paleozoic strata several thousand feet beneath the surface. At Rainier Mesa, perched water occurs only within the tuff aquitard, the top of which occurs at about 6,600 ft above mean sea level (amsl). The perched water table that exists in fractures within the aquitard occurs between 6,033 and 6,184 ft amsl in the east-central portion of Rainier Mesa. In some tunnels, perched water was found in poorly connected fractures. No water was found in the I-, J-, and K-Tunnels. The water table within the underlying lower carbonate aquifer exists at about 2,000 ft below the perched water table (Winograd and Thordarson, 1975). Groundwater beneath Rainier

Mesa may flow westward or southward within the Alkali Flat-Furnace Creek Ranch subbasin, or some part may flow eastward (USGS, 1996).

Well ER-12-1 is located near the base of the eastern slope of Rainier Mesa, alongside the U-12e Tunnel access road at the base of Dolomite Hill in Area 12, approximately 2.5 mi west of CAU 309. Well ER-12-1 is at 5,817 ft amsl and was drilled to a depth of 3,588 ft in 1991. The purpose of Well ER-12-1 was to determine the hydrogeology of Paleozoic carbonate rocks and the Eleana Formation (a regional aquitard in an area potentially down gradient from underground nuclear testing). Since 1997, Well ER-12-1 has been used as a monitoring well for the E-Tunnel evaporation ponds. Only the uppermost sleeve (1,757 ft) within ER-12-1 is open and accessing formational groundwater for the purposes of sampling (DRI, 1996). Groundwater in Well ER-12-1 was measured in September 2003 at 1,526.41 ft bgs (USGS and DOE, 2003).

Precipitation rates for this region (i.e., Rainier Mesa to Yucca Flat) averages from 6 to 12 inches (in.) as indicated on isohyetal maps (USGS, 1965). Precipitation deposited on Rainier Mesa either infiltrates into soil and rock, runs off in gullies and washes, or is lost to evapotranspiration. Precipitation that infiltrates into the overlying soil and exposed rock percolates through unsaturated rock material, locally recharging the groundwater system (USGS, 1996). Recharge on top of the Mesa is estimated at 140-acre feet per year based on a proportional percentage of precipitation. It should be noted that distribution, rate, and quantity of recharge are only estimates (USGS, 1996).

Potential evapotranspiration at the NTS is significantly greater than precipitation, thus limiting vertical migration of contaminants. The potential annual evaporation is the dominant factor influencing the movement of water in the upper saturated zone. Therefore, recharge to groundwater from precipitation is not significant at the NTS and does not provide a significant mechanism for migration of contaminants to groundwater.

A.3.0 CAS 12-06-09, Muckpile

Corrective Action Site 12-06-09 consists of a muckpile and debris located on the hillside in front of the I-, J-, and K-Tunnels on the eastern slopes of Rainier Mesa in Area 12. The muckpile includes mining debris (muck) and debris generated during the excavation, construction, and operation of the three tunnels. The muckpile also includes re-entry mining debris produced during nuclear tests which likely includes radioactive contaminated muck. Debris on the muckpile consists of scattered wood, twisted and rusted metal, cables, railroad tracks, and pipes. The top of the muckpile is surrounded by a two-strand yellow rope fence, which is posted with "Underground Radioactive Material" signs. The areas around the portals and additional structures are fenced with three-strand yellow-rope fences and posted with "Caution Contamination Area" signs. Debris within these posted areas is also included in the scope of CAS 12-06-09 and consist of wood, beams, twisted and rusted metal, cables, wooden pallets, wooden tunnel supports, and metal pipes. Additional detail is provided in the CAIP.

A.3.1 Corrective Action Investigation

A total of 42 environmental samples [including 3 FDs] were collected during investigation activities at CAS 12-06-09. The sample identifications (IDs), locations, types, and analyses are listed in Table A.3-1 and Figure A.3-1. The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following sections.

A.3.1.1 Field Screening

Investigation samples were field screened for VOCs, total alpha and beta/gamma radiation, and gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. The VOC headspace FSRs were not exceeded in samples collected at this CAS. Gross alpha and/or total beta/gamma radiation FSLs were exceeded in 31 samples. Samples were also analyzed for gamma radiation via the gamma spectrometer in Building 153. Gamma spectroscopy results were compared to the FSLs. Eight samples had FSRs exceeding the FSLs. The field screening results showed consistency with the results of the RSL flyover survey.

Table A.3-1
Samples Collected at 12-06-09, Muckpile
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
A01	309A039	0 - 0.5	Soil	Environmental	Set 1
	309A040	1.5 - 2	Soil	Environmental	Set 1
A02	309A041	0 - 0.5	Soil	Environmental	Set 1
A03	309A042	0 - 0.5	Soil	Environmental	Set 1
A04	309A032	0 - 0.5	Soil	Environmental	Set 1
	309A033	1.5 - 2	Soil	Environmental	Set 1
A05	309A034	0 - 0.5	Soil	Environmental	Set 1
A06	309A031	0 - 0.5	Soil	Environmental	Set 1
A07	309A025	0 - 0.5	Soil	Environmental	Set 1
	309A026	3 - 4	Soil	Environmental	Set 1
A08	309A019	0 - 0.5	Soil	Environmental	Set 1
A09	309A022	0 - 0.5	Soil	Environmental, MS/MSD	Set 1
	309A023	0 - 0.5	Soil	Field Duplicate of #309A022	Set 1
	309A024	2.5 - 3	Soil	Environmental	Set 1
A10	309A035	0 - 0.5	Soil	Environmental	Set 1
	309A036	1.5 - 2	Soil	Environmental	Set 1
A11	309A037	0 - 0.5	Soil	Environmental, MS/MSD	Set 1
	309A038	0 - 0.5	Soil	Field Duplicate of #309A037	Set 1
A12	309A027	0 - 0.5	Soil	Environmental	Set 1
	309A028	1.5 - 2	Soil	Environmental	Set 1
A13	309A029	0 - 0.5	Soil	Environmental	Set 1
	309A030	1.5 - 2	Soil	Environmental	Set 1
A14	309A013	0 - 0.5	Soil	Environmental	Set 1
A15	309A016	0 - 0.5	Soil	Environmental	Set 1
A16	309A017	0 - 0.5	Soil	Environmental	Set 1
A17	309A014	0 - 0.5	Soil	Environmental	Set 1
A18	309A015	0 - 0.5	Soil	Environmental	Set 1
A19	309A018	0 - 0.5	Soil	Environmental	Set 1
A20	309A020	0 - 0.5	Soil	Environmental	Set 1
A21	309A021	0 - 0.5	Soil	Environmental	Set 1
A22	309A010	0 - 0.5	Soil	Environmental	Set 1
A23	309A012	0 - 0.5	Soil	Environmental	Set 1
A24	309A011	0 - 0.5	Soil	Environmental	Set 1

Table A.3-1
Samples Collected at 12-06-09, Muckpile
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
A25	309A009	0 - 0.5	Soil	Environmental	Set 1
A26	309A007	0 - 0.5	Soil	Environmental	Set 1
A27	309A008	0 - 0.5	Soil	Environmental	Set 1
A28	309A006	0 - 0.5	Soil	Environmental	Set 1
A29	309A001	0 - 0.5	Soil	Environmental	Set 1
A30	309A002	0 - 0.5	Soil	Environmental, MS/MSD	Set 1
	309A003	0 - 0.5	Soil	Field Duplicate of #309A002	Set 1
A31	309A004	0 - 0.5	Soil	Environmental	Set 1
A32	309A005	0 - 0.5	Soil	Environmental	Set 1
NA	309A300	NA	Water	Trip Blank	Total VOCs
NA	309A301	NA	Water	Trip Blank	Total VOCs
NA	309A302	NA	Water	Trip Blank	Total VOCs
NA	309A304	NA	Water	Field Blank	Set 1, (except Be)
NA	309A305	NA	Water	Trip Blank	Total VOCs
NA	309A306	NA	Water	Source Blank	Set 1, (except Be)
NA	309A307	NA	Water	Trip Blank	Total VOCs
NA	309A308	NA	Water	Trip Blank	Total VOCs
NA	309A309	NA	Water	Equipment Rinsate	Set 1, (except Be)
NA	309A310	NA	Water	Trip Blank	Total VOCs
NA	309A311	NA	Water	Trip Blank	Total VOCs

Set 1 = Total VOCs, Total SVOCs, PCBs, TPH-DRO, RCRA Metals, Be, isotopic americium, isotopic Pu, isotopic U, Sr-90, gamma spectroscopy

ft bgs = Feet below ground surface
Be = Beryllium
MS/MSD = Matrix spike/matrix spike duplicate
NA = Not applicable
PCB = Polychlorinated biphenyl
RCRA - *Resource Conservation and Recovery Act*
SVOC = Semivolatile organic compound
TPH-DRO = Total petroleum hydrocarbons, diesel-range organics
VOC = Volatile organic compounds

A.3.1.2 Radiological Surveys

A radiological walkover survey was performed on January 21, 2004, at the CAS 12-06-09 muckpile and surrounding areas in front of K-Tunnel down to the CWD (CAS 12-08-02). The document entitled, *Preliminary Assessments Radiological Survey 2004* (Alderson, 2004), identifies results of a radiological survey conducted at various CASs on the NTS in January 2004. The objective of the radiological survey was to determine if radiological contamination is present in surficial soil at concentrations statistically greater than surficial soil from undisturbed background locations. The area surveyed covered 20,781 square feet (0.47 acres). The maximum gamma radiation emission rate was 8,492 cps, which is approximately 26.5 times greater than the mean undisturbed background gamma radiation emission rate. The most elevated gamma emission rates in the survey area were seen at the CWD in the northeast corner of the survey area in front of K-Tunnel re-entry, inside a posted contamination area.

A low-altitude, aerial radiological survey was conducted for the NNSA/NSO by the RSL. Refer to Section A.2.2.2 for further discussion regarding the flyover survey.

There were no swipe surveys performed on debris at CAS 12-06-09, except during the sampling process where swipes were collected from the sample table to see if removable contamination was present. No removable contamination was detected above release limits.

A.3.1.3 Visual Inspections

Prior to intrusive activities, the site was visually inspected and photo documented. The visual inspection focused on biasing factors such as staining or ditches and drainages off the muckpile that could provide a preferential pathway for the transport of contaminants. The visual inspection resulted in several sampling locations being relocated to better represent the potential contamination. The observations and changes were made as follows:

- Location A01 was moved so that the lowest area of the contamination area just outside the J-Tunnel portal could be sampled.
- Location A04 was moved to the front of the K-Tunnel portal within the contamination area posting.

- Location A11 was moved inside the contamination area to sample the soil beneath the effluent pipe discharge from the corregated above ground tank. The tank was observed to be empty and photographs were taken to document this observation.

- Location A23 was moved to the center of a drainage ditch.

- Location A29 was added to the sampling locations to capture any potential contaminant pathway from drainage of the hillside across the valley and adjacent to the J-Tunnel blowout.

- Locations A30 and A32 were selected within ditches to capture any potential contaminants that may have been migrating from the CAU 309 CASs or the T-Tunnel CAU.

- Location A31 was selected within the main wash of P-Tunnel.

A.3.1.4 Sample Collection

Forty-two environmental samples including three FDs were collected from thirty-two locations on and around the muckpiles.

Decision I and Decision II environmental sampling activities included the collection of biased surface and subsurface soil and muck samples on and surrounding the muckpiles (Figure A.3-1) below the base of the muckpiles, and locations at the southeast boundary of the CAU footprint.

Environmental samples were collected from the soil and muck at the muckpile from the surface interval from 0 to 0.5 ft bgs. According to the CAIP, at seven of these locations subsurface samples were collected at depths ranging from 1.5 to 4.0 ft bgs. A soil sample was collected directly below the effluent of the pipe beneath the effluent pipe discharge from the corrugated above-ground tank. The tank was observed to be void of sampling material and photographs were taken to document this observation.

Samples were not collected at this CAS for the purpose of waste characterization and disposal determination.

Investigation samples were collected as outlined in the CAU 309 CAIP (NNSA/NSO, 2004) and submitted for laboratory analysis.

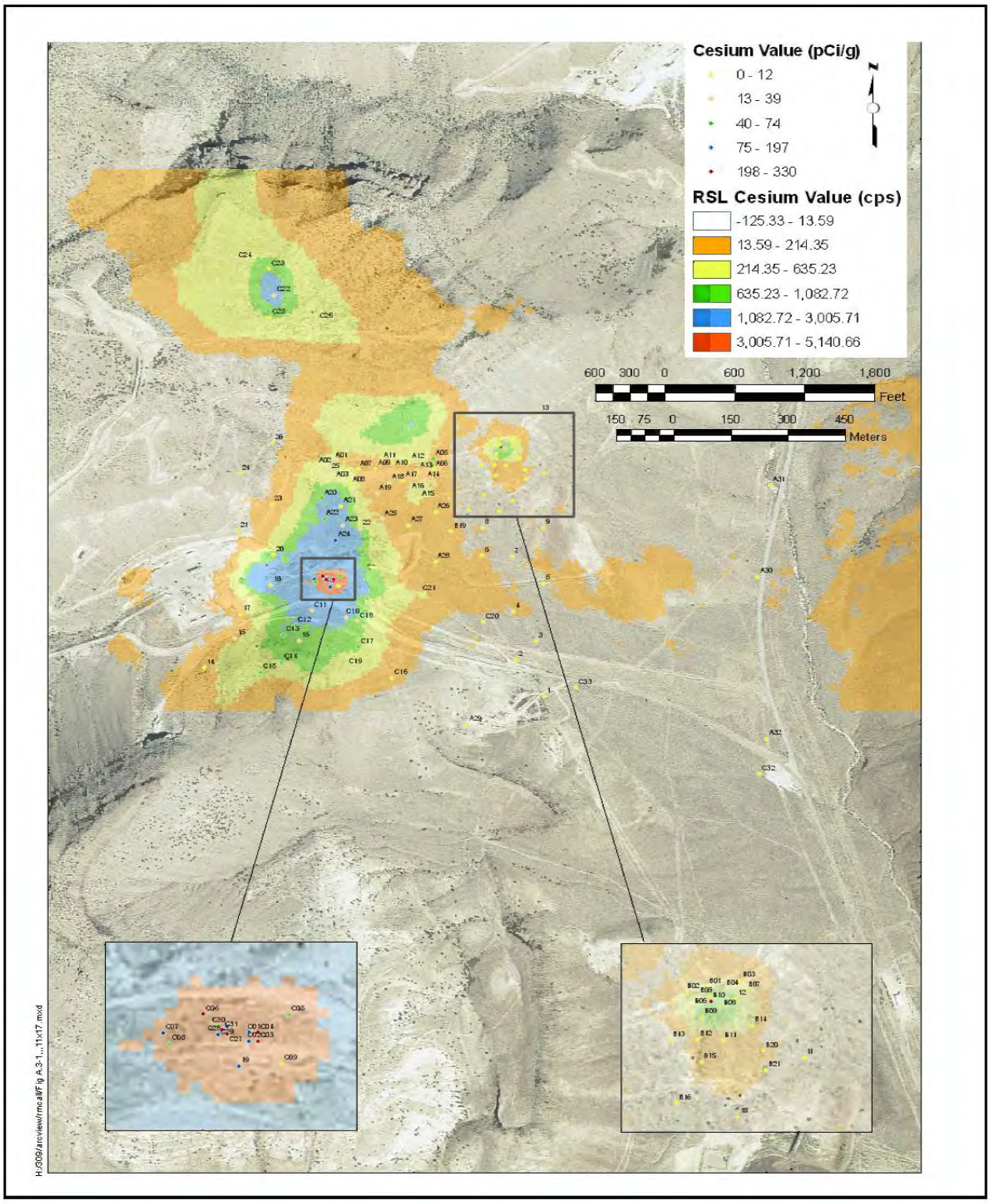

Figure A.3-1
Sample Locations and RSL Helicopter Survey for CAU 309

A.3.1.5 Deviations

There were no significant deviations from the CAIP requirements at this CAS. The investigation and sampling at CAS 12-06-09 is considered sufficient to meet the DQOs.

The requirements listed in the CAIP for this CAS have been met and no revisions to the CSM were necessary.

A.3.2 Investigation Results

The following sections provide analytical results from the samples collected to complete investigation activities as outlined in the CAIP. Investigation samples were analyzed for the CAIP-specified COPCs, which included total VOCs, total semivolatile organic compounds (SVOCs), TPH-DRO, total RCRA metals, gamma-emitting radionuclides, isotopic uranium (U), isotopic Pu, isotopic americium and strontium (Sr)-90. Beryllium and polychlorinated biphenyls (PCBs) are added parameters, because these contaminants are a common concern at the NTS. The analytical parameters and laboratory methods used to analyze the investigation samples are listed in Table A.2-2. Table A.3-1 lists the sample-specific analytical suite for CAS 12-06-09.

A.3.2.1 Total Volatile Organic Compounds

Total VOCs analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.3-2. No VOCs were detected at concentrations exceeding their respective FALs.

A.3.2.2 Total Semivolatile Organic Compounds

Total SVOCs analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.3-3. No SVOCs were detected at concentrations exceeding the respective FALs.

A.3.2.3 Total Petroleum Hydrocarbons

The TPH-DRO analytical results for soil samples collected at this CAS that were detected above MDCs are presented in Table A.3-4. One surface sample 309A019 at location A08 exceeded the PAL of 100 mg/kg for TPH-DRO. The TPH-DRO was not moved on to a Tier 2 evaluation, because

Table A.3-2
Soil Sample Results for Total VOCs Detected Above Minimum Reporting Limits at CAS 12-06-09, Muckpile

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (µg/kg)			
			2-Butanone	Methylene Chloride	P-Isopropyltoluene	Styrene
Final Action Levels[a]			27,000,000	21,000	2,000,000	1,700,000
A02	309A041	0 - 0.5	--	--	17	1 (J)
A08	309A019	0 - 0.5	6.4 (J)[b]	--	--	--
A23	309A012	0 - 0.5	--	2.6 (J)	--	--
A29	309A001	0 - 0.5	--	--	--	1.5 (J)

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2002).
[b]Qualifier added to laboratory data; record accepted. Improper preservation/pH or not documented.

ft bgs = Feet below ground surface
J = Estimated value
-- = Not detected above minimum reporting limits
µg/kg = Micrograms per kilogram

it is assumed to be present based on previous muckpile investigations. Therefore, TPH-DRO is considered a COC.

A.3.2.4 Total RCRA Metals and Beryllium

Total RCRA metals and beryllium analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.3-5. No metals were detected at concentrations exceeding their FALs

A.3.2.5 Polychlorinated Biphenyls

Total PCB analytical results for soil samples collected at CAS 12-06-09 did not exceed the MDCs.

Table A.3-3
Soil Sample Results for Total SVOCs Detected Above Minimum Reporting Limits at CAS 12-06-09, Muckpile

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (μg/kg)						
			Benzo(a)Anthracene	Benzo(b)Fluoranthene	Benzoic Acid	Bis(2-Ethylhexyl)Phthalate	Diethyl Phthalate	Fluoranthene	Pyrene
Final Action Levels[a]			2,100	2,100	100,000,000	120,000	100,000,000	22,000,000	29,000,000
A01	309A039	0 - 0.5	--	--	--	--	30 (J)	--	--
A08	309A019RR1	0 - 0.5	230 (J)[b]	--	--	--	--	--	490 (J)[b]
A10	309A035	0 - 0.5	--	30 (J)	--	--	--	27 (J)	24 (J)
A15	309A016	0 - 0.5	--	--	--	36 (J)[c]	--	--	--
A17	309A014	0 - 0.5	--	--	--	85 (J)[b]	--	--	--
A18	309A015	0 - 0.5	--	--	--	63 (J)[b]	--	--	--
A19	309A018	0 - 0.5	--	--	1,500 (J)[c]	140 (J)[b]	90 (J)[c]	--	--
A20	309A020	0 - 0.5	--	--	--	25 (J)[b]	--	--	--
A21	309A021	0 - 0.5	--	--	--	53 (J)[d]	--	--	--
A28	309A006	0 - 0.5	--	--	--	32 (J)	--	--	--
A30	309A003	0 - 0.5	--	--	--	57 (J)	--	--	--
A31	309A004	0 - 0.5	--	--	--	28 (J)	--	--	--

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2002).
[b]Qualifier added to laboratory data; record accepted. Matrix effects may exist. Internal standard area count exceeds control limits. Improper preservation/pH or not documented.
[c]Qualifier added to laboratory data; record accepted. Improper preservation/pH or not documented.
[d]Qualifier added to laboratory data; record accepted. Matrix effects may exist. Improper preservation/pH or not documented. Internal area response grossly exceeds the lower limit.

ft bgs = Feet below ground surface
J = Estimated value
-- = Not detected above minimum reporting limits
μg/kg = Micrograms per kilogram

Table A.3-4
Soil Sample Results for TPH-DRO Detected Above Minimum Reporting Limits at CAS 12-06-09, Muckpile
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel Range Organics
Preliminary Action Levels[a]			**100**
A01	309A039	0 - 0.5	2.8 (J)
A03	309A042	0 - 0.5	44 (M, Z)
A04	309A032	0 - 0.5	7.9 (M)
	309A033	1.5 - 2	11 (M)
A05	309A034	0 - 0.5	14 (M)
A06	309A031	0 - 0.5	7.8 (M)
A07	309A025	0 - 0.5	3.5 (J)
	309A026	3 - 4	44 (M)
A08	309A019	0 - 0.5	**3,100** (J)[b]
A10	309A035	0 - 0.5	16 (M, Z)
A11	309A037	0 - 0.5	3.9 (J)
	309A038	0 - 0.5	4.7 (J)
A13	309A029	0 - 0.5	8.1 (M)
A14	309A013	0 - 0.5	76 (J)[b]
A15	309A016	0 - 0.5	2.2 (J)[b]
A16	309A017	0 - 0.5	7.3 (J)[b]
A17	309A014	0 - 0.5	17 (J)[b]
A18	309A015	0 - 0.5	14 (J)[b]
A19	309A018	0 - 0.5	21 (J)[b]
A20	309A020	0 - 0.5	31 (J)[b]
A21	309A021	0 - 0.5	51 (J)[b]
A22	309A010	0 - 0.5	5.6 (Z)
A23	309A012	0 - 0.5	22 (H, Z)
A24	309A011	0 - 0.5	3.4 (J)
A25	309A009	0 - 0.5	33 (H, Z)
A27	309A008	0 - 0.5	31 (H, Z)
A28	309A006	0 - 0.5	4.2 (J)
A29	309A001	0 - 0.5	9.4 (H, Z)
A30	309A002	0 - 0.5	4.8 (J)
	309A003	0 - 0.5	20 (H, Z)

Table A.3-4
Soil Sample Results for TPH-DRO Detected Above Minimum Reporting Limits at CAS 12-06-09, Muckpile
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel Range Organics
Preliminary Action Levels[a]			100
A31	309A004	0 - 0.5	16 (H, Z)
A32	309A005	0 - 0.5	4.9 (J)

[a]Based on *Nevada Administrative Code*; Contamination of soil: Establishment of action levels (NAC, 2002)
[b]Qualifier added to laboratory data; record accepted. Improper preservation/pH or not documented.

ft bgs = Feet below ground surface
H = Fuel pattern in the heavier end of retention time window
J = Estimated value
M = A pattern resembling motor oil was detected
mg/kg = Milligrams per kilogram
Z = Result did not resemble any common total petroleum hydrocarbons products.

Table A.3-5
Soil Sample Results for Metals Detected Above Minimum Reporting Limits at CAS 12-06-09, Muckpile
(Page 1 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury
Final Action Levels			23[a]	67,000[b]	1,900[b]	450[b]	450[b]	750[b]	310[b]
A01	309A039	0 - 0.5	3.1	79	1.4	--	5.3	17	0.025 (J-)[c]
	309A040	1.5 - 2	3	77	0.72	--	5.1	8.2	0.0098 (J-)[c]
A02	309A041	0 - 0.5	2	57	0.8	--	3.5	17	0.017 (J-)[c]
A03	309A042	0 - 0.5	0.96 (B)	34	--	--	2.4	13	0.0027 (J-)[c]
A04	309A032	0 - 0.5	1.8	42	0.69	--	3.5	50	0.0046 (J-)[c]
	309A033	1.5 - 2	0.96 (B)	18	--	--	--	8	--
A05	309A034	0 - 0.5	1.3	58	0.56	0.059 (J-)[c]	2.6	44	0.006 (J-)[c]
A06	309A031	0 - 0.5	0.79 (B)	21	--	--	--	7.3	--
A07	309A025	0 - 0.5	1.1	32	0.59	--	2.2	5.9	0.0048 (J-)[c]
	309A026	3 - 4	0.95 (B)	29	--	--	1.7	5.2	--
A08	309A019	0 - 0.5	1.2 (J)[d]	55 (J)[d]	0.59 (J)[d]	--	3.6 (J)[e]	6.4 (J)[d]	0.0021 (J-)[f]
A09	309A022	0 - 0.5	2.7	61	0.9	--	4.2	13	0.0091 (J-)[c]
	309A023	0 - 0.5	2.8	57	0.92	--	4.2	11	0.0097 (J-)[c]
	309A024	2.5 - 3	0.71 (B)	21	--	--	--	2.8	--

Table A.3-5
Soil Sample Results for Metals Detected Above Minimum Reporting Limits at CAS 12-06-09, Muckpile
(Page 2 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury
Final Action Levels			**23[a]**	**67,000[b]**	**1,900[b]**	**450[b]**	**450[b]**	**750[b]**	**310[b]**
A10	309A035	0 - 0.5	1.7	56	0.69	--	3.8	13	0.0078 (J-)[c]
	309A036	1.5 - 2	1.3	55	0.51 (B)	--	18	5.7	0.0052 (J-)[c]
A11	309A037	0 - 0.5	1.3	42	0.62	0.23 (J-)[c]	2.2	8.9	0.0073 (J-)[c]
	309A038	0 - 0.5	1.4	38	0.61	0.41 (J-)[c]	2.1	8.9	0.0071 (J-)[c]
A12	309A027	0 - 0.5	2	49	0.64	--	3.4	10	0.0098 (J-)[c]
	309A028	1.5 - 2	0.42 (B)	--	--	--	4.9	1.2	--
A13	309A029	0 - 0.5	1.2	27	0.54	--	2.6	12	0.0064 (J-)[c]
	309A030	1.5 - 2	2.3	41	0.81	--	3.2	7.8	0.0096 (J-)[c]
A14	309A013	0 - 0.5	2.4 (J)[d]	65 (J)[d]	0.65 (J)[d]	--	3.9 (J)[e]	10 (J)[d]	0.013 (J-)[f]
A15	309A016	0 - 0.5	2.3 (J)[d]	78 (J)[d]	0.89 (J)[d]	--	3.9 (J)[e]	14 (J)[d]	0.016 (J-)[f]
A16	309A017	0 - 0.5	3.3 (J)[d]	110 (J)[d]	0.95 (J)[d]	--	6.9 (J)[e]	18 (J)[d]	0.018 (J-)[f]
A17	309A014	0 - 0.5	2.7 (J)[d]	81 (J)[d]	0.75 (J)[d]	--	4.9 (J)[e]	20 (J)[d]	0.017 (J-)[f]
A18	309A015	0 - 0.5	2.3 (J)[d]	90 (J)[d]	0.66 (J)[d]	--	4.1 (J)[e]	13 (J)[d]	0.015 (J-)[f]
A19	309A018	0 - 0.5	3.2 (J)[d]	110 (J)[d]	0.82 (J)[d]	--	6 (J)[e]	15 (J)[d]	0.024 (J-)[f]
A20	309A020	0 - 0.5	1.3 (J)[d]	110 (J)[d]	0.59 (J)[d]	--	3 (J)[e]	40 (J)[d]	0.0067 (J-)[f]
A21	309A021	0 - 0.5	0.9 (J)[d]	40 (J)[d]	0.43 (J)[d]	--	2 (J)[e]	8.2 (J)[d]	0.0042 (J-)[f]
A22	309A010	0 - 0.5	2.9	140	0.73 (J-)[c]	0.031 (B)	4.9	38	--
A23	309A012	0 - 0.5	1.3	60	0.61	--	1.9	17	--
A24	309A011	0 - 0.5	2.7	240	0.68	--	4.2	59	--
A25	309A009	0 - 0.5	1.7	48	0.45 (J-)[c]	--	2.1	7.6	--
A26	309A007	0 - 0.5	2.7	83	0.76	--	3.1	12	--
A27	309A008	0 - 0.5	3.7	120	0.89	--	6.4	12	--
A28	309A006	0 - 0.5	2	100	0.59	--	3.1	7.9	--
A29	309A001	0 - 0.5	4.3	64	2	--	4.1	18	0.029 (J-)[c]
A30	309A002	0 - 0.5	4	120	0.65	--	5.4	13	0.027 (J-)[c]
	309A003	0 - 0.5	3.6	110	0.61	--	5.2	11	--
A31	309A004	0 - 0.5	2.7	3,800	0.82	--	5.5	9.9	0.028 (J-)[c]
A32	309A005	0 - 0.5	3.5	150	1.1	--	6.5	12	0.024 (J-)[c]

Table A.3-5
Soil Sample Results for Metals Detected Above
Minimum Reporting Limits at CAS 12-06-09, Muckpile
(Page 3 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury
Final Action Levels			23[a]	67,000[b]	1,900[b]	450[b]	450[b]	750[b]	310[b]

[a]Based on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2002)
[c]Negative bias found in continuing calibration/method blank.
[d]Qualifier added to laboratory data; record accepted. Improper preservation/pH or not documented.
[e]Qualifier added to laboratory data; record accepted. Duplicate precision analysis (relative percent difference) exceeds control limits. Improper preservation/pH or not documented.
[f]Negative bias found in continuing calibration/method blank. Improper preservation/pH or not documented.

B = Value less than the contract required detection limit, but greater than or equal to the instrument detection limit.
ft bgs = Feet below ground surface
J = Estimated value
J- = The result is an estimated quantity, but the result may be biased low.
mg/kg = Milligrams per kilogram
-- = Not detected above minimum reporting limits

A.3.2.6 Gamma-Emitting Radionuclides

Gamma-emitting radionuclides analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.3-6. All gamma-emitting radionuclide concentrations except Am-241 and Cs-137 did not exceed their respective PALs, therefore, for these radionuclides, the PALs are considered the FALs. The radionuclide Cs-137 was detected at concentrations that exceeded the PAL (12.2 pCi/g) in 15 of the 42 environmental soil samples collected from 32 locations. Americium-241 was detected at concentration exceeding the PAL (12.7 PCi/g) in 11 of the 42 environmental samples at 11 locations. The exceedances for these two radionuclides, however, were limited to only the surface soils. Cesium-137 and Am-241 were moved onto a Tier 2 evaluation in which the RESRAD code was used to determine the site-specific FALs for these radionuclides. None of the Cs-137 or Am-241 concentrations exceeded their FALs of 196.7 pCi/g and 893.6 pCi/g, respectively. The calculation of the FAL for Cs-137 and Am-241 are presented in Appendix C. Although the CAI sample results for these radionuclide were below the site-specific FALs, Cs-137 and Co-60 were retained as COCs based on the results from previous muckpile investigations.

Table A.3-6
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentrations at CAS 12-06-09, Muckpile
(Page 1 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)															
			Actinium-228[a]		Americium-241[b]	Bismuth-212[a]		Bismuth-214[a]		Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Lead-212[a]		Lead-214[a]		Thallium-208[a]	
Final Action Levels			5	15	893.6	5	15	5	15	2.7	196.7	5.7	5	15	5	15	5	15
Depth bgs (cm)			<15	>15		<15	>15	<15	>15				<15	>15	<15	>15	<15	>15
A01	309A039	0 - 0.5	2.6 (G)	NA	2.6 (G)	--	NA	1.64 (G, J)	NA	--	24.4 (G)	--	2.92 (J)[c]	NA	1.37 (G, J)	NA	1.07 (G)	NA
	309A040	1.5 - 2	NA	1.78 (G)	--	NA	--	NA	1.09 (G, J)	--	2.96 (G)	--	NA	2.14 (J)[c]	NA	1.37 (G, J)	NA	0.74 (G)
A02	309A041	0 - 0.5	2.29 (G)	NA	--	--	NA	0.97 (G, J)	NA	--	24.7 (G)	--	2.17 (J)[c]	NA	1.42 (G, J)	NA	0.68 (G)	NA
A03	309A042	0 - 0.5	2.46 (G)	NA	--	--	NA	1.35 (G, J)	NA	--	17.9 (G)	--	2.64 (J)[c]	NA	1.5 (G, J)	NA	0.87 (G)	NA
A04	309A032	0 - 0.5	2.5 (G)	NA	122 (J)[c]	--	NA	1.12 (G, J)	NA	0.6 (G)	52.4 (G)	3.37 (J)[c]	2.78 (J)[c]	NA	1.54 (G, J)	NA	0.73 (G)	NA
	309A033	1.5 - 2	NA	2.39 (G)	21.7 (J)[c]	NA	--	NA	1.47 (G, J)	--	9.6 (G)	--	NA	2.19 (J)[c]	NA	1.41 (G, J)	NA	0.9 (G)
A05	309A034	0 - 0.5	2.28 (G)	NA	154 (J)[c]	--	NA	1.66 (G, J)	NA	0.7 (G)	74.3 (G)	4 (J)[c]	2.6 (J)[c]	NA	1.32 (G, J)	NA	0.85 (G)	NA
A06	309A031	0 - 0.5	2.34 (G)	NA	10.3 (J)[c]	--	NA	1.55 (G, J)	NA	--	4.6 (G)	--	2.48 (J)[c]	NA	1.41 (G, J)	NA	0.64 (G)	NA
A07	309A025	0 - 0.5	2.21 (G)	NA	--	--	NA	1.58 (G, J)	NA	--	0.45 (LT, G)	--	2.78 (J)[c]	NA	1.48 (G, J)	NA	0.87 (G)	NA
	309A026	3 - 4	NA	2.43 (G)	--	NA	--	NA	1.48 (G, J)	--	--	--	NA	3.29 (J)[c]	NA	1.56 (G, J)	NA	0.86 (G)
A08	309A019	0 - 0.5	2.61 (G)	NA	--	--	NA	1.3 (G, J)	NA	--	0.37 (LT, G)	--	2.15 (J)[c]	NA	1.55 (G, J)	NA	0.93 (G)	NA
A09	309A022	0 - 0.5	2 (G)	NA	--	--	NA	1.2 (G, J)	NA	--	1.07 (G)	--	2.27 (J)[c]	NA	1.17 (G, J)	NA	0.66 (G)	NA
	309A023	0 - 0.5	2.29 (G)	NA	--	--	NA	1.18 (G, J)	NA	--	0.94 (G)	--	2.41 (J)[c]	NA	1.27 (G, J)	NA	0.74 (G)	NA
	309A024	2.5 - 3	NA	2.46 (G)	--	NA	--	NA	1.32 (G, J)	--	--	--	NA	2.44 (J)[c]	NA	1.49 (G, J)	NA	0.83 (G)
A10	309A035	0 - 0.5	2.44 (G)	NA	1.55 (J)[c]	--	NA	1.4 (G, J)	NA	--	2.3 (G)	--	2.98 (J)[c]	NA	1.8 (G, J)	NA	0.72 (G)	NA
	309A036	1.5 - 2	NA	2.77 (G)	--	NA	--	NA	2.2 (G, J)	--	--	--	NA	3.22 (J)[c]	NA	2.05 (G, J)	NA	1.13 (G)
A11	309A037	0 - 0.5	2.25 (G)	NA	--	--	NA	1.55 (G, J)	NA	--	6.1 (G)	--	2.99 (J)[c]	NA	1.45 (G, J)	NA	0.91 (G)	NA
	309A038	0 - 0.5	2.59 (G)	NA	--	--	NA	1.2 (G, J)	NA	--	6.84 (G)	--	2.93 (J)[c]	NA	1.63 (G, J)	NA	0.99 (G)	NA
A12	309A027	0 - 0.5	2.27 (G)	NA	--	--	NA	1.01 (G, J)	NA	--	1.02 (G)	--	2.71 (J)[c]	NA	1.32 (G, J)	NA	0.88 (G)	NA
	309A028	1.5 - 2	NA	2.9 (G)	--	NA	--	NA	1.75 (G, J)	--	--	--	NA	2.85 (J)[c]	NA	1.99 (G, J)	NA	0.82 (G)

Table A.3-6
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentrations at CAS 12-06-09, Muckpile
(Page 2 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)															
			Actinium-228[a]		Americium-241[b]	Bismuth-212[a]		Bismuth-214[a]		Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Lead-212[a]		Lead-214[a]		Thallium-208[a]	
Final Action Levels			5	15	893.6	5	15	5	15	2.7	196.7	5.7	5	15	5	15	5	15
Depth bgs (cm)			<15	>15		<15	>15	<15	>15				<15	>15	<15	>15	<15	>15
A13	309A029	0 - 0.5	2.36 (G)	NA	--	--	NA	1.34 (G, J)	NA	--	0.68 (G)	--	2.87 (J)[c]	NA	1.7 (G, J)	NA	0.83 (G)	NA
	309A030	1.5 - 2	NA	2.63 (G)	--	NA	--	NA	1.35 (G, J)	--	--	--	NA	2.61 (J)[c]	NA	1.3 (G, J)	NA	0.84 (G)
A14	309A013	0 - 0.5	2.44 (G)	NA	25.1 (J)[c]	--	NA	1.27 (G, J)	NA	--	13.3 (G)	0.96 (J)[c]	2.54 (J)[c]	NA	1.86 (G, J)	NA	0.95 (G)	NA
A15	309A016	0 - 0.5	2.71 (G)	NA	60.2 (J)[c]	--	NA	1.22 (G, J)	NA	0.283 (G)	32.9 (G)	1.6 (J)[c]	2.57 (J)[c]	NA	1.6 (G, J)	NA	0.95 (G)	NA
A16	309A017	0 - 0.5	2.41 (G)	NA	25.6 (J)[c]	2.79 (G)	NA	1.35 (G, J)	NA	--	16 (G)	0.6 (J)[c]	2.4 (J)[c]	NA	1.41 (G, J)	NA	0.69 (G)	NA
A17	309A014	0 - 0.5	2.4 (G)	NA	11.7 (J)[c]	--	NA	1.48 (G, J)	NA	--	10 (G)	--	3.16 (J)[c]	NA	1.59 (G, J)	NA	0.84 (G)	NA
A18	309A015	0 - 0.5	2.6 (G)	NA	18.9 (J)[c]	2.54 (G)	NA	1.32 (G, J)	NA	--	15.4 (G)	--	2.58 (J)[c]	NA	1.39 (G, J)	NA	0.71 (G)	NA
A19	309A018	0 - 0.5	1.97 (G)	NA	27.4 (J)[c]	3.7 (G)	NA	1.53 (G, J)	NA	--	23 (G)	--	2.82 (J)[c]	NA	1.77 (G, J)	NA	0.85 (G)	NA
A20	309A020	0 - 0.5	2.48 (G)	NA	28.6 (J)[c]	--	NA	1.62 (G, J)	NA	--	71.6 (G)	--	2.21 (J)[c]	NA	1.97 (G, J)	NA	0.85 (G)	NA
A21	309A021	0 - 0.5	2.15 (G)	NA	4.12 (J)[c]	2.63 (G)	NA	1.03 (G, J)	NA	--	7.6 (G)	--	2.43 (J)[c]	NA	1.26 (G, J)	NA	0.67 (G)	NA
A22	309A010	0 - 0.5	2.91 (G)	NA	21.8 (J)[c]	--	NA	1.41 (G, J)	NA	--	73.8 (G)	--	2.17 (J)[c]	NA	1.36 (G, J)	NA	0.88 (G)	NA
A23	309A012	0 - 0.5	2.63 (G)	NA	15.9 (J)[c]	--	NA	1.5 (G, J)	NA	--	36.1 (G)	--	2.78 (J)[c]	NA	1.92 (G, J)	NA	0.9 (G)	NA
A24	309A011	0 - 0.5	2.32 (G)	NA	44.9 (J)[c]	--	NA	--	NA	--	150 (G, M3)	--	2.42 (J)[c]	NA	1.93 (G, J)	NA	0.96 (G)	NA
A25	309A009	0 - 0.5	2.74 (G)	NA	15.6 (J)[c]	--	NA	1.56 (G, J)	NA	--	14.4 (G)	--	3.08 (J)[c]	NA	1.46 (G, J)	NA	0.9 (G)	NA
A26	309A007	0 - 0.5	1.94 (G)	NA	--	--	NA	1.39 (G, J)	NA	--	9 (G)	--	2.41 (J)[c]	NA	1.76 (G, J)	NA	0.8 (G)	NA
A27	309A008	0 - 0.5	2.73 (G)	NA	--	--	NA	1.55 (G, J)	NA	--	4.98 (G)	--	2.87 (J)[c]	NA	1.78 (G, J)	NA	0.83 (G)	NA
A28	309A006	0 - 0.5	2.56 (G)	NA	--	--	NA	1.45 (G, J)	NA	--	4.09 (G)	--	2.85 (J)[c]	NA	1.42 (G, J)	NA	0.73 (G)	NA
A29	309A001	0 - 0.5	2.66 (G)	NA	--	--	NA	0.98 (G, J)	NA	--	--	--	2.8 (J)[c]	NA	1.03 (G, J)	NA	0.8 (G)	NA
A30	309A002	0 - 0.5	2.38 (G)	NA	--	--	NA	1.16 (G, J)	NA	--	2.91 (G)	--	2.32 (J)[c]	NA	1.34 (G, J)	NA	0.7 (G)	NA
	309A003	0 - 0.5	2.36 (G)	NA	--	--	NA	1.28 (G, J)	NA	--	2.53 (G)	--	2.41 (J)[c]	NA	1.68 (G, J)	NA	0.79 (G)	NA
A31	309A004	0 - 0.5	2.11 (G)	NA	--	--	NA	1.12 (G, J)	NA	--	--	--	2.5 (J)[c]	NA	1.17 (G, J)	NA	0.82 (G)	NA

Table A.3-6
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentrations at CAS 12-06-09, Muckpile
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Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)															
			Actinium-228[a]		Americium-241[b]	Bismuth-212[a]		Bismuth-214[a]		Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Lead-212[a]		Lead-214[a]		Thallium-208[a]	
Final Action Levels			**5**	**15**	**893.6**	**5**	**15**	**5**	**15**	**2.7**	**196.7**	**5.7**	**5**	**15**	**5**	**15**	**5**	**15**
Depth bgs (cm)			**<15**	**>15**		**<15**	**>15**	**<15**	**>15**				**<15**	**>15**	**<15**	**>15**	**<15**	**>15**
A32	309A005	0 - 0.5	2.32 (G)	NA	--	--	NA	1.28 (G, J)	NA	--	1.36 (G)	--	2.32 (J)[c]	NA	1.29 (G, J)	NA	0.78 (G)	NA

[a]Taken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment." (DOE, 1993). The PALs for these isotopes is specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).
[b]Taken from the construction, commercial, industrial land use scenario in Table 2.1 of the NCRP 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 document were scaled to a 25-millirem per year (mrem/yr) dose.
[c]Qualifier added to laboratory data; record accepted. Sample does not meet counting geometry requirements.

cm = Centimeter
ft bgs = Feet below ground surface
G = Sample density differs by more than 15% of laboratory control sample density.
J = Estimated value.
LT = Result is less than the requested minimum detectable concentration, greater than the sample specific minimum detectable concentration.
M3 = The reported minimum detected concentration was not met, but the reported activity is greater than the reported minimum detectable concentration.
NA = Not applicable
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits
> = Greater than
< = Less than

A.3.2.7 Strontium-90, Plutonium, Americium, and Uranium Isotopes

Isotopic Pu, U, and Am, and Sr-90 analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.3-7. Concentrations of Sr-90, isotopic Uranium (U-234, -235, and -238) did not exceed the initial PALs and the PALs for these radionuclides are considered the FALs. Concentrations of isotopic Am-241, Pu-238, and Pu-239 exceed the PALs and were moved to a Tier 2 evaluation to identify the FALs. The calculations for the determination of the FALs is presented in Appendix C. Although the CAI sample results for these radionuclide were below the site-specific FALs, Pu-239 was retained as a COC based on the results from previous muckpile investigations.

A.3.3 Nature and Extent of Contamination

Samples collected from the 32 locations within and adjacent to CAS 12-06-09 were not found to contain contaminants above FALs except for TPH-DRO. However, per the CAU 309 CAIP, the muckpile is considered to be contaminated at the highest concentrations of contaminants identified above FALs during previous (historical) investigations of muckpiles at NTS. The samples collected downslope from the muckpile (see locations A03 and A-14 through A28) were used to determine if contaminants had migrated beyond the CAS boundary (see locations A29, A30, A31, A32, C32, and C33) and the extent of the contamination identified in previous muckpile investigations or actually reported from the samples collected during this investigation (see Figures A.2-1 through A.2-4).

The highest contamination concentrations assigned to the muckpile from previously investigated muckpiles, the highest concentration found during the CAI at CAS 12-06-09, and whether or not the contaminant extended downslope beyond the boundary of the muckpile are presented in Table A.3-8. Based on previously investigated muckpiles, COCs at CAS 12-06-09 include arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239. The concentrations that exceed the FALs are bolded in the subsequent tables.

A.3.4 Revised Conceptual Site Model

The CAIP requirements were met at this CAS and no revisions were necessary to the CSM.

Table A.3-7
Soil Sample Results for Isotopes Detected Above Minimum Detectable Concentrations at CAS 12-06-09, Muckpile
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Americium-241	Plutonium-238	Plutonium-239	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels[a]			**893.6**	**1,075**	**968.7**	**838**	**143**	**17.5**	**105**
A01	309A039	0 - 0.5	5.33	1.69	19.2	0.92	1.52	0.059	1.12
	309A040	1.5 - 2	0.246	0.124	1.19	--	1.33	0.112	1.2
A02	309A041	0 - 0.5	4.64	1.73	19.1	2.59	1.56	0.109	1.2
A03	309A042	0 - 0.5	5.19	1.81	20.5	1.11	1.51	--	1.34
A04	309A032	0 - 0.5	102 (M3)	30.2 (M3)	348 (M3)	0.61	3.44	0.088	1.24
	309A033	1.5 - 2	15.6	6.2 (M3)	69 (M3)	--	2.08	0.102	1.53
A05	309A034	0 - 0.5	161 (M3)	53.6 (M3)	670 (M3)	1.41	4.72	--	1.22
A06	309A031	0 - 0.5	10.2	3.09	38.8	--	1.59	0.089	1.4
A07	309A025	0 - 0.5	0.249	0.081	1.06	--	1.38	0.083	1.36
	309A026	3 - 4	0.111	--	0.156	--	1.46	0.098	1.49
A08	309A019	0 - 0.5	0.246	0.105	1.44	--	1.68 (M3)	--	1.53 (M3)
A09	309A022	0 - 0.5	0.25	0.113	1.45	--	1.08	--	1.2
	309A023	0 - 0.5	0.413	0.182	1.5	--	1.19	0.064	1.12
	309A024	2.5 - 3	--	--	0.049 (LT)	--	1.32	0.065	1.33
A10	309A035	0 - 0.5	1.46	0.44	5.29	--	1.29	--	1.32
	309A036	1.5 - 2	--	--	0.171	--	1.91	0.172	1.79
A11	309A037	0 - 0.5	2.49	0.8	10.2	--	1.66	--	1.65
	309A038	0 - 0.5	3.11	0.91	12.2	--	1.64	0.118	1.6
A12	309A027	0 - 0.5	0.52	0.172	1.71	--	1.52	--	1.28
	309A028	1.5 - 2	--	--	0.051	--	1.67	0.07	1.71
A13	309A029	0 - 0.5	0.7	0.214	2.85	0.62	1.44	0.076	1.45
	309A030	1.5 - 2	0.092	0.078	0.71	--	1.62	0.1	1.41
A14	309A013	0 - 0.5	20.8 (M3)	5.6 (M3)	76 (M3)	--	1.63 (M3)	--	1.35 (M3)
A15	309A016	0 - 0.5	58.1 (M3)	17 (M3)	213 (M3)	0.67	2.92 (M3)	--	1.85 (M3)
A16	309A017	0 - 0.5	17.7 (M3)	7.4 (M3)	79 (M3)	0.93	1.3 (M3)	--	1.07 (M3)
A17	309A014	0 - 0.5	12.5 (M3)	3.63 (M3)	47.8 (M3)	0.6	1.63 (M3)	--	1.62 (M3)
A18	309A015	0 - 0.5	19.9 (M3)	6 (M3)	68 (M3)	0.84	2.09 (M3)	--	1.25 (M3)
A19	309A018	0 - 0.5	31.7 (M3)	9.9 (M3)	112 (M3)	1.38	1.88 (M3)	--	1.37 (M3)
A20	309A020	0 - 0.5	17.1 (M3)	5.2 (M3)	60.5 (M3)	3.93	2.05 (M3)	--	1.96 (M3)

Table A.3-7
Soil Sample Results for Isotopes Detected Above Minimum Detectable Concentrations at CAS 12-06-09, Muckpile
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Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Americium-241	Plutonium-238	Plutonium-239	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels[a]			**893.6**	**1,075**	**968.7**	**838**	**143**	**17.5**	**105**
A21	309A021	0 - 0.5	4.04 (M3)	1.77 (M3)	15.1 (M3)	0.49 (LT)	1.12 (M3)	--	1.59 (M3)
A22	309A010	0 - 0.5	18.5	6.7	77	4.1	1.69	0.208 (J)[b]	1.25
A23	309A012	0 - 0.5	10.5	4.26	47.1	1.93 (Y1)	1.83	0.11 (J)[b]	1.51
A24	309A011	0 - 0.5	28.9	14.4 (M3)	164 (M3)	7.4	2.22	0.162 (J)[b]	1.18
A25	309A009	0 - 0.5	10.1	3.73	44.1	0.65	1.72	0.166 (J)[b]	1.33
A26	309A007	0 - 0.5	1.79	1.97	8.8	1.23	1.47	0.126 (J)[b]	1.52
A27	309A008	0 - 0.5	1.01	0.9	5.17	0.8	1.27	0.08 (J)[b]	1.27
A28	309A006	0 - 0.5	0.66	0.56	3.08	--	1.41	0.202 (J)[b]	1.25
A29	309A001	0 - 0.5	--	--	--	--	1.47	0.116 (J)[b]	1.4
A30	309A002	0 - 0.5	0.49	0.85	2.74	0.62 (Y1)	1.09	0.102 (J)[b]	1.13
	309A003	0 - 0.5	0.86	1.78	4.96	--	1.05 (M3)	0.193 (J)[b]	1.26
A31	309A004	0 - 0.5	--	0.084	0.321	--	1.21	0.069 (J)[b]	1.29
A32	309A005	0 - 0.5	0.282	0.418	1.49	0.54 (J)[c]	1.18	0.103 (J)[b]	1.14

[a]Taken from the construction, commercial, industrial land use scenario in Table 2.1 of the NCRP 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 document were scaled to a 25-millirem per year dose.
[b]Qualifier added to laboratory data; record accepted. Duplicate precision analysis (relative percent difference) exceeds control limits
[c]Qualifier added to laboratory data; record accepted. Chemical yield exceeded the upper limits.

ft bgs = Feet below ground surface
J = Estimated value.
LT = Result is less than the requested minimum detectable concentration, greater than the sample specific minimum detectable concentration.
M3 = The requested minimum detectable concentration was not met, but the reported activity is greater than the reported minimum detectable concentration.
pCi/g = Picocuries per gram
Y1 = Chemical yield is in control at 100 to 110%. Quantitive yield is assumed.
-- = Not detected above minimum reporting limits.

Table A.3-8
Highest Concentrations Detected at CAU 309, at Previously Investigated NTS Muckpiles, and Extent

Contaminants of Concern	Highest Contaminant Concentration		Final Action Level[a]	Contaminant Extends Beyond Muckpile?
	CAS 12-06-09	Other NTS Muckpiles		
Arsenic	4.3 mg/kg	**38.8** mg/kg	23 mg/kg	No
Lead	59 mg/kg	**59,700** mg/kg	750 mg/kg	No
TPH-DRO	3,100 mg/kg	**10,000** mg/kg	100 mg/kg	No
Cesium-137	150 pCi/g	**3,050** pCi/g	196.7 pCi/g	No
Cobalt-60	0.7 pCi/g	**60** pCi/g	43.9 pCi/g	No
Plutonium-238	53.6 pCi/g	**127** pCi/g	1,075.0 pCi/g	No
Plutonium-239	670 pCi/g	**13,200** pCi/g	968.7 pCi/g	No

[a]Chemical final action levels (FALs) from CAU 309 CAIP preliminary action levels; radiological FALs from RESRAD Land Parcel 1.

DRO = Diesel-range organics
mg/kg = Milligrams per kilogram
pCi/g = Picocuries per gram
RESRAD - Residual Radioactive
TPH-DRO = Total petroleum hydrocarbons, diesel-range organics
µg/kg = Micrograms per kilogram

A.4.0 CAS 12-08-02, Contaminated Waste Dump

Corrective Action Site 12-08-02, CWD, consists of a muckpile and debris and is located on the hillside southeast of the front of the re-entry tunnel for K-Tunnel. During re-entry mining operations, potentially contaminated muck was removed from the tunnel and deposited on the muckpile. Debris on the CWD consists of lead bricks, lead shielding, rusted and twisted metal, wood, cables, a lighting fixture, and railroad tracks still attached to their wooden ties. It is likely that additional debris may be buried within this site. The CWD is posted with "Caution Contamination Area" signs, that are faded and some have fallen off the three-strand fence surrounding the muckpile. Similar debris is also located off the muckpile, close to the mountainside and K-Tunnel re-entry portal. Included in this debris is a wooden outhouse that is tipped on its side. The collection reservoir consists of a 55-gal drum. The drum contents were photographed and observed empty with no visible staining beneath the drum.

A.4.1 Corrective Action Investigation

A total of 23 environmental surface soil samples (including 1 FD) were collected during investigation activities at CAS 12-08-02. The sample IDs, locations, types, and analyses are listed in Table A.4-1. The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following sections.

Table A.4-1
Samples Collected at CAS 12-08-02, Contaminated Waste Dump
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
B01	309B007	0 - 0.5	Soil	Environmental	Set 1
B02	309B006	0 - 0.5	Soil	Environmental	Set 1
B03	309B010	0 - 0.5	Soil	Environmental	Set 1
B04	309B003	0 - 0.5	Soil	Environmental	Set 1
B05	309B001	0 - 0.5	Soil	Environmental, MS/MSD	Set 1
	309B002	0 - 0.5	Soil	Field Duplicate of #309B001	Set 1
B06	309B008	0 - 0.5	Soil	Environmental	Set 1
B07	309B011	0 - 0.5	Soil	Environmental	Set 1
B08	309B005	0 - 0.5	Soil	Environmental	Set 1
B09	309B009	0 - 0.5	Soil	Environmental	Set 1

Table A.4-1
Samples Collected at CAS 12-08-02, Contaminated Waste Dump
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
B10	309B004	0 - 0.5	Soil	Environmental	Set 1
	309B023	0 - 0.5	Soil	Environmental	Set 2
B11	309B014	0 - 0.5	Soil	Environmental	Set 1
B12	309B013	0 - 0.5	Soil	Environmental	Set 1
B13	309B012	0 - 0.5	Soil	Environmental	Set 1
B14	309B015	0 - 0.5	Soil	Environmental	Set 1
B15	309B018	0 - 0.5	Soil	Environmental	Set 1
B16	309B019	0 - 0.5	Soil	Environmental	Set 1
B17	309B021	0 - 0.5	Soil	Environmental	Set 1
B18	309B020	0 - 0.5	Soil	Environmental	Set 1
B19	309B022	0 - 0.5	Soil	Environmental	Set 1
B20	309B016	0 - 0.5	Soil	Environmental	Set 1
B21	309B017	0 - 0.5	Soil	Environmental	Set 1
NA	309B300	NA	Water	Trip Blank	Total VOCs
NA	309B301	NA	Water	Trip Blank	Total VOCs
NA	309B302	NA	Water	Trip Blank	Total VOCs
NA	309B500	NA	Swipe	Waste Management	Iso-U, Iso-Pu, Sr-90, gamma
NA	309B501	NA	Swipe	Waste Management	Iso-U, Iso-Pu, Sr-90, gamma
NA	309B502	NA	Swipe	Waste Management	Iso-U, Iso-Pu, Sr-90, gamma
NA	309B503	NA	Swipe	Waste Management	Iso-U, Iso-Pu, Sr-90, gamma
Brick 01	309B504	0 - 0.5	Soil	Waste Management	Set 1

Set 1 = Total VOCs, Total SVOCs, PCBs, TPH-DRO, RCRA Metals, Beryllium, Isotopic Americium, Iso-Pu, Iso-U, strontium-90, Gamma Spectroscopy
Set 2 = Isotopic Americium, Isotopic Plutonium, Isotopic Uranium, Strontium-90, Gamma Spectroscopy

ft bgs = Feet below ground surface
gamma = Gamma spectroscopy
Iso-Pu = Isotopic Plutonium
Iso-U = Isotopic Uranium
MS/MSD = Matrix spike/matrix spike duplicate
NA = Not applicable
PCBs = Polychlorinated Biphenyls
RCRA = *Resource Conservation and Recovery Act*
Sr-90 = Strontium-90
SVOCs = Semivolatile compounds
TPH-DRO = Total petroleum hydrocarbons, diesel-range organics
VOCs = Volatile organic compounds

A.4.1.1 Field Screening

Investigation samples were field screened for VOCs, total alpha and beta/gamma radiation, and gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where appropriate. The VOC headspace FSRs were not exceeded in samples collected at this CAS. Gross alpha and/or total beta/gamma radiation FSLs were exceeded in 9 samples. Samples were also analyzed for gamma radiation via a gamma spectrometer, and the results were compared to the FSLs indicating that 5 samples had FSRs exceeding the FSLs. The field screening results showed consistency with the results of the RSL flyover survey.

A.4.1.2 Radiological Surveys

See Section A.2.2.2 for information regarding the low-altitude, aerial radiological survey conducted by RSL, and Section A.3.1.2 for the radiological walkover survey that was performed by SNJV personnel on January 21, 2004, at the CAS 12-06-09 muckpile and the CAS 12-08-02 CWD.

Results for the swipe collection survey conducted on the lead bricks that were removed from inside the contamination area indicate no removable alpha and beta/gamma contamination above release limits (Table A.4-8). Additional swipes surveys were conducted on equipment that was used inside the CA at the CWD. No removable contamination was detected above release limits.

A.4.1.3 Visual Inspections

Prior to intrusive activities, the site was visually inspected and photo documented. The visual inspection focused on biasing factors such as staining or ditches and drainages off the muckpile that could provide a preferential pathway for the transport of contaminants. The visual inspection resulted in several sampling locations being moved. Specifically, observations and changes were made as follows:

- A 55-gal drum was used during the active life of the tunnels for a toilet and was observed tipped on its side. The tank was observed to be empty and photographs were taken to document this.
- Location B01 was moved due to presence of bedrock at this location. The location was moved inside the contamination area fencing just outside the K-Tunnel re-entry portal.

- Location B10 was moved upslope on the muckpile to the area with the highest radiological field screening within the contamination area posting fence. Although trinity glass was present in the area, the sample did not contain any. Another sample (309B023) was collected, for comparison purposes, that included the trinity glass.

- Location B12 was moved to the center of a drainage ditch.

- Location B20 was moved due to the presence of a bedrock outcrop at this location.

The walkover visual inspections did not identify any additional sample locations based on biasing factors (i.e., staining). No additional biased sample locations were identified.(Figure A.3-1).

A.4.1.4 Sample Collection

A total of 23 environmental samples (including 1 FD) were collected during investigation activities at CAS 12-08-02.

Decision I and Decision II environmental sampling activities included the collection of biased surface soil and muck samples on and surrounding the muckpiles, (Figure A.3-1) along the down slope edge of the muckpiles, and locations to the south downgradient of the CWD.

Environmental samples were collected from the soil and muck at the CWD from the surface interval from 0 to 0.5 ft bgs. Subsurface samples were not collected at this CAS due to hazardous working conditions. A soil sample was not collected below or within the 55-gal toilet drum, because the tank was observed to be void of sampling material, and there was no presence of staining in the surrounding soil. Photographs were taken to document this.

Samples were collected at this CAS for the purpose of waste characterization and disposal determination of lead bricks that were removed from this CAS. The analytical results for waste characterization samples are discussed in Section A.6.0.

Investigation samples were collected as specified in the CAU 309 CAIP (NNSA/NSO, 2004) and submitted for laboratory analysis.

A.4.1.5 Deviations

The only minor deviations from the planned sampling were that some samples could not be collected at the planned depths because of refusal. There were several sample locations where refusal was met due to the presence of bedrock or a hard stratigraphic layer. Refusal prevented collection of samples deeper than 0.5 ft bgs at several locations. Because contamination is expected to be found within the muckpile, these deviations are not significant.

Per the CAIP, lead brick removal would be attempted for bricks laying on the ground surface. Twenty bricks were removed, however, more lead bricks were observed partially buried or beneath the bricks removed. After a discussion with NNSA/NSO and NDEP, it was agreed that the remaining bricks would not be removed because of safety issues (airborn and slope instability hazards) and the planned closure strategy.

The requirements listed in the CAIP for this CAS have been met, and no revisions to the CSM were necessary.

A.4.2 Investigation Results

The following sections provide analytical results from the samples collected to complete investigation activities as outlined in the CAIP. Investigation samples were analyzed for the CAIP-specified COPCs, which included total VOCs, total SVOCs, TPH-DRO, total RCRA metals, gamma-emitting radionuclides, isotopic U, isotopic Pu, isotopic Am and Sr-90. Beryllium and PCBs are added parameters, because these contaminants are a common concern at the NTS. The analytical parameters and laboratory methods used to analyze the investigation samples are listed in Table A.2-2. Table A.4-1 lists the sample-specific analytical suite for CAS 12-08-02.

A.4.2.1 Total Volatile Organic Compounds

Total VOCs analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.4-2. No VOCs were detected at concentrations exceeding their respective FALs.

Table A.4-2
Soil Sample Results for Total VOCs Detected Above
Minimum Reporting Limits at CAS 12-08-02, Contaminated Waste Dump

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (µg/kg)
			Styrene
Final Action Levels[a]			1,700,000
B07	309B011	0 - 0.5	1 (J)
B19	309B022	0 - 0.5	1.1 (J)

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2002).

ft bgs = Feet below ground surface
J = Estimated value.
µg/kg = Micrograms per kilogram

A.4.2.2 Total Semivolatile Organic Compounds

Total SVOCs analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.4-3. No SVOCs were detected at concentrations exceeding the respective FALs.

Table A.4-3
Soil Sample Results for Total SVOCs Detected Above
Minimum Reporting Limits at CAS 12-08-02, Contaminated Waste Dump

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (µg/kg)
			Bis(2-Ethylhexyl)Phthalate
Final Action Levels[a]			120,000
B01	309B007	0 - 0.5	52 (J)
B02	309B006	0 - 0.5	26 (J)
B09	309B009	0 - 0.5	55 (J)
B14	309B015	0 - 0.5	95 (J)
B16	309B019	0 - 0.5	89 (J)

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2002).

ft bgs = Feet below ground surface
J = Estimated value
µg/kg = Micrograms per kilogram

A.4.2.3 Total Petroleum Hydrocarbons

The TPH-DRO analytical results for soil samples collected at this CAS that were detected above MDCs are presented in Table A.4-4. The TPH-DRO was not detected at a concentration exceeding the PAL of 100 mg/kg; therefore a Tier 2 evaluation was not conducted and the FAL is considered the PAL for TPH-DRO.

Table A.4-4
Soil Sample Results for TPH-DRO Detected Above Minimum Reporting Limits at CAS 12-08-02, Contaminated Waste Dump

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel Range Organics
Preliminary Action Levels[a]			100
B01	309B007	0 - 0.5	3 (J)
B02	309B006	0 - 0.5	12 (M)
B03	309B010	0 - 0.5	3.9 (J)
B09	309B009	0 - 0.5	3.3 (J)
B13	309B012	0 - 0.5	4.3 (J)
B17	309B021	0 - 0.5	2.4 (J)
B19	309B022	0 - 0.5	2 (J)

[a]Based on *Nevada Administrative Code*; Contamination of soil: Establishment of action levels (NAC, 2002)

ft bgs = Feet below ground surface
J = Estimated value
M = A pattern resembling motor oil was detected
mg/kg = Milligrams per kilogram

A.4.2.4 Total RCRA Metals and Beryllium

Total RCRA metals and beryllium analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.4-5. No metals were detected at concentrations exceeding their respective FALs.

A.4.2.5 Polychlorinated Biphenyls

Total PCB analytical results for soil samples collected at CAS 12-08-02 did not exceed the MDCs.

A.4.2.6 Gamma-Emitting Radionuclides

Gamma-emitting radionuclides analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.4-6. All gamma-emitting radionuclide concentrations except Am-241, Co-60, Cs-137, and Eu-152 did not exceed their respective PALs, therefore, for these radionuclides, the PALs are identified as the FALs. Cobalt-60 was detected at concentrations exceeding the PAL of 2.68 pCi/g in one sample at location B10. Cesium-137 was detected at concentrations that exceeded the PAL (12.2 pCi/g) in 8 of the 23 environmental soil samples at 6 locations. Americium-241 exceeded the PAL (12.7 PCi/g) in 6 of the 23 environmental samples at 4 locations. Europium-152 was reported at concentration that exceeded the PAL in two samples at location B10. These four radionuclides that reported concentrations exceeding their respective PALs were moved onto a Tier 2 evaluation in which the RESRAD code was used to determine the site-specific FALs for these radionuclides. The calculation of the FAL for Co-60, Cs-137, Am-241, and Eu-152 are presented in Appendix C. Based on the results of the Tier 2 evaluation, only Cs-137 had a reported concentration at one location (B10) that exceeded the FAL of 196.7 pCi/g, therefore, Cs-137 is considered a COC for the CWD. Although the CAI sample results for other radionuclide were below the site-specific FALs, Co-60 was retained as a COC based on the results from previous muckpile investigations.

A.4.2.7 Plutonium, Strontium-90, Americium, and Uranium Isotopes

Isotopic Pu, U, and Am, and Sr-90 analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.4-7. No Sr-90, isotopic Am, or U exceeded the FALs.

Concentrations of Sr-90 and isotopic Uranium (U-234, -235 and -238) did not exceed the PALs and therefore the PALs for these radionuclides are considered the FALs.

Concentrations of isotopic Am-241 were reported in four samples from three locations at concentration that exceeded the PAL of 12.7 pCi/g. Plutonium-238 was detected in four samples from three locations at concentrations that exceeded the PAL of 13 pCi/g. Plutonium-239 was detected in 11 samples from eight locations that exceeded the PAL of 12.2 pCi/g. These isotopes were moved to a Tier 2 evaluation in which the RESRAD code was used to determine the site-specific FAL for these isotopes. Plutonium-239 did exceed the FAL of 968.7 pCi/g in sample 309B004, at

Table A.4-5
Soil Sample Results for Metals Detected Above Minimum Reporting Limits at CAS 12-08-02, Contaminated Waste Dump

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury
Final Action Levels			**23[a]**	**67,000[b]**	**1,900[b]**	**450[b]**	**450[b]**	**750[b]**	**310[b]**
B01	309B007	0 - 0.5	2.7	54	1	--	2.3	16	0.0082 (J-)
B02	309B006	0 - 0.5	2.9	44	0.81	--	2.2	14	0.0038 (J-)
B03	309B010	0 - 0.5	2.7	120	1.1	--	3.2	64	0.015 (J-)
B04	309B003	0 - 0.5	2.1	77	1.1	--	3.2 (J)	22	0.014 (J-)
B05	309B001	0 - 0.5	0.79 (B)	--	0.43 (B)	--	3.3 (J)	27	--
	309B002	0 - 0.5	0.9 (B)	--	0.41 (B)	0.032 (J-)	--	24	--
B06	309B008	0 - 0.5	0.97 (B)	11 (J-)	0.68	--	--	6.7	--
B07	309B011	0 - 0.5	3.5	92	0.9	--	5.1	17	0.015 (J-)
B08	309B005	0 - 0.5	1.9	51	0.78	0.12 (J-)	3.2 (J)	53	0.014 (J-)
B09	309B009	0 - 0.5	4.2	99	1	--	6	13	0.044
B10	309B004	0 - 0.5	1.3	36	0.49 (B)	0.99	4.5 (J)	400	0.0068 (J-)
B11	309B014	0 - 0.5	4.4	150	1.1	--	6.9	15	0.026 (J-)
B12	309B013	0 - 0.5	2.4	58	0.96	--	2.5	11	0.017 (J-)
B13	309B012	0 - 0.5	3.6	76	1.4	--	2.4	15	0.025 (J-)
B14	309B015	0 - 0.5	3.5	74	0.98	--	4.9	10	0.022 (J-)
B15	309B018	0 - 0.5	4.2	91	0.84	--	5	12	0.022 (J-)
B16	309B019	0 - 0.5	4.7	120	0.99	--	7.2	12	0.017 (J-)
B17	309B021	0 - 0.5	4.2	79	1	--	6.9	13	0.019 (J-)
B18	309B020	0 - 0.5	4.1	110	0.93	--	6.3	12	0.019 (J-)
B19	309B022	0 - 0.5	4.6	120	1.3	--	7.8	13	0.02 (J-)
B20	309B016	0 - 0.5	3.8	86	1.3	--	4.8	10	0.079
B21	309B017	0 - 0.5	3.3	78	1.1	--	4.7	11	0.041

[a]Based on the background concentrations for metals. Background is considered the mean plus two times the standard deviation for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2002)

B = Value less than the contract required detection limit, but greater than or equal to the instrument detection limit.
ft bgs = Feet below ground surface
J = Estimated value. Qualifier added to laboratory data; record accepted. Duplicate precision analysis (relative percent difference) exceeds control limits.
J- = The result is an estimated quantity, but the result may be biased low. Negative bias found in continuing calibration/method blank.
mg/kg = Milligrams per kilogram
-- = Not detected above minimum reporting limits

Table A.4-6
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentrations at CAS 12-08-02, Contaminated Waste Dump
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)										
			Actinium-228[a]	Americium-241[b]	Bismuth-212[a]	Bismuth-214[a]	Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Europium-155[b]	Lead-212[a]	Lead-214[a]	Thallium-208[a]
Final Action Levels			**5**	**893.6**	**5**	**5**	**43.9**	**196.7**	**97.4**	**5.4**	**5**	**5**	**5**
Depth bgs (cm)			**<15**		**<15**	**<15**					**<15**	**<15**	**<15**
B01	309B007	0 - 0.5	2.53 (G)	6.6 (J)[c]	--	1.05 (G, J)	--	6.17 (G)	--	--	2.48 (J)[c]	1.27 (G, J)	0.89 (G)
B02	309B006	0 - 0.5	2.39 (G)	9.2 (J)[c]	--	1.37 (G, J)	--	8.1 (G)	--	--	2.84 (J)[c]	1.51 (G, J)	0.96 (G)
B03	309B010	0 - 0.5	2.2 (G)	6.4 (J)[c]	--	1.16 (G, J)	--	4.84 (G)	--	--	2.4 (J)[c]	1.24 (G, J)	0.84 (G)
B04	309B003	0 - 0.5	1.99 (G)	17.7 (J)[c]	--	1.5 (G, J)	--	13 (G)	--	--	2.74 (J)[c]	1.32 (G, J)	0.96 (G)
B05	309B001	0 - 0.5	2.37 (G)	41.1 (J)[c]	--	1.67 (G, J)	0.26 (G)	33 (G)	1.74 (J)[c]	--	2.74 (J)[c]	1.53 (G, J)	0.91 (G)
	309B002	0 - 0.5	3.04 (G)	51.9 (J)[c]	--	1.62 (G, J)	--	35.1 (G)	2.1 (J)[c]	--	2.69 (J)[c]	2 (G, J)	0.62 (G)
B06	309B008	0 - 0.5	2.8 (G)	2.9 (J)[c]	--	1.72 (G, J)	--	34.8 (G)	--	--	2.45 (J)[c]	1.97 (G, J)	0.89 (G)
B07	309B011	0 - 0.5	2.2 (G)	7.4 (J)[c]	--	1.16 (G, J)	--	6.7 (G)	--	--	2.22 (J)[c]	1.24 (G, J)	0.79 (G)
B08	309B005	0 - 0.5	2.2 (G)	41.5 (J)[c]	--	1.49 (G, J)	0.255 (G)	34.8 (G)	1.95 (J)[c]	--	2.52 (J)[c]	1.78 (G, J)	0.81 (G)
B09	309B009	0 - 0.5	2.66 (G)	1.42 (J)[c]	2.65 (G)	1.1 (G, J)	--	3.47 (G)	--	--	2.41 (J)[c]	1.36 (G, J)	0.78 (G)
B10	309B004	0 - 0.5	1.86 (G)	576 (J)[c]	--	1.84 (G, J)	2.73 (G)	**241** (G, M3)	17.4 (J)[c]	3.25 (J)[c]	2.98 (J)[c]	2.12 (G, J)	--
	309B023	0 - 0.5	2.82 (G)	468 (J)[c]	--	--	2.21 (G)	189 (G)	14.5 (J)[c]	--	3.08 (J)[c]	--	0.98 (G)
B11	309B014	0 - 0.5	2.23 (G)	--	--	1.35 (G, J)	--	2.63 (G)	--	--	2.58 (J)[c]	1.48 (G, J)	0.85 (G)
B12	309B013	0 - 0.5	2.59 (G)	--	--	1.19 (G, J)	--	4.55 (G)	--	--	2.28 (J)[c]	1.45 (G, J)	0.8 (G)
B13	309B012	0 - 0.5	2 (G)	4.8 (J)[c]	2.6 (G)	0.9 (G, J)	--	9.9 (G)	--	--	2.37 (J)[c]	1.09 (G, J)	0.65 (G)
B14	309B015	0 - 0.5	2.05 (G)	--	--	1.27 (G, J)	--	2.04 (G)	--	--	2.81 (J)[c]	1.49 (G, J)	0.89 (G)
B15	309B018	0 - 0.5	2.64 (G)	--	--	1.42 (G, J)	--	3.34 (G)	--	--	2.68 (J)[c]	1.49 (G, J)	0.81 (G)

Table A.4-6
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentrations at CAS 12-08-02, Contaminated Waste Dump
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)										
			Actinium-228[a]	Americium-241[b]	Bismuth-212[a]	Bismuth-214[a]	Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Europium-155[b]	Lead-212[a]	Lead-214[a]	Thallium-208[a]
Final Action Levels			**5**	**893.6**	**5**	**5**	**43.9**	**196.7**	**97.4**	**5.4**	**5**	**5**	**5**
Depth bgs (cm)			**<15**		**<15**	**<15**					**<15**	**<15**	**<15**
B16	309B019	0 - 0.5	2.13 (G)	--	--	1.41 (G, J)	--	0.58 (G)	--	--	2.53 (J)[c]	1.7 (G, J)	0.81 (G)
B17	309B021	0 - 0.5	2.31 (G)	--	--	1.49 (G, J)	--	2.48 (G)	--	--	2.48 (J)[c]	1.47 (G, J)	0.79 (G)
B18	309B020	0 - 0.5	2.12 (G)	--	--	1.45 (G, J)	--	1.24 (G)	--	--	2.44 (J)[c]	1.62 (G, J)	0.83 (G)
B19	309B022	0 - 0.5	2.61 (G)	--	--	1.4 (G, J)	--	1.08 (G)	--	--	2.59 (J)[c]	1.54 (G, J)	0.8 (G)
B20	309B016	0 - 0.5	2.18 (G)	--	3.5 (G)	1.32 (G, J)	--	1.32 (G)	--	--	2.48 (J)[c]	1.3 (G, J)	0.88 (G)
B21	309B017	0 - 0.5	1.87 (G)	--	--	1.41 (G, J)	--	2.87 (G)	--	--	2.86 (J)[c]	1.58 (G, J)	0.83 (G)

[a]Taken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment." (DOE, 1993). The preliminary action levels for these isotopes is specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).

[b]Taken from the construction, commercial, industrial land use scenario in Table 2.1 of the NCRP 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 document were scaled to a 25-millirem per year dose.

[c]Qualifier added to laboratory data; record accepted. Sample does not meet counting geometry requirements.

cm = Centimeter
ft bgs = Feet below ground surface
G = Sample density differs by more than 15% of laboratory control sample density.
J = Estimated value.
M3 = The reported minimum detected concentration was not met, but the reported activity is greater than the reported minimum detectable concentration.
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits
< = Less than
> = Greater than

Table A.4-7
Soil Sample Results for Isotopes Detected Above Minimum Reporting Limits at CAS 12-08-02, Contaminated Waste Dump

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Americium-241	Plutonium-238	Plutonium-239	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels[a]			**893.6**	**1,075**	**968.7**	**838**	**143**	**17.5**	**105**
B01	309B007	0 - 0.5	2.9 (Y2)	1.83	17.8	0.83	1.52	0.099	1.29
B02	309B006	0 - 0.5	7.2	3.35	32.7	0.88	1.49	0.095	1.27
B03	309B010	0 - 0.5	5.42	1.96	21.7	--	1.41	0.048 (LT)	1.27
B04	309B003	0 - 0.5	9.3 (M3)	3.19 (M3)	39 (M3)	1.19	2.38 (M3)	--	1.71 (M3)
B05	309B001	0 - 0.5	19.2 (M3)	7.3 (M3)	92 (M3)	7.4	2.1 (M3)	--	1.35 (M3)
	309B002	0 - 0.5	37.8 (M3)	13.8 (M3)	179 (M3)	6.2	2.64 (M3)	--	1.47 (M3)
B06	309B008	0 - 0.5	2.67	0.79	11.2	5.5	1.86	0.111	1.75
B07	309B011	0 - 0.5	7.1	2.83	28.6	1.17	1.34	0.067	1.15
B08	309B005	0 - 0.5	44.8 (M3)	14.3 (M3)	173 (M3)	6.8	2.78 (M3)	--	1.39 (M3)
B09	309B009	0 - 0.5	1.49	1.38	7	0.73	0.97	--	1.04
B10	309B004	0 - 0.5	527 (M3)	166 (M3)	**1,860** (M3)	34.4	16.6 (M3)	--	--
	309B023	0 - 0.5	--	55 (M3)	760 (M3)	12.6	5.32	0.135	1.52
B11	309B014	0 - 0.5	0.7	0.95	3.29	0.55	1.13	0.079	1.32
B12	309B013	0 - 0.5	1.5	2.07	8.7	1.15	1.45	0.137	1.35
B13	309B012	0 - 0.5	4.21	4.81	20.6	1.22	1.09	0.081	1.34
B14	309B015	0 - 0.5	0.75 (M3)	1.01	4.21	--	1	0.104	1.13
B15	309B018	0 - 0.5	1.66	2.29	9.1	--	1.06	--	1.17
B16	309B019	0 - 0.5	--	--	0.182	--	1.22	0.074	1.09
B17	309B021	0 - 0.5	0.5	0.95	3.43	0.63	1.25	0.117	1.28
B18	309B020	0 - 0.5	0.48	0.78	2.49	--	1.14	0.07	1.04
B19	309B022	0 - 0.5	0.283	0.56	1.51	--	1.06	0.064	1.07
B20	309B016	0 - 0.5	0.52	0.72	2.31	--	1.22	--	1.15
B21	309B017	0 - 0.5	0.93	1.63	5.25	--	1.15	0.059	1.15

[a]Taken from the construction, commercial, industrial land use scenario in Table 2.1 of the NCRP 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 document were scaled to a 25-millirem per year dose.

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
LT = Result is less than the requested minimum detectable concentration, greater than the sample specific minimum detectable concentration.
M3 = The requested minimum detectable concentration was not met, but the reported activity is greater than the reported minimum detectable concentration.
Y2 = Chemical yield outside default limits
-- = Not detected above minimum reporting limits

location B10, with a concentration of 1,860 pCi/g and, therefore, is considered a COC at this CAS. The calculation of the FAL for Pu-239 is presented in Appendix C.

A.4.3 Nature and Extent of Contamination

One sample (309B004) collected from location B10 at CAS 12-08-02 was found to contain contaminants above FALs. As presented in Section A.4.1.3, location B10 was moved upslope on the muckpile to the area with the highest radiological field screening within the contamination area posting fence. The sample did not contain trinity glass that was present on the ground surface. Another sample was collected (309B023) which included the trinity glass; however, the trinity glass sample concentrations were below the FALs. Sample 309B004 exceeded the FAL of 196.7 pCi/g for Cs-137 with a concentration of 241 pCi/g, and the FAL of 968.7 pCi/g for Pu-239 with a concentration of 1,860 pCi/g. Therefore, both are considered COCs at this CAS.

In addition, per the CAU 309 CAIP, the muckpile is considered to be contaminated at the highest concentrations of contaminants identified above FALs during previous (historical) investigations of muckpiles at NTS.

The contaminants assigned to the muckpile from previously investigated muckpiles, the highest concentration found during the CAI at the muckpile, and whether or not the contaminant extended downslope beyond the boundary of the muckpile are presented in Table A.4-8. Based on previously investigated muckpiles, COCs at CAS 12-08-02 include arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239.

Sample 309B004 was collected at the highest radiological field screening area inside the CA. None of the other sampling locations identified COCs, thus all chemical and radiological COCs were bounded by samples taken downslope from the base of the muckpile (see locations B07, B09, and B-11 through B21). The extent samples taken downstream and further down the washes, from the CAU 309 muckpiles, were not found to be contaminated with COCs (see locations A 29, A30, A31, A32, C32, and C33).

A.4.4 Revised Conceptual Site Model

The CAIP requirements were met at this CAS and no revisions were necessary to the CSM.

Table A.4-8
Highest Concentrations Detected at CAU 309 at Previously Investigated NTS Muckpiles and Extent

Contaminants of Concern	Highest Contaminant Concentration		Final Action Level[a]	Contaminant Extends Beyond Muckpile?
	CAS 12-08-02	Other NTS Muckpiles		
Arsenic	4.7 mg/kg	**38.8** mg/kg	23 mg/kg	No
Lead	400 mg/kg	**59,700** mg/kg	750 mg/kg	No
TPH-DRO	12 mg/kg	**10,000** mg/kg	100 mg/kg	No
Cesium-137	**241** pCi/g	**3,050** pCi/g	196.7 pCi/g	No
Cobalt-60	2.73 pCi/g	**60** pCi/g	43.9 pCi/g	No
Plutonium-238	166 pCi/g	127 pCi/g	1,075.0 pCi/g	No
Plutonium-239	**1,860** pCi/g	**13,200** pCi/g	968.7 pCi/g	No

[a]Chemical FALs from CAU 309 CAIP PALs; radiological FALs from RESRAD Land Parcel 1.

FALS = Final action levels
mg/kg = Milligrams per kilogram
NTS = Nevada Test Site
PALs - Preliminary action levels
pCi/g = Picocuries per gram
RESRAD - Residual Radioactive
TPH-DRO = Total petroleum hydrocarbons, diesel-range organics
µg/kg = Micrograms per kilogram

A.5.0 CAS 12-28-01 I-, J-, and K-Tunnel Debris

Corrective Action Site 12-28-01 is defined as debris ejected during the Des Moines and Platte Tests and the associated contamination that is not covered in the two muckpiles CASs. This site consists of debris scattered south of the I-, J-, and K-Tunnel muckpiles and extends down the hillside, across the valley, and onto the adjacent hillside to the south. In addition, the site covers contamination associated with "ventings" along fractures and various boreholes on the mesa top and face. The operational history is also similar to the other two CASs. The T-Tunnel ponds and other support facilities constructed in impacted areas after the release (blowout) do not appear to have spread contaminants. The T-Tunnel ponds are located in the posted area at the bottom of the canyon. These ponds are covered in CAU 478, CAS 12-23-01 and are excluded from further discussions in CAU 309.

A.5.1 Corrective Action Investigation

A total of 53 characterization samples (including 4 FDs) were collected during investigation activities at CAS 12-28-01, including 11 that were collected before the start of the CAI. The sample IDs, locations, types, and analyses are listed in Table A.5-1. The specific CAI activities conducted to satisfy the CAIP requirements at this CAS are described in the following sections.

In August 2004, SNJV personnel collected 26 surface soil samples for in-house analysis of gamma-emitting radionuclides. The locations are shown in Figure A.3-1 as locations 1 through 26 and are also listed in Table A.5-1. The results of this analysis were used to develop a correlation of on-site gamma spectroscopy with off-site laboratory analysis and to assess the general magnitude of the fallout plume. Eleven of these samples were sent to Paragon Analytical Laboratory for gamma-emitting radionuclides, isotopic Pu, Sr-90, beryllium, and lead analyses. These 11 samples are included in the 53 characterization samples collected above. Results of the 11 samples are included in the following sections and were used to determine current site conditions and if beryllium was present at levels that would require additional PPE for site workers. Results of the soil samples indicate lead and beryllium concentrations well below PALs and safety concerns. Radiological results from these 11 samples indicate Am-241, Cs-137, Pu-238, and Pu-239 and Pu-240 were

Table A.5-1
Samples Collected at CAS 12-28-01, I-, J-, and K-Tunnel Debris
(Page 1 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
C01	309C008A	0 - 0.5	Soil	Environmental	Set 2
C02	309C009A	0 - 0.5	Soil	Environmental	Set 2
C03	309C010A	0 - 0.5	Soil	Environmental	Set 2
C04	309C011A	0 - 0.5	Soil	Environmental	Set 2
C05	309C020	0 - 0.5	Soil	Environmental	Set 2
C06	309C021	0 - 0.5	Soil	Environmental	Set 2
	309C022	0.75 - 1	Soil	Environmental	Set 2
C07	309C023	0 - 0.5	Soil	Environmental, MS/MSD	Set 2
	309C024	0 - 0.5	Soil	Field Duplicate of #309C023	Set 2
	309C025	0.75 - 1	Soil	Environmental	Set 2
C08	309C026	0 - 0.5	Soil	Environmental	Set 2
C09	309C027	0 - 0.5	Soil	Environmental	Set 2
C10	309C003A	0 - 0.5	Soil	Environmental	Set 2
C11	309C001A	0 - 0.5	Soil	Environmental, MS/MSD	Set 2
	309C002A	0 - 0.5	Soil	Field Duplicate of #309C001A	Set 2
C12	309C004A	0 - 0.5	Soil	Environmental	Set 2
C13	309C005A	0 - 0.5	Soil	Environmental	Set 2
C14	309C006A	0 - 0.5	Soil	Environmental	Set 2
C15	309C007A	0 - 0.5	Soil	Environmental	Set 2
C16	309C039	0 - 0.5	Soil	Environmental	Set 2
C17	309C041	0 - 0.5	Soil	Environmental	Set 2
C18	309C042	0 - 0.5	Soil	Environmental	Set 2
C19	309C040	0 - 0.5	Soil	Environmental	Set 2
C20	309C031	0 - 0.5	Soil	Environmental	Set 2
C21	309C032	0 - 0.5	Soil	Environmental	Set 2
C22	309C033	0 - 0.5	Soil	Environmental	Set 2
C23	309C034	0 - 0.5	Soil	Environmental	Set 2
C24	309C035	0 - 0.5	Soil	Environmental	Set 2
C25	309C036	0 - 0.5	Soil	Environmental	Set 2
C26	309C037	0 - 0.5	Soil	Environmental, MS/MSD	Set 2
	309C038	0 - 0.5	Soil	Field Duplicate of #309C037	Set 2
C27	309C012A	0 - 0.5	Soil	Environmental	Set 2
	309C016	0.75 - 1	Soil	Environmental	Set 2

Table A.5-1
Samples Collected at CAS 12-28-01, I-, J-, and K-Tunnel Debris
(Page 2 of 2)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses
C28	309C013A	0 - 0.5	Soil	Environmental	Set 2
	309C017	0.75 - 1	Soil	Environmental	Set 2
C29	309C014A	0 - 0.5	Soil	Environmental	Set 2
	309C018	1 - 1.5	Soil	Environmental	Set 2
C30	309C015	0 - 0.5	Soil	Environmental	Set 2
	309C019	0.75 - 1	Soil	Environmental	Set 2
C31	309C028	0 - 0.5	Soil	Environmental	Set 2
C32	309C030	0 - 0.5	Soil	Environmental	Set 2
C33	309C029	0 - 0.5	Soil	Environmental	Set 2
Samples Collected Before Field Investigation Activities					
4	309C010	0 - 0.5	Soil	Environmental	Set 3
	309C011	0 - 0.5	Soil	Field Duplicate of 309C010	Set 3
5	309C009	0 - 0.5	Soil	Environmental	Set 3
8	309C008	0 - 0.5	Soil	Environmental	Set 3
12	309C007	0 - 0.5	Soil	Environmental	Set 3
15	309C003	0 - 0.5	Soil	Environmental	Set 3
16	309C004	0 - 0.5	Soil	Environmental	Set 3
19	309C005	0 - 0.5	Soil	Environmental	Set 3
22	309C006	0 - 0.5	Soil	Environmental	Set 3
23	309C002	0 - 0.5	Soil	Environmental	Set 3
25	309C001	0 - 0.5	Soil	Environmental	Set 3

Set 2 = Isotopic americium, isotopic plutonium, isotopic uranium, strontium-90, gamma spectroscopy
Set 3 = Beryllium, lead, isotopic plutonium, strontium-90, gamma spectroscopy

ft bgs = Feet below ground surface
MS/MSD = Matrix spike/matrix spike duplicate
NA = Not applicable

detected above PALs but below FALs in samples collected within the fallout plumes from the J- and K-Tunnels.

A.5.1.1 Field Screening

Investigation samples were field screened for VOCs, total alpha and beta/gamma radiation, and gamma radiation. The FSRs were compared to FSLs to guide subsequent sampling decisions where

appropriate. The VOC headspace FSRs were not exceeded in samples collected at this CAS. Gross alpha and/or total beta/gamma radiation FSLs were exceeded in 37 samples. Samples were also analyzed for gamma radiation via the gamma spectrometer in Building 153. Gamma spectroscopy results were compared to the FSLs. Seven samples had FSRs exceeding the FSLs. The field screening results showed consistency with the results of the RSL flyover survey.

A.5.1.2 Radiological Surveys

See Section A.2.2.2 for information regarding the low-altitude, aerial radiological survey conducted by RSL at CAU 309.

Results for the swipe collection survey conducted on the debris that were ejected from the J-Tunnel blowout from inside the contamination area, across the valley, indicate no removable alpha and beta/gamma contamination. The miscellaneous debris included the portal door and I-beams.

A.5.1.3 Visual Inspections

Prior to intrusive activities, the site was visually inspected and photo documented. The visual inspection focused on biasing factors such as staining or ditches and drainages off the blowout plume that could provide a preferential pathway for the transport of contaminants. The visual inspection resulted in several sampling locations being moved. Specifically, observations and changes were made as follows:

- Location C05 was moved because the location was inaccessible due to a steep embankment.
- Location C07 was moved beneath a wooden debris pile.
- Location C08 was moved inside the CA fence boundary.
- Location C10 was moved so a soil sample could be collected from directly beneath a debris pile. The debris pile included I-beams and various metal debris.
- Location C12 was moved so a soil sample could be collected from directly beneath a debris pile.
- Locations C27 through C30 were added to the sampling due to having the highest radiological field screening within the contamination area posting fence. The sample (309C016) at

location C27 was collected beneath sample 309C012A. The upper sample had higher concentrations of radiological contamination.

- Location C31 was moved to the center of locations C27 through C30. This sample contained trinity glass.
- Location C32 was added to capture contaminants from a drainage near a cement yard.
- Location C33 was added to capture contaminants from a drainage near an equipment yard.

No staining was observed during site walkovers. No additional biased sample locations were identified.

A.5.1.4 Sample Collection

A total of 53 environmental samples (including 4 FDs) were collected during investigation activities at CAS 12-28-01.

Decision I and Decision II environmental sampling activities included the collection of biased surface and subsurface soil samples within and surrounding the blowout plume (Figure A.3-1), on the mesa top, and locations to the south and east downgradient of the blowout plume.

Environmental samples were collected from the soil at the blowout plume from the surface interval from 0 to 0.5 ft bgs. Subsurface samples were collected at this CAS from intervals ranging from 0.75 to 1.5 ft bgs. Soil samples were collected below wooden and metal debris, however, no staining was evident in the soil. Photographs were taken to document these observation and are in project files.

No samples were collected at this CAS for waste characterization and disposal determination. Investigation samples were collected as outlined in the CAU 309 CAIP (NNSA/NSO, 2004) and submitted for laboratory analysis.

A.5.1.5 Deviations

There were no significant deviations from the CAIP requirements at this CAS. The investigation and sampling at CAS 12-28-01 is considered sufficient to meet the DQOs. The requirements listed in the CAIP for this CAS have been met, and no revisions to the CSM were necessary.

A.5.2 Investigation Results

The following sections provide analytical results from the samples collected to complete investigation activities as outlined in the CAIP. Investigation samples were analyzed for the CAIP-specified COPCs, which included gamma-emitting radionuclides, isotopic U, isotopic Pu, isotopic Am and Sr-90. The following parameters were not analyzed for at this CAS during the main CAI in June 2005, because they were not identified as required in the CAIP; total VOCs, total SVOCs, TPH-DRO, total RCRA metals, beryllium and PCBs. Beryllium, and lead, however, were included in the analytical suite for the eleven samples that were collected in August 2004. The analytical parameters and laboratory methods used to analyze the investigation samples are listed in Table A.2-2. Table A.5-1 lists the sample-specific analytical suite for CAS 12-28-01.

A.5.2.1 Beryllium and Lead

In August 2004, SNJV personnel collected 11 samples that were sent to Paragon Analytical Laboratory for beryllium and lead analyses. Beryllium and lead analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.5-2. No metals were detected at concentrations exceeding their FALs. These data supported the decision to eliminate these parameters from the analytical suite.Gamma-Emitting Radionuclides

Gamma-emitting radionuclides analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.5-3. None of the gamma-emitting radionuclide concentrations except Am-241 and Cs-137 exceeded their respective PALs; therefore, for these radionuclides, the PALs are identified as the FALs. Americium-241 exceeded the PAL (12.7 PCi/g) in 21 of the 53 environmental samples at 19 locations ranging from 12.4 to 150 pCi/g. Cesium-137 was detected at concentrations that exceeded the PAL (12.2 pCi/g) in 36 of the 53 environmental soil samples at 29 locations ranging in concentration from 12.2 to 330 pCi/g. These two radionuclides were moved onto a Tier 2 evaluation in which the RESRAD code was used to determine the site-specific FALs for these radionuclides. The calculation of the FAL for Am-241 and Cs-137 are presented in Appendix C. The Tier 2 evaluation resulted in a FAL for Am-241 of 893.6 pCi/g. None of the reported concentrations of Am-241 in the soil samples collected at this CAS exceeded this value. Based on the results of the Tier 2 evaluation, only Cs-137 had a reported concentration that exceeded the FAL of 196.7 pCi/g in 5 samples at 5 locations. Sample 309C010A

Table A.5-2
August, 2004, Soil Sample Results for Metals Detected Above Minimum Reporting Limits at CAS 12-28-01, I-, J-, and K-Tunnel Debris

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)	
			Beryllium	Lead
Final Action Levels[a]			**1,900**	**750**
4	309C010	0 - 0.5	0.43 (J-)	7.4
	309C011	0 - 0.5	0.48 (J-)	8.7
5	309C009	0 - 0.5	0.67	7.1
8	309C008	0 - 0.5	0.59	9
12	309C007	0 - 0.5	0.96	12
15	309C003	0 - 0.5	0.43 (J-)	14
16	309C004	0 - 0.5	0.66	17
19	309C005	0 - 0.5	0.98	37
22	309C006	0 - 0.5	0.76	17
23	309C002	0 - 0.5	0.93	7.3
25	309C001	0 - 0.5	0.54 (J-)	16

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2002)

ft bgs = Feet below ground surface
J- = The result is an estimated quantity, but the result may be biased low. Negative bias found in continuing calibration/method blank.
mg/kg = Milligrams per kilogram

at location C03 had the highest concentration of Cs-137 at 330 pCi/g. Based on this evaluation, Cs-137 is considered a COC for CAS 12-28-01.

Table A.5-3
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentration at CAS 12-28-01, I-, J-, and K-Tunnel Debris
(Page 1 of 4)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)																			
			Actinium-228[a]		Aluminum-26[b]	Americium-241[b]	Bismuth-212[a]		Bismuth-214[a]		Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Europium-155[b]	Lead-212[a]		Lead-214[a]		Thallium-208[a]	
Final Action Levels			**5**	**15**	**2.32**	**893.6**	**5**	**15**	**5**	**15**	**2.7**	**196.7**	**5.7**	**135**	**5**	**15**	**5**	**15**	**5**	**15**
Depth bgs (cm)			**<15**	**>15**			**<15**	**>15**	**<15**	**>15**					**<15**	**>15**	**<15**	**>15**	**<15**	**>15**
C01	309C008A	0 - 0.5	2.32 (G)	NA	--	52 (J)[c]	--	NA	--	NA	--	153 (G, M3)	1.5 (J)[c]	--	1.97 (J)[c]	NA	--	NA	--	NA
C02	309C009A	0 - 0.5	2.11 (G)	NA	--	82 (J)[c]	--	NA	--	NA	--	167 (G, M3)	1.63 (J)[c]	--	2.1 (J)[c]	NA	--	NA	0.8 (G)	NA
C03	309C010A	0 - 0.5	2.34 (G)	NA	--	117 (J)[c]	--	NA	--	NA	0.4 (G)	**330** (G)	2.95 (J)[c]	--	2.14 (J)[c]	NA	--	NA	--	NA
C04	309C011A	0 - 0.5	1.76 (G, TI)	NA	--	73.9 (J)[c]	--	NA	--	NA	--	**211** (G, M3)	2.05 (J)[c]	--	1.77 (J)[c]	NA	--	NA	--	NA
C05	309C020	0 - 0.5	1.54 (G)	NA	--	21.4 (J)[c]	--	NA	1.23 (G, J)	NA	--	67.8 (G)	--	--	2.17 (J)[c]	NA	1.43 (G, J)	NA	0.9 (G)	NA
C06	309C021	0 - 0.5	--	NA	--	88 (J)[c]	--	NA	--	NA	0.41 (G)	**230** (G, M3)	2.45 (J)[c]	--	1.69 (J)[c]	NA	--	NA	--	NA
	309C022	0.75 - 1	NA	1.28 (G)	--	1.14 (J)[c]	NA	--	NA	0.84 (G, J)	--	3.05 (G)	--	--	NA	1.75 (J)[c]	NA	1.04 (G, J)	NA	0.44 (G)
C07	309C023	0 - 0.5	2.13 (G)	NA	--	34.8 (J)[c]	--	NA	1.13 (G, J)	NA	--	100 (G)	--	--	2.61 (J)[c]	NA	1.88 (G, J)	NA	0.88 (G)	NA
	309C024	0 - 0.5	2.7 (G, TI)	NA	--	36.2 (J)[c]	--	NA	1.3 (G, J)	NA	0.26 (G, TI)	96 (G, M3)	--	--	1.77 (J)[c]	NA	--	NA	0.77 (G)	NA
	309C025	0.75 - 1	NA	2.66 (G)	--	5.6 (J)[c]	NA	--	NA	1.36 (G, J)	--	13.9 (G)	--	--	NA	2.33 (J)[c]	NA	1.64 (G, J)	NA	0.81 (G)
C08	309C026	0 - 0.5	1.84 (G)	NA	--	24.7 (J)[c]	--	NA	1.12 (G, J)	NA	--	59.2 (G)	--	0.74 (J)	2.2 (J)[c]	NA	1.4 (G, J)	NA	0.74 (G)	NA
C09	309C027	0 - 0.5	1.24 (G)	NA	--	5.3 (J)[c]	--	NA	0.58 (G, J)	NA	--	12.2 (G)	--	--	1.37 (J)[c]	NA	0.83 (G, J)	NA	0.52 (G)	NA
C10	309C003A	0 - 0.5	1.65 (G)	NA	--	6.5 (J)[c]	--	NA	1.09 (G, J)	NA	--	22 (G)	--	--	1.95 (J)[c]	NA	1.37 (G, J)	NA	0.46 (G)	NA
C11	309C001A	0 - 0.5	2.27 (G)	NA	--	11.2 (J)[c]	--	NA	1.21 (G, J)	NA	--	39.3 (G)	--	--	2.95 (J)[c]	NA	1.49 (G, J)	NA	0.99 (G)	NA
	309C002A	0 - 0.5	2.41 (G)	NA	--	10.5 (J)[c]	--	NA	1.39 (G, J)	NA	--	32.8 (G)	--	--	2.81 (J)[c]	NA	1.65 (G, J)	NA	0.96 (G)	NA
C12	309C004A	0 - 0.5	1.85 (G)	NA	0.109 (G, TI)	18.6 (J)[c]	--	NA	1.61 (G, J)	NA	--	66.4 (G)	--	--	2.12 (J)[c]	NA	1.52 (G, J)	NA	0.59 (G)	NA
C13	309C005A	0 - 0.5	2.16 (G)	NA	--	15.5 (J)[c]	--	NA	1.73 (G, J)	NA	--	52.1 (G)	--	--	2.79 (J)[c]	NA	1.87 (G, J)	NA	0.97 (G)	NA
C14	309C006A	0 - 0.5	2.66 (G)	NA	--	22.9 (J)[c]	2.9 (G)	NA	1.6 (G, J)	NA	--	69.2 (G)	--	--	2.55 (J)[c]	NA	1.85 (G, J)	NA	0.71 (G)	NA
C15	309C007A	0 - 0.5	2.56 (G)	NA	--	16.7 (J)[c]	--	NA	1.28 (G, J)	NA	--	55.5 (G)	--	--	2.3 (J)[c]	NA	1.48 (G, J)	NA	0.61 (G)	NA
C16	309C039	0 - 0.5	2.49 (G)	NA	--	--	--	NA	1.65 (G, J)	NA	--	1.79 (G)	--	--	2.77 (J)[c]	NA	1.55 (G, J)	NA	1.01 (G)	NA

Table A.5-3
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentration at CAS 12-28-01, I-, J-, and K-Tunnel Debris
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Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)																	
			Actinium-228[a]		Aluminum-26[b]	Americium-241[b]	Bismuth-212[a]		Bismuth-214[a]		Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Europium-155[b]	Lead-212[a]		Lead-214[a]		Thallium-208[a]	
Final Action Levels			5	15	2.32	893.6	5	15	5	15	2.7	196.7	5.7	135	5	15	5	15	5	15
Depth bgs (cm)			<15	>15			<15	>15	<15	>15					<15	>15	<15	>15	<15	>15
C17	309C041	0 - 0.5	1.87 (G)	NA	--	18.4 (J)[c]	--	NA	1.33 (G, J)	NA	--	68.7 (G)	--	--	2.12 (J)[c]	NA	2.09 (G, J)	NA	0.7 (G)	NA
C18	309C042	0 - 0.5	1.63 (G)	NA	--	6.26 (J)[c]	--	NA	1.4 (G, J)	NA	--	28 (G)	--	--	2.12 (J)[c]	NA	1.38 (G, J)	NA	0.7 (G)	NA
C19	309C040	0 - 0.5	1.95 (G)	NA	--	6.15 (J)[c]	--	NA	1.7 (G, J)	NA	--	22.9 (G)	--	--	2.87 (J)[c]	NA	1.91 (G, J)	NA	0.89 (G)	NA
C20	309C031	0 - 0.5	2.34 (G)	NA	--	0.74 (J)[c]	2.97 (G)	NA	1.28 (G, J)	NA	--	2.87 (G)	--	--	2.53 (J)[c]	NA	1.49 (G, J)	NA	0.74 (G)	NA
C21	309C032	0 - 0.5	1.66 (G)	NA	--	--	--	NA	1.14 (G, J)	NA	--	5.06 (G)	--	--	2.19 (J)[c]	NA	1.01 (G, J)	NA	0.67 (G)	NA
C22	309C033	0 - 0.5	2.43 (G)	NA	--	8.4 (J)[c]	--	NA	1.43 (G, J)	NA	--	23.9 (G)	--	--	3.13 (J)[c]	NA	1.71 (G, J)	NA	1.08 (G)	NA
C23	309C034	0 - 0.5	2.37 (G)	NA	--	1.86 (J)[c]	--	NA	1.53 (G, J)	NA	--	4.64 (G)	--	--	3.18 (J)[c]	NA	1.81 (G, J)	NA	0.89 (G)	NA
C24	309C035	0 - 0.5	2.33 (G)	NA	--	8.2 (J)[c]	--	NA	1.52 (G, J)	NA	--	13 (G)	--	--	3.02 (J)[c]	NA	1.72 (G, J)	NA	0.96 (G)	NA
C25	309C036	0 - 0.5	2.86 (G)	NA	--	7.4 (J)[c]	2.9 (G)	NA	1.6 (G, J)	NA	--	12 (G)	--	--	3.33 (J)[c]	NA	1.85 (G, J)	NA	0.86 (G)	NA
C26	309C037	0 - 0.5	2.57 (G)	NA	--	12.5 (J)[c]	--	NA	1.82 (G, J)	NA	--	20.8 (G)	--	--	3.45 (J)[c]	NA	1.88 (G, J)	NA	0.97 (G)	NA
	309C038	0 - 0.5	2.63 (G)	NA	--	9.4 (J)[c]	--	NA	1.41 (G, J)	NA	--	17 (G)	--	--	3.24 (J)[c]	NA	1.62 (G, J)	NA	0.99 (G)	NA
C27	309C012A	0 - 0.5	1.92 (G)	NA	--	105 (J)[c]	--	NA	--	NA	0.5 (G)	**280** (G)	3.08 (J)[c]	--	--	NA	--	NA	--	NA
	309C016	0.75 - 1	NA	2.3 (G)	--	12.4 (J)[c]	NA	2.6 (G)	NA	0.95 (G, J)	--	36 (G)	--	--	NA	2.39 (J)[c]	NA	1.36 (G, J)	NA	0.67 (G)
C28	309C013A	0 - 0.5	1.69 (G)	NA	--	42.2 (J)[c]	--	NA	1.15 (G, J)	NA	--	106 (G, M3)	--	--	1.93 (J)[c]	NA	--	NA	0.86 (G)	NA
	309C017	0.75 - 1	NA	2 (G)	--	--	NA	--	NA	1.48 (G, J)	--	6.3 (G)	--	--	NA	2.29 (J)[c]	NA	1.71 (G, J)	NA	0.51 (G)
C29	309C014A	0 - 0.5	2.05 (G)	NA	--	17.4 (J)[c]	--	NA	1.13 (G, J)	NA	--	51.7 (G)	--	--	2.2 (J)[c]	NA	--	NA	0.85 (G)	NA
	309C018	1 - 1.5	1.57 (G)	NA	--	2.84 (J)[c]	NA	--	NA	1.25 (G, J)	--	4.78 (G)	--	--	NA	2.37 (J)[c]	NA	1.46 (G, J)	NA	0.73 (G)
C30	309C015	0 - 0.5	1.98 (G)	NA	--	47.3 (J)[c]	--	NA	1.19 (G, J)	NA	--	150 (G)	1.61 (J)[c]	--	1.98 (J)[c]	NA	1.75 (G, J)	NA	0.74 (G)	NA
	309C019	0.75 - 1	NA	2.08 (G)	--	--	NA	--	NA	1.02 (G, J)	--	14.6 (G)	--	--	NA	2.24 (J)[c]	NA	1.36 (G, J)	NA	0.72 (G)
C31	309C028	0 - 0.5	1.83 (G)	NA	--	150 (J)[c]	--	NA	--	NA	0.64 (G)	**280** (G)	3.95 (J)[c]	--	1.52 (J)[c]	NA	--	NA	--	NA
C32	309C029	0 - 0.5	2.47 (G)	NA	--	1.42 (J)[c]	--	NA	1.06 (G, J)	NA	--	4.33 (G)	--	--	2.29 (J)[c]	NA	1.36 (G, J)	NA	0.79 (G)	NA

Table A.5-3
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentration at CAS 12-28-01, I-, J-, and K-Tunnel Debris
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Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)																	
			Actinium-228[a]		Aluminum-26[b]	Americium-241[b]	Bismuth-212[a]		Bismuth-214[a]		Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Europium-155[b]	Lead-212[a]		Lead-214[a]		Thallium-208[a]	
Final Action Levels			5	15	2.32	893.6	5	15	5	15	2.7	196.7	5.7	135	5	15	5	15	5	15
Depth bgs (cm)			<15	>15			<15	>15	<15	>15					<15	>15	<15	>15	<15	>15
C33	309C030	0 - 0.5	2.24 (G)	NA	--	--	--	NA	1.18 (G, J)	NA	--	2.33 (G)	--	--	2.61 (J)[c]	NA	1.37 (G, J)	NA	0.8 (G)	NA
Samples Collected Prior to Field Investigation Activities																				
4	309C010	0 - 0.5	2.11 (G)	NA	--	--	--	NA	1.24 (G, J)	NA	--	3.62 (G)	--	--	2.77 (J)[c]	NA	1.63 (G, J)	NA	0.71 (G)	NA
	309C011	0 - 0.5	2.16 (G)	NA	--	0.92 (J)[c]	--	NA	1.51 (G, J)	NA	--	3.01 (G)	--	--	2.66 (J)[c]	NA	1.68 (G, J)	NA	0.76 (G)	NA
5	309C009	0 - 0.5	2.65 (G)	NA	--	--	--	NA	1.37 (G, J)	NA	--	2.2 (G)	--	--	2.93 (J)[c]	NA	1.36 (G, J)	NA	0.98 (G)	NA
8	309C008	0 - 0.5	2.22 (G)	NA	--	--	--	NA	1.3 (G, J)	NA	--	3.39 (G)	--	--	2.71 (J)[c]	NA	1.44 (G, J)	NA	0.7 (G)	NA
12	309C007	0 - 0.5	2.54 (G)	NA	--	3.44 (J)[c]	--	NA	1.15 (G, J)	NA	--	2.48 (G)	--	--	2.83 (J)[c]	NA	1.44 (G, J)	NA	0.95 (G)	NA
15	309C003	0 - 0.5	1.94 (G)	NA	--	5.8 (J)[c]	--	NA	1.28 (G, J)	NA	--	26.2 (G)	--	--	2.58 (J)[c]	NA	1.54 (G, J)	NA	0.72 (G)	NA
16	309C004	0 - 0.5	1.93 (G)	NA	--	11.6 (J)[c]	--	NA	1.59 (G, J)	NA	--	34.9 (G)	--	--	2.88 (J)[c]	NA	1.8 (G, J)	NA	0.7 (G)	NA
19	309C005	0 - 0.5	1.95 (G)	NA	--	38.1 (J)[c]	--	NA	--	NA	--	122 (G, M3)	--	--	2.05 (J)[c]	NA	--	NA	--	NA
22	309C006	0 - 0.5	2.1 (G)	NA	--	5.5 (J)[c]	--	NA	1.52 (G, J)	NA	--	23.1 (G)	--	--	2.84 (J)[c]	NA	1.82 (G, J)	NA	0.76 (G)	NA
23	309C002	0 - 0.5	2.2 (G)	NA	--	1.83 (J)[c]	--	NA	1.98 (G, J)	NA	--	4.35 (G)	--	--	3 (J)[c]	NA	2.14 (G, J)	NA	0.86 (G)	NA
25	309C001	0 - 0.5	2.29 (G)	NA	--	8.6 (J)[c]	--	NA	1.39 (G, J)	NA	--	30.5 (G)	--	--	2.82 (J)[c]	NA	1.37 (G, J)	NA	0.81 (G)	NA

Table A.5-3
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Detectable Concentration at CAS 12-28-01, I-, J-, and K-Tunnel Debris
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Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)																	
			Actinium-228[a]		Aluminum-26[b]	Americium-241[b]	Bismuth-212[a]		Bismuth-214[a]		Cobalt-60[b]	Cesium-137[b]	Europium-152[b]	Europium-155[b]	Lead-212[a]		Lead-214[a]		Thallium-208[a]	
Final Action Levels			5	15	2.32	893.6	5	15	5	15	2.7	196.7	5.7	135	5	15	5	15	5	15
Depth bgs (cm)			<15	>15			<15	>15	<15	>15					<15	>15	<15	>15	<15	>15

[a]Taken from the generic guidelines for residual concentrations of actinium-228, bismuth-214, lead-212, lead-214, thallium-208, and thorium-232, as found in Chapter IV of DOE Order 5400.5, Change 2, "Radiation Protection of the Public and Environment." (DOE, 1993). The PALs for these isotopes is specified as 5 pCi/g averaged over the first 15 cm of soil and 15 pCi/g for deeper soils (DOE, 1993). For purposes of this document, 15 cm is assumed to be equivalent to 0.5 ft (6 inches); therefore, 5 pCi/g represents the PALs for these radionuclides in the surface soil (0 to 0.5 ft depth).
[b]Taken from the construction, commercial, industrial land use scenario in Table 2.1 of the NCRP 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 document were scaled to a 25-mrem/yr. dose.
[c]Qualifier added to laboratory data; record accepted. Sample does not meet counting geometry requirements.

cm = Centimeter
ft bgs = Feet below ground surface
G = Sample density differs by more than 15% of laboratory control sample density.
J = Estimated value.
M3 = The reported minimum detected concentration was not met, but the reported activity is greater than the reported minimum detectable concentration.
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits
< = Less than
> = Greater than

A.5.2.3 Plutonium, Strontium-90, Americium, and Uranium Isotopes

Isotopic Pu, U and Am, and Sr-90 analytical results for environmental samples collected at this CAS that were detected above MDCs are presented in Table A.5-4. Concentrations of Sr-90 and isotopic U (i.e., U-234, -235, and -238) did not exceed the PALs and therefore the PALs for these radionuclides are considered the FALs.

Table A.5-4
Soil Sample Results for Isotopes Detected Above
Minimum Detectable Concentrations at CAS 12-28-01, I-, J-, and K-Tunnel Debris
(Page 1 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Americium-241	Plutonium-238	Plutonium-239	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels[a]			**893.6**	**1,075**	**968.7**	**838**	**143**	**17.6**	**105**
C01	309C008A	0 - 0.5	47.6 (M3)	17.9 (M3)	187 (M3)	7.5	2.51	0.081	0.96
C02	309C009A	0 - 0.5	54.8 (M3)	21.6 (M3)	222 (M3)	6.2	2.47	0.115	0.86
C03	309C010A	0 - 0.5	102 (M3)	33.6 (M3)	378 (M3)	17.5	4 (M3)	0.146	1.06
C04	309C011A	0 - 0.5	57 (M3)	22.7 (M3)	243 (M3)	10.2	2.62	0.091	0.93
C05	309C020	0 - 0.5	11.8	4.53 (M3)	50.6 (M3)	3.54	1.16	0.05 (LT)	0.93
C06	309C021	0 - 0.5	70 (M3)	24.9 (M3)	284 (M3)	13.6 (Y1)	3.24	0.074	1
	309C022	0.75 - 1	1.11 (M3)	0.37	4.45	--	0.95	0.08	1
C07	309C023	0 - 0.5	39.6 (M3)	14.7 (M3)	154 (M3)	3.9	2.8	0.064	1.24
	309C024	0 - 0.5	31.8 (M3)	11 (M3)	132 (M3)	4.6	2.86	0.071	1.44
	309C025	0.75 - 1	4.53	1.57	18	0.48 (LT)	1.93	0.075	1.41
C08	309C026	0 - 0.5	15.8 (M3)	5.4 (M3)	61 (M3)	2.08	2.25	--	1.21
C09	309C027	0 - 0.5	3.03 (M3)	1.06	11.8	0.56	0.87	0.059	0.78
C10	309C003A	0 - 0.5	6.1	2.53	24.5	1.91	1.33	--	1.09
C11	309C001A	0 - 0.5	15.8	5.4	65	3	1.79	0.083	1.45
	309C002A	0 - 0.5	10.4	4.05	43.6	3.57	1.95	0.089	1.52
C12	309C004A	0 - 0.5	22.2	8.5	91	4.5	2.09	0.085	1.28
C13	309C005A	0 - 0.5	18.4	5.73	61.2	3.87	2.05	0.073	1.39
C14	309C006A	0 - 0.5	15.7	5.79	58.8	4.4	2.01	0.131	1.25
C15	309C007A	0 - 0.5	13.2	5.39	50.8	2.81	1.56	--	1.28
C16	309C039	0 - 0.5	0.54	0.96	3.3	0.58 (Y1)	1.19	0.094	1.3

Table A.5-4
Soil Sample Results for Isotopes Detected Above
Minimum Detectable Concentrations at CAS 12-28-01, I-, J-, and K-Tunnel Debris
(Page 2 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Americium-241	Plutonium-238	Plutonium-239	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels[a]			**893.6**	**1,075**	**968.7**	**838**	**143**	**17.6**	**105**
C17	309C041	0 - 0.5	18.1	6.7	73	3.5	2.28	0.083	1.52
C18	309C042	0 - 0.5	7.5	2.99	29.9	1.88	1.42	--	1.13
C19	309C040	0 - 0.5	4.15	2.14	21.9	1.57 (Y1)	1.52	0.06	1.35
C20	309C031	0 - 0.5	0.62	1.21	3.76	0.58 (Y1)	1.07	0.072	1.1
C21	309C032	0 - 0.5	0.89	0.86	4.26	0.48 (LT)	0.84	0.065	0.91
C22	309C033	0 - 0.5	7.6	3.12	33.7	1.7	1.9	0.062	1.33
C23	309C034	0 - 0.5	1.94	0.7	8.2	0.59	1.27	0.063	1.18
C24	309C035	0 - 0.5	9.3	3.07	34.1	1.29	1.51	0.077	1.39
C25	309C036	0 - 0.5	9.1	3.14	32.9	1.52	1.68	0.076	1.4
C26	309C037	0 - 0.5	10.8	3.39	31.4	1.4	1.93	0.084	1.47
	309C038	0 - 0.5	8.1	3.55	30.5	1.5	1.6	0.055	1.43
C27	309C012A	0 - 0.5	93 (M3)	37.4 (M3)	385 (M3)	15.1	3.88	0.131	1.1
	309C016	0.75 - 1	14.2 (M3)	4.1 (M3)	53.9 (M3)	2.04	1.72	0.065	0.98
C28	309C013A	0 - 0.5	32.5 (M3)	15.6 (M3)	157 (M3)	6.5	1.97	0.081	1.05
	309C017	0.75 - 1	1.44	0.61	7 (M3)	0.43 (LT)	2.9	0.095	1.47
C29	309C014A	0 - 0.5	14.4 (M3)	5.2 (M3)	62 (M3)	2.81	1.75	0.077	1.05
	309C018	1 - 1.5	1.28	0.61	6.8	--	1.43	0.056	1.01
C30	309C015	0 - 0.5	44.5 (M3)	14.6 (M3)	180 (M3)	7.7	2.55	--	0.98
	309C019	0.75 - 1	4.4	1.68	19.4	1	1.3	0.057	0.98
C31	309C028	0 - 0.5	69 (M3)	25.4 (M3)	326 (M3)	14.2 (Y1)	3.93	0.102	0.95
C32	309C029	0 - 0.5	1.44	2.62	8.2	0.59 (Y1)	1.27	0.069	1.03
C33	309C030	0 - 0.5	0.82	2.48 (J)	5.5 (M3)	--	1.13	0.057	1.07
Samples Collected Before Field Investigation Activities									
4	309C010	0 - 0.5	--	2.01	6.6	0.56	--	--	--
	309C011	0 - 0.5	--	1.86	5.69	0.69	--	--	--
5	309C009	0 - 0.5	--	0.312	1.61	--	--	--	--
8	309C008	0 - 0.5	--	2.8	8	1.04 (Y1)	--	--	--

Table A.5-4
Soil Sample Results for Isotopes Detected Above
Minimum Detectable Concentrations at CAS 12-28-01, I-, J-, and K-Tunnel Debris
(Page 3 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)						
			Americium-241	Plutonium-238	Plutonium-239	Strontium-90	Uranium-234	Uranium-235	Uranium-238
Final Action Levels[a]			**893.6**	**1,075**	**968.7**	**838**	**143**	**17.6**	**105**
12	309C007	0 - 0.5	--	1.07	9.8	0.59	--	--	--
15	309C003	0 - 0.5	--	2.23	25.2	1.83	--	--	--
16	309C004	0 - 0.5	--	3.49	37.6	2.1	--	--	--
19	309C005	0 - 0.5	--	11.6	130	7.5 (Y1)	--	--	--
22	309C006	0 - 0.5	--	3.37	32.2	1.74	--	--	--
23	309C002	0 - 0.5	--	0.81	7.4	--	--	--	--
25	309C001	0 - 0.5	--	1.76	21.3	1.54	--	--	--

[a]Taken from the construction, commercial, industrial land use scenario in Table 2.1 of the NCRP 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 document were scaled to a 25-mrem/yr. dose.

ft bgs = Feet below ground surface
J = Estimated value. Qualifier added to laboratory data; record accepted. Duplicate precision analysis (relative percent difference) exceeds control limits.
LT = Result is less than the requested minimum detectable concentration, greater than the sample specific minimum detectable concentration.
M3 = The requested minimum detectable concentration was not met, but the reported activity is greater than the reported minimum detectable concentration.
pCi/g = Picocuries per gram
Y1 = Chemical yield is in control at 100 to 110%. Quantitive yield is assumed.
-- = Not detected above minimum reporting limits.

Concentrations of isotopic Am-241 were reported in 20 samples from 19 locations at concentration that exceeded the PAL of 12.7 pCi/g and ranged in concentration from 13.2 to 93 pCi/g. Plutonium-238 was detected in 10 of the 53 environmental samples at 10 surface sample locations at concentrations that exceeded the PAL of 13 pCi/g. Plutonium-239, the most widespread radionuclide, was detected in 36 samples from 25 locations that exceeded the PAL of 12.2 pCi/g. These isotopes were moved to a Tier 2 evaluation in which the RESRAD code was used to determine the site-specific FALs. None of the three isotopes reported concentrations that exceeded their

respective FALs. Based on this evaluation, these radioisotopes are not considered COCs identified for CAS 12-28-01. The calculation of the FAL for these three isotopes is presented in Appendix C.

A.5.3 Nature and Extent of Contamination

The radionuclide Cs-137 was detected at concentrations that exceeded the FAL (196.7 pCi/g) in five of the collected soil samples. The five locations were all within the posted CA fencing located across the valley from J-Tunnel where the portal door was found. In addition, all 5 samples were collected from the surface interval (0.0 to 0.5 ft bgs). Sample 309C010A had the highest concentration at 330 pCi/g at location C03. Location C04 (sample 309C011A) had a concentration of Cs-137 of 211 pCi/g.

Location C06 was under a debris pile and sample 309C021 had a concentration of Cs-137 of 230 pCi/g and the underlying shallow subsurface sample (309C022) had a concentration of only 3.05 pCi/g. This shows a decrease in Cs-137 concentration between the surface and shallow subsurface (0.75-1.0 ft bgs) by two orders of magnitude. Locations C27 through C30 were added to the sampling due to having the highest radiological field screening within the contamination area posting fence. Sample (309C016) at location C27 had a concentration of Cs-137 of 36 pCi/g and was collected beneath sample 309C012A, which had a concentration of 280 pCi/g. Samples from both locations C06 and C27 help demonstrates contamination is restricted to the surficial soils at CAS 12-28-01.

Location C31 (sample 309C028) was moved to the center of locations C27 through C30. This sample contained trinity glass and had a Cs-137 concentration of 280 pCi/g.

None of the other sampling locations around those listed above (see locations C05, C07, C08, and C09) or collected elsewhere at this CAS identified COCs, thus all radiological COCs were bounded to within the posted CA fencing. The extent samples taken downstream and further down the washes from the CAU 309 blowout plume, were not found to be contaminated with COCs (see locations A29, A30, A31, A32, C32, and C33).

Samples collected on top of the mesa were not found to be contaminated with COCs (see locations C22 through C26).

A.5.4 Revised Conceptual Site Model

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

A.6.0 Waste Management

Section A.6.1 through Section A.6.3 address investigation-derived waste (IDW). Section A.6.4 addresses the analytical results of the waste characterization samples collected from various potential remediation waste streams.

A.6.1 Investigation-Derived Waste

Investigation-derived waste was generated during the field investigation activities of CAU 309. The waste streams generated include disposable PPE and disposable sampling equipment. Investigation-derived waste was segregated to the greatest extent possible, and waste minimization techniques were integrated into the field activities to reduce the amount of waste generated. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste. Decontamination activities were planned and executed to minimize or eliminate the volume of rinsate generated.

One hazardous waste accumulation area was established to manage hazardous and potentially hazardous waste generated during the CAI. The amount, type, and source of waste placed into each drum was recorded in a waste management logbook that is maintained in the project file. Wastes generated during a CAI that is known to be hazardous based on process knowledge and/or sample analytical results are placed in containers and labeled "Hazardous Waste." There were no drums of hazardous waste generated from the CAI. Potentially hazardous waste generated during the CAI was placed in containers and labeled "Hazardous Waste – Pending Analysis." Two drums of potentially hazardous waste were generated during the CAI.

A.6.2 Waste Streams

Investigation-derived waste generated during the investigation was segregated into the following waste streams:

- Disposable PPE and sampling equipment including, but not limited to: plastic sheeting, glass/plastic sample jars, PPE, soil, sampling scoops, aluminum foil, and bowls
- Lead bricks from a posted Radioactive Contamination Area (mixed waste).

A.6.3 Investigation-Derived Waste Generated

A total of two drums of IDW were generated during the investigation:

- One drum of PPE/plastic is pending characterization as low-level waste (LLW) and recommendation for disposal at the NTS according to the requirements contained in the *Nevada Test Site Waste Acceptance Criteria* (NNSA/NSO, 2003). This drum was generated at CASs 12-08-02 and 12-28-01.
- One drum of lead bricks is characterized as mixed waste based on process knowledge.

Office waste and lunch trash was disposed of in designated sanitary waste bins allocated for disposal at the NTS sanitary landfill. Sanitary industrial waste was inspected and disposed of in designated sanitary industrial waste bins located at Building 23-153 and allocated for disposal at the NTS industrial waste landfill.

A.6.4 Non-IDW Waste Characterization

Waste characterization samples (swipes and soil) were collected from the surface of the lead bricks and the soil beneath them in at CAS 12-08-02. The analytical suite was tailored to characterize the waste for disposal and to support recommended actions. Results were reviewed against federal regulations, state regulations, and DOE directives/policies/guidance and waste disposal criteria for NTS facilities. Section A.6.4.1 describes the waste characterization samples collected during the CAI at CAU 309. Complete results (including non-detect results) for all samples are maintained in project files.

A.6.4.1 CAS 12-08-02, Contaminated Waste Dump

One waste characterization sample of soil and 4 swipe samples were collected from 5 locations at this CAS. The four swipe samples were collected from the surface of the lead bricks that were removed from the posted contamination area and analyzed for isotopic U, isotopic Pu, and Sr-90. Results show no removable radiological contamination above regulatory release limits. One sample was collected from the soil beneath one of the lead bricks and analyzed for the parameters listed in Table A.3-2. Results indicate lead concentrations of 840 mg/kg and the FAL is 750 mg/kg.

Table A.6-1 lists all the detected results. All analytical data was reviewed to determine a recommended waste disposal path for the waste streams present. Miscellaneous metal and wood debris were swipe surveyed and analyzed for gamma radiation via the gamma spectrometer in Building 153. Results from the gamma spectrometer indicate no removable radiological contamination above regulatory release limits on the debris surveyed.

Table A.6-1
Waste Management Samples Detected Above Minimum Reporting Limits at CAS 12-08-02, Contaminated Waste Dump
(Page 1 of 2)

Sample Number	Sample Matrix	Parameter	Result	Units
309B500	Wipe	Plutonium-238	0.42 (M3)	pCi/sample
		Plutonium-239	4.5 (M3)	pCi/sample
		Uranium-234	0.33 (M3)	pCi/sample
309B501	Wipe	Cesium-137	3.1 (M3)	pCi/sample
		Plutonium-238	0.91 (M3)	pCi/sample
		Plutonium-239	11.8 (M3)	pCi/sample
		Uranium-234	0.41 (M3)	pCi/sample
		Uranium-238	0.32 (M3)	pCi/sample
309B502	Wipe	Cesium-137	5.3 (M3)	pCi/sample
		Plutonium-238	1.06 (M3)	pCi/sample
		Plutonium-239	15.6 (M3)	pCi/sample
		Strontium-90	3.6	pCi/sample
		Uranium-234	0.5 (M3)	pCi/sample
		Uranium-235	0.078	pCi/sample
		Uranium-238	0.33 (M3)	pCi/sample
309B503	Wipe	Cesium-137	7.4 (M3)	pCi/sample
		Plutonium-238	1.4 (M3)	pCi/sample
		Plutonium-239	17.4	pCi/sample
		Strontium-90	3.22	pCi/sample
		Uranium-234	0.44 (M3)	pCi/sample
		Uranium-238	0.27 (M3)	pCi/sample
309B504	Soil	Actinium-228	2.63 (G)	pCi/g
		Americium-241	163 (M3)	pCi/g
		Americium-241	188 (J)[a]	pCi/g
		Arsenic	1.7	mg/kg
		Barium	25	mg/kg

Table A.6-1
Waste Management Samples Detected Above Minimum Reporting Limits at CAS 12-08-02, Contaminated Waste Dump
(Page 2 of 2)

Sample Number	Sample Matrix	Parameter	Result	Units
309B504	Soil	Bismuth-212	3.4 (G)	pCi/g
		Bismuth-214	1.15 (G, J)	pCi/g
		Cadmium	0.69	mg/kg
		Chromium	3.6	mg/kg
		Cobalt-60	1.34 (G)	pCi/g
		Cesium-137	164 (G)	pCi/g
		Europium-152	9 (J)[a]	pCi/g
		Lead	840	mg/kg
		Mercury	0.0017 (J-)	mg/kg
		Lead-212	3.25 (J)[a]	pCi/g
		Lead-214	1.8 (G, J)	pCi/g
		Plutonium-238	40.2 (M3)	pCi/g
		Plutonium-239	516 (M3)	pCi/g
		Strontium-90	27.5 (J)[b]	pCi/g
		Thallium-208	0.88 (G)	pCi/g
		Uranium-234	5.4	pCi/g
		Uranium-235	0.101	pCi/g
		Uranium-238	1.43	pCi/g

[a]Qualifier added to laboratory data; record accepted. Sample does not meet counting geometry requirements.
[b]Qualifier added to laboratory data; record accepted. Some of sample activity reported as strontium-90 may be due to alpha emitting contamination.

G = Sample density differs by more than 15% of laboratory control sample density.
J = Estimated value.
J- = The result is an estimated quantity, but the result may be biased low. Negative bias found in continuing calibration/method blank.
M3 = The reported minimum detected concentration was not met, but the reported activity is greater than the reported minimum detectable concentration.
mg/kg = Milligrams per kilogram
pCi/g = Picocuries per gram

A.7.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 309 CAI. The following sections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in Appendix B.

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of any COPCs present. Rigorous QA/QC was implemented for all laboratory samples including documentation, verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the Industrial Sites QAPP (NNSA/NV, 2002).

A.7.1 Data Validation

Data validation was performed according to the Industrial Sites QAPP and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 309 were evaluated for data quality according to approved protocols and procedures. These guidelines are implemented in a tiered process and are presented in Sections A.7.1.1 through A.7.1.3. 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 2 and Tier 2 evaluations. A Tier 3 evaluation was performed on approximately 5 percent of the data analyzed.

A.7.1.1 Tier 1 Evaluation

Tier 1 evaluation for chemical and radiochemical analysis examines, but is not limited to:

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

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

A.7.1.2 Tier 2 Evaluation

Tier 2 evaluation for chemical and radiochemical analysis examines, but is not limited to:

Chemical:

- 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 (MS)/matrix spike duplicate (MSD) percent recoveries (%R) and relative percent differences (RPDs) evaluated and qualifiers applied to laboratory results, as necessary.
- Field duplicate RPDs evaluated using professional judgment and qualifiers applied to laboratory results, as necessary.
- Laboratory duplicate RPDs evaluated and qualifiers applied to laboratory results, as necessary.
- Surrogate %R evaluated and qualifiers applied to laboratory results, as necessary.

- Laboratory control sample (LCS) %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.

Radioanalytical:

- 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 for Standards and Technology (NIST)-traceable sources.
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations.
- Detector system response to daily or weekly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system.

- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements.
- Documentation of all QC sample preparation complete and properly performed.
- Spectra lines, photon emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration.

A.7.1.3 Tier 3

The Tier 3 review is an independent examination of the Tier 2 evaluation. A Tier 3 review of 5 percent of the sample analytical data was performed by TechLaw, Inc., of Lakewood, Colorado. Tier 2 and Tier 3 results were compared and where differences are noted, data was reviewed and changes were made accordingly. This review included the following additional evaluations:

Chemical:

- Recalculation of all laboratory results from raw data.

Radioanalytical:

- Quality Control sample results (e.g., calibration source concentration, %R, and RPD) verified.
- Radionuclides and their concentration validated as appropriate considering their decay schemes, half-lives, and process knowledge and history of the facility and site.
- Each identified line in spectra verified against emission libraries and calibration results.
- Independent identification of spectra lines, area under the peaks, and quantification of radionuclide concentration in a random number of sample results.

A.7.2 Field Quality Control Samples

Field QC samples consisted of 11 trip blanks, 1 equipment rinsate blank, 1 field blank, 1 source blank, 8 MS/MSDs, and 8 FDs collected and submitted for analysis by the laboratory analytical methods shown in Table A.2-2. The QC samples were assigned individual sample numbers and sent to the laboratory "blind." Additional samples were selected by the laboratory to be analyzed as laboratory duplicates.

Field blanks, source blanks, and equipment rinsates were analyzed for the applicable parameters listed in Table A.2-2 and trip blanks were analyzed for VOCs only.

During the CAI, 8 FDs were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in Table A.2-2. For these samples, the duplicate results precision (i.e., RPDs between the environmental sample results and their corresponding FD sample results) were evaluated to the guidance from approved procedures.

A.7.2.1 Laboratory Quality Control Samples

Analysis of method QC blanks were performed on each sample delivery group (SDG) for inorganics. Analysis for surrogate spikes and preparation blanks (PBs) were performed on each SDG for organics only. Initial and continuing calibration and LCSs were performed for each SDG. The results of these analyses were used to qualify associated environmental sample results according to approved procedures. 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.

A.7.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.7.4 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. Twenty-one nonconformances were issued by the laboratories that may or may not have resulted in qualifying data. These laboratory nonconformances have been accounted for and resolved during the data qualification process.

A.8.0 Summary

Organic, inorganic, and radionuclide constituents detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 309. Assessment of the data generated from investigation activities indicates the FALs were exceeded for radionuclides at CASs 12-08-02 and CAS 12-28-01.

In addition, per the CAU 309 CAIP, the muckpiles at CASs 12-06-09 and 12-08-02 are considered to be contaminated with arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239.

The following summarizes the results for each CAS.

CAS 12-06-09, Muckpile

Based on field observations and analytical results for soil samples collected at this CAS, no COCs were identified during the CAI except for TPH-DRO. The TPH-DRO contamination was limited to the muckpile. Based on previously investigated muckpiles, COCs also include arsenic, lead, Cs-137, Co-60, and Pu-239 within the muckpile.

Based on results of the CAI, Chemical and Radiological COCs were bounded in the downslope direction by samples taken below the toe of the muckpile (see locations A03 and A-14 through A28). Extent samples taken downstream and further down the washes, from the CAU 309 muckpiles, were not found to be contaminated with COCs (see locations A 29, A30, A31, A32, C32, and C33) (Figures A.2-1 through A.2-4).

COCs are confined to the muckpile and no migration is evident. The corrective action alternative at this CAS will be close in place. A use restriction will be placed around the muckpile at CAS 12-06-09.

CAS 12-08-02, Contaminated Waste Dump

Based on field observations and analytical results for soil samples collected at this CAS, the COCs Cs-137 and Pu-239 were identified during the CAI. Sample 309B004 exceeded the FAL of 196.7 pCi/g for Cs-137 with a concentration of 241 pCi/g and the FAL of 968.7 pCi/g for Pu-239 with

a concentration of 1,860 pCi/g. Therefore, both are considered COCs at this CAS. The Cs-137 and Pu-239 contamination was limited to the muckpile.

In addition, based on previously investigated muckpiles, additional COCs include arsenic, lead, TPH-DRO, and Co-60 and are assumed present within the muckpile (contaminated waste dump) only but not the surrounding areas.

Based on results of the samples collected during the CAI, COCs are confined to the muckpile. The corrective action alternative at this CAS will be close in place. A use restriction will be placed around the existing CA fencing at the muckpile at CAS 12-08-02.

CAS 12-28-01, I-, J-, and K-Tunnel Debris

Because there are no muckpiles associated with this CAS, the COCs from previous NTS muckpile investigations do not apply. Based on field observations and analytical results of the environmental samples collected at this CAS, Cs-137 contamination has been released to the surface soil at sample locations C03, C04, C06, C27, and C31. These five locations are all within the posted CA fencing located across the valley from J-tunnel where the portal door was found. This contamination is bounded laterally within the posted CA fencing (see locations C05, C07, C08, and C09) and vertically to the surficial soils as evident at locations C06 and C27, where Cs-137 concentrations decreased sharply at depths of 1-ft bgs.

The corrective action alternative at this CAS will be close in place. A use restriction will be placed around the existing CA fencing at CAS 12-28-01.

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Appendix B

Data Assessment for CAU 309

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 309 CAIP (NNSA/NSO, 2004) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA involves five steps that begin with a review of the DQOs and end with an answer to the DQO decisions. 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 1) or false positive (Type 2) decision errors, and review any special features, potential problems, or any deviations to the sampling design.

Step 2: Conduct a Preliminary Data Review – A preliminary data review should be performed by reviewing QA reports and inspecting the data both numerically and graphically, validating and verifying the data to ensure that the measurement systems performed according to 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 the hypotheses. Identify the key underlying assumptions that could cause a change in one of the DQO decisions.

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

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

B.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A of the CAU 309 CAIP. The DQO decisions are presented with the DQO provisions to limit false negative or false positive decision errors. Special features, potential problems, or any deviations to the sampling design are also presented.

B.1.1.1 Decision I

The Decision I statement as presented in the CAU 309 CAIP for all three CASs (12-08-02, 12-06-09, and 12-28-01): "Is any COPC present in environmental media within the CAS at a concentration exceeding its corresponding final action level?"

The Decision I statement is further defined in three supporting decision statements for the investigation of CASs 12-08-02 and 12-06-09 to contend with two types of analytical data inputs (i.e., historical and newly acquired data). Due to issues with collecting sufficient representative sample populations to answer Decision I directly, the investigation adopted an approach that conservatively infers the partial resolution of Decision I through the use of historical NTS muckpile data. Additional details regarding this approach are provided in Appendix A of the CAU 309 CAIP (NNSA/NSO, 2004).

The Decision Ia statement is: "Are COPCs present in muck samples collected during previous muckpile investigations at levels above current PALs?"

The Decision Ib statement is: "Are COCs present in the samples that can be collected at CAU 309 muckpiles?"

The Decision Ic statement is: "Does the data acquired at CAU 309 muckpiles support the CSM, including the outputs of Decisions Ia and Ib?"

Decision I Rules:

- If the population parameter of any COPC in a target population exceeds the FAL for that COPC, then that COPC is identified as a COC.

- If all COPC concentrations from the muckpiles (CASs 12-08-02 and 12-06-09) are less than corresponding FAL, the decision will be that only those COPCs considered to be expected COCs (i.e., from historical NTS muckpile data) will be assumed to be present at the CAU 309 muckpiles.

- If COCs are not identified from the fallout plume (CAS 12-28-01), then the investigation is complete.

- If a COC is detected, then the Decision II statement must be resolved.

Population parameter: The maximum observed sample result.

B.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 historical data evaluations (Decision Ia for muckpile investigations) combined with data generated from accessible portions of the CAU 309 muckpile will identify COCs, if present, anywhere within the CASs.

2. Having a high degree of confidence that locations selected for newly acquired data will identify COCs if present anywhere within the CAS.

3. Having a high degree of confidence that analyses conducted on the newly acquired data will be sufficient to detect any COCs present in the samples.

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

Criterion 1:

The following methods (stipulated in the CAU 309 DQOs [NNSA/NSO, 2004]) were used in selecting sample locations.

1. Selection of sampling locations associated with FSRs was accomplished by analyzing samples for VOCs using a photoionization detector, alpha and beta/gamma emitting radionucludes using a hand-held NE Technology Electra, and gamma emitting radionuclides using a gamma spectroscopy.

2. Selection of sampling locations associated with elevated radiological readings based on previous aerial and walkover radiological surveys, and other historical survey data.

3. Selection of sampling locations based on reviews of aerial photographs and evaluations, areas of soil erosion on muckpiles, areas of sediment accumulation within washes, and presence of debris, waste, or equipment.

4. Selection of sampling locations associated with visual indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination.

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

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

Criterion 2:

All samples were analyzed using the analytical methods listed in Table 3-5 and Table 3-6 of the CAIP and for the chemical and radiological parameters listed in Section A.3.2.2 of the CAIP. Table B.1-1 provides a reconciliation of samples analyzed to the planned analytical program.

Table B.1-1
CAU 309 Analyses Performed

CAS	ANALYTES										
	Total VOCs	Total SVOCs	PCBs	Metals	TPH-DRO	Gamma Spectroscopy	Isotopic Uranium	Isotopic Americium	Isotopic Plutonium	Strontium-90	Beryllium
12-06-09	RS	RS	RS	RS	RS	RS	RS	RS	RS	RS	RS
12-08-02	RS	RS	RS	RS	RS	RS	RS	RS	RS	RS	RS
12-28-01	--	--	--	--	--	RS	RS	RS	RS	RS	RS

PCB = Polychlorinated biphenyl
RS = Required and submitted
SVOC = Semivolatile organic compound
TPH-DRO = Total petroleum hydrocarbons, diesel-range organics
VOC = Volatile organic compound
-- = Not required or submitted

Samples were submitted for all of the analytical methods specified in the analytical program specified in Section 4.2.3, Table 4-1, of the CAIP.

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The sensitivity acceptance criterion defined in the CAIP is that analytical detection limits will be less than the corresponding action level. This criterion was not achieved for the analytical results listed in Table B.1-2. Results not meeting the sensitivity acceptance criterion will not be used in making DQO decisions and will therefore be considered as rejected data. The impact on DQO decisions is addressed in the assessment of completeness.

Table B.1-2
Analytes Failing Sensitivity Criteria

Sample Number	Parameter	Result	Minimum Detection Concentration	Final Action Level
309A019	Dibenzo(A,H)anthracene	410 (µg/kg)	410 (µg/kg)	210 (µg/kg)
309B023	Am-241	260 (pCi/g)	120 (pCi/g)	12.7 (pCi/g)

Am-241 = Americium-241
pCi/g = Picocuries per gram
µg/kg = Micrograms per kilogram

Criterion 3:

To satisfy the third criterion, the entire dataset, as well as individual sample results, were assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The DQI acceptance criteria are presented in Table 6-1 of the CAIP. As presented in Tables B.1-3 through B.1-5, these criteria were met for each the DQIs.

Precision

The duplicate precision is evaluated using the RPD, normalized difference. For the purpose of determining the data precision of chemical analyses, the relative percent difference between duplicate analyses was calculated. The absolute difference was used when concentrations exceeded five times the RSL. For radionuclides, the RPD was not calculated unless both the sample and its duplicate had concentrations of the target radionuclide exceeding five times their MDC. Otherwise, radionuclide duplicate results were evaluated using the normalized difference. Table B.1-3 provides the chemical and radiological precision analysis results for all constituents that were qualified for precision. The

chemical analyte qualified for precision was chromium. Radionuclides qualified for precision were Pu-238 and U-235.

Table B.1-3
Precision Measurements

Parameter	CAS Number	User Test Panel	Number of Analytes Qualified	Number of Measurements Performed	Percent within Criteria
Chromium	7440-47-3	EPA 6010B	13	61	78.7
Plutonium-238	13981-16-3	UGTAISOPU	1	115	99.1
Uranium-235	15117-96-1	HASL300	11	115	90.4
Uranium-235	15117-96-1	ISOU	11	105	89.5

CAS = Chemical Abstract Service
EPA = Environmental Protection Agency, SW-846 methods (EPA, 1999 and 2002)

As shown in Table B.1-3, the precision rate for the radionuclides were above the CAIP acceptance criterion of 80 percent; however, chromium was below the acceptance criterion. The precision rate for all other constituents is 100 percent. The precision rate for chromium was 78.7 percent. However, there is negligible potential for a false negative DQO decision error, because the highest reported values are still small in comparison to the FAL. The FAL (450 mg/kg) is 65 times higher than the highest reported chromium value (6.9 mg/kg). Therefore, the chromium results that were qualified for reasons of precision can be confidently used to support DQO decisions. As the precision rate for all constituents exceed the acceptance criteria for precision, the dataset is determined to be acceptable for the DQI of precision.

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 MS recoveries that were outside control limits and could potentially be reported at concentrations lower or higher than actual concentrations. Table B.1-4 provides the chemical accuracy analysis results for all constituents qualified for accuracy. Accuracy rates are above the CAIP criterion of 80 percent. There was no radiological data qualified for accuracy.

Table B.1-4
Accuracy Measurements

Parameter	CAS Number	User Test Panel	Number of Analytes Qualified	Number of Measurements Performed	Percent within Criteria
Chlorobenzene	108-90-7	EPA 8260	2	61	96.7

CAS = Chemical Abstract Service
EPA = Environmental Protection Agency, SW-846 methods (EPA, 1999 and 2002)

As the accuracy rate for all other constituents exceed the acceptance criteria for accuracy, the dataset is determined to be acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A of the CAU 309 CAIP (NNSA/NSO, 2004) was used to address sampling and analytical requirements for CAU 309. 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 these criteria. Therefore, the analytical data acquired during the CAU 309 CAI are considered representative of the population parameters.

Comparability

Field sampling, as described in the CAU 309 CAIP (NNSA/NSO, 2004), was performed and documented according to approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per the DOE were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NTS. Therefore, project datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements.

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

Completeness

The CAU 309 CAIP (NNSA/NSO, 2004) defines acceptable criteria for completeness to be 80 percent of CAS-specific non-critical analytes identified in the CAIP having valid results and 100 percent of critical analytes (including Decision II samples) having valid results. Also, the dataset must be sufficiently complete to be able to make the DQO decisions. Critical analytes for CAU 309 are the expected COCs established based on data from previously investigated NTS muckpiles (arsenic, lead, TPH-DRO, Pu-239, Cs-137, and Co-60). Americium -241 was identified as a critical analyte based on the need to move to a Tier 2 evaluation for newly acquired data.

Rejected data (either qualified as rejected or data that failed the criterion of sensitivity) were not used in the resolution of DQO decisions and are not counted toward meeting the completeness acceptance criterion. Table B.1-5 provides the rejected data for the site. Dibenzo(A,H)Anthracene and Am-241 failed the criterion for sensitivity in specific samples while Co-60 and several SVOCs were qualified as rejected due to analytical quality issues. Dibenzo(A,H)Anthracene and the other SVOCs meets the criteria because they are not critical analytes. The samples containing the Am-241 and Co-60 are located on the muckpile, therefore, does not affect any DQO decisions.

B.1.1.1.2 DQO Provisions To Limit False Positive Decision Error

The false positive decision error was controlled by assessing the potential for false positive analytical results. Quality assurance/QC samples such as field blanks, trip blanks, LCSs, and method blanks were used to determine whether a false positive analytical result may have occurred. Of 30 QA/QC samples submitted, the review of the field blank analytical data resulted in 19 acetone and/or methylene chloride samples being qualified due to possible field blank contamination; however, since these analytes were either not detected or not detected above PALs, no false positive analytical results were detected in the soil samples.

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.

Table B.1-5
Rejected Measurements

Parameter	CAS Number	User Test Panel	Number of Analytes Qualified	Number of Measurements Performed	Percent within Criteria
Benzo(A)Pyrene	50-32-8	EPA8270	6	61	90.2
Dibenzo(A,H)Anthracene	53-70-3	EPA8270	6	61	90.2
Benzo(B)Fluoranthene	205-99-2	EPA8270	6	61	90.2
Benzo(G,H,I)Perylene	191-24-2	EPA8270	6	61	90.2
Benzo(K)Fluoranthene	207-08-9	EPA8270	6	61	90.2
Indeno(1,2,3-CD)Pyrene	193-39-5	EPA8270	6	61	90.2
Pyrene	129-00-0	EPA8270	2	61	96.7
Di-N-Octyl Phthalate	117-84-0	EPA8270	2	61	96.7
Chrysene	218-01-9	EPA8270	2	61	96.7
Butyl Benzyl Phthalate	85-68-7	EPA8270	2	61	96.7
Benzo(A)Anthracene	56-55-3	EPA8270	2	61	96.7
3,3'-Dichlorobenzidine	91-94-1	EPA8270	2	61	96.7
Bis(2-ethylhexyl)phthalate	117-81-7	EPA8270	1	61	98.3
Cobalt-60	10198-40-0	HASL300	2	115	98.2

CAS = Chemical Abstract Service
EPA = Environmental Protection Agency, SW-846 methods (EPA, 1999 and 2002)
HASL = Health and Safety Laboratory

B.1.1.2 Decision II

Decision II as presented in the CAU 309 CAIP: "If a COC is present, is sufficient information available to evaluate appropriate corrective action alternatives?"

Decision Rules:

- 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.
- If observed COC concentrations in a sample from all bounding directions are less than the PALs, then the decision will be that the extent of contamination has been defined in the lateral and/or vertical direction.

- If wastes are to be generated as part of a corrective action, samples will be collected to sufficiently characterize the potential wastes.

Population parameters: The population parameters for Decision II data will be the observed concentration of each unbounded COC in any sample or the observed concentration of each sample used to characterize the potential waste streams.

B.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 of having a high degree of confidence that:

1. Sample locations selected will identify the extent of the COCs.
2. Analyses conducted will be sufficient to detect any COCs present in the samples.
3. The dataset is of sufficient quality and completeness.
4. The potential waste streams are characterized.

Criterion 1:

In general, soil sample results from both historic and newly acquired data demonstrate that the vertical and lateral extent of COCs were defined. The extent sample locations and concentrations for the contaminants driving the extent of contamination are shown in Figures A.3-2 through A.3-5.

At CAS 12-06-09, field observations and analytical results for soil samples collected at this CAS identified no COCs beyond the footprint of the muckpile. Sample locations A03 and A14 through A28, primarily located at the base of the muckpile, bounded the COCs in the downslope direction. Extent samples taken downstream and further down the washes from the CAU 309 muckpiles were found not to be contaminated with COCs (see locations A29, A30, A31, A32, C32, and C33 in Figure A.3-1).

At CAS 12-08-02, field observations and analytical results for soil samples collected at this CAS identified no COCs beyond the footprint of the muckpile. Extent samples taken downstream and further down the washes, from the CAU 309 muckpiles, were found not to be contaminated with COCs (see locations A29, A30, A31, A32, C32, and C33 in Figure A.3-1).

At CAS 12-28-01, Cs-137 is the only COC and was only detected at five locations within the posted CA fencing. The contaminated soil is limited laterally by nearby sample locations C05, C07, C08, and C09 (also within the posted CA). Contamination is restricted vertically to the surface soils as evident at locations C06 and C27, where Cs-137 concentrations decrease about tenfold at the 1-ft depth. Extent samples taken downstream and further down the washes from the CAU 309 muckpiles, were found not to be contaminated with COCs (see locations A29, A30, A31, A32, C32, and C33 in Figure A.3-1).

Criterion 2:

All samples were analyzed for the COCs present at the corresponding CAS;

- CAS 12-06-09 – arsenic, lead, TPH-DRO, Cs-137, Pu-239, and Co-60
- CAS 12-08-02 – arsenic, lead, TPH-DRO, Cs-137, Pu-239, and Co-60
- CAS 12-28-01 – Cs-137

The second criterion for extent (sensitivity) was accomplished for all analyses as demonstrated in Table B.1-2.

Criterion 3:

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

B.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. Of 30 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.

B.1.1.3 Sampling Design

The CAIP made the following commitments for sampling:

1. Biased locations will have soil samples collected from the surface and shallow subsurface based on results of radiological survey results, visual site inspections for soil staining, debris that may contribute to soil contamination, and areas of erosion and drainage.

   Result: Surface and subsurface soil and muck samples were investigated by hand and/or hand augering on and surrounding the muckpiles, below the base of the muckpiles, and at extent locations within drainages/washes near the southeast boundary of the CAU footprint. Biased samples and/or swipes were also collected at select locations of debris and equipment.

B.1.2 Conduct a Preliminary Data Review

A preliminary data review was conducted by reviewing QA reports and inspecting the data. The contract analytical laboratories generate a QA non-conformance report when data quality does not meet contractual requirements. All data received from the analytical laboratories met contractual requirements, and a QA non-conformance report was not generated. Data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified. The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO Decision I was the comparison of the maximum analyte result from each CAS to the corresponding FAL. The test for making DQO Decision II was the comparison of all COC analyte results from each bounding sample to the corresponding FALs.

The key assumptions that could impact a DQO decision are listed in Table B.1-6.

Table B.1-6
Key Assumptions

Exposure Scenario	Site workers are only exposed to contaminants of concern (COCs) through oral ingestion, inhalation, external exposure to radiation, or dermal contact (by absorption) of COCs absorbed onto the soils. Exposure to contamination is limited to industrial site workers, construction/remediation workers, and military personnel conducting training. The investigation results did not reveal any potential exposures than those identified in the conceptual site models (CSMs).
Affected Media	Surface soil, shallow subsurface soil, and debris such as concrete, metal, and wood. The investigation results did not reveal any affected media other than those identified in the CSMs.
Location of Contamination/Release Points	Muckpiles and surface soils surrounding muckpiles where potentially contaminated muck and debris placed on ground surface; fallout out from J- and K-Tunnel containment failures. The investigation results did not reveal any locations of contamination or release points other than those identified in the CSMs.
Transport Mechanisms	Surface transport may occur as a result of erosion or storm water runoff. Surface transport beyond shallow substrate is not a concern. The investigation results did not reveal any transport mechanisms other than those identified in the CSMs.
Preferential Pathways	None. The investigation results did not reveal any preferential pathways other than those identified in the CSMs.
Lateral and Vertical Extent of Contamination	Contamination, if present, may be contiguous to the release points or could be present in isolated areas due to the nature of the fallout plume. Concentrations are expected to decrease with distance and depth from the source, except for the fallout plume, a possibility exists the muckpile shielded the initial blast at areas downhill of the muckpile. Therefore, higher concentrations levels could be found on the adjacent hillside south of the tunnels. Previous muckpile investigations indicate contamination does not migrate vertically beneath the muckpiles.
Groundwater impacts	None. The investigation results did not reveal groundwater impacts other than those identified in the CSMs.
Future Land Use	Nonresidential. The investigation results did not reveal any future land uses other than those identified in the CSMs.
Other Data Quality Objective Assumptions	The muckpiles and fallout plume are contained within one watershed and drain southwest into the P-Tunnel drainage channel. Potential contamination is not expected outside of the watershed containing all three CASs.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 309 DQOs and Table B.1-6. All data collected during the CAI supported the CSMs.

B.1.4.1 Other DQO Commitments

The CAIP made the following commitments for sampling:

1. Decision II sampling will consist of defining the extent of contamination where COCs have been confirmed at the Decision I locations. If COCs extend beyond Decision I locations, then additional Decision II samples will be collected. Decision II sample locations will be arranged in a triangular pattern around the Decision I locations at distances based on site conditions, process knowledge, and biasing factors. At CAU 309, locations may be adjusted to concentrate Decision II samples down slope where migration is more likely. Initial step-outs will be at least as deep as the vertical extent of contamination defined at the Decision I location. A clean sample (i.e., COCs are less than FALs) collected from each step-out direction (lateral or vertical) will define the extent of contamination in that direction.

   Result: Decision II samples were collected at the base of the muckpiles and within downstream locations as identified in the CAIP. Results of various extent samples support that COCs are not migrating beyond the muckpile.

B.1.5 Results

This section resolves the two DQO decisions for each of the CAU 309 CASs.

B.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 the following CASs.

- CAS 12-08-02 – arsenic, lead, TPH-DRO, Cs-137, Pu-239, and Co-60
- CAS 12-06-09 – arsenic, lead, TPH-DRO, Cs-137, Pu-239, and Co-60
- CAS 12-28-01 – Cs-137

B.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: Samples were collected from CASs 12-06-09, 12-08-02, and 12-28-01 to define lateral extent. Vertical extent is assumed to be limited to the muckpiles (CASs 12-06-09 and 12-08-02) based on the evaluation of previous NTS muckpile investigations.

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 and/or vertical direction.

Result: No COCs were present in extent samples from any of the three CASs. The extent of COC plumes are displayed in Figures A.3-2 through A.3-5.

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

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

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Appendix C

Risk Assessment for CAU 309

C.1.0 Risk-Based Corrective Action Process

This section contains documentation of the ASTM Method E1739-95 (ASTM, 1995) risk-based corrective action process as applied to CAU 309. The ASTM Method E1739-95 defines three tiers (or levels) in evaluating DQO decisions involving increasingly sophisticated analyses.

- Tier 1 – Sample results from source areas (highest concentrations) compared to PALs based on generic (non-site-specific) conditions.
- Tier 2 – Sample results from exposure points compared to SSTLs calculated using site-specific inputs and Tier 1 formulas (from the ASTM procedure).
- Tier 3 – Sample results from exposure points compared to SSTLs and points of compliance calculated using chemical fate/transport and probabilistic modeling.

The risk-based corrective action decision process stipulated in ASTM Method E1739-95 is summarized in Figure C.1-1.

C.1.1 A. Scenario

Corrective Action Unit 309 is comprised of the three Corrective Action Sites (CASs) that are listed below:

- CAS 12-06-09, Muckpile
- CAS 12-08-02, CWD
- CAS 12-28-01, I-, J-, and K-Tunnel Debris

Corrective Action Site 12-06-09 consists of a muckpile and debris located on the hillside in front of the I-, J-, and K-Tunnels on the eastern slopes of Rainier Mesa in Area 12. The muckpile includes mining debris (muck) and debris generated during the excavation and construction of the I-, J-, and K-Tunnels. Debris on the muckpile consists of scattered wood, twisted and rusted metal, cables, railroad tracks, and pipes.

Corrective Action Site 12-08-02 consists of a muckpile and debris and is located on the hillside southeast of the front of the re-entry tunnel for K-Tunnel. During re-entry mining operations, potentially contaminated muck was removed from the tunnel and deposited on the muckpile. Debris on the CWD consists of rusted and twisted metal, wood, cables, a lighting fixture, lead

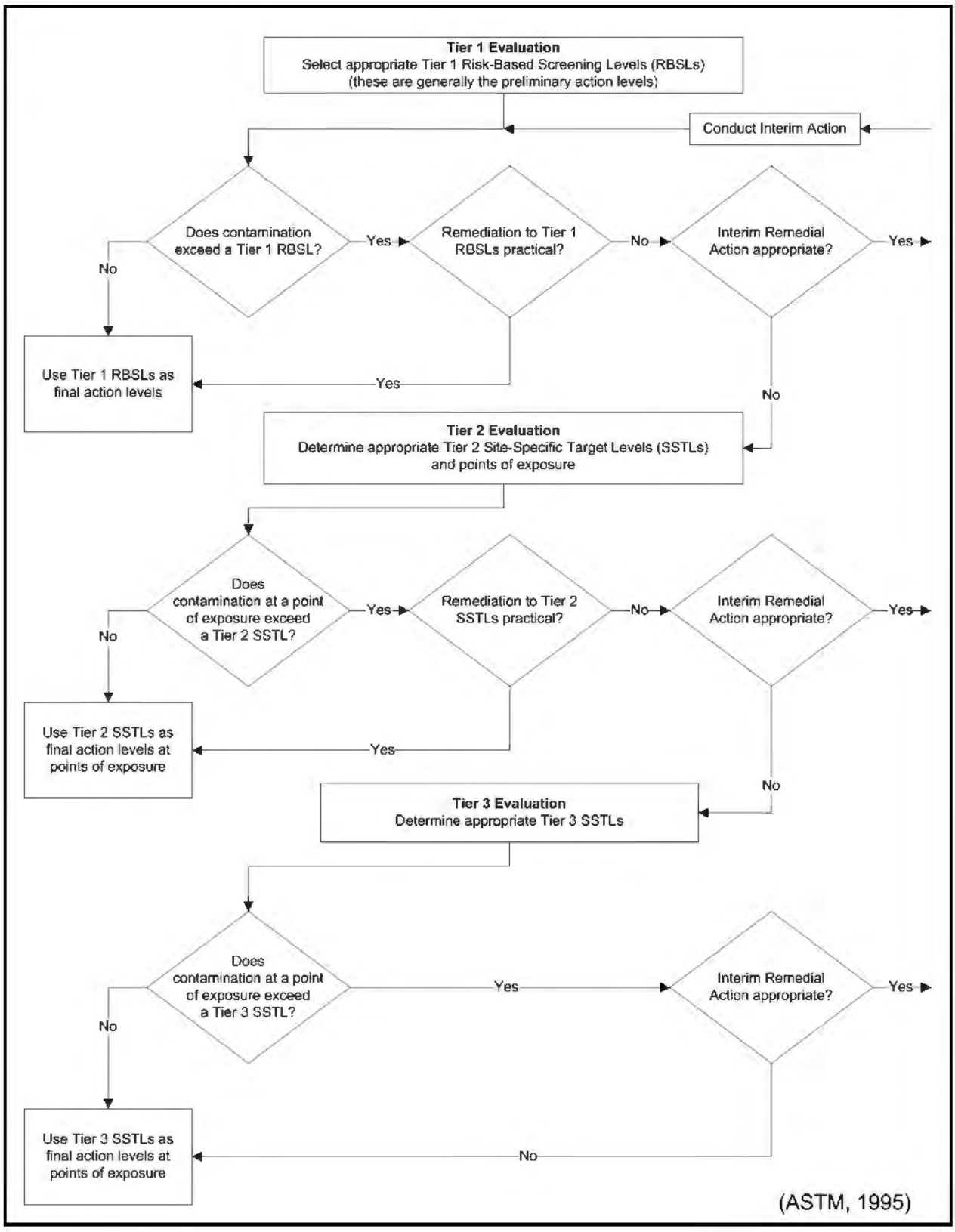

Figure C.1-1
ASTM Method E1739-95 Risk-Based Corrective Action Decision Process

bricks and railroad tracks still attached to their wooden supports. Much of the debris was observed to be buried. The CWD is posted with a "Caution Contamination Area" sign. Similar debris is also located off the muckpile, close to the mountainside and K-Tunnel re-entry tunnel. Included in this debris is a wooden outhouse that is tipped on its side. The collection reservoir consists of a 55-gal drum. The drum was observed to be empty and was photographed. There is no visible staining beneath the drum.

Corrective Action Unit 12-28-01 is defined as debris ejected during the Des Moines and Platte Tests and the associated contamination that is not covered in the two muckpiles CASs. This site consists of debris scattered south of the I-, J-, and K-Tunnel muckpiles and extends down the hillside, across the valley, and onto the adjacent hillside to the south. The CAS also covers contamination associated with "ventings" along fractures and various boreholes on the mesa top and face. The operational history is also similar to the other two CASs except that T-Tunnel ponds and other support facilities constructed in impacted areas after the release may have redistributed some contaminants.

C.1.2 B. Site Assessment

The CAI at CASs 12-06-09, muckpile, CAS 12-08-02 (CWD), and CAS 12-28-01 involved visual inspections and radiological surveys of the muckpiles, corrugated tank, toilet, and other miscellaneous debris and soil sampling at biased locations, including beneath structural components identified as potential sources for contaminant releases. The CAI results indicate no residual materials were present in the corrugated and 55-gal tanks. The structural integrity of these system components (e.g., tanks, piping) at each of these CASs are intact, empty, therefore, not releasing contaminants to the surrounding environment. However, COCs on or in the muckpiles and in surface soils at CAS 12-08-02 (CWD). The COCs are limited to the muckpiles and are confined to the source release point of each muckpile, and no migration was identified as a result of the CAI.

The CAI at CAS 12-28-01 involved visual inspection of the fallout plume and soil sampling at biased locations identified from the radiological flyover survey and/or beneath structural components identified in the CAIP as potential sources for contaminant releases. The CAI results indicate debris present at the CAS is not releasing contaminants to the surrounding environment.

However, COCs (specifically radionuclides) were identified in surface soils within the posted contamination area fencing. The COCs are limited to the surface soil only and are confined to the expected source release point from the J-Tunnel containment failure. No migration was identified as a result of the CAI. The source, release point, and nature and extent of the COCs are consistent with the CAU 309 CSM presented in the CAIP.

The maximum concentration of constituent identified at each CAS and their corresponding PALs are presented in Table C.1-1.

Table C.1-1
Maximum Reported Value for Tier 1 Comparison
Page 1 of 3

Constituent	Maximum Result	Sample Number	PAL	Units
CAS 12-06-09, Muckpile				
Benzo(a)Anthracene	230	209A019RR1	2,100	µg/kg
Benzo(b)Fluoranthene	30	309A035	2,100	µg/kg
Benzoic Acid	1,500	309A018	100,000,000	µg/kg
Bis(2-Ethylhexyl)Phthalate	140	309A018	120,000	µg/kg
Diethyl Phthalate	90	309A018	100,000,000	µg/kg
Fluoranthene	27	309A035	22,000,000	µg/kg
Pyrene	490	309A019RR1	29,000,000	µg/kg
Diesel Range Organics	3,100	309A019	100	mg/kg
Arsenic	4.3	309A001	23	mg/kg
Barium	3,800	309A004	67,000	mg/kg
Beryllium	1.4	309A039	1,900	mg/kg
Cadmium	0.41	309A038	450	mg/kg
Chromium	6.9	309A017	450	mg/kg
Lead	59	309A011	750	mg/kg
Mercury	0.029	309A011	310	mg/kg
Actinium-228	2.91	309A010	15	pCi/g
Bismuth-212	3.7	309A018	5	pCi/g
Bismuth-214	2.2	309A036	5	pCi/g
Cesium-137	150	309A011	12.2	pCi/g
Cobalt-60	0.7	309A034	2.7	pCi/g
Europium-152	4	309A034	5.7	pCi/g
Lead-212	3.29	309A026	5	pCi/g

Table C.1-1
Maximum Reported Value for Tier 1 Comparison
Page 1 of 3

Constituent	Maximum Result	Sample Number	PAL	Units
Lead-214	2.05	309A036	5	pCi/g
Thallium-228	1.07	309A039	5	pCi/g
Americium-241	161	309A034	12.7	pCi/g
Plutonium-238	53.6	309A034	13	pCi/g
Plutonium-239	670	309A034	12.7	pCi/g
Strontium-90	3.93	309A020	838	pCi/g
Uranium-234	4.72	309A034	143	pCi/g
Uranium-235	0.208	309A010	17.5	pCi/g
Uranium-238	1.96	309A020	105	pCi/g
CAS 12-08-02, Contaminated Waste Dump				
Styrene	1.1	309B022	1,700,000	µg/kg
Bis(2-Ethylhexyl)Phthalate	95	309B015	120,000	µg/kg
Diesel Range Organics	12	309B006	100	mg/kg
Arsenic	4.7	309B019	23	mg/kg
Barium	150	309B014	67,000	mg/kg
Beryllium	1.3	309B022	1,900	mg/kg
Cadmium	0.99	309B004	450	mg/kg
Chromium	7.8	309B022	450	mg/kg
Lead	400	309B004	750	mg/kg
Mercury	0.079	309B016	310	mg/kg
Actinium-228	3.04	309B002	5	pCi/g
Americium-241	576	309B004	12.7	pCi/g
Bismuth-212	3.5	309B016	5	pCi/g
Bismuth-214	1.84	309B004	5	pCi/g
Cesium-137	241	309B004	12.2	pCi/g
Cobalt-60	2.73	309B004	2.7	pCi/g
Europium-152	17.4	309B004	5.7	pCi/g
Europium-154	3.25	309B004	5.4	pCi/g
Lead-212	3.08	309B023	5	pCi/g
Lead-214	2.12	309B004	5	pCi/g
Thallium-208	0.98	309B023	5	pCi/g
Plutonium-238	166	309B004	13	pCi/g
Plutonium-239	1,860	309B004	12.7	pCi/g

Table C.1-1
Maximum Reported Value for Tier 1 Comparison
Page 1 of 3

Constituent	Maximum Result	Sample Number	PAL	Units
Strontium-90	34.4	309B004	838	pCi/g
Uranium-234	16.6	309B004	143	pCi/g
Uranium-235	0.137	309B013	17.5	pCi/g
Uranium-238	1.71	309B003	105	pCi/g
CAS 12-28-01, I-, J-, K-Tunnel Debris				
Beryllium	0.98	309C005	1,900	mg/kg
Lead	37	309C005	750	mg/kg
Actinium-228	2.86	309C036	5	pCi/g
Aluminum-26	0.109	309C004A	2.32	pCi/g
Americium-241	150	309C028	12.7	pCi/g
Bismuth-212	2.97	309C031	15	pCi/g
Bismuth-214	1.98	309C002	15	pCi/g
Cesium-137	330	C309C010A	12.2	pCi/g
Cobalt-60	0.64	309C028	2.7	pCi/g
Europium-152	3.95	309C028	5.7	pCi/g
Europium-154	0.74	309C026	135	pCi/g
Lead-212	3.45	309C037	15	pCi/g
Lead-214	2.14	309C002	15	pCi/g
Thallium-208	1.08	309C033	15	pCi/g
Plutonium-238	37.4	309C012A	13	pCi/g
Plutonium-239	385	309C012A	12.7	pCi/g
Strontium-90	17.5	309C010A	838	pCi/g
Uranium-234	4	309C010A	143	pCi/g
Uranium-235	0.146	309C010A	17.6	pCi/g
Uranium-238	1.52	309C002A	105	pCi/g

FAL = Final action level
ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
PAL = Preliminary action level
pCi/g = Picocuries per gram
μg/kg = Micrograms per kilogram

C.1.3 C. Site Classification and Initial Response Action

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

Based on the CAI, none of the CASs present an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at these sites. The CAI demonstrated that the contamination present at the various CASs within CAU 309 is limited to the points of release (e.g., muckpiles, fallout plume). The results further showed that there has been limited migration into the subsurface or laterally away from the source of the contamination. A detailed discussion of the nature and extent of contamination is presented in Appendix A of this report. Based on this information, all three of the CASs are determined to be Classification 3 sites as defined by ASTM Method E1739-95. At all three CASs COCs were identified that may pose long-term threats to human health, safety, or the environment.

C.1.4 D. Development of Tier 1 Look-Up Table of Risk-Based Screening Level Selection

Tier 1 action levels have been defined as the PALs established during the DQO process. The PALs are a tabulation of chemical-specific (but not site-specific) screening levels based on the type of media (soil) and potential exposure scenarios (industrial). These are very conservative estimates of risk, are preliminary in nature, and are used as action levels for site screening purposes. Although the PALs are not intended to be used as FALs, a FAL may be defined as the Tier 1 action level (i.e., PAL) value if individual constituent analytical results are below the corresponding Tier 1 action level value. The FAL may also be established as the Tier 1 action level value if individual constituent analytical results exceed the corresponding Tier 1 action level value and implementing a corrective action based on the FAL is practical. The PALs are defined as:

- The EPA Region 9 Risk-Based Preliminary Remediation Goals (PRGs) for Industrial Soils (2004).
- 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).

- Total petroleum hydrocarbons concentrations above the action level of 100 mg/kg per NAC 445A.2272 (NAC, 2003).

- For COPCs without established PRGs, a protocol similar to EPA Region 9 will be used to establish an action level; otherwise, an established PRG from another EPA region may be chosen.

- The PALs for material, equipment, and structures with residual surface contamination are the allowable total residual surface contamination values for unrestricted release of material and equipment listed in the DOE Order 5400.5 (DOE, 1993), which is also Table 4-2 of the NV/YMP Radcon Manual (DOE/NV, 2000).

- The PALs for radioactive contaminants are based on the NCRP Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled to 25 millirem per year dose constraint (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 an industrial reuse scenario. Because the CAU 309 CASs in Area 12 is not assigned work stations and are considered to be in remote or occasional use areas, the use of industrial reuse based PALs is conservative. The Tier 1 look-up table is defined as the PAL concentrations or activities defined in the CAIP.

C.1.5 E. Exposure Pathway Evaluation

The DQOs stated that site workers would only be exposed to COCs through oral ingestion, inhalation, or dermal contact (absorption) due to exposure to potentially contaminated media (i.e., soil) at the CASs. The results of the CAI showed that all COCs identified at CASs within CAU 309 are localized near the release point and have not migrated more than 15 ft vertically or laterally. Because COCs were identified in the muckpiles and surface soil at CAS 12-28-01, the only potential exposure pathways would be through worker contact with the contaminated soil. The limited migration demonstrated by the analytical results, elapsed time since the suspected release, and depth to groundwater supports the selection and evaluation only surface and shallow subsurface contact as the complete exposure pathways. Groundwater is not considered to be a significant exposure pathway.

C.1.6 F. Comparison of Site Conditions with Tier 1 Risk-Based Screening Levels

All analytical results from CAU 309 samples were less than corresponding Tier 1 action levels (i.e., PALs) except for those listed in Table C.1-2.

Table C.1-2
COPCs Detected Above Preliminary Action Levels

	TPH-DRO	Co-60	Eu-152	Cs-137	Pu-239	Pu-238	Am-241
CAS 12-06-09	x			x	x	x	x
CAS 12-08-02		x	x	x	x	x	x
CAS 12-28-01				x	x		x

Am = Americium
CAS = Corrective action site
Co = Cobalt
COPC = Contaminant of potential concern
Cs = Cesium
Eu = Europium
Pu = Plutonium
TPH-DRO = Total petroleum hydrocarbons, diesel-range organics

C.1.7 G. Evaluation of Tier 1 Results

For all constituents at all CASs not listed in Table C.1-2, the FALs were established as the Tier 1 risk-based screening levels (RBSLs). It was determined that no further action is required for these constituents at these CASs.

It was determined by NNSA/NSO that remediation to the remaining constituents listed in Table C.1-2 was not practical. Therefore, a Tier 2 SSTL will be calculated for these constituents at these CASs.

C.1.8 H. Tier 1 Remedial Action Evaluation

TPH-DRO Evaluation

Total petroleum hydrocarbons, diesel-range organics was not moved to a Tier 2 evaluation, because it is listed as a COC from previous muckpile investigations and is, therefore, assumed present within the two muckpile CASs.

Radionuclide Evaluation

Actions to remediate Am-241, Co-60, Cs-137, Eu-152, Pu-238, and Pu-239 at the CAU 309 CASs to Tier 1 action levels would be very difficult and expensive while potentially not providing a significant risk reduction. Therefore, these radionuclides were moved to a Tier 2 evaluation.

C.1.9 I. Tier 2 Evaluation

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

C.1.10 J. Development of Tier 2 Table of Site-Specific Target Levels

Evaluation of Radiological Constituent SSTLs

The Tier 2 evaluation consisted of evaluating the mixture of all radionuclides detected at each CAS to develop Tier 2 action levels for the radionuclides that exceeded Tier 1 levels. The CAS-specific Tier 2 action levels were calculated using the RESRAD code (version 6.22) and site-specific parameters. The RESRAD calculations were based on continued industrial use of the site assuming that a worker will be on the site for 250 days per year, 8 hours per day for 25 years. A more detailed discussion of the RESRAD code, site-specific parameters used, and the printed RESRAD outputs is provided in Attachment A of this Appendix. These SSTLs and the maximum reported level for each radiological constituent per CAS are presented in Table C.1-3.

Table C.1-3
Tier 2 SSTLs and CAU 309 Results for Radiological Constituents

Common Name	SSTL (pCi/g)	Maximum Reported Value (mg/kg)		
		12-06-09	12-08-02	12-28-01
Americium-241	12.7	161	576	150
Cobalt-60	2.7	0.7	2.73	0.64
Europium-152	5.7	4	17.4	3.95
Cesium-137	12.2	150	241	330
Plutonium-238	13	53.6	166	37.4
Plutonium-239	12.7	670	1,860	385

mg/kg = milligram per kilogram
pCi/g = Picocuries per gram
SSTL = Site-specific target level

Although all detected radionuclides at a CAS are used in the sum-of-fractions calculation and a unique Tier 2 action level is developed for all radionuclides, only the six radionuclides which initially exceeded Tier 1 have a Tier 2-based FAL. Table C.1-4 provides the CAS-specific FALs established for the six radionuclides specific to each CAS.

Table C.1-4
Final Action Levels for Radionuclides by CAS

Corrective Action Unit	Americium-241 (pCi/g)	Cobalt-60 (pCi/g)	Europium-152 (pCi/g)	Cesium-137 (pCi/g)	Plutonium-238 (pCi/g)	Plutonium-239 (pCi/g)
12-06-09	893.6[b]	2.7[a]	5.7[a]	196.7[b]	1,075[b]	968.7[b]
12-08-02	893.6[b]	97.4[b]	43.9[b]	196.7[b]	1,075[b]	968.7[b]
12-28-01	893.6[b]	2.7[a]	5.7[a]	196.7[b]	1,075[b]	968.7[b]

[a]Tier 1 action level (preliminary action level)
[b]Tier 2 action level (site-specific target level)
CAS = Corrective action site
pCi/g = Picocuries per gram

C.1.11 K. Comparison of Site Conditions with Tier 2 Table 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 309, the Tier 2 action levels were compared to maximum constituent concentrations from each sample location.

A comparison between the maximum concentration of the radionuclides identified above Tier 1 action levels (Am-241, Co-60, Eu-152, Cs-137, Pu-238, and Pu-239), as shown in Table C.1-1, was conducted against the CAS-specific Tier 2-based FALs listed in Table C.1-4. The only isotopes identified above Tier 2-based FALs is Cs-137 and Pu-239 at CAS 12-08-02 and Cs-137 at CAS 12-28-01. None of the other radionuclides are identified above the Tier 2 action levels.

C.1.12 L. Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation of the radiological constituents, CASs 12-08-02 and 12-28-01 pose an unacceptable risk. Based on the results of previous muckpile investigations CASs 12-06-09 and

12-08-02 are considered contaminated from a radiological and chemical standpoint. Therefore, the close in place corrective action is required at all three CASs within CAU 309.

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

C.2.0 Regulatory Basis

The FFACO Part III, Section III.3 (FFACO, 1996) stipulates conformance with Chapter 445 of the NAC (NAC, 2003). Section NAC 445A.227 lists the factors to be considered in determining whether corrective action is required.

Section NAC 445A.227 states:

1. Except as otherwise provided in NAC 445A.22715, the Director may require an owner or operator to take corrective action if the release of a hazardous substance, hazardous waste, or a regulated substance contaminates soil and the level of contamination exceeds the action level established for the soil pursuant to NAC 445A.2272.
2. In determining whether corrective action is required, the Director shall consider:
   (a) The depth of any groundwater.
   (b) The distance to irrigation wells or wells for drinking water.
   (c) The type of soil that is contaminated.
   (d) The annual precipitation.
   (e) The type of waste or substance that was released.
   (f) The extent of the contamination.
   (g) The present and potential use for the land.
   (h) The preferred routes of migration.
   (i) The location of structures or impediments.
   (j) The potential for a hazard related to fire, vapor, or explosion.
   (k) Any other information specifically related to the site that the director determines is appropriate.

For sites where it is determined that corrective action is required (the corrective action process applies to all FFACO sites), Section NAC 445A.22705 stipulates a process to determine the necessary remediation standards (or FALs) based on an evaluation of the risk the site poses to public health and the environment.

Section NAC 445A.22705 states:

1. Except as otherwise provided in NAC 445A.22715, if an owner or operator is required to take corrective action pursuant to NAC 445A.227, the owner or operator may conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary. Such an evaluation must be conducted using Method E1739-95, adopted by the ASTM, as it exists on October 3, 1996, or an equivalent method approved by the Division.

2. The Division shall determine whether an evaluation complies with the requirements of Method E1739-95, or an equivalent method of testing approved by the Division. The Division may reject, require revisions be made to, or withdraw its concurrence with the evaluation at any time after the completion of the evaluation for the following reasons:

   (a) The evaluation does not comply with the applicable requirements for conducting the evaluation.

   (b) Conditions at the site have changed.

   (c) New information or previously unidentified information that would alter the results of the evaluation becomes available and demonstrates that the release may have a detrimental impact on public health or the environment.

Therefore, in compliance with Section NAC 445A.22705, NNSA/NSO will "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary" using ASTM Method E1739-95.

C.3.0 Recommendations

Organic, inorganic, and radionuclide constituents detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 309. Assessment of the data generated from investigation activities indicates the FALs were exceeded for radionuclides in 6 surface soil samples from 6 locations at CAS 12-08-02 and at CAS 12-28-01.

In addition, per the CAU 309 CAIP, the muckpiles at CASs 12-06-09 and 12-08-02 are considered to be contaminated at the highest concentrations of contaminants identified above FALs during previous (historical) investigations of muckpiles at NTS. Based on previously investigated muckpiles, COCs at CASs 12-06-09 and 12-08-02 include arsenic, lead, TPH-DRO, Cs-137, Co-60, and Pu-239.

As COCs were identified above the corresponding FALs at all three CASs, it was determined through discussions with NDEP and NNSA/NSO personnel that a closure in place with use restrictions is proposed for each of the three CASs.

No further corrective action is necessary, which will be protective of human health, safety, and the environment.

C.4.0 References

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Attachment A

RESRAD Parameters Used for Analysis of

CAU 309 Results

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit 309, Area 12 Muckpiles, Nevada Test Site, Nevada

November 2005

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Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit 309, Area 12 Muckpiles, Nevada Test Site, Nevada

1.0 Introduction

The U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Environmental Restoration Project, Industrial Sites Sub-Project has numerous soil sites impacted from the development, testing, and production of nuclear weapons that are scheduled to undergo characterization and remediation. These impacts can take the form of chemical and/or radiological contaminants. Similar to its approach for chemical contamination, the NNSA/NSO is committed to properly evaluating, radiologically characterizing, and where appropriate, remediating these sites to ensure the doses to radiation workers and members of the public are maintained as-low-as-reasonably achievable below the primary dose limits as stated in DOE Order 5400.5 (DOE, 1993).

To accomplish this, DOE must evaluate the potential for residual radioactive (RESRAD) contamination in surface soils, and determine compliance with the requirements of DOE Order 5400.5 (DOE, 1993). The DOE Order 5400.5 requires that: "The Authorized Limits shall be established to (1) provide that, at a minimum, the basic dose limits … will not be exceeded, or (2) be consistent with applicable generic guidelines." Because generic guidelines have not been established for volumetric residual radioactivity for the radionuclides of concern at Corrective Action Unit (CAU) 309 land areas, Authorized Limits or final action levels (FALs) were derived using the RESRAD material code (Yu et al., 2001) computer program. The goal of this effort was to produce Authorized Limits, in units of picocuries per gram (pCi/g) in soil above background, for CAU 309 that would result in radiation doses less than 25 millirem per year (mrem/yr) to an industrial worker at the site.

To develop the FALs, a "realistic" yet conservative radiation dose analysis was conducted using approved exposure scenarios and site-specific data to determine the translation between surface soil concentrations and individual radiation doses. For this analysis, site-specific data included soil sampling results obtained during site investigation activities at CAU 309, and meteorological data obtained from the Air Resources Laboratory/Special Operations and Research Division. This report provides the radiation dose modeling analysis supporting the technical derivation of the Authorized Limits for CAU 309, Area 12 Muckpiles, Nevada Test Site (NTS), Nevada. This report also defines the radionuclides considered and approved exposure scenarios for the NTS, identifies the applicable exposure pathways and key input data or assumptions, presents the radiation doses for unit concentrations of radionuclides in soil, and establishes the FALs for CAU 309.

2.0 Facility Description

Corrective Action Unit 309 is comprised of three CASs (Figure 2-1), which were grouped together based on the geographical location of the sites, technical similarities (muckpiles), and the agency responsible for closure. The two muckpiles were derived from similar geological material, lie within 600 feet (ft) of each other, were created from and managed through similar tunnel activities (e.g., drilling activities, weapon-related tests) during the same time period (1962 to 1963), and have been subjected to the same environmental conditions. The muckpiles are located in Area 12 of the NTS and include CASs 12-06-09 and 12-08-02. The third CAS, 12-28-01, resulted from the containment failures of the J- and K-Tunnels, lies in the vicinity of the other two CASs, affects the same geological material, and has also been subjected to the same environmental conditions.

2.1 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 309. The CAS-specific summaries are designed to illustrate all significant, known activities that could pertain to the corrective action investigation (CAI) or evaluation of the CASs.

2.1.1 CAS 12-06-09, Muckpile

The muckpile includes mining debris (muck) and debris generated during the excavation and construction of the I-, J-, and K-Tunnels. The muckpile also includes re-entry mining debris produced during nuclear tests that likely includes radioactively contaminated muck. Construction of the I-, J-, and K-Tunnels started in late 1961. The tunnels were used for weapon-related tests.

Tests at both J-Tunnel and K-Tunnel were conducted under Operation Nougat. Only one test each was conducted in J- and K-Tunnel. The Platte test was detonated in K-Tunnel on April 14, 1962, and the Des Moines test in J-Tunnel on June 13, 1962. The engineered containment structures for the tests failed and these tests were not contained. As a result, decontamination and re-entry problems were extensive. When the containment systems were breached, radioactive material and debris were ejected out of the portals onto the muckpile and across the canyon. No testing was conducted in I-Tunnel due to the catastrophic failure of the J- and K-Tunnels containment systems. Fissures created in the mountainside from the Des Moines test caused the area to be unstable. The area containing the I-, J-, and K-Tunnels was abandoned following the Des Moines test.

2.1.2 CAS 12-08-02, Contaminated Waste Dump

Corrective Action Site 12-08-12 consists of a muckpile and debris. During re-entry mining operations, potentially contaminated muck was removed from the K-Tunnel and deposited on the muckpile. Debris on the CAS consists of rusted and twisted metal, wood, cables, a lighting fixture, and railroad tracks still attached to their ties.

2.1.3 CAS 12-28-01, I-, J-, and K-Tunnel Debris

Corrective Action Site 12-28-01 is defined as debris ejected during the Des Moines and Plattes tests and the associated contamination that is not covered in the two muckpiles CASs. This CAS consists of debris scattered south of the I-, J-, and K-Tunnel Muckpiles and extends down the hillside, across the

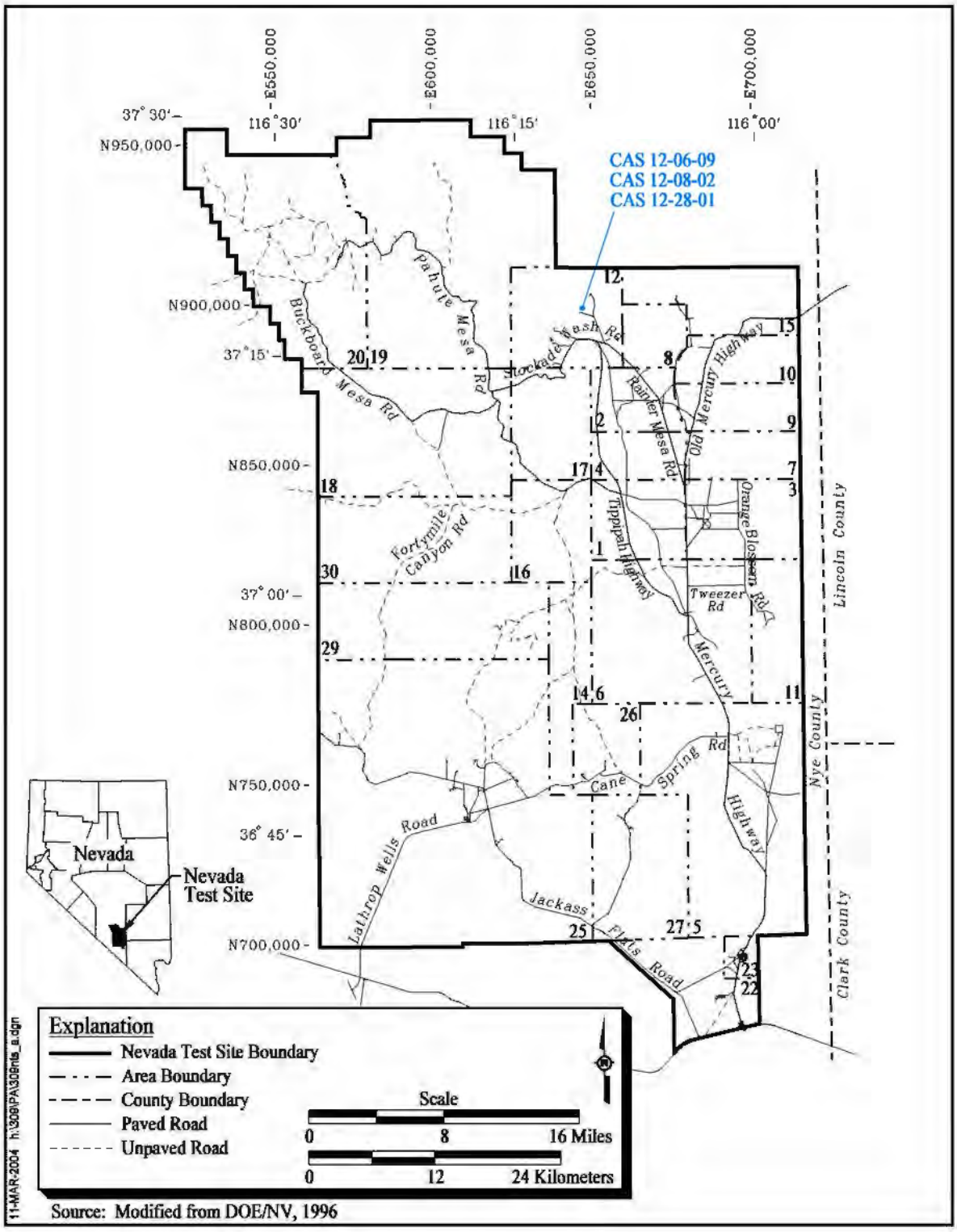

Figure 2-1.
Nevada Test Site and CAU 309 Location Map

valley and onto the adjacent hillside to the south. In addition, the site covers the potential contamination associated with "ventings" along fractures and boreholes.

2.2. Release Information

The CAS-specific release information is discussed in this section. Based on historical information and process knowledge, the primary sources of potential contamination released to the soil within CAU 309 consist of potential contaminated muck and debris from the muckpiles, release of contamination on muckpiles from spill/leaks, and release of contamination by forceful ejection from tunnels, vents, boreholes, and fractures.

It is expected that vertical migration of contamination would be limited due to the low annual rate of precipitation and high annual potential evapotranspiration rate at the site. The limited recharge to groundwater from precipitation does not provide a significant mechanism for vertical migration of contamination to groundwater. Also, process knowledge from previous muckpile investigations shows the native material underlying these muckpiles has been largely uncontaminated. However, lateral migration may be an important transport mechanism due to higher erosion rate and the steep slops of the area.

The following subsections contain CAS-specific descriptions of known or potential releases associated with CAU 309.

2.2.1 CAS 12-28-01, I-, J-, and K-Tunnel Debris

The Platte test (K-Tunnel) was detonated on April 14, 1962. Immediately following the detonation, a fissure opened up in the face of the mesa, releasing large amount of radioactive effluent into the atmosphere over several minutes. Also, effluent escaped from the tunnel portal and from the instrumentation pipe on top of the mesa.

The Des Moines (J-Tunnel) was detonated on June 13, 1962. Following the detonation, a dense black cloud, apparently containing both gaseous and particulate material, emanated from the tunnel portal, the top of the mesa, and a monitoring hole about halfway up the side of the mesa.

This historical information verifies what was seen during SNJV site visits by the debris path emanating from the J-Tunnel fallout and the lack of debris observed in front of K-Tunnel.

2.2.2 CASs 12-06-09, Muckpile and 12-08-02, Contaminated Waste Dump

The muckpiles consist of potentially contaminated muck and debris removed from nearby tunnels. Historical documentation identifies posted dumps (i.e., muckpiles) in the current locations of these muckpiles. The nature of this contamination was not defined. The current status of contamination at the dump is unknown. Potential release of contamination from these muckpiles into the surrounding environment is unknown, although the most likely means would be from overland transport in storm water run-off to drainages downslope from the muckpiles.

2.3 Current Radiological Posting

The top of CAS 12-06-09 Muckpile is surrounded by a two-strand yellow rope fence and posted with "Underground Radioactive Material" sign. The area around the portals and additional structures are fenced with three-strand yellow rope fence and posted with a "Caution Contamination Area" sign. Corrective Action Site 12-08-02, Contaminated Waste Dump is posted with a "Caution Contamination Area" sign.

3.0 Site Investigation Activities

3.1 Site Investigation Plans

Corrective action investigation activities were performed as set forth in the CAU 309 CAIP (SNJV, 2004). The scope of the Area 12 Muckpiles investigation included the following:

- Conduct land area survey using field-screening instruments to locate areas with elevated radiological levels.
- Collect bias soil samples the CAU.
- Conduct volatile organic compound and radiological field screening for health and safety monitoring and as an indication of the presence or absence of contaminants of potential concern (COPCs).
- Conduct laboratory analysis of the environmental and quality control samples to determine the presence or absence of COPCs.

The data quality objective (DQO) process is a seven-step strategic planning approach based on the scientific method used to plan data collection activities for CAU 309, Area 12 Muckpiles. The DQOs are designed to ensure that data collected will provide sufficient and reliable information to identify, evaluate, and technically defend the recommended corrective actions (e.g., no further action, closure in place, or clean closure).

The primary objective of the investigation was to provide sufficient information and data to develop appropriate corrective action alternatives for CAU 309. This objective was achieved by identifying the nature and extent, both horizontal and vertical of contaminants of concern (COCs) (i.e., COPCs at concentrations above action levels), and the vertical and lateral extent of the COCs.

The investigation strategy was developed by representatives of NDEP and NNSA/NSO, according to the U.S. Environmental Protection Agency (EPA) *Guidance for Quality Assurance Project Plans*, EPA QA/G-5 (EPA, 2002a) and *Guidance for the Data Quality Objectives Process*, EPA QA/G-4 (EPA, 2000b). The investigation strategy also identifies and references the associated EPA Quality System Documents entitled *Data Quality Objectives for Hazardous Waste Site Investigation*, EPA QA/G-4HW (EPA, 2000a), and *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA QA/G-5S (EPA, 2002b), upon which the DQO process is based. The CAU 309 CAIP contains a detailed description of the investigation strategy and the DQO process.

3.2 Summary of Specific Site Investigation Activities

This section provides a brief description of work activities conducted to support the investigation of radioactive contamination at CAU 309.

Land Area Radiological Walkover Surveys
A land area radiological survey was performed on January 2004 at the muckpile and surrounding areas in front of the tunnels. The results of the surveys were used to guide the investigation and provide for site worker safety, focusing on the identification of "hot-spot" areas.

Field Screening
Field-screening activities for alpha and beta/gamma radiation were performed at locations, as specified in the CAU 309 CAIP (SNJV, 2004). 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 the pad. The radiation FSLs are instrument-specific and were established for each instrument before use. The CAU 309 Corrective Action Decision Document/Closure Report (CADD/CR) identify where field screening was conducted and how the FSLs were used to aid in the selecting sample locations.

Soil Sampling
Intrusive investigation activities (i.e., surface and subsurface soil sampling) were conducted at the CAU. Before the start of sampling, the sampling location was screened for alpha and beta/gamma radiation. Additional screening was conducted during sample collection to both guide the investigation and to ensure that radiological controls were adequate to protect workers during sampling activities. Labeled sample containers were filled according tothe analytical requirements. Additional soil was transferred into an aluminum pan, homogenized, and field screened for alpha and beta/gamma radiation. All remaining sample containers were then filled. The excess soil was returned to the sampling location. A detailed discussion for how the sampling met DQOs is provided in the CAU 309 CADD/CR.

In August 2004, 26 surface soil samples were collected at CAS 12-28-01 and of these samples, 11 were sent for off-site laboratory analysis. Results indicated levels for americium (Am-241), cesium (Cs-137), plutonium (Pu)-238, and Pu-239/240 were above PALs in samples collected within the fallout plumes from the J- and K-Tunnels.

3.3 Sampling Locations

To achieve the objective of identifying the nature and extent of both horizontal and vertical COCs, judgmental bias method was used for selecting sample locations and evaluating analytical results. The selection of soil sample locations was based on site conditions using the strategy developed during the DQO process, as outlined in the CAU 309 CAIP (SNJV, 2004) and subsequent record of technical changes.

Sampling points for CAU 309 were selected based on the approach provided in the CAIP, which included interpretation of existing engineering drawings, aerial and land surveys and photographs, interviews with former and current site employees, information obtained during site visits, and site-specific biasing factors. In some cases, field screening results and/or laboratory analytical results determined the need for step-out sampling locations. Sample locations were staked, labeled

appropriately, and surveyed with a global positioning system (GPS) instrument. The CAU 309 CADD/CR contains a detailed description of the actual sample locations. The actual locations have been plotted based on the coordinates collected by the GPS instrument and presented in the CAU 309 CADD/CR.

4.0 Site Investigation Sample Results

The RESRAD calculations are based on validated analytical soil sample results obtained during site investigation activities and other applicable information specified in the CAIP. The RESRAD calculations involving the area within CAU 309 are based upon the value of the maximum radionuclide concentration. The RESRAD calculations performed for the contaminants of concern (COCs) present at the CAU 309 using the maximum radionuclide concentrations obtained from the soil sample results. The CAU 309 CADD/CR contains a detailed description of the sample results, analytical parameters, and laboratory methods used to analyze the soil samples. The following section provides a summary of the samples taken at CAU 309.

The highest principal radionuclide (with a half-life greater than six months) concentrations detected at this CAU are listed in Table 4-1. These maximum radionuclide concentration values were used to perform the RESRAD calculations.

Table 4-1. Radionuclide* Concentrations Assigned to CAU 309

Radionuclides	Maximum Activity Concentration (pCi/g)	Results Taken From
Aluminum-26	0.109	Sample analysis results
Americium-241	102	Sample analysis results
Cesium-137	330	Sample analysis results
Cobalt-60	0.64	Sample analysis results
Europium-152	3.95	Sample analysis results
Europium-155	0.74	Sample analysis results
Plutonium-238	37.4	Sample analysis results
Plutonium-239	385	Sample analysis results
Strontium-90	17.5	Sample analysis results
Uranium-234	4	Sample analysis results
Uranium-235	0.146	Sample analysis results
Uranium-238	1.52	Sample analysis results

*Not all radionuclides are considered for clean-up under DOE Order 5400.5
pCi/g = Picocuries per gram

5.0 Initial Concentrations for Principal Radionuclides

Principal radionuclides are defined as radionuclides with a half-life greater than six months. The decay products of any principal radionuclide down to, but not including, the next principal radionuclide in its decay chain are defined as associated radionuclides. The RESRAD assumes that a principal radionuclide is in secular equilibrium with its associated radionuclides at the point of exposure. Therefore, associated radionuclides and radionuclides with half-lives less than six months are not input into the RESRAD calculations.

5.1 Authorized Values Initial Concentrations of Principal Radionuclides for Area Averaging/Hot-Spot Scenarios

The DOE Order 5400.5 (DOE, 1993) states: "Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m^2" (5400.5, IV, 4.a.). DOE Order 5400.5 also states: "If the average concentration of any surface or below-surface area less than or equal to 25 square meters (m^2), exceeds the limit or guideline by a factor of $(100/A)^{0.5}$, [where A is the area (in square meters) of the region in which concentrations are elevated], limits for "hot-spots" shall also be developed and applied" (5400.5, IV, 4.a.(1)). DOE G 441.1-XX (DOE, 2002) discusses the rationale for the hotspot criterion in Section 5.2.2.

The purpose of the hot-spot criterion is to ensure that applying the homogeneous criteria, in which the concentrations of RESRAD material are averaged over a 100-m^2 area, does not result in the release of small areas that, because of averaging, contain unacceptably high concentrations of RESRAD material. The hot-spot criterion is used to supplement Authorized Limits for larger areas and is intended to prevent excessive exposures from a small, contaminated area that is within a larger area that meets the basic Authorized Limits. Thus, it is intended for use in areas where the RESRAD material concentrations are not uniform. Also, the above hotspot criterion was derived conservatively, assuming the Authorized Limits were based on a dose constraint of 25 mrem/yr and selected to ensure unlikely exposure conditions would not cause the primary dose limit (100 mrem/yr) to be exceeded. The authorized exposure scenarios specify that the value of the maximum concentration of principal radionuclides obtained from site-specific sampling results be entered as the principal radionuclide concentrations for RESRAD hot-spot calculations. The authorized area parameters for RESRAD hot-spot calculations are 1 m^2, 10 m^2, and 100 m^2 contamination areas.

When site investigations results conclude that the concentrations in the soil are expected to be at (or very near) background levels and that there is no reason to believe that there are significant variations in the concentrations across the site. Thus, there is no reason to adopt a minimum survey area of 100 m^2 to ensure the sampling method is representative. Therefore, because the expected soil concentrations for sites meeting this criteria are far below those that would result in a dose equal to the dose limit (100 mrem/yr), and because there is no need to adopt the 100 m^2 averaging area to ensure representativeness, the 100 m^2 averaging area need not be used in developing the Authorized Limits.

5.2 Initial Concentrations of Principal Radionuclide for CAU 309

As described in the CAU 309 CAIP, the site is considered to be contaminated at the highest concentration; therefore, the maximum radionuclide concentration values were used to perform the RESRAD calculations. Because these initial radionuclide concentrations were bound by the CAIP and consist of the maximum radionuclide concentrations identified during the CAI at CAU 309, hot-spot calculations and analysis of the radionuclide spatial distribution are not required. The RESRAD calculations already assume uniform distribution of contamination at the maximum concentrations from the dataset.

The initial radionuclide concentrations used for the three RESRAD calculations are listed in Table 4-1 of this attachment.

5.3 Inhomogeneous Contamination and Initial Radionuclide Concentrations

A contaminated zone is inhomogeneous if it contains a contaminated region within which the concentration of a radionuclide exceeds three times the average for the contaminated zone. The RESRAD uses a mathematical construct that assumes uniform distribution of radionuclides within a volume. However, RESRAD recognizes that radiological contamination is inhomogeneous in nature and provides detailed guidance for applying inhomogeneous criteria (hot-spot criteria, sum of fractions rule, etc.). The RESRAD User Manual states that the inhomogeneous release criteria are generally more realistic and hence less restrictive than the homogeneous release criteria. This shows that the approved initial radionuclide concentration values (i.e., arithmetic mean plus 95 percent Upper Confidence Level [UCL] or the maximum radionuclide concentration from the sample dataset) will result in more restrictive release criteria. The arithmetic mean plus the 95 percent UCL are used for the initial concentrations of principal radionuclides when the sample results are obtained using a random sampling method. The maximum radionuclide concentrations values are used for the initial concentrations of principal radionuclides when the sample results are obtained using a non-random (i.e., judgmental sampling) sampling method. CAU 309 used a judgmental sampling method, thus the maximum principal radionuclide concentrations values are used for RESRAD calculations.

The RESRAD states that a statistical approach should always be considered as a first priority regarding the estimation of soil concentrations, as cited in the *Data Collection Handbook To Support Modeling Impacts of Radioactive Material in Soil* (Yu et al., 1993). The 95 percent UCL represents a value that has a 5 percent chance that the actual mean of the dataset would exceed it.

6.0 Authorized RESRAD Exposure Pathways and Scenarios

This section describes the input parameters, exposures scenarios, and guidance for calculating site-specific radiological remediation levels for projects using the RESRAD computer code, as agreed to by NNSA/NSO, Stoller-Navarro Joint Venture (SNJV), Bechtel Nevada (BN), and NDEP.

6.1 Guidance for RESRAD Calculations

The guidance in this section was developed by NNSA/NSO, SNJV, BN, and NDEP and is only applicable to soils containing RESRAD material. This guidance does not apply to structures, facilities, equipment, and building materials containing contaminated surfaces or volume contamination. The primary dose limit for any member of the public is 100-mrem total effective dose equivalent (TEDE) in a year. This limit applies to the sum of internal and external doses resulting from all modes of exposure to all radiation sources other than background radiation and doses received as a patient from medical sources as required by DOE 5400.5, II.1.a. (3)(a) (DOE, 1993). The dose constraint is defined as one quarter of the dose limit (i.e., 25-mrem) and will be applied to ensure that in a 1,000-year period the maximally exposed individual does not exceed the dose constraint in any single year. The requirements of Chapter IV of DOE 5400.5 Chapter IV will not specifically apply if NNSA/NSO chooses to continue to own and actively control access or use of the site. However, the radiation protection requirements in the other sections of DOE 5400.5 will apply to NNSA/NSO-owned and -maintained sites.

Due to the large spatial variability in background amongst sites, the “above background criterion” will be defined as the concentration of a specific radionuclide in soil that equals or exceeds its

corresponding PAL. The source data for these radionuclide specific PALs are taken directly from NCRP Report No. 129 Table 2.1, Construction, Commercial, Industrial land-use scenario column for a 25-mrem dose constraint (NCRP, 1999). The generic guidelines for residual concentrations of Radium (Ra)-226, Ra-228, Thorium (Th)-230, and Th-232 are found in Chapter IV of DOE Order 5400.5, Change 2 "*Radiation Protection of the Public and Environment*."

Background radiation refers to the local area and includes:

- Concentration of naturally occurring radionuclides.
- Cosmic radiation.
- Radionuclides of anthropogenic origin that have been globally dispersed and are present at low concentrations such as fallout from nuclear weapons. (Note: This is not the case at the NTS, because the historical aspects of the NTS, e.g., above- and below-ground testing, and other operations resulted in dispersion of radionuclides locally.)

Due to the impracticality of determining "true" background, a dose constraint with no background subtraction will be used (i.e., a dose constraint not in excess of background). The use of the dose constraint with no background subtraction is a far more conservative and sensitive approach, because it does not deal with the uncertainty of natural background.

6.2 Description of Approved Scenarios

Based on the future land use as identified in the *Nevada Test Site Resource Management Plan* (DOE/NV, 1998), the following two exposure scenarios have been identified as "actual" and "likely" use scenarios. Stoller-Navarro Joint Venture has approval to use two scenarios (Scenario A and Scenario B) for use with the RESRAD code (NDEP, 2004). Both scenarios consider radiation exposures to the critical population group via the following pathways:

- Direct exposure to external radiation from the contaminated soil.
- Internal dose from inhalation of airborne radionuclides.
- Internal dose from ingestion of contaminated soil.

The two scenarios vary the parameters associated with the future land use of the site but use the same dose constraint parameter of 25 mrem/yr. Scenario A is approved for sites in Mercury or within 500 ft of an active building. Scenario B is approved for all other sites. Scenarios A and B are briefly described below.

For Scenario A, the future land use assumes continued industrial use of the site. This scenario addresses long-term exposure received by industrial workers exposed daily to residual levels of radionuclides in soil during an average workday outdoors on site (EPA, 1991). Scenario A parameters are based on the following:

- A worker will be outdoors at the site for a total of 2,000 hours per year (hrs/yr) (250 days per year, 8 hours per day) for 25 years.

- Indoor fraction time is zero, which means that the worker is outside being exposed for the entire workday.

- The outdoor time fraction is 0.228 and is calculated by dividing the total work hours at the site per year (2,000 hrs/yr) by the total number of hours in a year (8,760 hrs/yrs).

- Worker exposures are limited to working hours and do not include contributions from ingestion of drinking water, plant foods, meat, or fish taken from the immediate area.

For Scenario B, the future land use assumes land use restrictions with a low occupancy factor and lighter work activities at the site. The assumptions for Scenario B includes the following:

- A worker will be at the site and outdoors for a total of 335 hours per year for 25 years.

- The indoor fraction time is zero.

- The outdoor time fraction is 0.038, which is calculated by dividing the total work hours at the site per year (335 hrs/yr) by the total number of hours in a year (8,760 hrs/yr).

- The worker exposures are limited to working hours and do not include contributions from ingestion of drinking water, plant foods, meat or fish taken from the immediate area.

When Scenario B is selected, a "Use Restriction" will be included at closure that will state the use scenario and the requirement for an occupant agency or entity to re-evaluate the closure if site use changes to fit the parameters of Scenario A.

Table 6-1 lists the pathways considered for Scenarios A and B.

Table 6-1. Summary of Pathways Considered for Scenarios A and B

Pathway	Scenario A	Scenario B
External exposure	Yes	Yes
Particulate inhalation	Yes	Yes
Radon inhalation	No	No
Ingestion of soil	Yes	Yes
Ingestion of produce from on-site garden	No	No
Ingestion of meat from on-site livestock	No	No
Ingestion of milk from on-site livestock	No	No
Ingestion of fish from on-site pond	No	No
Ingestion of water from on-site well	No	No

6.3 RESRAD Parameters

The RESRAD User's Manual states, "The RESRAD default parameter values were carefully selected and are realistic, although conservative, parameter values. (In most cases, use of these values will not result in underestimation of the dose or risk.) Site-specific parameters should always be used whenever possible. Therefore, use of default values that significantly overestimate the dose or risk for a particular site is discouraged." (Yu et al., 2001)

Table 6-2 lists the RESRAD default values along with the site-specific RESRAD parameters approved for use with Scenarios A and B. A reference or reason is provided for parameters that require site-specific input.

Table 6-2. Approved RESRAD Parameters

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Parameter	Units	Scenario A	Scenario B	Defaults	Reference/Rationale
Dose Conversion Factors					Use FGR 13 Morbidity
R02 Exposure Pathways					
Pathway 1- External Gamma		Active	Active		
Pathway 2- Inhalation		Active	Active		
Pathway 3- Plant Ingestion		Suppressed	Suppressed		
Pathway 4- Meat Ingestion		Suppressed	Suppressed		
Pathway 5- Milk Ingestion		Suppressed	Suppressed		
Pathway 6- Aquatic Foods		Suppressed	Suppressed		
Pathway 7- Drinking Water		Suppressed	Suppressed		
Pathway 8- Soil Ingestion		Active	Active		
Pathway 9- Radon		Suppressed	Suppressed		
R011 Contaminated Zone					
Area of CZ	m^2	Site Specific	Site Specific	1.000E+04	Maximum area of contamination out to two successive sample intervals below PALs. (~ 15 ft intervals laterally)
Thickness of CZ	m	Site Specific	Site Specific	2.000E+00	Maximum identified depth plus two successive intervals below PALs as identified during the site characterization. (~ 5 ft. intervals vertically)
Length Parallel to Aquifer Flow	m	not used	not used	1.000E+02	Not used with the above pathway selection
Radiation Dose Limit	mrem/yr	25	25	2.5E+001	RESRAD Default (DOE, 1993)
Elapsed Time Since Placement of Material	yr	0.0	0.0	0.0	RESRAD Default
R012 Initial Principal Radionuclide					
Site Specific Parent Radionuclide with half-life greater than 180 days, does not include naturally occurring and primordial radionuclides	pCi/g	Site Specific	Site Specific	0.0	The arithmetic mean plus the 95% UCL for the site.

Table 6-2. Approved RESRAD Parameters

Parameter	Units	Scenario A	Scenario B	Defaults	Reference/Rationale
R013 Cover and Contaminated Zone Hydrological Data					
Cover Depth	m	Site Specific	Site Specific	0.0	The minimum depth as identified during the site characterization
Density of Cover Material	g/cm^3	1.5	1.5	1.5	RESRAD Default unless site data significantly different
Cover Depth Erosion Rate	m/yr	1.000E-03	1.000E-03	1.000E-03	RESRAD Default unless site data significantly different
Density of Contaminated Zone	g/cm^3	1.5	1.5	1.5	RESRAD Default unless site data significantly different
Contamination Zone Erosion Rate	m/yr	1.000E-03	1.000E-03	1.000E-03	RESRAD Default unless site data significantly different
Contaminated Zone Total Porosity	-	4.000E-01	4.000E-01	4.000E-01	RESRAD Default unless site data significantly different
Contaminated Zone Field Capacity	-	2.000E-01	2.000E-01	2.000E-01	RESRAD Default unless site data significantly different
Contaminated Zone Hydraulic Conductivity	m/yr	1.000E+01	1.000E+01	1.000E+01	RESRAD Default unless site data significantly different
Contaminated Zone b Parameter	-	5.300E+00	5.300E+00	5.300E+00	RESRAD Default unless site data significantly different
Average Annual Wind Speed	m/sec	Site Specific	Site Specific	2.000E+00	Data from Air Resources Laboratory http://www.sord.nv.doe.gov/arlsord-1.htm
Humidity in Air	g/m^3	not used	not used	8.000E+00	Not used with the above pathway selection
Evapotranspiration Coefficient	-	5.000E-01	5.000E-01	5.000E-01	RESRAD Default not significant due to lack of groundwater pathway
Precipitation	m/yr	Site Specific	Site Specific	1.000E+00	Data from Air Resources Laboratory http://www.sord.nv.doe.gov/arlsord-1.htm
Irrigation	m/yr	0	0	2.000E-01	Assumes no artificial supply of water to soil
Irrigation Mode	-	overhead	overhead	overhead	RESRAD Default
Runoff Coefficient	-	4.000E-01	4.000E-01	2.000E-01	Open Sandy Loam 30% impervious Table 10.1 (Yu, et. al., 1993)
Watershed Area for Nearby Stream or Pond	m^2	not used	not used	1.000E+06	Not used with the above pathway selection
Accuracy for Water/Soil Computations	-	not used	not used	1.000E-03	Not used with the above pathway selection

Table 6-2. Approved RESRAD Parameters

Parameter	Units	Scenario A	Scenario B	Defaults	Reference/Rationale
R014 Saturated Zone Hydrological Data					
Density of Saturated Zone	g/cm^3	not used	not used	1.500E+00	Not used with the above pathway selection
Saturated Zone Total Porosity	-	not used	not used	4.000E-01	Not used with the above pathway selection
Saturated Zone Effective Porosity	-	not used	not used	2.000E-01	Not used with the above pathway selection
Saturated Zone Field Capacity	-	not used	not used	2.000E-01	Not used with the above pathway selection
Saturated Zone Hydraulic Conductivity	m/yr	not used	not used	1.000E+02	Not used with the above pathway selection
Saturated Zone Hydraulic Gradient	-	not used	not used	2.000E-02	Not used with the above pathway selection
Saturated Zone b Parameter	-	not used	not used	5.300E+00	Not used with the above pathway selection
Water Table Drop Rate	m/yr	not used	not used	1.000E-03	Not used with the above pathway selection
Well Pump Intake Depth	m	not used	not used	1.000E+01	Not used with the above pathway selection
Model: Nondispersion or Mass-Balance	-	ND	ND	ND	RESRAD Default
Well Pumping Rate	m^3/yr	not used	not used	2.500E+02	Not used with the above pathway selection
R015 Uncontaminated and Unsaturated Strata Hydrological Data					
Number of Unsaturated Zone Strata	-	not used	not used	1	Not used with the above pathway selection
Thickness	m	not used	not used	4.000E+00	Not used with the above pathway selection
Soil Density	g/cm^3	not used	not used	1.500E+00	Not used with the above pathway selection
Total Porosity	-	not used	not used	4.000E-01	Not used with the above pathway selection
Effective Porosity	-	not used	not used	2.000E-01	Not used with the above pathway selection
Field Capacity	-	not used	not used	2.000E-01	Not used with the above pathway selection
Soil-specific b Parameter	-	not used	not used	5.300E+00	Not used with the above pathway selection
Hydraulic Conductivity	m/yr	not used	not used	1.000E+01	Not used with the above pathway selection

Table 6-2. Approved RESRAD Parameters

Parameter	Units	Scenario A	Scenario B	Defaults	Reference/Rationale
R016 Distribution Coefficients and Leach Rates					
Contaminated Zone K_d (all Zones)	cm^3/g				RESRAD Defaults
Saturated Leach Rate	/yr	0.0	0.0	0.0	Not used
Solubility Constant	-	0.0	0.0	0.0	Not used
R017 Inhalation and External Gamma					
Inhalation Rate	m^3/yr	8.400E+03	1.230E+04	8.400E+03	RESRAD Default and for an individual performing outdoor activities, a typical activity mix can consist of 37% at a moderate activity level, 28% at both resting and light activity levels, and 7% at a heavy activity level, which results in a 1.4 m^3/h (12,300 m^3/yr) inhalation rate. (Yu, et. al., 1993)
Mass Loading for Inhalation	g/m^3	6.00E-04	6.00E-04	1E-04	The estimated mass loading for construction activities (Yu, et. al., 1993)
Exposure Duration	yr	25	25	30	Standard for Industrial/Commercial Scenario
Shielding Factor Inhalation	-	1	1	0.4	Assumes no indoor time fraction
Shielding Factor External Gamma	-	1	1	0.7	Assumes no indoor time fraction
Fraction of Time Spent Indoors	-	0.0	0.0	0.5	Assumes no indoor time fraction
Fraction of Time Spent Outdoors	-	0.228	0.038	0.25	Based on Industrial/Commercial use scenarios for standard occupancy and low occupancy
Shape Factor	-	1.0	1.0	1.0	RESRAD Default

Table 6-2. Approved RESRAD Parameters

Parameter	Units	Scenario A	Scenario B	Defaults	Reference/Rationale
R018 Ingestion Pathway Data, Dietary Parameters					
Fruits, Vegetables, and Grain Consumption	kg/yr	not used	not used	1.600E+02	Not used with the above pathway selection
Leafy Vegetable Consumption	kg/yr	not used	not used	1.400E+01	Not used with the above pathway selection
Milk Consumption	L/yr	not used	not used	9.200E+01	Not used with the above pathway selection
Meat and Poultry Consumption	kg/yr	not used	not used	6.300E+01	Not used with the above pathway selection
Fish Consumption	kg/yr	not used	not used	5.400E+00	Not used with the above pathway selection
Other Seafood Consumption	kg/yr	not used	not used	9.000E-01	Not used with the above pathway selection
Soil Ingestion Rate	g/yr	1.752E+02	1.752E+02	36.5	480 mg/day (EPA, 1991)
Drinking Water Intake	L/yr	not used	not used	5.100E+02	Not used with the above pathway selection
Drinking Water Contaminated Fraction	-	not used	not used	1.000E+00	Not used with the above pathway selection
Household Water Contaminated Fraction	-	not used	not used	1.000E+00	Not used with the above pathway selection
Livestock Water Contaminated Fraction	-	not used	not used	1.000E+00	Not used with the above pathway selection
Irrigation Water Contaminated Fraction	-	not used	not used	1.000E+00	Not used with the above pathway selection
Aquatic Food Contamination Fraction	-	not used	not used	5.000E-01	Not used with the above pathway selection
Plant Food Contamination Fraction	-	not used	not used	-1	Not used with the above pathway selection
Meat Contamination Fraction	-	not used	not used	-1	Not used with the above pathway selection
Milk Contamination Fraction	-	not used	not used	-1	Not used with the above pathway selection
R019 Ingestion Pathway Data, Nondietary					
Livestock Fodder Intake for Meat	kg/day	not used	not used	6.800E+01	Not used with the above pathway selection
Livestock Fodder Intake for Milk	kg/day	not used	not used	5.500E+01	Not used with the above pathway selection
Livestock Water Intake for Meat	L/day	not used	not used	5.000E+01	Not used with the above pathway selection
Livestock Water Intake for Milk	L/day	not used	not used	1.600E+02	Not used with the above pathway selection

Table 6-2. Approved RESRAD Parameters

Parameter	Units	Scenario A	Scenario B	Defaults	Reference/Rationale
Livestock Soil Intake	kg/day	not used	not used	5.000E-01	Not used with the above pathway selection
Mass Loading for Foliar Deposition	g/m^3	not used	not used	1.000E-04	Not used with the above pathway selection
Depth of Soil Mixing layer	m	not used	not used	1.500E-01	Not used with the above pathway selection
Depth of Roots	m	not used	not used	9.000E-01	Not used with the above pathway selection
Drinking Water Fraction from Groundwater	-	not used	not used	1.000E+00	Not used with the above pathway selection
Household Water Fraction from Groundwater	-	not used	not used	1.000E+00	Not used with the above pathway selection
Livestock Water Fraction from Groundwater	-	not used	not used	1.000E+00	Not used with the above pathway selection
Irrigation Fraction from Groundwater	-	not used	not used	1.000E+00	Not used with the above pathway selection
R021 Radon					
Radon Parameters Not Used					Not used with the above pathway selection

cm^3/g = Cubic centimeters per gram
kg/day = Kilograms per day
kg/yr = Kilograms per year
g/m^3 = Grams per cubic meter
g/yr = Grams per year
L/day = Liter per day
L/yr = Liter per year
m = Meter
m^2 = Square meter
m/yr = Meters per year
m^3/yr = Cubic meters per year
mrem/yr = Millirem per year
pCi/g = Picocuries per gram
/yr = Per year

6.4 Residual Radioactive Material Guidelines

The RESRAD material guideline represents the concentration of RESRAD material that can remain in place and still allow use of that area without radiological restrictions. Using site-specific parameters and sample analysis results, the radioactive material guideline, G, can be calculated for a given dose limit of H_{EL} for an individual as follows;

$$G = H_{EL} / DSR ,$$

where DSR is the total dose/source concentration ratio. The dose limit H_{EL}, used to derive the RESRAD material guideline is 25 mrem/yr.

Single radionuclide guidelines are calculated for individual radionuclides such that the annual dose to industrial/construction workers at the site should not exceed an annual dose limitation of 25 mrem/yr. Sites contaminated with two or more radionuclides (i.e., a mixture of radionuclides) require further evaluation to ensure that collective exposures from individual radionuclides do not exceed the 25 mrem/yr annual dose constraint. This evaluation is performed using a sum of the fractions method. The initial soil concentration of each radionuclide is divided by the single radionuclide guideline for that radionuclide to produce a ratio. These ratios are then summed. If the sum is less than or equal to unity, then the collective annual dose from all radionuclides at the site should not exceed the 25 mrem/yr annual dose constraint. If the sum does exceed unity, the annual dose to industrial/construction workers could exceed the 25 mrem/yr dose constraint, even if the concentrations of residual radionuclides at the site are below the single radionuclide guideline values. For sites where the sum of the ratios exceeds unity, RESRAD material guidelines for mixtures of radionuclides are calculated such that the following equation is satisfied;

$$\overline{M} = \sum_i \overline{S}_i(0) / G_i(t_m) \leq 1$$

Where:

	$M(bar)$	=	average mixture sum (dimensionless)
	$S_i(bar)naught$	=	initial concentration of the ith principal radionuclide averaged over an area determined by scenario activities
	$G_i(t_m)$	=	single radionuclide soil concentration guideline for the ith principal radionuclide at time t maximum.

For a site where the sum of the ratios does not exceed unity, the RESRAD guidelines for single radionuclides are the radionuclide concentrations to be used as the FAL. For sites where the sum of the ratios exceeds unity, the RESRAD guidelines for mixtures of radionuclides are mathematically adjusted such that the above equation is satisfied; these adjusted values are then used as the FAL.

7.0 RESRAD Calculations for CAU 309

This section discuses the RESRAD calculations and results for the CAU 309, Area 12 Muckpiles.

7.1 Selection of RESRAD Exposure Scenario

Scenario B was selected as the exposure scenario for the CAU 309 because of the remote location of the site. Because Scenario B parameters will be used for these calculations, a "Use Restriction" will be implemented at closure that will state the use scenario and the requirement for an occupant agency or entity to re-evaluate the closure if site use changes to fit the parameters of Scenario A.

7.2 User Input Parameters

The RESRAD default parameters that were modified for the calculations performed for the calculations in this report. A complete list of the RESRAD default parameters and the parameters used for CAU 309 is provided in Table A.1 in Attachment A.

7.3 Radionuclide Concentrations and Dose Estimates for CAU 309

Uncertainty in the derivation of dose estimates and dose/source contribution ratios comes from the distribution of possible input parameter values, as well as uncertainty in the conceptual model used to represent the site. The pathway contributions to the total annual dose at time zero are 64.25 percent for external exposure, 17.34 percent for inhalation, and 18.422 percent for soil ingestion pathways. Therefore, uncertainties in the following parameters: erosion rate, thickness of contaminated zone, occupancy factors, mass loading, inhalation rate, and wind speed have the greatest significance on the model predictions. The detailed results for this RESRAD exposure scenario are provided in Exhibit 1, RESRAD Summary Report: CAU 309 of this attachment.

The maximum dose contributions and total dose/source concentration ratios for the CAU 309 under Scenario B parameters have been predicted to occur at time zero. The calculated maximum dose contributions for all considered pathways are presented in Table 7-1. Figure 7-1 shows that at time zero, the TEDE to industrial/construction workers for the considered pathways is 67.63 mrem/yr and that the annual dose rate drops below 25 mrem/yr until after the first 100 years.

Figure 7-2 shows the breakdown of the total dose into the component pathways. Together, Figures 7-1 and 7-2 both show that the dose from Cs-137 at time zero is 41.94 mrem/yr and drops to 4.03 mrem/yr after the 100-year time interval. This data also shows that the annual dose from external radiation (mostly from Cs-137) at time zero is 43.45 mrem/yr and is reduced to 4.07 mrem/yr within 100 years. Within 100 years, the annual dose for Cs-137 is calculated at 4.03 mrem/yr, which will account for 17.43 percent of the total annual dose. Plutonium-239, with annual dose of 17.67 mrem/yr, conversely, accounts for 26, 12 percent of the total dose at year zero. Its contribution is divided between inhalation and soil ingestion with the doses of 8.59 and 9.07 mrem/yr, respectively. The contribution to total dose from Pu-239 after the first

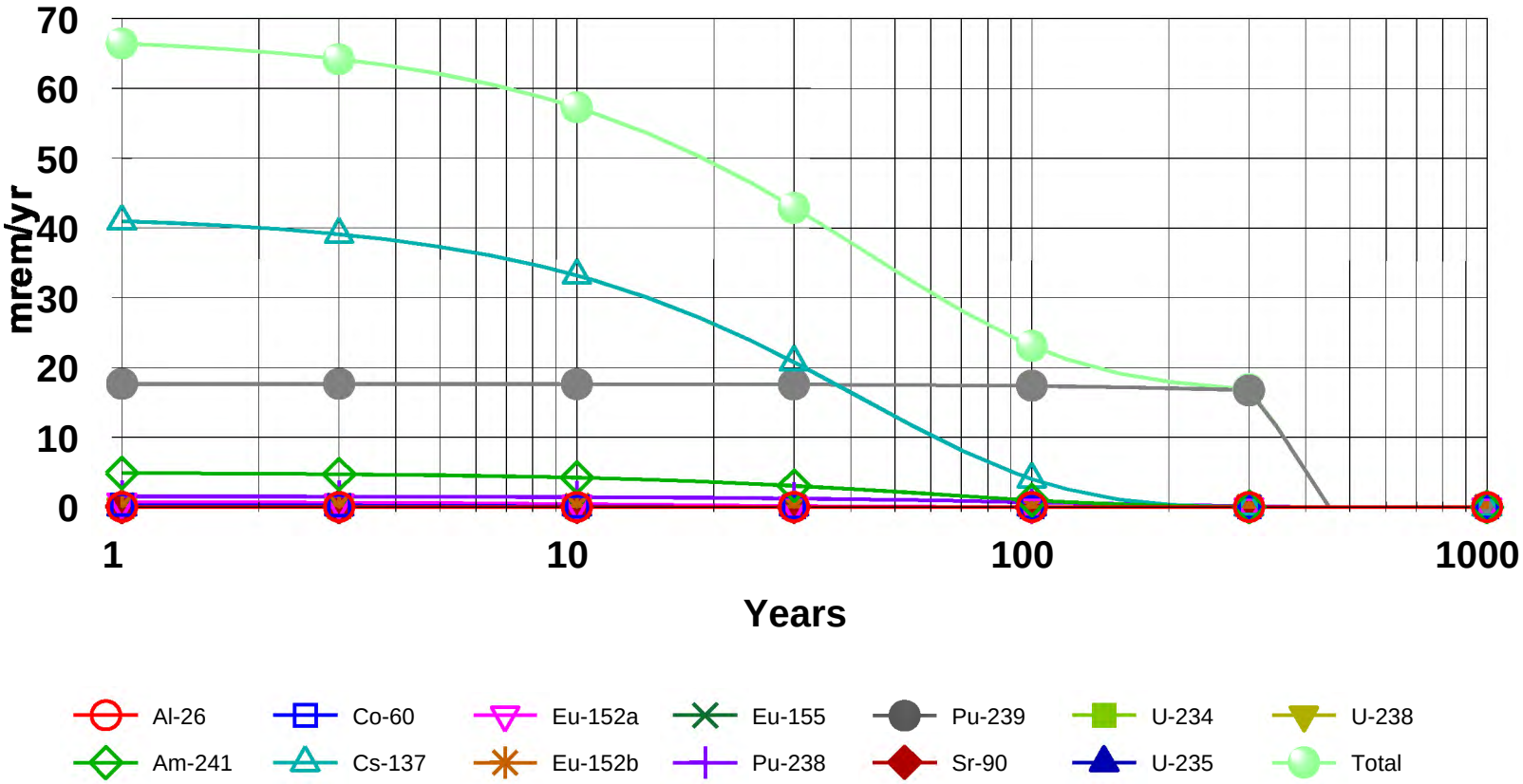
100 years increases to 75.11 percent at 17.36 mrem/yr. Inhalation and soil digestion maintain to be the major pathways for Pu-239 after the first 100 years with doses of 9.44 and 8.20 mrem/yr for the former and latter, respectively.

Because Cs-137 has a half-life of 30.2 years and Pu-239 2.41E+04 years, the concentrations of Cs-137 and Pu-239 at this site will not decay to a safe level through the radioactive decay processes within the first 100-year time interval. Site remediation and/or controls that reduce workers exposures and minimize the spread of radioactive contamination into uncontaminated areas are recommended for this site.

7.4 Residual Radioactive Material Guidelines for CAU 309

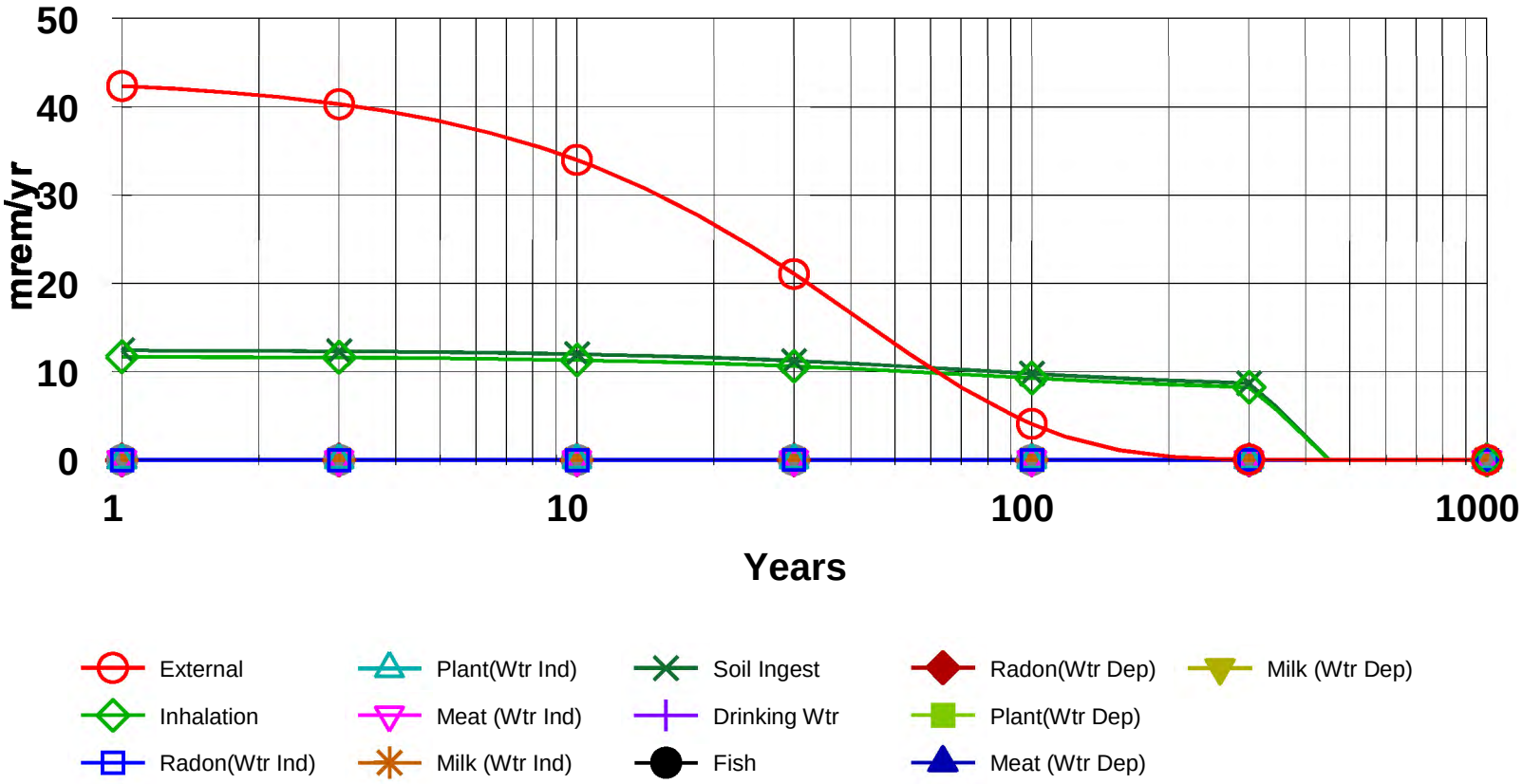
The sum of the ratios for CAU 309 exceeded unity. The RESRAD guidelines for mixtures of radionuclides were calculated for this site. Table 7-2 presents the calculations results for deriving guidelines for mixtures radionuclides for this CAU. The FALs for the CAU 309 scenario are the RESRAD material guideline values for mixture radionuclides.

Figure 7-1. CAU 309 Scenario B: Dose Rate Per Year All Radionuclides Summed, All Pathways Summed



Site1.RAD 10/19/2005 09:26 Includes All

Figure 7-2. CAU 309 Scenario B: Annual Dose All Radionuclides Summed, Component Pathways



Site1.RAD 10/19/2005

Table 7-1. Maximum Dose* Contributions for CAU 309 Using Scenario B**

Radionuclide	External		Inhalation		Soil Ingestion		Total	
	Annual Dose	Fraction	Annual Dose	Fraction	Annual Dose	Fraction	Annual Dose	Fraction
Americium-241	1.679E-01	0.0025	2.337E-00	0.0346	2.452E+00	0.0363	4.957E+00	0.0733
Cobalt-60	3.640E-01	0.0054	6.830E-06	0.0000	1.074E-04	0.0000	3.641E-01	0.0054
Cesium-137	4.183E+01	0.6185	5.412E-04	0.0000	1.086E-01	0.0016	4.194E+01	0.6201
Plutonium-238	2.137E-04	0.0000	7.595E-01	0.0112	7.936E-01	0.0117	1.553E+00	0.0230
Plutonium-239	4.300E-03	0.0001	8.590E+00	0.1270	9.073E+00	0.1341	1.767E+01	0.2612
Strotium-90	1.595E-02	0.0002	1.173E-03	0.0000	1.753E-02	0.0003	3.465E-02	0.0005
Uranium-234	6.088E-05	0.0000	2.738E-02	0.0004	7.515E-03	0.0001	3.496E-02	0.0005
Uranium-235	4.169E-03	0.0001	9.315E-04	0.0000	2.589E-04	0.0000	5.360E-03	0.0001
Uranium-238	8.677E-03	0.0001	9.302E-03	0.0001	2.714E-03	0.0000	2.069E-02	0.0003

*Dose in millirem per year
**Occur at t = 0

Table 7-2. CAU 309 Sum of Fractions and Proportional Scaling

Radionuclide	Initial Radionuclide Concentration (pCi/g)	Mixture Radionuclides Guidelines* (pCi/g)	Ratio for Mixture Radionuclide Guidelines (%)
Aluminum-26	1.090E-01	7.310E+01	0.06
Americium-241	1.020E+02	5.145E+02	7.33
Cobalt-60	6.400E-01	4.394E+01	0.54
Cesiums-137	3.300E+02	1.967E+02	62.02
Europium-152	3.950E+00	9.741E+01	1.50
Europium-155	7.400E-01	3.871E+03	0.01
Plutonium-238	3.740E+01	6.019E+02	2.30
Plutonium-239	3.850E+02	5.448E+02	26.12
Stronium-90	1.750E+01	1.262E+04	0.05
Uranium-234	4.000E+00	2.860E+03	0.05
Uranium-235	1.460E-01	6.810E+02	0.01
Uranium-238	1.520E+00	1.836E+03	0.03
Total	8.782E+02	2.394E+04	100.00

* The mixture radionuclide guidelines apply to areas uniformly contaminated with a mixture of radionuclides. The FALs are the radionuclide guidelines for mixture radionuclides (i.e., Mixture Radionuclide Guidelines).

pCi/g = Picocuries per gram

Table 7-3. RESRAD Parameters Input Values for CAU 309

(Page 1 of 2)

Parameter	Units	CAU 309	Defaults	Reference/Rationale
R011 Contaminated Zone				
Area of CZ	m^2	471233	1.000E+04	Estimated using the site boundary
Thickness of CZ	m	0.450E+00	2.000E+00	Maximum depth from contaminated samples
R012 Initial Principal Radionuclide				
Americium-241 (soil)	pCi/g	1.020E+02	0.0	
Aluminum-26 (soil)	pCi/g	1.090E-01	0.0	
Europium-152 (soil)	pCi/g	3.950E+00	0.0	
Europium-155 (soil)	pCi/g	7.400E-01	0.0	For CAU 309: The maximum concentration from sample results.
Cesium-137 (soil)	pCi/g	3.300E+02	0.0	
Cobalt-60 (soil)	pCi/g	6.400E-01	0.0	
Stronium-90 (soil)	pCi/g	1.750E+01	0.0	
Plutonium-238 (soil)	pCi/g	3.740E+01	0.0	
Plutonium-239 (soil)	pCi/g	3.850E+02	0.0	
Uranium-234 (soil)	pCi/g	4.000E+00	0.0	
Uranium-235 (soil)	pCi/g	1.460E-01	0.0	
Uranium-238 (soil)	pCi/g	1.520E+00	0.0	
R013 Cover and Contaminated Zone Hydrological Data				
Average Annual Wind Speed	m/sec	3.4	2.000E+00	Data from Air Resource Laboratory (2005)
Precipitation	m/yr	3.260E-01	1.000E+00	Data from Air Resources Laboratory
Runoff Coefficient	-	4.000E-01	2.000E-01	Open Sandy Loam 30% impervious Table 10.1 (Yu, et al., 1993)

Table 7-3. RESRAD Parameters Input Values for CAU 309

(Page 2 of 2)

Parameter	Units	CAU 309	Defaults	Reference/Rationale
R017 Inhalation and External Gamma				
Inhalation Rate	m^3/yr	1.230E+04	8.400E+03	RESRAD Default and for an individual performing outdoor activities, a typical activity mix can consist of 37% at a moderate activity level, 28% at both resting and light activity levels, and 7% at a heavy activity level, which results in a 1.4 m^3/h (12,300 m^3/yr) inhalation rate. (Yu, et al., 1993)
Mass Loading for Inhalation	g/m^3	6.00E-04	1E-04	The estimated mass loading for construction activities. (Yu, et al., 1993)
Exposure Duration	yr	25	30	Standard for Industrial/Commercial Scenario
Shielding Factor Inhalation	-	1.0	0.4	Assumes no indoor time fraction
Shielding Factor External Gamma	-	1.0	0.7	Assumes no indoor time fraction
Fraction of Time Spent Indoors	-	0.0	0.5	Assumes no indoor time fraction
Fraction of Time Spent Outdoors	-	0.038	0.25	Scenario specific based on Industrial/ Commercial Use Scenarios for standard occupancy and low occupancy.
Soil Ingestion Rate	g/yr	1.752E+02	36.5	EPA, 1991; 480 mg/day

cm^3/g = Cubic centimeters per gram
g/cm^3 = Grams per cubic centimeter
g/m^3 = Grams per cubic meter
g/yr = Grams per year
kg/day = Kilograms per day
kg/yr = Kilograms per year
L/day = Liters per day
L/yr = Liters per year
m = Meter
m^2 = Square meter
m/sec = Meters per second
m/yr = Meters per year
m^3/h = Cubic meters per hour
m^3/yr = Cubic meters per year
mrem/yr = Millirem per year
N/A = Not applicable
pCi/g = Picocuries per gram
yr = Year
/yr = Per year
UCL = Upper confidence level

References:

AEC, see Atomic Energy Commission.

ARL, see Air Resources Laboratory.

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Yu C., Loureiro C., Cheng C. C., Jones L. G., Wang Y. Y., Chia Y. P., and Faillace E. 1993. *Data Collection Handbook To Support Modeling the Impacts of Radioactive Material in Soil*, ANL/EAIS-8. Chicago, IL: Environmental Assessment Division, Argonne National Laboratory.

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

Attachment A

RESRAD Parameters Used for Analysis of CAU 309 Results

The parametric values used in the RESRAD code for the analysis of the CAU 309 results are listed in Table A.1. Some parameters are site-specific, while other values are default RESRAD values. The dose conversion factors used for inhalation and ingestion were the default FGR 13 morbidity values and correspond to the guidance and recommendations per the August 9, 2002, memorandum from A. Lawrence, Office of Environmental Policy & Guidance, to Distribution, titled "Radiation Risk Estimation from Total Effective Dose Equivalents (TEDEs)" (EH-412-2002-1) (Lawrence, 2002).

Table A.1. RESRAD Parameters

(Page 1 of 6)

Parameter	Units	CAU 309	Defaults	Reference/Rationale
R011 Contaminated Zone				
Area of CZ	m^2	5.625E+04	1.000E+04	Estimated using the site boundary
Thickness of CZ	m	1.500E-01	2.000E+00	Maximum depth from contaminated samples
Length Parallel to Aquifer Flow	m	not used	1.000E+02	Not Used
Radiation Dose Limit	mrem/yr	2.5E+001	2.5E+001	RESRAD Default (Yu, et al., 1993)
Elapsed Time Since Placement of Material	yr	0.0	0.0	RESRAD Default
R012 Initial Principal Radionuclide				
Americium-241 (soil)	pCi/g	1.020E+02	0.0	
Aluminum-26 (soil)	pCi/g	1.090E-01	0.0	
Europium-152 (soil)	pCi/g	3.950E+00	0.0	
Europium-155 (soil)	pCi/g	7.400E-01	0.0	For CAU 309: The maximum concentration from sample results.
Cesium-137 (soil)	pCi/g	3.300E+02	0.0	
Cobalt-60 (soil)	pCi/g	6.400E-01	0.0	
Stronium-90 (soil)	pCi/g	1.750E+01	0.0	
Plutonium-238 (soil)	pCi/g	3.740E+01	0.0	
Plutonium-239 (soil)	pCi/g	3.850E+02	0.0	
Uranium-234 (soil)	pCi/g	4.000E+00	0.0	
Uranium-235 (soil)	pCi/g	1.460E-01	0.0	
Uranium-238 (soil)	pCi/g	1.520E+00	0.0	

Table A.1. RESRAD Parameters
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Parameter	Units	CAU 309	Defaults	Reference/Rationale
R013 Cover and Contaminated Zone Hydrological Data				
Cover Depth	m	0.0	0.0	No Cover Assumed
Density of Cover Material	g/cm^3	not used	1.5	No Cover Assumed
Cover Depth Erosion Rate	m/yr	not used	1.000E-03	No Cover Assumed
Density of Contaminated Zone	g/cm^3	1.5	1.5	RESRAD Default
Contamination Zone Erosion Rate	m/yr	1.000E-03	1.000E-03	RESRAD Default
Contaminated Zone Total Porosity	-	4.000E-01	4.000E-01	RESRAD Default
Contaminated Zone Field Capacity	-	2.000E-01	2.000E-01	RESRAD Default
Contaminated Zone Hydraulic Conductivity	m/yr	1.000E+01	1.000E+01	RESRAD Default
Contaminated Zone b Parameter	-	5.300E+00	5.300E+00	RESRAD Default
Average Annual Wind Speed	m/sec	3.400E+00	2.000E+00	Data from Air Resource Laboratory (2005)
Humidity in Air	g/m^3	not used	8.000E+00	Not used
Evapotranspiration Coefficient	-	5.000E-01	5.000E-01	RESRAD Default
Precipitation	m/yr	3.260E-01	1.000E+00	Data from Air Resources Laboratory
Irrigation	m/yr	2.000E-01	2.000E-01	RESRAD Default
Irrigation Mode	-	overhead	overhead	RESRAD Default
Runoff Coefficient	-	4.000E-01	2.000E-01	Open Sandy Loam 30% impervious Table 10.1 (Yu, et al., 1993)
Watershed Area for Nearby Stream or Pond	m^2	not used	1.000E+06	Not used
Accuracy for Water/Soil Computations	-	not used	1.000E-03	Not used

Table A.1. RESRAD Parameters

(Page 3 of 6)

Parameter	Units	CAU 309	Defaults	Reference/Rationale
R014 Saturated Zone Hydrological Data				
Density of Saturated Zone	g/cm^3	not used	1.500E+00	Not used
Saturated Zone Total Porosity	-	not used	4.000E-01	Not used
Saturated Zone Effective Porosity	-	not used	2.000E-01	Not used
Saturated Zone Field Capacity	-	not used	2.000E-01	Not used
Saturated Zone Hydraulic Conductivity	m/yr	not used	1.000E+02	Not used
Saturated Zone Hydraulic Gradient	-	not used	2.000E-02	Not used
Saturated Zone b Parameter	-	not used	5.300E+00	Not used
Water Table Drop Rate	m/yr	not used	1.000E-03	Not used
Well Pump Intake Depth	m	not used	1.000E+01	Not used
Model: Nondispersion or Mass-Balance	-	not used	ND	Not used
Well Pumping Rate	m^3/yr	not used	2.500E+02	Not used
R015 Uncontaminated and Unsaturated Strata Hydrological Data				
Number of Unsaturated Zone Strata	-	not used	1	Not used
Thickness	m	not used	4.000E+00	Not used
Soil Density	g/cm^3	not used	1.500E+00	Not used
Total Porosity	-	not used	4.000E-01	Not used
Effective Porosity	-	not used	2.000E-01	Not used
Field Capacity	-	not used	2.000E-01	Not used
Soil-specific b Parameter	-	not used	5.300E+00	Not used
Hydraulic Conductivity	m/yr	not used	1.000E+01	Not used

Table A.1. RESRAD Parameters

(Page 4 of 6)

Parameter	Units	CAU 309	Defaults	Reference/Rationale
R016 Distribution Coefficients and Leach Rates				
Contaminated Zone K_d (all Zones)	cm^3/g			RESRAD Default
Saturated Leach Rate	/yr	0.0	0.0	Not used
Solubility Constant	-	0.0	0.0	Not used
R017 Inhalation and External Gamma				
Inhalation Rate	m^3/yr	1.230E+04	8.400E+03	RESRAD Default and for an individual performing outdoor activities, a typical activity mix can consist of 37% at a moderate activity level, 28% at both resting and light activity levels, and 7% at a heavy activity level, which results in a 1.4 m^3/h (12,300 m^3/yr) inhalation rate. (Yu, et al., 1993)
Mass Loading for Inhalation	g/m^3	6.00E-04	1E-04	The estimated mass loading for construction activities. (Yu, et al., 1993)
Exposure Duration	yr	25	30	Standard for Industrial/Commercial Scenario
Shielding Factor Inhalation	-	1.0	0.4	Assumes no indoor time fraction
Shielding Factor External Gamma	-	1.0	0.7	Assumes no indoor time fraction
Fraction of Time Spent Indoors	-	0.0	0.5	Assumes no indoor time fraction
Fraction of Time Spent Outdoors	-	0.038	0.25	Scenario specific based on Industrial/ Commercial Use Scenarios for standard occupancy and low occupancy.
Shape Factor	-	1.0	1.0	RESRAD Default
R018 Ingestion Pathway Data, Dietary Parameters				
Fruits, Vegetables, and Grain Consumption	kg/yr	not used	1.600E+02	Not used
Leafy Vegetable Consumption	kg/yr	not used	1.400E+01	Not used
Milk Consumption	L/yr	not used	9.200E+01	Not used
Meat and Poultry Consumption	kg/yr	not used	6.300E+01	Not used

Table A.1. RESRAD Parameters
(Page 5 of 6)

Parameter	Units	CAU 309	Defaults	Reference/Rationale
Fish Consumption	kg/yr	not used	5.400E+00	Not used
Other Seafood Consumption	kg/yr	not used	9.000E-01	Not used
Soil Ingestion Rate	g/yr	1.752E+02	36.5	EPA, 1991; 480 mg/day
Drinking Water Intake	L/yr	not used	5.100E+02	Not used
Drinking Water Contaminated Fraction	-	not used	1.000E+00	Not used
Household Water Contaminated Fraction	-	not used	1.000E+00	Not used
Livestock Water Contaminated Fraction	-	not used	1.000E+00	Not used
Irrigation Water Contaminated Fraction	-	not used	1.000E+00	Not used
Aquatic Food Contamination Fraction	-	not used	5.000E-01	Not used
Plant Food Contamination Fraction	-	not used	-1	Not used
Meat Contamination Fraction	-	not used	-1	Not used
Milk Contamination Fraction	-	not used	-1	Not used
R019 Ingestion Pathway Data, Nondietary				
Livestock Fodder Intake for Meat	kg/day	not used	6.800E+01	Not used
Livestock Fodder Intake for Milk	kg/day	not used	5.500E+01	Not used
Livestock Water Intake for Meat	L/day	not used	5.000E+01	Not used
Livestock Water Intake for Milk	L/day	not used	1.600E+02	Not used
Livestock Soil Intake	kg/day	not used	5.000E-01	Not used
Mass Loading for Foliar Deposition	g/m^3	not used	1.000E-04	Not used
Depth of Soil Mixing Layer	m	1.500E-01	1.500E-01	RESRAD Default
Depth of Roots	m	not used	9.000E-01	Not used

Table A.1. RESRAD Parameters
(Page 6 of 6)

Parameter	Units	CAU 309	Defaults	Reference/Rationale
Drinking Water Fraction from Groundwater	-	not used	1.000E+00	Not used
Household Water Fraction from Groundwater	-	not used	1.000E+00	Not used
Livestock Water Fraction from Groundwater	-	not used	1.000E+00	Not used
Irrigation Fraction from Groundwater	-	not used	1.000E+00	Not used
R021 Radon				
Radon Parameters Not Used				Not used

cm^3/g = Cubic centimeters per gram
g/cm^3 = Grams per cubic centimeter
g/m^3 = Grams per cubic meter
g/yr = Grams per year
kg/day = Kilograms per day
kg/yr = Kilograms per year
L/day = Liters per day
L/yr = Liters per year
m = Meter
m^2 = Square meter
m/sec = Meters per second
m/yr = Meters per year
m^3/h = Cubic meters per hour
m^3/yr = Cubic meters per year
mg.day = Milligrams per day
mrem/yr = Millirem per year
N/A = Not applicable
pCi/g = Picocuries per gram
yr = Year
/yr = Per year
UCL = Upper confidence level

Exhibit 1

RESRAD Summary Report:
CAU 309 Area 12 Muckpiles

(29 Pages)

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Al-26	7.960E-05	7.960E-05	DCF2(2)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(3)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(4)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(5)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(6)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(8)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(9)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(10)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(11)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(12)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(13)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(14)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(15)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(16)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(17)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(18)
B-1	U-233	1.350E-01	1.350E-01	DCF2(19)
B-1	U-234	1.320E-01	1.320E-01	DCF2(20)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(21)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(22)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Al-26	1.460E-05	1.460E-05	DCF3(2)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(3)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(4)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(5)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(6)
D-1	Eu-155	1.530E-06	1.530E-06	DCF3(8)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(9)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(10)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(11)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(12)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(13)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(14)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(15)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(16)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(17)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(18)
D-1	U-233	2.890E-04	2.890E-04	DCF3(19)
D-1	U-234	2.830E-04	2.830E-04	DCF3(20)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(21)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(22)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Al-26 , plant/soil concentration ratio, dimensionless	4.000E-03	4.000E-03	RTF(2,1)
D-34	Al-26 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-04	5.000E-04	RTF(2,2)
D-34	Al-26 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-04	2.000E-04	RTF(2,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(3,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(3,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(4,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(4,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(5,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(5,3)
D-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(6,3)
D-34				
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(8,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(8,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(9,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(9,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(10,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(10,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(11,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(11,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(11,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(12,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(12,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(12,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(13,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(13,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(13,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(14,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(14,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(14,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(15,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(15,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(15,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(16,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(16,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(16,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(17,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(17,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(17,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(18,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(18,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(18,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(19,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(19,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(19,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(20,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(20,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(20,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(21,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(21,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(21,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(22,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(22,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(22,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Al-26 , fish	5.000E+02	5.000E+02	BIOFAC(2,1)
D-5	Al-26 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(3,2)
D-5				
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(4,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(4,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(5,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(5,2)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(6,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)
D-5				
D-5	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(8,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(8,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(9,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(9,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(10,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(10,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(11,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(12,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(12,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(13,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(13,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(14,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(14,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(15,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(15,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(16,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(16,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(17,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(17,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(18,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(18,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(19,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(19,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(20,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(20,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(21,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(21,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(22,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(22,2)

Site-Specific Parameter Summary

Menu	Parameter		User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)		4.712E+05	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)		4.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)		not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)		2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)		0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)		1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)		3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)		1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)		3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)		1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)		3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)		1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)		not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)		not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g):	Al-26	1.090E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g):	Am-241	1.020E+02	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g):	Co-60	6.400E-01	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g):	Cs-137	3.300E+02	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g):	Eu-152	3.950E+00	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g):	Eu-155	7.400E-01	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g):	Pu-238	3.740E+01	0.000E+00	---	S1(13)
R012	Initial principal radionuclide (pCi/g):	Pu-239	3.850E+02	0.000E+00	---	S1(14)
R012	Initial principal radionuclide (pCi/g):	Sr-90	1.750E+01	0.000E+00	---	S1(16)
R012	Initial principal radionuclide (pCi/g):	U-234	4.000E+00	0.000E+00	---	S1(20)
R012	Initial principal radionuclide (pCi/g):	U-235	1.460E-01	0.000E+00	---	S1(21)
R012	Initial principal radionuclide (pCi/g):	U-238	1.520E+00	0.000E+00	---	S1(22)
R012	Concentration in groundwater (pCi/L):	Al-26	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L):	Am-241	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L):	Co-60	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L):	Cs-137	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L):	Eu-152	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L):	Eu-155	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L):	Pu-238	not used	0.000E+00	---	W1(13)
R012	Concentration in groundwater (pCi/L):	Pu-239	not used	0.000E+00	---	W1(14)
R012	Concentration in groundwater (pCi/L):	Sr-90	not used	0.000E+00	---	W1(16)
R012	Concentration in groundwater (pCi/L):	U-234	not used	0.000E+00	---	W1(20)
R012	Concentration in groundwater (pCi/L):	U-235	not used	0.000E+00	---	W1(21)
R012	Concentration in groundwater (pCi/L):	U-238	not used	0.000E+00	---	W1(22)
R013	Cover depth (m)		0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)		not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)		not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)		1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)		1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity		4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity		2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)		1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter		5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)		3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)		not used	8.000E+00	---	HUMID

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.260E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Al-26				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	0.000E+00	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	0.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.466E+00	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.451E-02	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.930E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.930E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.552E-04	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.552E-04	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.465E-04	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(14,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.465E-04	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	not used	3.000E+01	---	DCNUCU(16,1)
R016	Saturated zone (cm**3/g)	not used	3.000E+01	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.703E-03	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(20)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(20,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.837E-03	ALEACH(20)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(20)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(21)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(21,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.837E-03	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(22)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(22,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.837E-03	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.451E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.552E-04	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	not used	-1.000E+00	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	not used	-1.000E+00	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.137E-03	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.837E-03	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.925E-03	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.174E-03	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(17)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(17,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.884E-06	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(18)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(18,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.884E-06	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(19)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(19,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.837E-03	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R017	Inhalation rate (m**3/yr)	1.230E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	1.000E+00	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	1.000E+00	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	3.800E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.752E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	471233.00 square meters	Al-26	1.090E-01
Thickness:	0.45 meters	Am-241	1.020E+02
Cover Depth:	0.00 meters	Co-60	6.400E-01
		Cs-137	3.300E+02
		Eu-152	3.950E+00
		Eu-155	7.400E-01
		Pu-238	3.740E+01
		Pu-239	3.850E+02
		Sr-90	1.750E+01
		U-234	4.000E+00
		U-235	1.460E-01
		U-238	1.520E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	6.763E+01	6.644E+01	6.420E+01	5.726E+01	4.291E+01	2.311E+01	1.693E+01	0.000E+00
M(t):	2.705E+00	2.658E+00	2.568E+00	2.290E+00	1.717E+00	9.246E-01	6.771E-01	0.000E+00

0Maximum TDOSE(t): 6.763E+01 mrem/yr   at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	3.727E-02	0.0006	2.367E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.558E-06	0.0000
Am-241	1.679E-01	0.0025	2.337E+00	0.0346	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.452E+00	0.0363
Co-60	3.640E-01	0.0054	6.830E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.074E-04	0.0000
Cs-137	4.183E+01	0.6185	5.412E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.086E-01	0.0016
Eu-152	1.014E+00	0.0150	4.424E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.660E-04	0.0000
Eu-155	4.771E-03	0.0001	1.487E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.034E-06	0.0000
Pu-238	2.137E-04	0.0000	7.595E-01	0.0112	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.936E-01	0.0117
Pu-239	4.300E-03	0.0001	8.590E+00	0.1270	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.073E+00	0.1341
Sr-90	1.595E-02	0.0002	1.173E-03	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.753E-02	0.0003
U-234	6.088E-05	0.0000	2.738E-02	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.515E-03	0.0001
U-235	4.169E-03	0.0001	9.315E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.589E-04	0.0000
U-238	8.677E-03	0.0001	9.302E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.714E-03	0.0000
Total	4.345E+01	0.6425	1.173E+01	0.1734	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.246E+01	0.1842

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

0 Water Dependent Pathways

0 Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.728E-02	0.0006
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.957E+00	0.0733
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.641E-01	0.0054
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.194E+01	0.6201
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.014E+00	0.0150
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.780E-03	0.0001
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.553E+00	0.0230
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.767E+01	0.2612
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.465E-02	0.0005
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.496E-02	0.0005
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.360E-03	0.0001
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.069E-02	0.0003
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.763E+01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	8.602E-03	0.0001	5.464E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.283E-06	0.0000
Am-241	1.653E-01	0.0025	2.299E+00	0.0346	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.413E+00	0.0363
Co-60	3.190E-01	0.0048	5.987E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.413E-05	0.0000
Cs-137	4.086E+01	0.6150	5.287E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.061E-01	0.0016
Eu-152	9.618E-01	0.0145	4.198E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.576E-04	0.0000
Eu-155	4.147E-03	0.0001	1.293E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.114E-06	0.0000
Pu-238	2.120E-04	0.0000	7.534E-01	0.0113	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.872E-01	0.0118
Pu-239	4.300E-03	0.0001	8.589E+00	0.1293	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.071E+00	0.1365
Sr-90	1.543E-02	0.0002	1.134E-03	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.695E-02	0.0003
U-234	6.053E-05	0.0000	2.722E-02	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.471E-03	0.0001
U-235	4.145E-03	0.0001	9.263E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.576E-04	0.0000
U-238	8.626E-03	0.0001	9.248E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.698E-03	0.0000
Total	4.235E+01	0.6375	1.168E+01	0.1758	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.241E+01	0.1867

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

0 Water Dependent Pathways

0 Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.603E-03	0.0001
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.878E+00	0.0734
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.191E-01	0.0048
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.097E+01	0.6166
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.620E-01	0.0145
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.155E-03	0.0001
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.541E+00	0.0232
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.766E+01	0.2659
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.351E-02	0.0005
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.476E-02	0.0005
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.329E-03	0.0001
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.057E-02	0.0003
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.644E+01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	4.581E-04	0.0000	2.910E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.831E-08	0.0000
Am-241	1.600E-01	0.0025	2.227E+00	0.0347	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.336E+00	0.0364
Co-60	2.451E-01	0.0038	4.600E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.232E-05	0.0000
Cs-137	3.899E+01	0.6074	5.045E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.012E-01	0.0016
Eu-152	8.661E-01	0.0135	3.781E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.419E-04	0.0000
Eu-155	3.134E-03	0.0000	9.767E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.620E-06	0.0000
Pu-238	2.086E-04	0.0000	7.414E-01	0.0115	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.747E-01	0.0121
Pu-239	4.298E-03	0.0001	8.586E+00	0.1337	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.068E+00	0.1412
Sr-90	1.443E-02	0.0002	1.061E-03	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.585E-02	0.0002
U-234	5.987E-05	0.0000	2.691E-02	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.384E-03	0.0001
U-235	4.097E-03	0.0001	9.161E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.551E-04	0.0000
U-238	8.526E-03	0.0001	9.141E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.667E-03	0.0000
Total	4.030E+01	0.6277	1.159E+01	0.1806	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.231E+01	0.1917

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.581E-04	0.0000
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.723E+00	0.0736
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.452E-01	0.0038
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.910E+01	0.6090
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.663E-01	0.0135
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.139E-03	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.516E+00	0.0236
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.766E+01	0.2751
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.134E-02	0.0005
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.435E-02	0.0005
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.268E-03	0.0001
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.033E-02	0.0003
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.420E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	1.596E-08	0.0000	1.014E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.381E-12	0.0000
Am-241	1.430E-01	0.0025	1.989E+00	0.0347	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.087E+00	0.0365
Co-60	9.740E-02	0.0017	1.828E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.875E-05	0.0000
Cs-137	3.310E+01	0.5781	4.283E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.592E-02	0.0015
Eu-152	6.003E-01	0.0105	2.621E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.836E-05	0.0000
Eu-155	1.175E-03	0.0000	3.663E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.733E-06	0.0000
Pu-238	1.972E-04	0.0000	7.008E-01	0.0122	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.322E-01	0.0128
Pu-239	4.293E-03	0.0001	8.575E+00	0.1498	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.057E+00	0.1582
Sr-90	1.141E-02	0.0002	8.388E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.254E-02	0.0002
U-234	5.779E-05	0.0000	2.584E-02	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.089E-03	0.0001
U-235	3.934E-03	0.0001	8.821E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.467E-04	0.0000
U-238	8.184E-03	0.0001	8.775E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.560E-03	0.0000
Total	3.397E+01	0.5933	1.130E+01	0.1974	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.198E+01	0.2093

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

0 Water Dependent Pathways

0 Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.596E-08	0.0000
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.219E+00	0.0737
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.743E-02	0.0017
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.319E+01	0.5796
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.004E-01	0.0105
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.177E-03	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.433E+00	0.0250
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.764E+01	0.3080
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.479E-02	0.0004
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.298E-02	0.0006
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.063E-03	0.0001
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.952E-02	0.0003
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.726E+01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	2.926E-21	0.0000	1.861E-26	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.369E-25	0.0000
Am-241	1.036E-01	0.0024	1.441E+00	0.0336	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.512E+00	0.0352
Co-60	6.972E-03	0.0002	1.310E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.060E-06	0.0000
Cs-137	2.073E+01	0.4830	2.682E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.381E-02	0.0013
Eu-152	2.105E-01	0.0049	9.198E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.452E-05	0.0000
Eu-155	7.133E-05	0.0000	2.223E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.051E-07	0.0000
Pu-238	1.679E-04	0.0000	5.966E-01	0.0139	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.234E-01	0.0145
Pu-239	4.278E-03	0.0001	8.545E+00	0.1991	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.025E+00	0.2103
Sr-90	5.840E-03	0.0001	4.292E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.416E-03	0.0001
U-234	5.388E-05	0.0000	2.300E-02	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.311E-03	0.0001
U-235	3.503E-03	0.0001	7.962E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.254E-04	0.0000
U-238	7.280E-03	0.0002	7.809E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.278E-03	0.0001
Total	2.107E+01	0.4909	1.062E+01	0.2474	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.123E+01	0.2617

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.926E-21	0.0000
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.057E+00	0.0712
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.974E-03	0.0002
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.078E+01	0.4842
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.106E-01	0.0049
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.145E-05	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.220E+00	0.0284
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.757E+01	0.4095
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.268E-02	0.0003
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.936E-02	0.0007
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.524E-03	0.0001
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.737E-02	0.0004
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.291E+01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Am-241	3.360E-02	0.0015	4.666E-01	0.0202	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.897E-01	0.0212
Co-60	6.816E-07	0.0000	1.290E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.028E-10	0.0000
Cs-137	4.018E+00	0.1738	5.214E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.046E-02	0.0005
Eu-152	5.362E-03	0.0002	2.355E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.840E-07	0.0000
Eu-155	3.927E-09	0.0000	1.224E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.789E-12	0.0000
Pu-238	9.568E-05	0.0000	3.397E-01	0.0147	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.549E-01	0.0154
Pu-239	4.226E-03	0.0002	8.441E+00	0.3652	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.915E+00	0.3857
Sr-90	5.595E-04	0.0000	4.112E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.146E-04	0.0000
U-234	5.743E-05	0.0000	1.532E-02	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.202E-03	0.0002
U-235	2.335E-03	0.0001	5.670E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.667E-04	0.0000
U-238	4.822E-03	0.0002	5.190E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.514E-03	0.0001
Total	4.069E+00	0.1760	9.268E+00	0.4010	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.777E+00	0.4230

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.899E-01	0.0428
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.818E-07	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.028E+00	0.1743
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.364E-03	0.0002
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.934E-09	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.948E-01	0.0301
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.736E+01	0.7511
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.215E-03	0.0001
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.958E-02	0.0008
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.069E-03	0.0001
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.153E-02	0.0005
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.311E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Am-241	1.397E-03	0.0001	1.858E-02	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.950E-02	0.0012
Co-60	2.083E-18	0.0000	4.589E-23	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.214E-22	0.0000
Cs-137	3.351E-02	0.0020	4.824E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.679E-05	0.0000
Eu-152	1.329E-07	0.0000	6.658E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.498E-11	0.0000
Eu-155	2.629E-21	0.0000	8.263E-25	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.909E-24	0.0000
Pu-238	1.929E-05	0.0000	6.775E-02	0.0040	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.077E-02	0.0042
Pu-239	3.930E-03	0.0002	8.123E+00	0.4798	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.579E+00	0.5068
Sr-90	6.487E-07	0.0000	5.038E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.531E-07	0.0000
U-234	1.073E-04	0.0000	4.819E-03	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.330E-03	0.0001
U-235	7.039E-04	0.0000	2.120E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.737E-05	0.0000
U-238	1.349E-03	0.0001	1.611E-03	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.699E-04	0.0000
Total	4.102E-02	0.0024	8.216E+00	0.4853	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.672E+00	0.5122

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.948E-02	0.0023
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.084E-18	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.361E-02	0.0020
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.330E-07	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.633E-21	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.385E-01	0.0082
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.671E+01	0.9869
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.452E-06	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.256E-03	0.0004
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.833E-04	0.0001
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.430E-03	0.0002
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.693E+01	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

0 Water Independent Pathways (Inhalation excludes radon)

0 Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

0 Water Dependent Pathways

0 Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Al-26	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)							
Al-26	Al-26	1.000E+00	3.420E-01	7.893E-02	4.203E-03	1.465E-07	2.685E-20	0.000E+00	0.000E+00	0.000E+00
0Am-241	Am-241	1.000E+00	4.860E-02	4.782E-02	4.630E-02	4.136E-02	2.997E-02	9.703E-03	3.856E-04	0.000E+00
Am-241	Np-237	1.000E+00	1.598E-08	4.756E-08	1.091E-07	3.085E-07	7.601E-07	1.489E-06	1.470E-06	0.000E+00
Am-241	U-233	1.000E+00	2.112E-15	1.469E-14	7.649E-14	6.489E-13	4.710E-12	3.114E-11	8.332E-11	0.000E+00
Am-241	Th-229	1.000E+00	1.107E-18	1.653E-17	1.907E-16	4.859E-15	1.062E-13	2.620E-12	2.796E-11	0.000E+00
Am-241	äDSR(j)		4.860E-02	4.782E-02	4.630E-02	4.136E-02	2.997E-02	9.705E-03	3.871E-04	0.000E+00
0Co-60	Co-60	1.000E+00	5.689E-01	4.987E-01	3.831E-01	1.522E-01	1.090E-02	1.065E-06	3.256E-18	0.000E+00
0Cs-137	Cs-137	1.000E+00	1.271E-01	1.241E-01	1.185E-01	1.006E-01	6.297E-02	1.221E-02	1.018E-04	0.000E+00
0Eu-152	Eu-152	7.208E-01	1.850E-01	1.755E-01	1.581E-01	1.096E-01	3.842E-02	9.787E-04	2.426E-08	0.000E+00
0Eu-152	Eu-152	2.792E-01	7.165E-02	6.800E-02	6.123E-02	4.244E-02	1.488E-02	3.791E-04	9.398E-09	0.000E+00
Eu-152	Gd-152	2.792E-01	1.207E-17	3.538E-17	7.848E-17	1.980E-16	3.717E-16	4.535E-16	4.233E-16	0.000E+00
Eu-152	äDSR(j)		7.165E-02	6.800E-02	6.123E-02	4.244E-02	1.488E-02	3.791E-04	9.398E-09	0.000E+00
0Eu-155	Eu-155	1.000E+00	6.459E-03	5.615E-03	4.243E-03	1.591E-03	9.656E-05	5.316E-09	3.559E-21	0.000E+00
0Pu-238	Pu-238	1.000E+00	4.153E-02	4.120E-02	4.054E-02	3.832E-02	3.262E-02	1.858E-02	3.703E-03	0.000E+00
Pu-238	U-234	1.000E+00	1.237E-08	3.687E-08	8.487E-08	2.426E-07	6.134E-07	1.245E-06	9.408E-07	0.000E+00
Pu-238	Th-230	1.000E+00	8.753E-14	6.103E-13	3.197E-12	2.770E-11	2.131E-10	1.696E-09	6.752E-09	0.000E+00
Pu-238	Ra-226	1.000E+00	1.972E-16	2.946E-15	3.406E-14	8.746E-13	1.950E-11	5.058E-10	5.027E-09	0.000E+00
Pu-238	Pb-210	1.000E+00	1.415E-19	4.347E-18	1.074E-16	7.811E-15	4.533E-13	2.814E-11	5.108E-10	0.000E+00
Pu-238	äDSR(j)		4.153E-02	4.120E-02	4.054E-02	3.832E-02	3.263E-02	1.858E-02	3.704E-03	0.000E+00
0Pu-239	Pu-239	1.000E+00	4.589E-02	4.588E-02	4.587E-02	4.581E-02	4.565E-02	4.509E-02	4.339E-02	0.000E+00
Pu-239	U-235	1.000E+00	1.809E-11	5.414E-11	1.256E-10	3.690E-10	1.010E-09	2.730E-09	4.808E-09	0.000E+00
Pu-239	Pa-231	1.000E+00	4.999E-16	3.488E-15	1.829E-14	1.592E-13	1.241E-12	1.030E-11	4.478E-11	0.000E+00
Pu-239	Ac-227	1.000E+00	1.432E-17	2.121E-16	2.407E-15	5.789E-14	1.087E-12	1.791E-11	1.027E-10	0.000E+00
Pu-239	äDSR(j)		4.589E-02	4.588E-02	4.587E-02	4.581E-02	4.565E-02	4.509E-02	4.339E-02	0.000E+00
0Sr-90	Sr-90	1.000E+00	1.980E-03	1.915E-03	1.791E-03	1.417E-03	7.248E-04	6.944E-05	8.298E-08	0.000E+00
0U-234	U-234	1.000E+00	8.740E-03	8.689E-03	8.588E-03	8.244E-03	7.335E-03	4.874E-03	1.511E-03	0.000E+00
U-234	Th-230	1.000E+00	9.277E-08	2.776E-07	6.440E-07	1.893E-06	5.192E-06	1.412E-05	2.617E-05	0.000E+00
U-234	Ra-226	1.000E+00	2.785E-10	1.943E-09	1.020E-08	8.907E-08	7.004E-07	5.967E-06	2.475E-05	0.000E+00
U-234	Pb-210	1.000E+00	2.495E-13	3.707E-12	4.235E-11	1.041E-09	2.068E-08	3.900E-07	2.679E-06	0.000E+00
U-234	äDSR(j)		8.740E-03	8.689E-03	8.589E-03	8.246E-03	7.341E-03	4.894E-03	1.564E-03	0.000E+00
0U-235	U-235	1.000E+00	3.671E-02	3.650E-02	3.607E-02	3.463E-02	3.082E-02	2.048E-02	6.168E-03	0.000E+00
U-235	Pa-231	1.000E+00	1.521E-06	4.540E-06	1.047E-05	3.016E-05	7.795E-05	1.706E-04	1.573E-04	0.000E+00
U-235	Ac-227	1.000E+00	5.798E-08	3.992E-07	2.033E-06	1.597E-05	9.471E-05	3.691E-04	4.097E-04	0.000E+00
U-235	äDSR(j)		3.671E-02	3.650E-02	3.609E-02	3.468E-02	3.099E-02	2.102E-02	6.735E-03	0.000E+00

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)							
U-238	U-238	1.000E+00		1.361E-02	1.353E-02	1.338E-02	1.284E-02	1.142E-02	7.582E-03	2.255E-03	0.000E+00
U-238	U-234	1.000E+00		1.238E-08	3.694E-08	8.520E-08	2.454E-07	6.343E-07	1.389E-06	1.287E-06	0.000E+00
U-238	Th-230	1.000E+00		8.758E-14	6.110E-13	3.205E-12	2.791E-11	2.179E-10	1.817E-09	8.051E-09	0.000E+00
U-238	Ra-226	1.000E+00		1.972E-16	2.948E-15	3.413E-14	8.797E-13	1.983E-11	5.331E-10	5.783E-09	0.000E+00
U-238	Pb-210	1.000E+00		1.416E-19	4.350E-18	1.075E-16	7.848E-15	4.596E-13	2.946E-11	5.822E-10	0.000E+00
U-238	äDSR(j)			1.361E-02	1.353E-02	1.338E-02	1.284E-02	1.143E-02	7.583E-03	2.257E-03	0.000E+00

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Al-26	7.310E+01	3.167E+02	5.948E+03	1.707E+08	*1.921E+10	*1.921E+10	*1.921E+10	*1.921E+10
Am-241	5.145E+02	5.228E+02	5.399E+02	6.044E+02	8.341E+02	2.576E+03	6.459E+04	*3.430E+12
Co-60	4.394E+01	5.014E+01	6.526E+01	1.642E+02	2.294E+03	2.347E+07	*1.131E+15	*1.131E+15
Cs-137	1.967E+02	2.014E+02	2.110E+02	2.486E+02	3.970E+02	2.048E+03	2.455E+05	*8.701E+13
Eu-152	9.741E+01	1.027E+02	1.140E+02	1.645E+02	4.690E+02	1.841E+04	7.427E+08	*1.765E+14
Eu-155	3.871E+03	4.453E+03	5.893E+03	1.571E+04	2.589E+05	4.703E+09	*4.651E+14	*4.651E+14
Pu-238	6.019E+02	6.068E+02	6.166E+02	6.524E+02	7.663E+02	1.346E+03	6.749E+03	*1.711E+13
Pu-239	5.448E+02	5.449E+02	5.451E+02	5.457E+02	5.477E+02	5.544E+02	5.761E+02	*6.212E+10
Sr-90	1.262E+04	1.305E+04	1.396E+04	1.765E+04	3.449E+04	3.600E+05	3.013E+08	*1.365E+14
U-234	2.860E+03	2.877E+03	2.911E+03	3.032E+03	3.406E+03	5.108E+03	1.598E+04	*6.245E+09
U-235	6.810E+02	6.849E+02	6.928E+02	7.210E+02	8.068E+02	1.189E+03	3.712E+03	*2.160E+06
U-238	1.836E+03	1.847E+03	1.869E+03	1.947E+03	2.188E+03	3.297E+03	1.108E+04	*3.360E+05

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Al-26	1.090E-01	0.000E+00	3.420E-01	7.310E+01	3.420E-01	7.310E+01
Am-241	1.020E+02	0.000E+00	4.860E-02	5.145E+02	4.860E-02	5.145E+02
Co-60	6.400E-01	0.000E+00	5.689E-01	4.394E+01	5.689E-01	4.394E+01
Cs-137	3.300E+02	0.000E+00	1.271E-01	1.967E+02	1.271E-01	1.967E+02
Eu-152	3.950E+00	0.000E+00	2.566E-01	9.741E+01	2.566E-01	9.741E+01
Eu-155	7.400E-01	0.000E+00	6.459E-03	3.871E+03	6.459E-03	3.871E+03
Pu-238	3.740E+01	0.000E+00	4.153E-02	6.019E+02	4.153E-02	6.019E+02
Pu-239	3.850E+02	0.000E+00	4.589E-02	5.448E+02	4.589E-02	5.448E+02
Sr-90	1.750E+01	0.000E+00	1.980E-03	1.262E+04	1.980E-03	1.262E+04
U-234	4.000E+00	0.000E+00	8.740E-03	2.860E+03	8.740E-03	2.860E+03
U-235	1.460E-01	0.000E+00	3.671E-02	6.810E+02	3.671E-02	6.810E+02
U-238	1.520E+00	0.000E+00	1.361E-02	1.836E+03	1.361E-02	1.836E+03

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Al-26	Al-26	1.000E+00	3.728E-02	8.603E-03	4.581E-04	1.596E-08	2.926E-21	0.000E+00	0.000E+00	0.000E+00
0Am-241	Am-241	1.000E+00	4.957E+00	4.878E+00	4.723E+00	4.219E+00	3.057E+00	9.897E-01	3.933E-02	0.000E+00
0Np-237	Am-241	1.000E+00	1.630E-06	4.852E-06	1.113E-05	3.147E-05	7.753E-05	1.519E-04	1.499E-04	0.000E+00
0U-233	Am-241	1.000E+00	2.154E-13	1.498E-12	7.802E-12	6.619E-11	4.804E-10	3.177E-09	8.499E-09	0.000E+00
0Th-229	Am-241	1.000E+00	1.129E-16	1.686E-15	1.945E-14	4.956E-13	1.083E-11	2.672E-10	2.852E-09	0.000E+00
0Co-60	Co-60	1.000E+00	3.641E-01	3.191E-01	2.452E-01	9.743E-02	6.974E-03	6.818E-07	2.084E-18	0.000E+00
0Cs-137	Cs-137	1.000E+00	4.194E+01	4.097E+01	3.910E+01	3.319E+01	2.078E+01	4.028E+00	3.361E-02	0.000E+00
0Eu-152	Eu-152	7.208E-01	7.307E-01	6.934E-01	6.244E-01	4.328E-01	1.518E-01	3.866E-03	9.583E-08	0.000E+00
Eu-152	Eu-152	2.792E-01	2.830E-01	2.686E-01	2.419E-01	1.676E-01	5.879E-02	1.497E-03	3.712E-08	0.000E+00
Eu-152	äDOSE(j)		1.014E+00	9.620E-01	8.663E-01	6.004E-01	2.106E-01	5.364E-03	1.330E-07	0.000E+00
0Gd-152	Eu-152	2.792E-01	4.768E-17	1.398E-16	3.100E-16	7.822E-16	1.468E-15	1.791E-15	1.672E-15	0.000E+00
0Eu-155	Eu-155	1.000E+00	4.780E-03	4.155E-03	3.139E-03	1.177E-03	7.145E-05	3.934E-09	2.633E-21	0.000E+00
0Pu-238	Pu-238	1.000E+00	1.553E+00	1.541E+00	1.516E+00	1.433E+00	1.220E+00	6.947E-01	1.385E-01	0.000E+00
0U-234	Pu-238	1.000E+00	4.625E-07	1.379E-06	3.174E-06	9.072E-06	2.294E-05	4.658E-05	3.518E-05	0.000E+00
U-234	U-234	1.000E+00	3.496E-02	3.476E-02	3.435E-02	3.298E-02	2.934E-02	1.949E-02	6.042E-03	0.000E+00
U-234	U-238	1.000E+00	1.881E-08	5.614E-08	1.295E-07	3.730E-07	9.641E-07	2.111E-06	1.957E-06	0.000E+00
U-234	äDOSE(j)		3.496E-02	3.476E-02	3.435E-02	3.299E-02	2.936E-02	1.954E-02	6.079E-03	0.000E+00
0Th-230	Pu-238	1.000E+00	3.274E-12	2.282E-11	1.196E-10	1.036E-09	7.971E-09	6.341E-08	2.525E-07	0.000E+00
Th-230	U-234	1.000E+00	3.711E-07	1.110E-06	2.576E-06	7.572E-06	2.077E-05	5.648E-05	1.047E-04	0.000E+00
Th-230	U-238	1.000E+00	1.331E-13	9.287E-13	4.872E-12	4.242E-11	3.312E-10	2.761E-09	1.224E-08	0.000E+00
Th-230	äDOSE(j)		3.711E-07	1.110E-06	2.576E-06	7.573E-06	2.078E-05	5.655E-05	1.049E-04	0.000E+00
0Ra-226	Pu-238	1.000E+00	7.374E-15	1.102E-13	1.274E-12	3.271E-11	7.294E-10	1.892E-08	1.880E-07	0.000E+00
Ra-226	U-234	1.000E+00	1.114E-09	7.774E-09	4.081E-08	3.563E-07	2.802E-06	2.387E-05	9.900E-05	0.000E+00
Ra-226	U-238	1.000E+00	2.998E-16	4.481E-15	5.187E-14	1.337E-12	3.014E-11	8.103E-10	8.791E-09	0.000E+00
Ra-226	äDOSE(j)		1.114E-09	7.774E-09	4.081E-08	3.563E-07	2.802E-06	2.389E-05	9.920E-05	0.000E+00
0Pb-210	Pu-238	1.000E+00	5.292E-18	1.626E-16	4.015E-15	2.921E-13	1.695E-11	1.053E-09	1.910E-08	0.000E+00
Pb-210	U-234	1.000E+00	9.980E-13	1.483E-11	1.694E-10	4.165E-09	8.273E-08	1.560E-06	1.072E-05	0.000E+00
Pb-210	U-238	1.000E+00	2.152E-19	6.612E-18	1.634E-16	1.193E-14	6.985E-13	4.478E-11	8.850E-10	0.000E+00
Pb-210	äDOSE(j)		9.980E-13	1.483E-11	1.694E-10	4.166E-09	8.275E-08	1.561E-06	1.074E-05	0.000E+00
0Pu-239	Pu-239	1.000E+00	1.767E+01	1.766E+01	1.766E+01	1.764E+01	1.757E+01	1.736E+01	1.671E+01	0.000E+00
0U-235	Pu-239	1.000E+00	6.966E-09	2.084E-08	4.835E-08	1.420E-07	3.890E-07	1.051E-06	1.851E-06	0.000E+00
U-235	U-235	1.000E+00	5.360E-03	5.328E-03	5.267E-03	5.056E-03	4.499E-03	2.990E-03	9.005E-04	0.000E+00
U-235	äDOSE(j)		5.360E-03	5.328E-03	5.267E-03	5.056E-03	4.499E-03	2.991E-03	9.024E-04	0.000E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pa-231	Pu-239	1.000E+00	1.925E-13	1.343E-12	7.043E-12	6.130E-11	4.779E-10	3.966E-09	1.724E-08	0.000E+00
Pa-231	U-235	1.000E+00	2.221E-07	6.629E-07	1.529E-06	4.404E-06	1.138E-05	2.490E-05	2.297E-05	0.000E+00
Pa-231	äDOSE(j)		2.221E-07	6.629E-07	1.529E-06	4.404E-06	1.138E-05	2.490E-05	2.299E-05	0.000E+00
0Ac-227	Pu-239	1.000E+00	5.512E-15	8.167E-14	9.269E-13	2.229E-11	4.183E-10	6.895E-09	3.954E-08	0.000E+00
Ac-227	U-235	1.000E+00	8.465E-09	5.829E-08	2.969E-07	2.331E-06	1.383E-05	5.389E-05	5.981E-05	0.000E+00
Ac-227	äDOSE(j)		8.465E-09	5.829E-08	2.969E-07	2.331E-06	1.383E-05	5.390E-05	5.985E-05	0.000E+00
0Sr-90	Sr-90	1.000E+00	3.465E-02	3.351E-02	3.134E-02	2.479E-02	1.268E-02	1.215E-03	1.452E-06	0.000E+00
0U-238	U-238	1.000E+00	2.069E-02	2.057E-02	2.033E-02	1.952E-02	1.737E-02	1.152E-02	3.428E-03	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Al-26	Al-26	1.000E+00	1.090E-01	2.515E-02	1.340E-03	4.669E-08	8.568E-21	0.000E+00	0.000E+00	0.000E+00
0Am-241	Am-241	1.000E+00	1.020E+02	1.004E+02	9.719E+01	8.682E+01	6.291E+01	2.037E+01	8.120E-01	1.028E-05
0Np-237	Am-241	1.000E+00	0.000E+00	3.275E-05	9.659E-05	3.034E-04	7.716E-04	1.529E-03	1.551E-03	7.073E-04
0U-233	Am-241	1.000E+00	0.000E+00	7.169E-11	6.353E-10	6.692E-09	5.184E-08	3.507E-07	9.472E-07	6.488E-07
0Th-229	Am-241	1.000E+00	0.000E+00	2.261E-15	6.034E-14	2.147E-12	5.178E-11	1.323E-09	1.459E-08	6.974E-08
0Co-60	Co-60	1.000E+00	6.400E-01	5.610E-01	4.310E-01	1.713E-01	1.228E-02	1.209E-06	4.313E-18	0.000E+00
0Cs-137	Cs-137	1.000E+00	3.300E+02	3.224E+02	3.076E+02	2.612E+02	1.636E+02	3.179E+01	2.951E-01	2.275E-08
0Eu-152	Eu-152	7.208E-01	2.847E+00	2.702E+00	2.433E+00	1.687E+00	5.920E-01	1.516E-02	4.298E-07	5.215E-23
Eu-152	Eu-152	2.792E-01	1.103E+00	1.047E+00	9.425E-01	6.533E-01	2.293E-01	5.872E-03	1.665E-07	2.020E-23
Eu-152	äS(j):		3.950E+00	3.749E+00	3.376E+00	2.340E+00	8.213E-01	2.103E-02	5.963E-07	7.235E-23
0Gd-152	Eu-152	2.792E-01	0.000E+00	6.895E-15	1.964E-14	5.500E-14	1.064E-13	1.306E-13	1.224E-13	9.543E-14
0Eu-155	Eu-155	1.000E+00	7.400E-01	6.433E-01	4.861E-01	1.823E-01	1.106E-02	6.091E-07	4.126E-19	0.000E+00
0Pu-238	Pu-238	1.000E+00	3.740E+01	3.710E+01	3.651E+01	3.451E+01	2.938E+01	1.673E+01	3.346E+00	1.198E-02
0U-234	Pu-238	1.000E+00	0.000E+00	1.053E-04	3.115E-04	9.892E-04	2.583E-03	5.306E-03	4.035E-03	1.244E-04
U-234	U-234	1.000E+00	4.000E+00	3.977E+00	3.931E+00	3.773E+00	3.357E+00	2.231E+00	6.937E-01	1.163E-02
U-234	U-238	1.000E+00	0.000E+00	4.284E-06	1.270E-05	4.065E-05	1.085E-04	2.403E-04	2.243E-04	1.255E-05
U-234	äS(j):		4.000E+00	3.977E+00	3.931E+00	3.774E+00	3.360E+00	2.236E+00	6.979E-01	1.177E-02
0Th-230	Pu-238	1.000E+00	0.000E+00	4.750E-10	4.236E-09	4.557E-08	3.742E-07	3.047E-06	1.225E-05	1.991E-05
Th-230	U-234	1.000E+00	0.000E+00	3.590E-05	1.071E-04	3.497E-04	9.907E-04	2.725E-03	5.083E-03	6.077E-03
Th-230	U-238	1.000E+00	0.000E+00	1.932E-11	1.725E-10	1.866E-09	1.554E-08	1.326E-07	5.936E-07	1.105E-06
Th-230	äS(j):		0.000E+00	3.590E-05	1.071E-04	3.498E-04	9.911E-04	2.728E-03	5.096E-03	6.098E-03
0Ra-226	Pu-238	1.000E+00	0.000E+00	6.860E-14	1.835E-12	6.580E-11	1.621E-09	4.377E-08	5.037E-07	1.759E-06
Ra-226	U-234	1.000E+00	0.000E+00	7.772E-09	6.947E-08	7.533E-07	6.327E-06	5.548E-05	2.656E-04	5.536E-04
Ra-226	U-238	1.000E+00	0.000E+00	2.789E-15	7.470E-14	2.689E-12	6.695E-11	1.874E-09	2.355E-08	9.579E-08
Ra-226	äS(j):		0.000E+00	7.772E-09	6.947E-08	7.534E-07	6.329E-06	5.552E-05	2.661E-04	5.555E-04
0Pb-210	Pu-238	1.000E+00	0.000E+00	5.299E-16	4.204E-14	4.827E-12	3.198E-10	2.079E-08	3.833E-07	1.592E-06
Pb-210	U-234	1.000E+00	0.000E+00	7.992E-11	2.111E-09	7.244E-08	1.587E-06	3.096E-05	2.153E-04	5.035E-04
Pb-210	U-238	1.000E+00	0.000E+00	2.155E-17	1.711E-15	1.970E-13	1.317E-11	8.842E-10	1.775E-08	8.645E-08
Pb-210	äS(j):		0.000E+00	7.992E-11	2.111E-09	7.244E-08	1.588E-06	3.098E-05	2.157E-04	5.052E-04
0Pu-239	Pu-239	1.000E+00	3.850E+02	3.849E+02	3.848E+02	3.843E+02	3.830E+02	3.783E+02	3.653E+02	3.231E+02
0U-235	Pu-239	1.000E+00	0.000E+00	3.780E-07	1.127E-06	3.680E-06	1.041E-05	2.845E-05	5.191E-05	5.600E-05
U-235	U-235	1.000E+00	1.460E-01	1.452E-01	1.435E-01	1.377E-01	1.225E-01	8.144E-02	2.534E-02	4.258E-04
U-235	äS(j):		1.460E-01	1.452E-01	1.435E-01	1.377E-01	1.226E-01	8.147E-02	2.539E-02	4.818E-04

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pa-231	Pu-239	1.000E+00	0.000E+00	3.995E-12	3.568E-11	3.856E-10	3.209E-09	2.725E-08	1.200E-07	2.044E-07
Pa-231	U-235	1.000E+00	0.000E+00	3.071E-06	9.106E-06	2.914E-05	7.776E-05	1.721E-04	1.603E-04	8.914E-06
Pa-231	äS(j):		0.000E+00	3.071E-06	9.106E-06	2.914E-05	7.776E-05	1.722E-04	1.605E-04	9.119E-06
0Ac-227	Pu-239	1.000E+00	0.000E+00	4.195E-14	1.101E-12	3.693E-11	7.644E-10	1.303E-08	7.624E-08	1.406E-07
Ac-227	U-235	1.000E+00	0.000E+00	4.823E-08	4.178E-07	4.070E-06	2.574E-05	1.025E-04	1.157E-04	6.835E-06
Ac-227	äS(j):		0.000E+00	4.823E-08	4.178E-07	4.070E-06	2.575E-05	1.025E-04	1.158E-04	6.976E-06
0Sr-90	Sr-90	1.000E+00	1.750E+01	1.692E+01	1.583E+01	1.252E+01	6.405E+00	6.136E-01	7.543E-04	4.914E-14
0U-238	U-238	1.000E+00	1.520E+00	1.511E+00	1.494E+00	1.434E+00	1.276E+00	8.479E-01	2.638E-01	4.433E-03

 BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time = 5.21 seconds

Appendix D

Closure Activity Summary for CAU 309 (Use Restriction)

Appendix D
Closure Activity Summary

CAU Use Restriction Information

CAU Number/Description: CAU 309, Area 12 Muckpiles

Applicable CAS Number(s)/Description(s):

- CAS 12-06-09, Muckpile
- CAS 12-08-02, CWD
- CAS 12-28-01, I, J, and K-Tunnel Debris

Contact (organization/project): NNSA/NSO Industrial Sites Project Manager

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

CAS 12-06-09

Southeast Corner:	N = 4119198	E = 574740
Southwest Corner:	N = 4119198	E = 574420
Northwest Corner:	N = 4119305	E = 574420
Northeast Corner:	N = 4119305	E = 574740

CAS 12-08-02

Southeast Corner:	N = 4119280	E = 574935
Southwest Corner:	N = 4119280	E = 574842
Northwest Corner:	N = 4119350	E = 574842
Northeast Corner:	N = 4119350	E = 574935

CAS 12-28-01

Southeast Corner:	N = 4118900	E = 574485
Southwest Corner:	N = 4118900	E = 574370
Northwest Corner:	N = 4118951	E = 574370
Northeast Corner:	N = 4118951	E = 574485

Survey Date: October 2005 **Survey Method (GPS, etc.):** GPS coordinates
Site Monitoring Requirements: Inspection of postings

Required Frequency (quarterly, annually?): Annual

If Monitoring Has Started, Indicate last Completion Date: Not Applicable

Use Restrictions

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 Closure Report or other CAU 309 documentation, unless appropriate concurrence is obtained in advance.

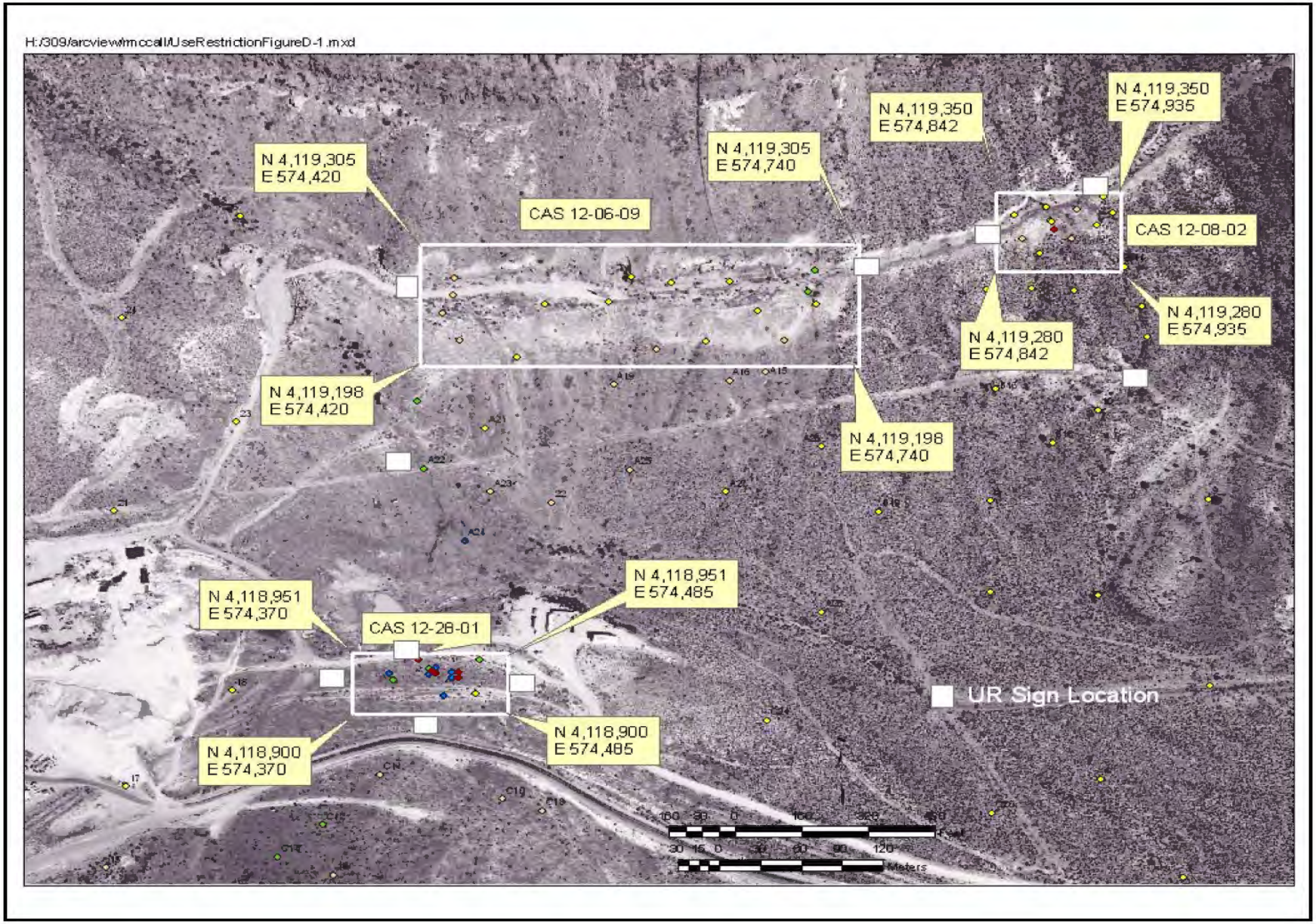
Comments: This Use Restriction is for the surface and subsurface disturbances. CASs 12-06-09 and 12-08-02 are restricted from the surface to the bottom of the muckpiles, estimated to be not greater than 100 ft bgs. The restricted area is identified by signs that are placed on existing fencing going around the muckpiles at the access road to the muckpiles from the west and east. Two additional signs are at the lower power line road also from the west and east. At CAS 12-28-01 signs are attached to the existing fencing surrounding the contamination area. Annual post-closure inspections will be conducted to ensure postings are in place, intact, and readable. Maintenance or replacement of the existing road and utilities can be conducted without prior approval from NDEP. See the Corrective Action Decision Document/Closure Report for additional information on the condition of the site.

Submitted By: _____ **Date:** _____

cc with copy of survey map (paper and digital (.dgn) formats):
CAU Files (2 copies)

The use restriction signs will state the following information:

WARNING
Surface and Subsurface Contamination
FFACO Site CAU 309/CAS XX-XX-XX
Area 12 Muckpiles
No activities that may alter or modify the containment control are
permitted without U.S. Government permission.
Before working in this area,
Contact Real Estate Services at 295-2528



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Appendix E

Borehole and Sample Location Coordinates for CAU 309

a

E.1.0 Sample Location Coordinates

Sample location coordinates for the CAI sampling were determined using a Trimble 5800 GPS Unit with centimeter-level accuracy. These coordinates identify the CAU 309 Decision I and II sampling locations (easting and northing positions). Ground surface elevations at CAU 309 were not collected, because the sample locations were selected using the computer and biasing the locations based on the radiological flyover survey.

Sampling locations and other points of interest, (e.g., metal debris, lead bricks) are shown on Figure A.3-1, while the corresponding coordinates for the CAU 309 CAS locations are listed in Table E.1-1.

Table E.1-1
Sample Location Coordinates and
Locations of Interest for CAU 309
(Page 1 of 5)

Easting (m)	Northing (m)	Location
CAS 12-06-09, Muckpile		
574444.859	4119275.448	A01
574444.2754	4119260.848	A02
574448.8369	4119221.256	A03
574704.675	4119263.034	A04
574709.0234	4119282.337	A05
574709.739	4119252.62	A06
574511.3568	4119252.62	A07
574490.7852	4119207.22	A08
574558.6716	4119254.265	A09
574603.6608	4119271.593	A10
574574.475	4119275.672	A11
574646.4141	4119272.464	A12
574666.9857	4119246.812	A13
574686.8418	4119222.031	A14
574673.1572	4119193.958	A15

Table E.1-1
Sample Location Coordinates and
Locations of Interest for CAU 309
(Page 2 of 5)

Easting (m)	Northing (m)	Location
574646.4141	4119186.505	A16
574628.8835	4119220.385	A17
574593.0173	4119213.803	A18
574561.7126	4119183.214	A19
574417.5322	4119169.177	A20
574467.888	4119146.042	A21
574422.8988	4119110.613	A22
574471.713	4119090.855	A23
574452.5935	4119048.661	A24
574573.9661	4119109.742	A25
574714.3005	4119129.586	A26
574644.0886	4119090.769	A27
574714.3005	4118986.805	A28
574795.963	4118518.68	A29
575557.88	4118942.902	A30
575591.412	4119206.658	A31
575581.676	4118477.852	A32
CAS 12-08-02, Contaminated Waste Dump		
574878.877	4119336.537	B01
574855.4398	4119329.479	B02
574920.2852	4119345.161	B03
574900.4291	4119334.416	B04
574881.378	4119324.446	B05
574860.8063	4119309.635	B06
574927.1722	4119331.899	B07
574896.6725	4119309.635	B08
574873.7754	4119296.374	B09
574884.211	4119317.111	B10

Table E.1-1
Sample Location Coordinates and
Locations of Interest for CAU 309
(Page 3 of 5)

Easting (m)	Northing (m)	Location
574898.9086	4119264.236	B11
574867.7754	4119265.881	B12
574834.8682	4119265.01	B13
574935.5798	4119284.854	B14
574872.9704	4119235.292	B15
574841.7552	4119180.019	B16
574800.5225	4119137.04	B17
574882.8985	4119132.877	B18
574756.2487	4119073.442	B19
574949.079	4119250.566	B20
574952.1938	4119224.325	B21
574882.639	4119323.529	Brick 01
CAS 12-28-01, I-, J-, and K-Tunnel Debris		
574443	4118935	C01
574443	4118930	C02
574448	4118930	C03
574448	4118935	C04
574464.201	4118945.631	C05
574418.7623	4118945.72	C06
574397.5645	4118934.782	C07
574400.565	4118928.52	C08
574460.375	4118916.751	C09
574480.1591	4118826.076	C10
574390.8564	4118846.693	C11
574348.663	4118803.499	C12
574316.2618	4118776.125	C13
574312.8631	4118698.201	C14
574256.1569	4118668.87	C15

Table E.1-1
Sample Location Coordinates and
Locations of Interest for CAU 309
(Page 4 of 5)

Easting (m)	Northing (m)	Location
574600.061	4118651.446	C16
574511.9607	4118741.277	C17
574509.4564	4118815.523	C18
574481.4611	4118684.455	C19
574838.9604	4118813.684	C20
574673.7612	4118893.448	C21
574291.4864	4119753.631	C22
574277.8018	4119827.974	C23
574191.5798	4119851.109	C24
574281.5584	4119689.259	C25
574405.1671	4119676.868	C26
574431.427	4118934.477	C27
574426.434	4118933.87	C28
574426.625	4118938.421	C29
574431.536	4118938.792	C30
574429.111	4118936.477	C31
575563.574	4118376.212	C32
575084.268	4118624.552	C33
Samples Collected Before Field Activities		
574999.603	4118599.667	1
574926.09	4118704.689	2
574978.385	4118758.184	3
574918.118	4118842.786	4
574998.386	4118923.651	5
574837.61	4119004.42	6
574916.297	4119001.608	7
574837.238	4119083.724	8
574997.463	4119084.661	9

Table E.1-1
Sample Location Coordinates and
Locations of Interest for CAU 309
(Page 5 of 5)

Easting (m)	Northing (m)	Location
574916.819	4119161.629	10
574999.718	4119241.416	11
574915.158	4119321.348	12
574984.061	4119412.209	13
574109.005	4118681.986	14
574189.754	4118766.449	15
574356.917	4118760.358	16
574205.026	4118836.583	17
574282.892	4118919.594	18
574437.465	4118915.339	19
574290.347	4119007.095	20
574196.393	4119074.381	21
574516.016	4119081.361	22
574285.185	4119150.997	23
574201.676	4119240.742	24
574436.058	4119245.062	25
574288.424	4119328.891	26

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

Appendix F

Nevada Division of Environmental Protection Comments

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: Draft Corrective Action Decision Document/Closure Report for Corrective Action Unit 309: Area 12 Muckpiles, Nevada Test Site, Nevada	2. Document Date: November 2005
3. Revision Number: 0	4. Originator/Organization: Stoller-Navarro
5. Responsible NNSA/NV ERP Project Mgr.: Janet Appenzeller-Wing	6. Date Comments Due: December 7, 2005
7. Review Criteria: Full	
8. Reviewer/Organization/Phone No.: Don Elle, NDEP, 486-2850, ext. 229	9. Reviewer's Signature:

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1) Executive Summary Page ES-1 3rd Paragraph		NNSA/NSO states that "typical approach for the investigation was modified to incorporate the results of previous muckpile investigations in lieu of both sampling on the steep slopes and sampling into the underlying native. Therefore, the two CAU 309 muckpiles... were assigned radiological and chemical contamination values based on historical data." NNSA/NSO must reconcile these statements with the fact that sampling was indeed conducted as described on page 13, and data used to support the conclusions. The Section 2.1 Investigation Activities is the same and needs a similar reconciliation.	Both the executive summary and Section 2.1 were modified to clarify that samples were collected during the field investigation.	
2) Executive Summary Page ES-2 1st and 2nd Paragraphs		NNSA/NSO states "the FALs were exceeded for Cs-137 and Pu-239" and abruptly states in the next paragraph that "...the DQO data needs were met..." without a logical transition as to why the sites should be closed in place with the results exceeding the FALs, or how the data needs were met. The body of the text must also reflect those changes.	The executive summary was modified to further address the rationale for no further action except the use restriction. Additional verbiage was added on how the data needs were met.	

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to NNSA/NV Environmental Restoration Division, Attn: QAC, M/S 505.

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