Nevada
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DOE/NV--1483

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 570: Area 9 Yucca Flat Atmospheric Test Sites Nevada National Security Site, Nevada

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

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CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 570: AREA 9 YUCCA FLAT ATMOSPHERIC TEST SITES NEVADA NATIONAL SECURITY SITE, NEVADA

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

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Date: 8/15/2012

CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 570: AREA 9
YUCCA FLAT ATMOSPHERIC TEST SITES
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Tiffany A. Lantow Date: 8/16/2012

Tiffany A. Lantow
Soils Activity Lead

Approved by: /s/ Robert F. Boehlecke Date: 8/16/12

Robert F. Boehlecke
Environmental Management Operations Manager

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List of Acronyms and Abbreviations

Ac	Actinium
Ag	Silver
agl	Above ground level
Al	Aluminum
Am	Americium
AMS	Aerial Measuring Systems
ASTM	ASTM International
bgs	Below ground surface
BJY	Buster Jangle Y
CA	Contamination area
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
Ci	Curie
cm	Centimeter
Cm	Curium
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
cps	Counts per second
Cs	Cesium

List of Acronyms and Abbreviations *(Continued)*

CSM	Conceptual site model
DOE	U.S. Department of Energy
DQI	Data quality indicator
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FFACO	*Federal Facility Agreement and Consent Order*
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
GPS	Global Positioning System
GZ	Ground zero
HASL	Health and Safety Laboratory
HCA	High contamination area
HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inch
K	Potassium
keV	Kiloelectron volt
kt	Kiloton
LCS	Laboratory control sample
m	Meter
MDC	Minimum detectable concentration
mi	Mile

List of Acronyms and Abbreviations *(Continued)*

mL/g	Milliliters per gram
mm/yr	Millimeters per year
mrem/IA-yr	Millirem per Industrial Area year
mrem/OA-yr	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
MS	Matrix spike
MSD	Matrix spike duplicate
NAC	*Nevada Administrative Code*
NAD	North American Datum
NaI	Sodium iodide
Nb	Niobium
NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSS	Nevada National Security Site
Np	Neptunium
Pa	Protactinium
PAL	Preliminary action level
Pb	Lead
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PET	Potential evapotranspiration
PPE	Personal protective equipment
PRG	Preliminary Remediation Goal
PSM	Potential source material

List of Acronyms and Abbreviations *(Continued)*

Pu	Plutonium
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
REOP	Real Estate/Operations Permit
RESRAD	Residual Radioactive
RIDP	Radionuclide Inventory and Distribution Program
RMA	Radioactive material area
RRMG	Residual radioactive material guideline
RSL	Remote Sensing Laboratory
RWMS	Radioactive waste management site
SOW	Statement of work
Sr	Strontium
SSTL	Site-specific target level
SVOC	Semivolatile organic compound
Tc	Technetium
TED	Total effective dose
Th	Thorium
Tl	Thallium
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
TSCA	*Toxic Substances Control Act*
U	Uranium

List of Acronyms and Abbreviations *(Continued)*

UCC	Yucca Dry Lake
UCL	Upper confidence limit
URMA	Underground radioactive material area
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
µR/hr	Microroentgens per hour

Executive Summary

Corrective Action Unit (CAU) 570: Area 9 Yucca Flat Atmospheric Test Sites is located in Area 9 of the Nevada National Security Site, which is approximately 65 miles northwest of Las Vegas, Nevada. CAU 570 comprises the following six corrective action sites (CASs):

- 02-23-07, Atmospheric Test Site - Tesla
- 09-23-10, Atmospheric Test Site T-9
- 09-23-11, Atmospheric Test Site S-9G
- 09-23-14, Atmospheric Test Site - Rushmore
- 09-23-15, Eagle Contamination Area
- 09-99-01, Atmospheric Test Site B-9A

These sites are being investigated because existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives (CAAs). Additional information will be obtained by conducting a corrective action investigation before evaluating CAAs and selecting the appropriate corrective action for each CAS. The results of the field investigation will support a defensible evaluation of viable CAAs that will be presented in the Corrective Action Decision Document.

The sites will be investigated based on the data quality objectives (DQOs) developed on April 30, 2012, by representatives of the Nevada Division of Environmental Protection and the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office. The DQO process was used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 570. The site investigation process will also be conducted in accordance with the *Soils Activity Quality Assurance Plan*, which establishes requirements, technical planning, and general quality practices to be applied to this activity.

The presence and nature of contamination at CAU 570 will be evaluated based on information collected from a field investigation. Radiological contamination will be evaluated based on a comparison of the total effective dose at sample locations to the dose-based final action level. The total effective dose will be calculated as the total of separate estimates of internal and external dose. Results from the analysis of soil samples will be used to calculate internal radiological dose. Thermoluminescent dosimeters placed near the center of each sample location will be used to measure external radiological dose.

Appendix A provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS.

This Corrective Action Investigation Plan has been developed in accordance with the *Federal Facility Agreement and Consent Order* that was agreed to by the State of Nevada; DOE, Environmental Management; U.S. Department of Defense; and DOE, Legacy Management. Under the *Federal Facility Agreement and Consent Order*, this Corrective Action Investigation Plan will be submitted to the Nevada Division of Environmental Protection for approval. Fieldwork will be conducted following approval of the plan.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains project-specific information, including facility descriptions, environmental sample collection objectives, and criteria for conducting site investigation activities at Corrective Action Unit (CAU) 570: Yucca Flat Atmospheric Test Sites, Nevada National Security Site (NNSS), Nevada.

This CAIP has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) (1996, as amended) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management.

CAU 570 is located in Area 9 of the NNSS, which is approximately 65 miles (mi) northwest of Las Vegas, Nevada. CAU 570 comprises the six corrective action sites (CASs) shown on Figure 1-1 and listed below:

- 02-23-07, Atmospheric Test Site - Tesla (hereafter referred to as Tesla)
- 09-23-10, Atmospheric Test Site T-9 (hereafter referred to as Sugar)
- 09-23-11, Atmospheric Test Site S-9G (hereafter referred to as Ganymede)
- 09-23-14, Atmospheric Test Site - Rushmore (hereafter referred to as Rushmore)
- 09-23-15, Eagle Contamination Area (hereafter referred to as Eagle)
- 09-99-01, Atmospheric Test Site B-9A (hereafter referred to as Charleston, Hood, Lassen, Morgan, Owens, Wheeler, and Wilson; or collectively as B-9A)

The corrective action investigation (CAI) will include field inspections, radiological surveys, geophysical surveys, sampling of environmental media, analysis of samples, and assessment of investigation results. Data will be obtained to support evaluation of corrective action alternatives (CAAs) and waste management decisions.

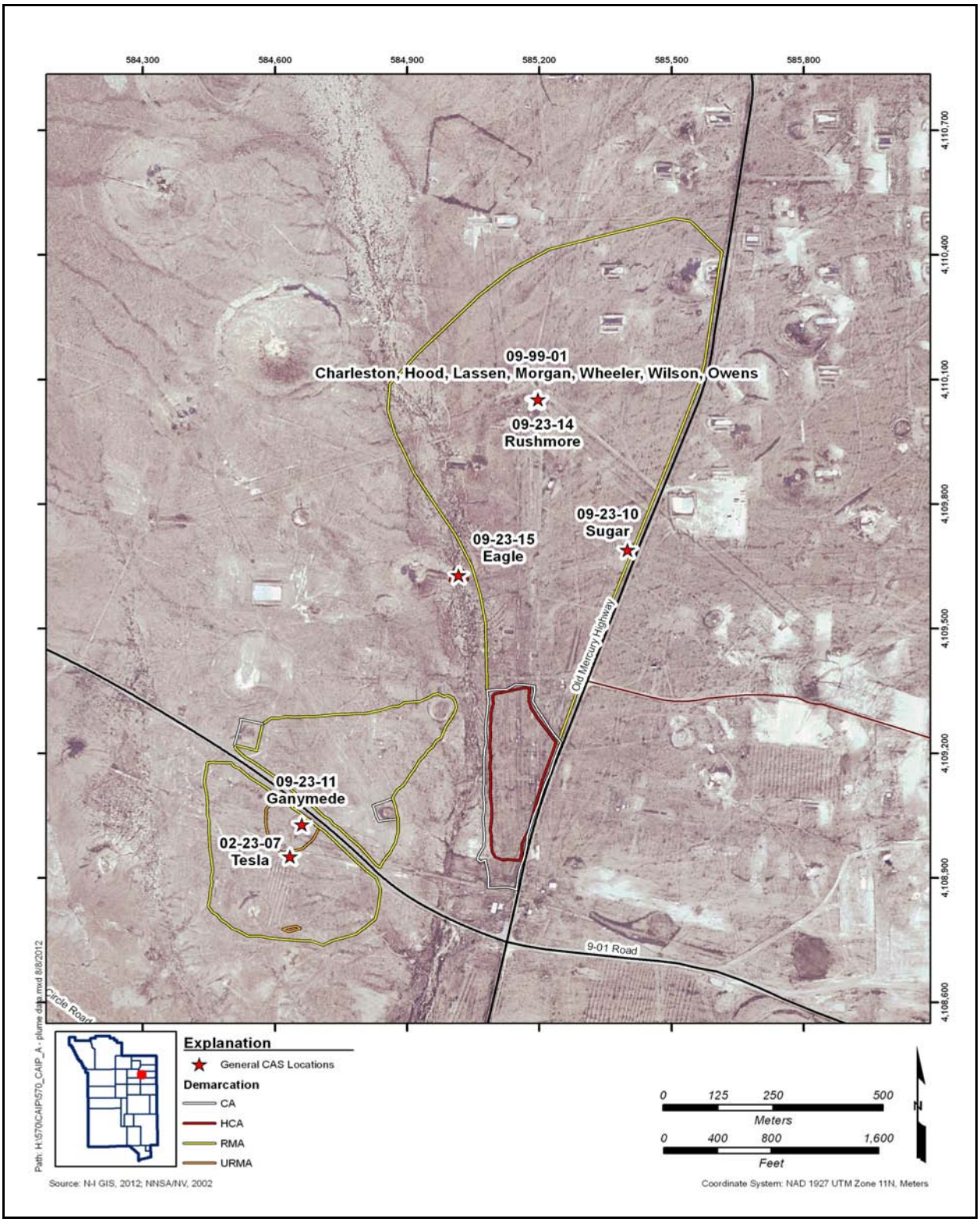

Figure 1-1
CAU 570, CAS Location Map

1.1 Purpose

The CASs in CAU 570 are being investigated because hazardous and/or radioactive contaminants may be present in concentrations that exceed risk-based corrective action (RBCA) levels. Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs. Additional information will be generated by conducting a CAI before evaluating and selecting CAAs.

1.1.1 CAU 570 History and Description

CAU 570, Yucca Flat Atmospheric Test Sites, consists of six inactive sites located in the western portion of Area 9. The sites consist of releases of radionuclides to the soil surface from nuclear testing conducted in the 1950s and '60s. Operational histories for each CAS are detailed in Section 2.2.

1.1.2 Data Quality Objective Summary

The sites will be investigated based on data quality objectives (DQOs) developed by representatives of the Nevada Division of Environmental Protection (NDEP) and the DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO). The DQOs are used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 570. This CAIP describes the investigative approach developed to collect the necessary data identified in the DQO process. Discussions of the DQO methodology and the DQOs specific to CAU 570 are presented in Appendix A. A summary of the DQO process is provided below.

The DQO problem statement for CAU 570 is as follows: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 570." To address this problem, resolution of the following decision statements is required:

- **Decision I.** "Is any contaminant of concern (COC) associated with the CAS present in environmental media?" For judgmental sampling decisions, any contaminant associated with a CAS that is present at concentrations exceeding its corresponding final action level (FAL) will be defined as a COC. For probabilistic sampling decisions, any contaminant for which the 95 percent upper confidence limit (UCL) of the mean exceeds its corresponding FAL will be defined as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2012c).

- **Decision II.** "Is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include to following:

  - The lateral and vertical extent of COC contamination
  - The information needed to predict potential remediation waste types and volumes
  - Any other information needed to evaluate the feasibility of remediation alternatives

A corrective action will be determined for any site containing a COC. The evaluation of the need for corrective action will include the potential for wastes that are present at the site to cause the future contamination of site environmental media if the wastes were to be released (see Section 3.4).

The informational inputs and data needs to resolve the problem statement and the decision statements were generated as part of the DQO process for this CAU and are documented in Appendix A. The information necessary to resolve the DQO decisions will be generated for each CAU 570 CAS by collecting and analyzing samples generated during a field investigation. The presence of a COC will be determined by collecting and analyzing samples following these two criteria:

- To make a judgmental sampling decision, samples must be collected in areas most likely to contain a COC.

- To make a probabilistic sampling decision, samples must be collected from unbiased locations that represent contamination within the sampling unit (see Section A.5.4).

DQOs for CAU 570 defined similarities in conceptual site model (CSM) properties of several releases that would allow a common investigative approach (e.g., surface deposition of relatively immobile contaminants, migration and mixing of contaminants in drainage channels, or similarities in release sources such as weapons tests or safety shots). Based on these similarities, the following groups were established to simplify the planning and investigation of various releases:

- **Group 1 (Atmospheric Tests).** This release category is specific to the atmospheric deposition of radionuclide contamination from nuclear weapons testing (comprised mainly of fission and activation products) onto the soil surface that has not been displaced through excavation or migration. The contamination associated with the this type of release is limited to the top 5 centimeters (cm) of soil. Atmospheric releases of radionuclides that have been distributed at the NNSS from nuclear testing have been found to be concentrated in the upper 5 cm of undisturbed soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CAIP, surface is defined as the upper 5 cm of soil.

- **Group 2 (Safety/Low-Yield Tests).** This release category is specific to the atmospheric deposition of radionuclide contamination from safety experiments comprised mainly of unfissioned nuclear material (from the scattering of nuclear material due to the detonation of chemical explosives) onto the soil surface that has not been displaced through excavation or migration. The contamination associated with this type of release will be limited to the top 5 cm of soil. Atmospheric releases of radionuclides that have been distributed at the NNSS from nuclear testing have been found to be concentrated in the upper 5 cm of undisturbed soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977).

- **Group 3 (Debris/Spills).** This group investigates any chemical or radiological contamination associated with debris and/or spills. The debris will be evaluated for potential source material (PSM) and spills will be evaluated based on the presence of biasing factors such as discoloration or elevated instrument readings.

- **Group 4 (Migration/Mechanical Disturbance).** This group investigates radionuclide contaminants that were initially deposited onto the soil surface, but have subsequently been displaced through erosion or mechanical disturbance of the soil.

As shown in the CSM in Section 3.1, it is assumed that contamination exceeding the FAL is present in surface soil within the radiologically posted high contamination area (HCA) at Eagle and in the subsurface at Sugar (blast crater). These areas will be defined as default contamination boundaries (see Section 3.4) and require corrective action (see Section A.3.1).

The releases associated with each group will be investigated outside these default contamination boundaries. The investigation of surface soil radioactivity will be accomplished using a combination of judgmental and probabilistic sampling schemes. The investigation of subsurface soil radioactivity will be accomplished using a judgmental sampling scheme at depth or by conservative assumption that radioactivity is present at depth based on process knowledge (e.g., buried material).

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO process, the scope of the CAI for CAU 570 includes the following activities:

- Move surface debris and/or materials, as needed, to facilitate sampling.
- Conduct radiological surveys.
- Perform field screening.

- Measure *in situ* external dose rates using thermoluminescent dosimeters (TLDs) or other dose-measurement devices.
- Collect and submit environmental samples for laboratory analysis to determine whether any COC is present.
- Collect and submit environmental samples for laboratory analysis to determine the nature and extent of any COCs that are present.
- Collect samples of waste material, if present, to determine the potential for a release to result in contamination exceeding FALs.
- Collect samples of potential remediation wastes, if present.
- Collect quality control (QC) samples.

Contamination of environmental media originating from activities not identified in the CSM of any CAS will not be considered as part of this CAU unless the CSM and the DQOs are modified to include the release. If not included in the CSM, contamination originating from these sources will not be considered for sample location selection and/or will not be considered COCs. If such contamination is present, the contamination will be identified as part of another CAS (either new or existing).

1.3 CAIP Contents

Section 1.0 presents the purpose and scope of this CAIP, while Section 2.0 provides background information about CAU 570. Objectives of the investigation, including the CSM, are presented in Section 3.0. Field investigation and sampling activities are discussed in Section 4.0, and waste management issues for this project are discussed in Section 5.0. General field and laboratory quality assurance (QA) (including collection of QA samples) is presented in Section 6.0 and in the *Soils Activity Quality Assurance Plan* (QAP) (NNSA/NSO, 2012b). The project schedule and records availability are discussed in Section 7.0. Section 8.0 provides a list of references.

Appendix A provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS, while Appendix B contains information on the project organization. Appendix C contains responses to NDEP comments on the draft version of this document.

2.0 Facility Description

CAU 570 comprises six CASs all located in Area 9 of the NNSS as listed in Table 2-1.

Table 2-1
CAU 570 CASs

CAS Number	CAS Name	Associated Tests	Site Name
02-23-07	Atmospheric Test Site - Tesla	Tesla	Tesla
09-23-10	Atmospheric Test Site T-9	Sugar	Sugar
09-23-11	Atmospheric Test S-9G	Ganymede	Ganymede
09-23-14	Atmospheric Test Site - Rushmore	Rushmore	Rushmore
09-23-15	Eagle Contamination Area	Eagle	Eagle
09-99-01	Atmospheric Test Site B-9A	Charleston, Hood, Lassen, Morgan, Owens, Wheeler, and Wilson	B-9A

2.1 Physical Setting

The following sections describe the general physical settings of Area 9 of the NNSS. General background information pertaining to topography, geology, hydrogeology, and climatology is provided for this specific area of the NNSS region in the *Geologic Map of the Nevada Test Site, Southern Nevada* (Frizzell and Shulters, 1990); *CERCLA Preliminary Assessment of DOE's Nevada Operations Office Nuclear Weapons Testing Areas* (DRI, 1988); *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977); and the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996).

CAU 570 is located within the Yucca Flat Tributary Flow System, a part of the regional carbonate aquifer flow system, and moves generally from northeast to southwest (Fenelon et al., 2010).

Local topography around CAU 570 is relatively flat with gradual sloping foothills east of the site. Much of the area has been disturbed and non-native soils in the form of medium to large-sized gravel is present. Precipitation runoff flow from the CASs is generally toward the center of the CAU into an ephemeral channel that generally flows to the south toward the Yucca Flat dry lake. Several craters

are present in and around the CAU, and evidence suggests that runoff throughout the area drains into these craters.

Groundwater flow in Yucca Flat generally is from the northeast to southwest. Within the overlying alluvial and volcanic aquifers, lateral groundwater flow occurs from the margins to the center of the basin and downward into the carbonate aquifer (Laczniak et al., 1996). The average annual precipitation at the Yucca Dry Lake (UCC) rain gauge is 16.80 cm (6.61 inches [in.]). Average annual potential evapotranspiration (PET) has been estimated for the Area 3 Radioactive Waste Management Site (RWMS) as 157 cm (61.81 in.) (ARL/SORD, 2012). The nearest rain gauge to CAU 570 is Buster Jangle Y (BJY) in Area 1. Additional rainfall and PET data are presented in Table 2-2.

Table 2-2
Rainfall and PET Information for Yucca Flat

	Area 3 PET (cm)	UCC Precipitation (cm)	BJY Precipitation (cm)
Minimum	150.2	2.90	3.81
Maximum	160.8	41.17	37.36
Mean	157	16.80	16.21
95% UCL	160.2	18.78	18.10

Source: ARL/SORD, 2012

The nearest groundwater well to CAU 570 with recent data is U.S. Geological Survey (USGS) DOE Hole Number ER-2-1, located approximately 1,300 meters (m) west of the Tesla site (USGS, 2012). The most recent recorded depth to the water table is approximately 525 m below ground surface (bgs).

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 570 that may have resulted in releases of contaminants to the environment. The CAS-specific summaries are designed to describe the current definition of each CAS and document all significant, known activities.

2.2.1 CAS 02-23-07, Atmospheric Test Site - Tesla

Tesla, the third test of the Teapot series, was a weapons-related test detonated at the T-9b tower site atop a 300-foot (ft) tower. The test was detonated on March 1, 1955, and had a yield of 7 kilotons (kt) (Maag et al., 1981).

2.2.2 CAS 09-23-10, Atmospheric Test Site T-9

Sugar, the sixth nuclear test of Operation Buster-Jangle, the first of the Jangle phase, was a weapons-effects test detonated from a 1-m platform. The detonation created a crater 28 m in diameter by 6.4 m deep. Test objectives included evaluating civil or military effects of a nuclear detonation on various targets such as military hardware. The test was detonated on November 19, 1951, and had a yield of 1.2 kt (GE, 1979).

2.2.3 CAS 09-23-11, Atmospheric Test Site S-9G

Ganymede, the 36th test of Operation Hardtack II, was a safety experiment detonated at ground level inside a gravel containment that consisted of a wooden structure covered with 20 ft of gravel. The test took place on October 30, 1958, and had zero yield (H&N, 1959).

2.2.4 CAS 09-23-14, Atmospheric Test Site - Rushmore

Rushmore was a part of the Operation Hardtack II effort that was detonated at the B-9A balloon pad after rehabilitation of the pad. The device was suspended 500 ft in the air by a 67-ft-diameter balloon tethered to the B-9A pad. The weapons-related test took place on October 22, 1958, and had a yield of 188 tons (H&N, 1959).

2.2.5 CAS 09-23-15, Eagle Contamination Area

The Eagle Contamination Area is a fenced mound of soil and debris located east of the U9av crater (Eagle). The fenced area is less than 0.5 acres and is posted as an HCA. Eagle, the 17th test of Operation Niblick, was a weapons-related test that took place on December 12, 1963, and had a yield of 5.3 kt (DOE/NV, 2000). During the Eagle test, the line-of-site pipe ruptured, venting nuclear material to the atmosphere while damaging and scattering the pipe cap as well as associated structures

and experiments (Olsen, 1964). The contaminated debris and soil from the Eagle test were collected in a mound and later fenced and identified as an HCA.

2.2.6 CAS 09-99-01, Atmospheric Test Site B-9A

The B-9A balloon pad was the site of seven weapons-related balloon tests in 1957 as part of Operation Plumbbob. The contamination from the tests was due primarily to induced activity in the soil (GE, 1979). Specifics regarding the seven tests are listed below:

- **Lassen.** A test anchored 152 m above the ground detonated on June 5, 1957, with a yield of 0.0005 kt (GE, 1979).
- **Wilson.** A test anchored 152 m above the ground detonated on June 18, 1957, with a yield of 10 kt (GE, 1979).
- **Hood.** A test anchored 457 m above the ground detonated on July 5, 1957, with a yield of 74 kt (GE, 1979).
- **Owens.** A test anchored 152 m above the ground detonated on July 25, 1957, with a yield of 9.7 kt (GE, 1979).
- **Wheeler.** A test anchored 152 m above the ground detonated on September 6, 1957, with a yield of 0.197 kt (GE, 1979).
- **Charleston.** A test anchored 457 m above the ground detonated on September 28, 1957, with a yield of 12 kt (GE, 1979).
- **Morgan**. A test anchored 152 m above the ground detonated on October 7, 1957, with a yield of 8 kt (GE, 1979).

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, general historical NNSS practices, and visual surveys were used to identify wastes that may be present. The potential wastes that were identified at the six study groups include metal, cables, wood, lead, batteries, and other various debris associated with atmospheric and underground nuclear testing.

Additional wastes generated during the investigation may include investigation-derived waste (IDW), decontamination liquids, and soils. Potential waste types include sanitary waste, hydrocarbon waste,

Resource Conservation and Recovery Act (RCRA) hazardous waste, *Toxic Substances Control Act* (TSCA) waste, radioactive waste, and mixed waste.

2.4 Release Information

The releases of contamination to CAU 570 are directly or indirectly associated with several nuclear tests conducted in the area. The investigation of specific releases at CAU 570 will depend upon the nature of these releases. Therefore, the releases at CAU 570 have been categorized into one of four groups defined in Section 1.1.2 (e.g., Group 1, Group 2).

Exposure routes to receptors include ingestion and inhalation of radionuclides in surface soil (internal exposure). Site workers may also be exposed to direct radiation by performing activities in proximity to radiologically contaminated materials (i.e., external dose). Therefore, the CSM will include the potential for receptors to receive an internal dose from contaminated soil and an external dose from contaminated soil and debris.

The following subsections contain group-specific descriptions of known or suspected releases associated with CAU 570.

2.4.1 Groups 1 and 2

The Groups 1 and 2 investigation addresses fission products deposited onto surface soils from fallout including activated soil products and unfissioned nuclear materials deposited onto soils that have not been relocated due to excavation.

The release of radionuclides from the tests was distributed in roughly concentric patterns on the ground surface, exhibiting a pattern of surface contamination that is generally decreasing in concentration with increasing distance from the release locations. This is illustrated in the 1994 and 2012 aerial radiological surveys showing the gross count and americium signatures of the CAU 570 releases (Figures 2-1 and 2-2) (BN, 1999a; NSTec, 2012).

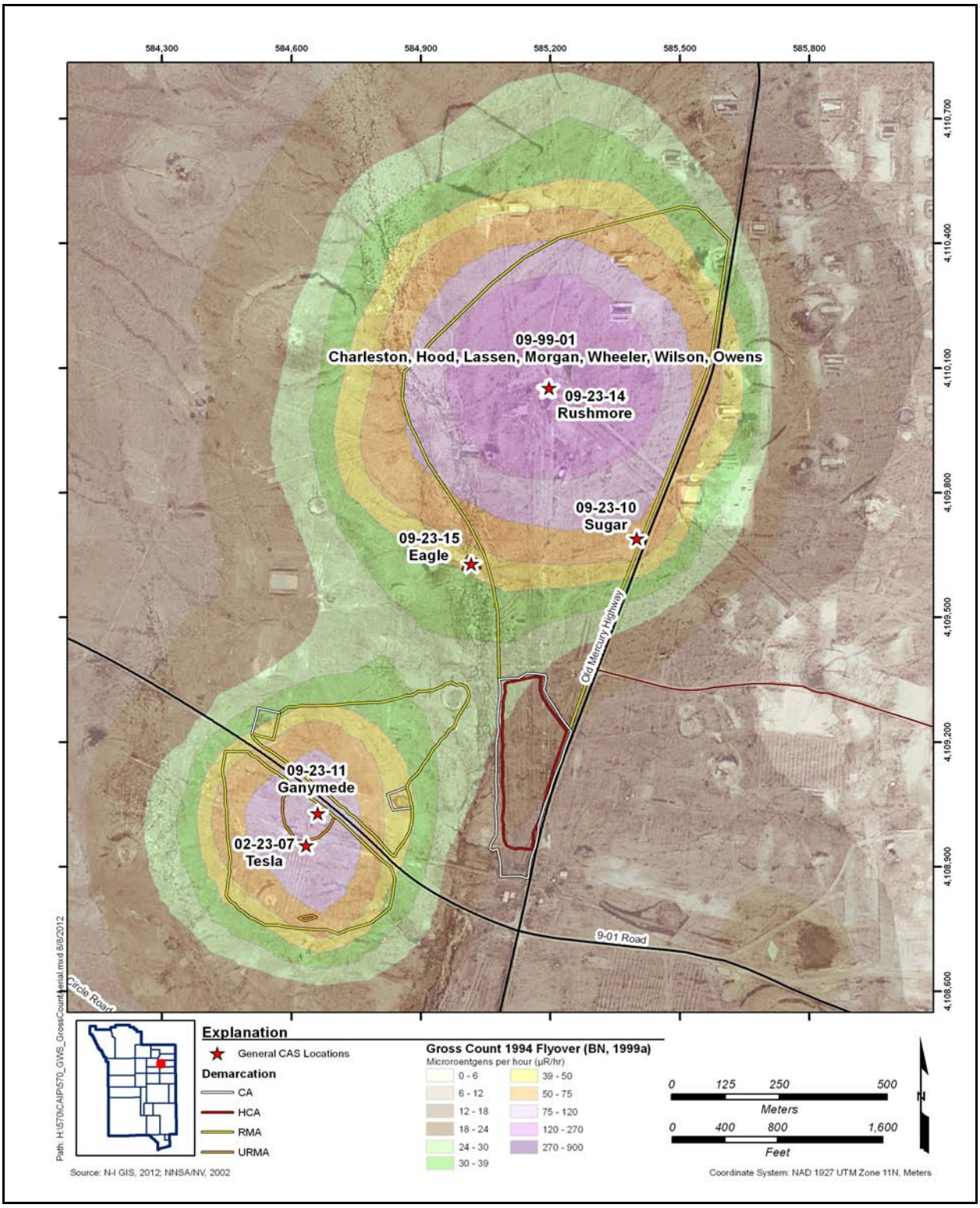

Figure 2-1
CAU 570 Gross Count Aerial Data

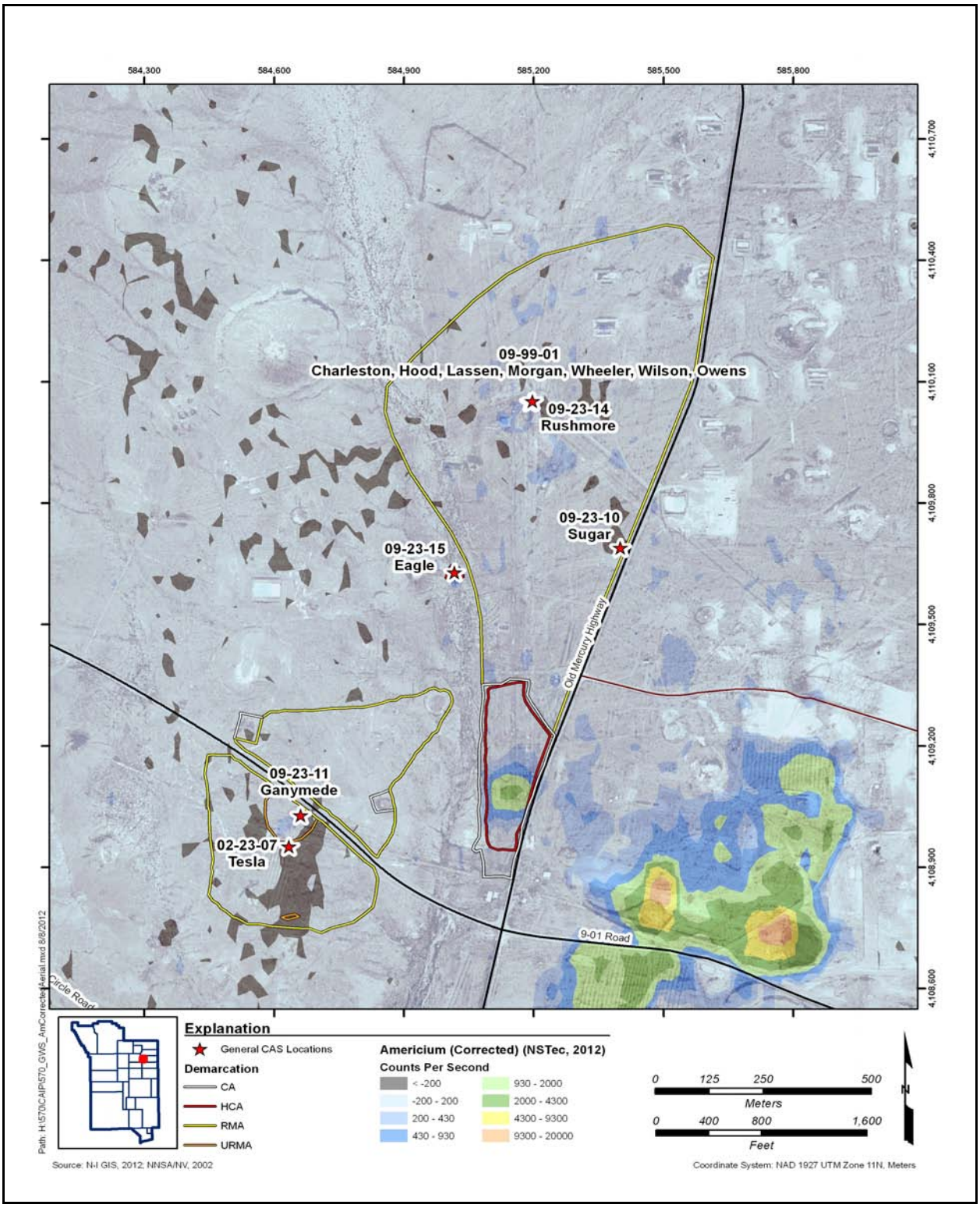

Figure 2-2
CAU 570 Americium Aerial Data

2.4.2 Group 3

The Group 3 investigation addresses the contamination associated with the debris present at CAU 570 including potential releases from lead-acid batteries, lead plates, spills, wastes, debris, or mud pits associated with activities conducted at the site. The batteries and the lead plates contain exposed lead that is assumed to have the potential to release contamination to the surrounding surface and subsurface soil.

2.4.3 Group 4

The Group 4 investigation will address contamination migration that includes the relocation of contamination into windrows due to scraping surface soils, the excavation of surface soils that relocated contamination to depths greater than 5 cm, and the relocation and deposition of contamination into sedimentation areas due to stormwater runoff.

2.5 Investigative Background

All previous investigation data are assessed in the planning phase as biasing information for selecting appropriate sampling locations. A variety of radiation surveys were conducted in the CAU 570 area. These include aerial and ground-based surveys. Table 2-3 lists the method descriptions for the different radiation surveys conducted within the area of CAU 570. This table includes advantages, limitations, spatial and spectral resolution, measurement dates, and applied use as a comparison of the radiation survey methods. Details of the surveys are discussed in Sections 2.5.1 through 2.5.3.

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), the quality required of a dataset will be determined by its intended use in decision making. Ground-based and aerial radiological survey data are classified as decision-supporting, and are not used, by themselves, to make corrective action decisions. However, the radiation surveys are used to identify bias used in the selection of sample locations and will be evaluated for use in defining corrective action boundaries in the Corrective Action Decision Document (CADD). For defining corrective action boundaries, the radiation surveys will be used only in terms of defining a relative spatial distribution of contamination.

Table 2-3
Comparison of Radiation Survey Methods
(Page 1 of 2)

	NaI Detector	FIDLER	PRM-470	Aerial Radiological Survey (200 ft agl)	Aerial Radiological Survey (50 ft agl)
Method Description Summary	Ground-based, NaI gamma spectroscopy unit	Ground-based instrument that detects low-energy gamma emissions	Ground-based organic plastic scintillator instrument that detects gamma emissions	Helicopter-mounted thallium-activated NaI gamma-ray scintillation detectors	Helicopter-mounted thallium-activated NaI gamma-ray scintillation detectors
Advantages and Limitations	Advantages: Can post-process data to identify specific gamma-emitting radionuclides of interest Limitations: Detector mounted on a trailer pulled by a UTV, may have issues with terrain and a higher potential for contamination	Advantages: Lightweight hand-held instrument designed to see low-energy gamma emissions Limitations: Does not discriminate between low-energy gamma emissions from different isotopes	Advantages: Lightweight hand-held instrument that detects gamma emissions Limitations: Does not distinguish between the radionuclides emitting the gamma emissions	Advantages: Gives a wide area of view (as opposed to ground-based surveys); can survey large areas quickly Limitations: Because it is elevated and moving at a fast rate, does not distinguish small localized areas of contamination or materials that are contaminated	Advantages: Gives a wide area of view (as opposed to ground-based surveys); can survey large areas quickly Limitations: Because it is elevated and moving at a fast rate, does not distinguish small localized areas of contamination or materials that are contaminated
Spatial Resolution	Mounted ~1.5 ft agl; detector for Am-241; pulled at ~3 miles per hour	Held at ~6 in. agl, has a small field of view	Held at ~1 m agl, has a small field of view	Altitude: 60 m Line Spacing: 150 m 120-m diameter window	Altitude: 15 m Line Spacing: 23 m 30-m diameter window
Spectral Resolution	28 to 4,000 keV	10 to 100 keV	All gamma emitters	38 to 3,026 keV	38 to 3,026 keV
Measurement Date	2012	2012	2012	1994	1998 & 2012

Table 2-3
Comparison of Radiation Survey Methods
(Page 2 of 2)

	NaI Detector	FIDLER	PRM-470	Aerial Radiological Survey (200 ft agl)	Aerial Radiological Survey (50 ft agl)
Applied Use	Processed for energies in the 57- to 70-keV range (Am-241) relative to the 38- to 50-keV and 70- to 82-keV background windows; used to identify Am-241 contamination as an indicator of plutonium contamination	Energies in the 59-keV range, which are indicative of Am-241 or other higher-energy emitters; used to identify Am-241 contamination as an indicator of plutonium contamination	Nondiscriminatory gamma count used to identify contamination from nuclear testing	For Am-241: Processed for energies in the 57- to 70-keV range (Am-241) relative to the 38- to 50-keV and 70- to 82-keV background windows. Used to identify Am-241 contamination as an indicator of plutonium contamination. For man-made: Processed for energies in the 38- to 1,294-keV window relative to the 1,394- to 3,026-keV background window. Used to identify contamination from nuclear testing.	For Am-241: Processed for energies in the 57- to 70-keV range (Am-241) relative to the 38- to 50-keV and 70- to 82-keV background windows. Used to identify Am-241 contamination as an indicator of plutonium contamination. For man-made: Processed for energies in the 38- to 1,294-keV window relative to the 1,394- to 3,026-keV background window. Used to identify contamination from nuclear testing.

agl = Above ground level
Am = Americium
FIDLER = Field instrument for the detection of low-energy radiation
keV = Kiloelectron volt
NaI = Sodium iodide

Source: N-I GIS, 2012; BN, 1999b; Riedhauser, 1999; Buchheit and Marianno, 2005; TSA Systems, 2005

The aerial radiation surveys provide spectral information that was used to differentiate specific isotopic signatures. This allowed the separate mapping of Am-241 contamination, man-made gamma activity, and gross gamma activity within the surveyed areas. The presence of Am-241 is used as an indicator of the potential presence of plutonium contamination.

The radionuclide activity in this area is due to a combination of fission products (primarily high-energy gamma radiation) and unfissioned nuclear material (primarily low-energy gamma, beta, and alpha radiation). The sources of these radiation types are not necessarily co-located.

The Radionuclide Inventory and Distribution Program (RIDP) conducted an investigation from 1981 through 1986 that estimated the inventory of man-made radionuclides at the NNSS through *in situ* gamma spectroscopy (McArthur and Mead, 1987). These RIDP data were extrapolated to estimate levels of plutonium across an area that includes CAU 570 as discussed in Section 2.5.2. More detailed discussions of these investigations are found in Appendix A.

2.5.1 Radiological Surveys

All previous investigation data are assessed in the planning phase as biasing information used in selecting appropriate sampling locations. Three aerial surveys and one ground-based radiological survey were conducted between 1994 and 2012. The 2012 ground-based survey results are discussed in more detail in Section 2.5.3. Each aerial survey is described as follows:

- An aerial radiological survey was conducted in 1994 by flying along a set of parallel flight lines spaced 500 ft apart at 200 ft agl. The purpose of the survey was to provide a more detailed measurement of areas containing elevated levels of radioactivity (BN, 1999a).
- An aerial radiological survey was conducted in 1999 by flying along a set of parallel flight lines spaced 75 ft apart at 50 ft agl. The purpose of the survey was to measure, map, and define the areas of elevated radioactivity. The values of the areas surveyed ranged from less than 70 counts per second (cps) to more than 32,000 cps (BN, 1999b).
- An aerial radiological survey was conducted in 2012 by flying along a set of parallel flight lines spaced 75 ft apart at 50 ft agl. The purpose of the survey was to measure, map, and define areas of elevated radioactivity.

Aerial radiological surveys conducted at the NNSS in 1994, 1998, and 2012 provide coverage of the entire site at discrete energies. These flyover data were processed to produce gross count, man-made contamination, and americium concentration data layers (BN, 1999a and b; NSTec, 2012).

Figure 2-1 shows the results of an aerial survey depicting the gross count data, and shows the two areas of concentration around the B-9A balloon pad and the Tesla tower site. Figure 2-2 displays the results of an aerial survey depicting the americium data. The areas of increased americium activity shown in the survey are not part of CAU 570 but will be investigated in CAU 571. The values in the lowest contour range (represented by the darkest areas in the figure) are not indicative of actual americium presence or absence (note the negative counts per second for this level in the legend). These negative values result from an algorithm that corrects the americium response for the presence of europium and are indicative of the inability of this method to detect americium at these locations.

In 2012, a preliminary field investigation was completed at CAU 570. This effort included ground-based radiological and visual surveys. During the visual survey, which included walking the area inside the contamination area (CA) fence line at Sugar and the radioactive material areas throughout the CAU, photographs were taken and site conditions were noted. Radiological surveys were completed around the test ground zeroes (GZs), around the HCA at Eagle, inside the CA at Sugar, and within the radioactive materials areas located throughout CAU 570. The appropriate radiological instruments were used to detect the suspected contaminants at a particular location. Specifically, the PRM-470, FIDLER, and an NaI detector were used throughout the CAU. Because the FIDLER did not show any areas of significantly elevated gamma activity that was not previously identified by the PRM-470, it is assumed that any alpha contamination will only be detected through soil samples. Figures 2-3 and 2-4 show the results of the ground-based radiological survey from the PRM-470 and NaI, and FIDLER radiological instruments, respectively.

Each of the four investigation groups has unique characteristics that result in certain survey data being optimal for use in biasing information. Group 1 is related to high-yield tests that resulted in the deposition of fission products (primarily cesium and strontium) and activation products (primarily cobalt and europium). For this study group, gross gamma and man-made spectra are of the greatest use in delineating the spatial distribution of contaminants. Therefore, the 2012 ground-based gamma surveys from the PRM-470 have provided bias in determining sample locations for Group 1.

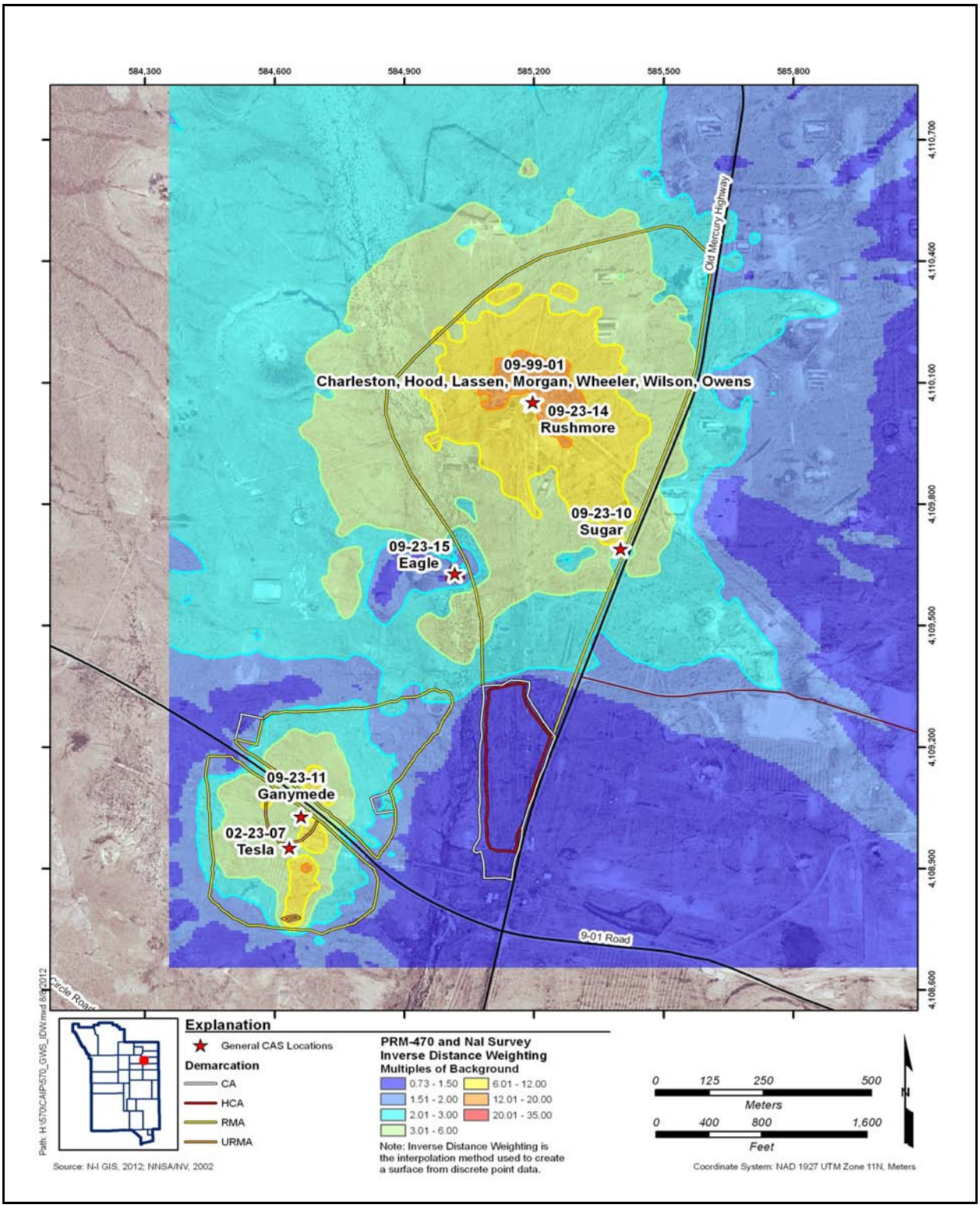

Figure 2-3
CAU 570 PRM-470 and Nal Survey Results

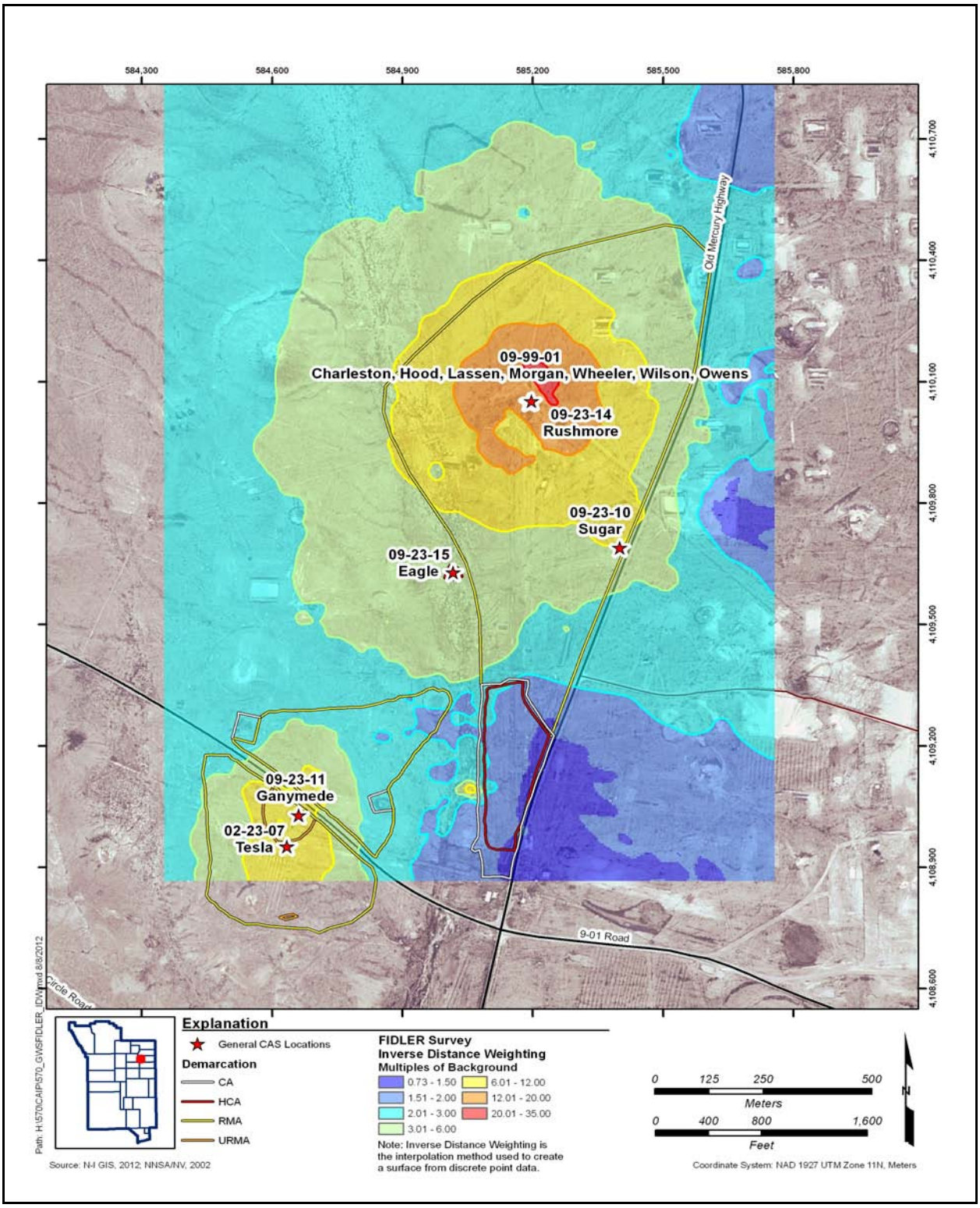

Figure 2-4
CAU 570 FIDLER Survey Results

The Group 2 investigation focuses on low-yield and/or safety shots that produced contamination that is characterized by a heterogeneous distribution of americium, plutonium, and related contaminants. Therefore, the 2012 ground-based gamma survey from the FIDLER has provided bias in determining sample locations for Group 2.

The Group 3 investigation focuses on debris and chemical spills associated with the tests. Visual surveys will provide the bias in identifying sample locations. The radiation surveys will not be used to identify bias (see Section 2.5.3).

The Group 4 investigation focuses on contamination relocated by migration and mechanical disturbance. Ground-based gamma and visual surveys conducted during the field investigation will provide bias in determining sample locations.

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), ground-based radiological survey data are classified as decision-supporting, and will be used for sample location planning and preliminary corrective action boundary identification.

2.5.2 Radionuclide Inventory and Distribution Program

As part of an effort to assess the implications of contamination on future uses of the NNSS, the RIDP was established in 1981 to make a comprehensive survey of the important man-made radionuclides in surface soil (McArthur and Mead, 1987).

Data collected for the RIDP in the 1980s allowed for estimates of surface soil inventories throughout the NNSS. The RIDP estimated the inventory through *in situ* soil measurements by gamma spectroscopy and limited confirmatory soil sampling (McArthur and Mead, 1987; Gray et al., 2007). Desert Research Institute reported *in situ* gamma spectroscopy measurements for Area 9, which included the CAU 570 area (McArthur and Mead, 1987). Estimates of the primary radiological soil contaminants released to local surface soils in the area of CAU 570 are as follows: Am-241 at 3 curies (Ci), plutonium (Pu)-238 at 1.6 Ci, Pu-239/240 at 63 Ci, cobalt (Co)-60 at 1.4 Ci, cesium (Cs)-137 at 2.9 Ci, strontium (Sr)-90 at 5.5 Ci, europium (Eu)-152 at 31 Ci, Eu-154 at 2.9 Ci, and Eu-155 at 0.44 Ci. The total estimated inventory of radionuclides remaining in the soils in this area is about

111.74 Ci. Although the RIDP data present a general distribution of contamination, there is not sufficient resolution to provide bias in selecting sample locations within CAU 570.

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), ground-based radiological survey data are classified as decision-supporting, and will be used for sample location planning and preliminary corrective action boundary identification.

2.5.3 Visual Surveys

Figure 2-3 shows the results of a PRM-470 and NaI ground-based survey and identifies the areas of highest gamma readings around the B-9A and Tesla sites. Figure 2-4 shows the results of a FIDLER ground-based survey and demonstrates that the areas of highest readings are understandably in the areas of high gamma radiation as shown by the PRM-470 survey. The FIDLER survey data tend to be less effective in a strong gamma field inasmuch as a FIDLER is for the detection of low-energy gamma radiation. While the ground-based radiological surveys were being conducted, a debris sweep was also conducted in the area outside the HCA. Pieces of lead, metal culverts, dried tar, and batteries were located. Figure 2-5 shows the location of the debris. Group 3 sample locations will be based on the results of the visual surveys to locate and identify debris and spills conducted throughout CAU 570.

2.5.4 National Environmental Policy Act

The *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996) includes site investigation activities such as those proposed for CAU 570.

In accordance with the NNSA/NSO *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed before beginning site investigation activities at CAU 570. This checklist requires NNSA/NSO activity personnel to evaluate their proposed project activities against a list of potential impacts that include, but are not limited to, air quality, chemical use, waste generation, noise level, and land use. Completion of the checklist results in a determination of the appropriate level of NEPA documentation by the NNSA/NSO NEPA Compliance Officer. This will be accomplished before mobilization for the field investigation.

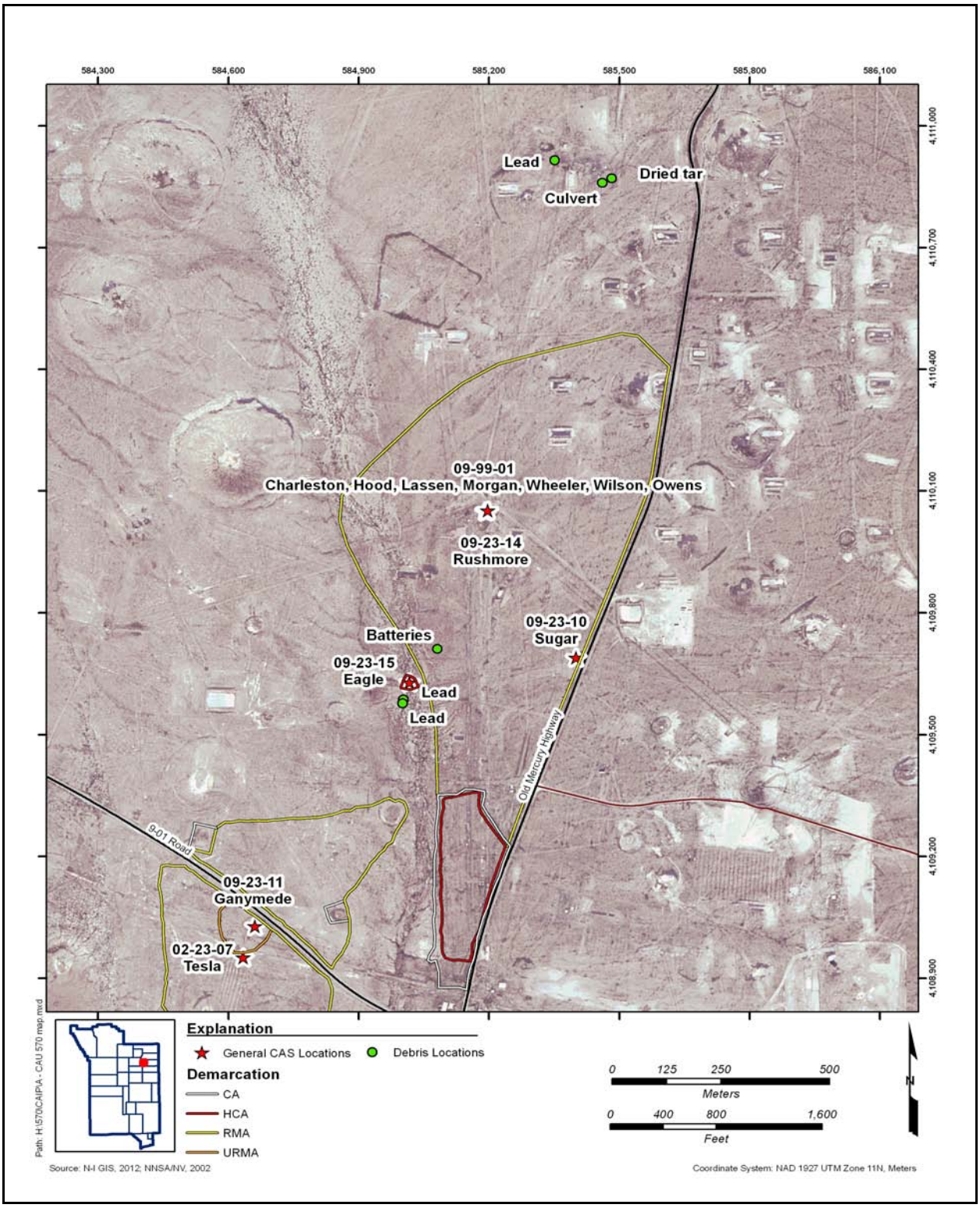

Figure 2-5
CAU 570 Debris Locations

3.0 Objectives

This section presents an overview of the DQOs for CAU 570 and formulation of the CSM. Also presented is a summary listing of the contaminants of potential concern (COPCs), the preliminary action levels (PALs), and the process used to establish FALs. Additional details and figures depicting the CSM are located in Appendix A.

3.1 Conceptual Site Model

The CSM describes the most probable scenario for current conditions at each site and defines the assumptions that are the basis for identifying the future land use, contaminant sources, release mechanisms, migration pathways, exposure points, and exposure routes. The CSM was used to develop appropriate sampling strategies, planned analyses, and data collection methods. The CSM was developed for CAU 570 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs. Figure 3-1 depicts a representation of the conceptual pathways to receptors from CAU 570 sources. Figure 3-2 depicts a graphical representation of the CSM. If evidence of contamination that is not consistent with the presented CSM is identified during investigation activities, the situation will be reviewed, the CSM will be revised, the DQOs will be reassessed, and a recommendation will be made as to how best to proceed. In such cases, decision makers listed in Section A.2.1 will be notified and given the opportunity to comment on and/or concur with the recommendation.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for CAU 570.

3.1.1 Land-Use and Exposure Scenarios

Land-use zones where the CAU 570 CASs are located dictate future land use, and restrict current and future land use to nonresidential (i.e., industrial) activities.

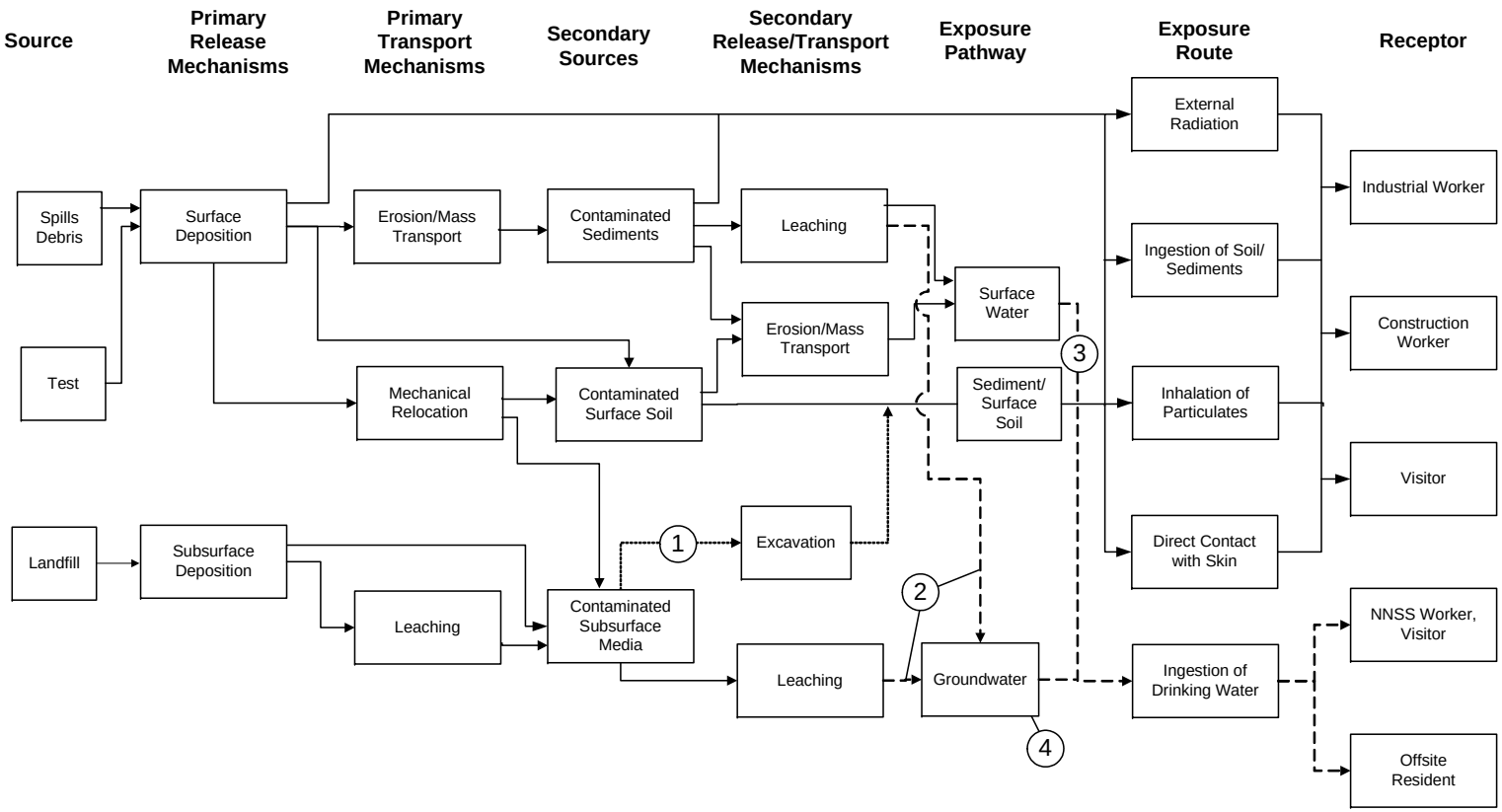

Figure 3-1
CSM Diagram

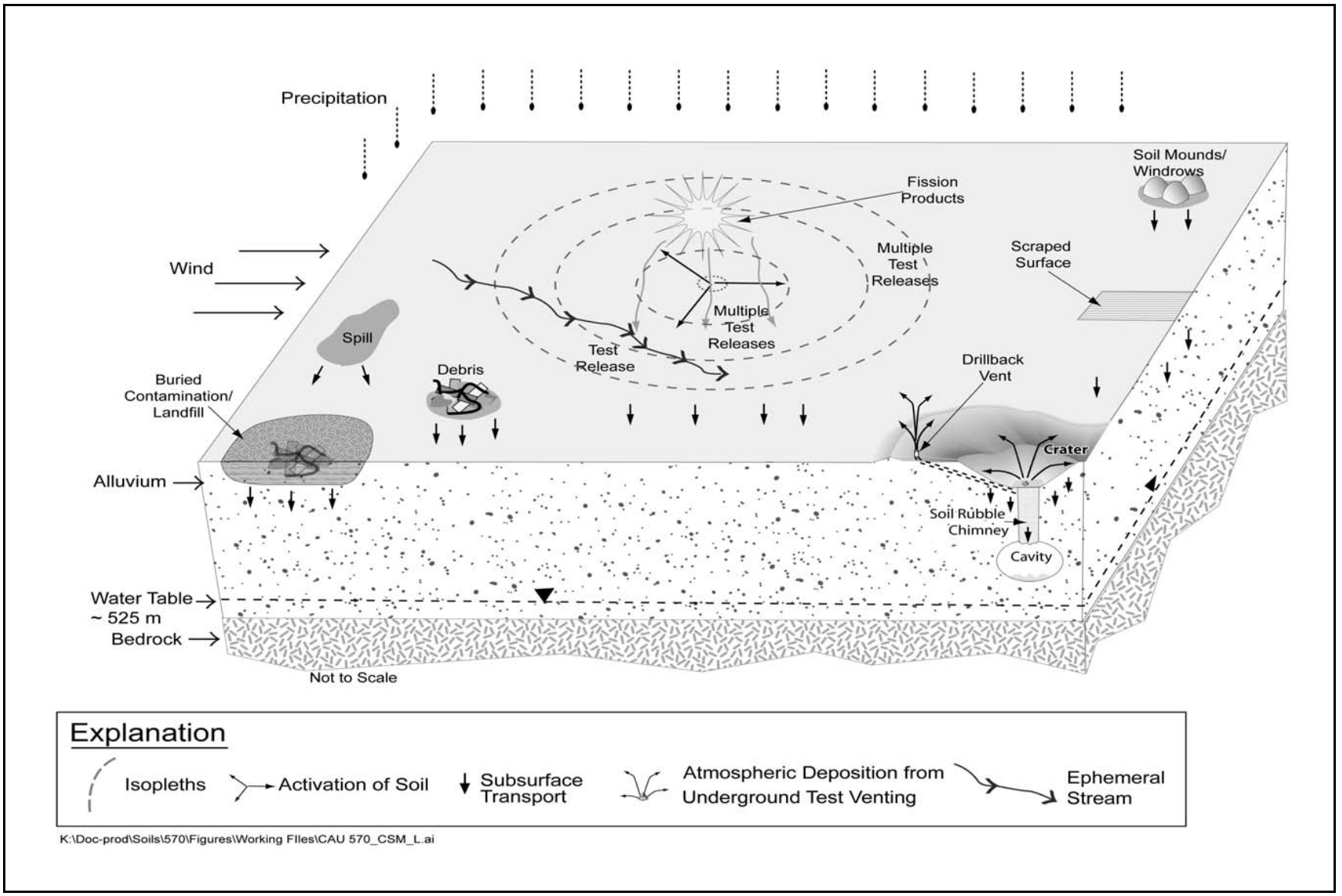

Figure 3-2
CAU 570 CSM

The CAU 570 site is located in the land-use zone described as "Nuclear Test Zone" within the NNSS. This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons-effects tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

Exposure scenarios for the CAU 570 CASs have been categorized into the following three types based on current and projected future land uses:

- **Industrial Area.** This scenario addresses exposure to industrial workers exposed daily to contaminants in soil during an average workday. This scenario assumes that this is the regular assigned work area for the worker who will be on the site for an entire career (250 days per year, 8 hours per day, for 25 years). The total effective dose (TED) calculated using this exposure scenario is the TED an industrial worker receives during 2,000 hours of annual exposure to site contaminants and is expressed in terms of millirem per Industrial Area year (mrem/IA-yr).
- **Remote Work Area.** This exposure scenario assumes noncontinuous work activities at a site. This scenario addresses exposure to industrial workers exposed to contaminants in soil during a portion of an average workday. This scenario assumes that this is an area where the worker regularly visits but is not an assigned work area where the worker spends an entire workday. A site worker under this scenario is assumed to be on the site for an equivalent of 336 hours (or 42 days) per year for an entire career (25 years). The TED calculated using this exposure scenario is the TED a remote area worker receives during 336 hours of annual exposure to site radioactivity and is expressed in terms of millirem per Remote Work Area Year (mrem/RW-yr).
- **Occasional Use Area.** This exposure scenario assumes occasional work activities at a site. This scenario addresses exposure to industrial workers who are not assigned to the area as a regular worksite but may occasionally use the site. This scenario assumes that this is an area where the worker does not regularly visit but may occasionally use for short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 80 hours (or 10 days) per year for 5 years. The TED calculated using this exposure scenario is the TED an occasional use area worker receives during 80 hours of annual exposure to site radioactivity and is expressed in terms of millirem per Occasional Use Area year (mrem/OU-yr).

The CAU 570 land-use zone and exposure scenario are based on current and future land use at the NNSS. CAU 570 is a remote location without any site improvements and where no regular work is performed. There is still the possibility, however, that site workers could occupy these locations on an occasional and temporary basis such as a military exercise. Therefore, this site is classified as an Occasional Use Area.

3.1.2 Contaminant Sources

The contamination sources for CAU 570 study groups are releases of radiological contamination to the atmosphere and soil as a result of nuclear tests (safety experiments, weapons-effects tests, and weapons-related tests). The atmospheric detonations irradiated the surrounding soil with neutrons, causing the activation of some elements in the soil (primarily Eu-152 and -154). Fission fragments were deposited in an annular pattern around GZs. Radionuclides with a low melting point (e.g., iodine) traveled significant distances before condensing and falling out of the plume, while those with higher melting points (e.g., cesium) condensed earlier and were deposited closer to respective GZs. The nuclear fuel that did not fission (e.g., uranium [U]-235) has a very high melting point and is generally found very near to GZ. Different mixtures of radionuclides may be present at these release sites based on the varying composition of the nuclear source material used in the test devices and the type of test (safety or weapons related). Contamination on the soil surface may be sources for future migration.

Other sources of contamination include radionuclides deposited by injection into native materials, spills, wastes, and debris. Debris itself can present a source of contamination. During the preliminary investigations at CAU 570, batteries and metallic lead were identified. The batteries and lead may release lead to the soil. No stained soil was identified during preliminary investigations, but stained soil and debris may be identified during site characterization activities, and will be investigated as appropriate.

3.1.3 Release Mechanisms

The release mechanism for the contaminants in Group 1 is associated with the detonation of nuclear devices in the atmosphere at heights ranging from 3 to 1,500 ft. This released fission products and unfissioned nuclear fuel, as well as neutron activation of soil and debris.

The release mechanism for the contaminants in Group 2 is associated with the detonation of low-yield or safety experiments. In the case of low-yield experiments, the release mechanism dispersed unfissioned nuclear material to surface soils. In the case of Ganymede, the release mechanism dispersed radioactive material into a confining gravel bunker using high explosives.

The release mechanism for the contaminants in Group 3 is associated with the placement of debris and spill materials onto surface soils from equipment, discarded debris, or stored materials.

The release mechanism for the contaminants in Group 4 is associated with the relocation of contaminants through the flow of surface waters to sedimentation areas; the scraping of contaminated surface soil into windrows; and the movement and deposition of contaminants by mechanical means (e.g., excavation) at depths exceeding 5 cm.

3.1.4 Migration Pathways

Surface migration pathways for CAU 570 include the lateral migration of potential contaminants across surface soils into ephemeral drainages transecting the site since the original deposition. The drainages entering and leaving these areas are generally dry but are subject to infrequent stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical (infiltration) and lateral transport of contaminants. The potential exists for contaminated sediments entrained by these stormwater events to be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identified as sedimentation areas. The area near CAU 570 drains into a gently sloping area that flows north to south down the middle of the CAU toward Yucca Flat Dry Lake. Several craters are present in and around the CAU, and preliminary evidence suggests that sheet flow runoff throughout the area may drain into these craters. Evidence is also present of runoff of flow along the old Mercury Highway and flowing into the Sugar crater that deposited soils in the crater. The topography of the area is very flat, and visual surveys have not identified surface collection features as indicated by eroded sediment. This is supported by the 1994 flyover survey (BN, 1999a) which suggests that there is no migration away from the plume.

Other migration pathways for contamination from the site include wind-borne material and material displaced from roads in the vicinity (e.g., moved during road maintenance).

Potential migration pathways include the lateral migration of contaminants across soil surfaces and accumulation in drainages and craters, and vertical migration of potential contaminants into the subsurface soils. Contaminants may also be moved through mechanical disturbance due to maintenance or construction activities at the site. Specifically, this can include activities such as

construction of viewing and parking areas, removal of surface contamination through scraping or grading, and construction and maintenance of roadways (e.g., grading of roads).

Migration is influenced by physical and chemical characteristics of the contaminants and media. Contaminant characteristics include, but are not limited to, solubility, density, and adsorption potential. Media characteristics include permeability, porosity, water-holding capacity, sorting, chemical composition, and organic content. In general, contaminants with low solubility, high affinity for media, and high density can be expected to be found relatively close to release points. Contaminants with high solubility, low affinity for media, and low density can be expected to be found farther from release points. These factors affect the migration pathways and potential exposure points for the contaminants in the various media under consideration.

Infiltration and percolation of precipitation serve as driving forces for downward migration of contaminants. However, due to high PET (annual PET at the Area 3 RWMS has been estimated at 157 cm [Yucel, 2009]) and limited precipitation for this region (16.21 cm per year [ARL/SORD, 2012]), percolation of infiltrated precipitation at the NNSS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

Subsurface migration pathways at CAU 570 are expected to be predominately vertical, although spills or leaks at the ground surface may also have limited lateral migration before infiltration. The depth of infiltration (shape of the subsurface contaminant plume) will be dependent upon the type, volume, and duration of the discharge as well as the presence of relatively impermeable layers that could modify vertical or lateral transport pathways, both on the ground surface (e.g., concrete) and in the subsurface (e.g., caliche layers).

For surface contamination to reach the water table, the contaminants would have to be dissolved in infiltrating precipitation and then be transported through the vadose zone alluvium, which extends the entire unsaturated thickness of 525 m at ER-2-1 (USGS, 2012).

The vertical penetration distance of infiltrating precipitation in 1,000 years would be the groundwater recharge rate (in millimeters per year [mm/yr]) divided by the volumetric moisture content (cubic centimeters per cubic centimeter) of the subsurface vadose alluvium times 1,000 years. The groundwater recharge rate in the vicinity of CAU 570 has been estimated to range from less than

0.1 mm/yr to 2.5 mm/yr based on regional infiltration studies (SNJV, 2006). The moisture content observed in the subsurface alluvium in shallow boreholes near the Area 3 RWMS indicates moisture contents in the range of 0.05 to 0.1 (Kwicklis et al., 2006). Based on these observations, penetration distances of infiltrating precipitation may be as much as 50 m in 1,000 years (using the maximum groundwater recharge rate of 2.5 mm/yr and the minimum moisture content of 0.05).

Underground test craters have associated chimneys of disturbed geologic material that may provide a preferential pathway. Collection of stormwater into these craters also provides additional localized infiltration that will enhance contaminant migration rates.

3.1.5 Exposure Points

Exposure points for the CSM are expected to be areas of surface contamination where visitors and site workers may come in contact with contaminated surface soil. Subsurface exposure points may exist if construction workers come in contact with contaminated media during excavation activities.

3.1.6 Exposure Routes

Exposure routes to site workers include ingestion and inhalation from disturbance of, or direct contact with, contaminated media. Site workers may also be exposed to direct ionizing radiation by performing activities in proximity to radioactive materials.

3.1.7 Additional Information

Information concerning topography, geology, climatic conditions, hydrogeology, floodplains, and infrastructure at the CAU 570 CASs is presented in Section 2.1 as it pertains to the investigation. This information has been addressed in the CSM and will be considered during the evaluation of CAAs, as applicable. Climatic and site conditions (e.g., surface and subsurface soil descriptions) as well as specific structure descriptions will be recorded during the CAI. Areas of erosion and deposition in the area will be qualitatively evaluated to provide additional information on potential offsite migration of contamination.

3.2 Contaminants of Potential Concern

The COPCs for CAU 570 are defined as the contaminants reasonably expected at the site that could contribute to a dose or risk exceeding FALs. Based on the nature of the releases identified in Section 2.4 and previous investigation results presented in Section 2.5, the following contaminants could reasonably be suspected to be present at CAU 570:

- Uranium isotopes (U-234, U-235, and U-238)
- Plutonium isotopes (Pu-238 and Pu-239/240)
- Am-241
- Cs-137
- Europium isotopes (Eu-152, Eu-154, and Eu-155)

These COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs and other releases (including those that may be discovered during the investigation). Other specific COPCs (and subsequently the analyses requested) will be determined for discovered potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

Although not suspected to be present, analysis for other COPCs will be performed to eliminate the possibility of their presence due to an incomplete history of site testing operations as discussed in Section A.2.2.2.

These COPCs will be reported by the analytical methods identified in Table 3-1 for Decision I environmental samples taken at each of the CASs. The analytes reported for each analytical method are listed in Table 3-2.

3.3 Preliminary Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation, thereby streamlining the consideration of remedial alternatives. The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NSO, 2012c). This process conforms with *Nevada*

Table 3-1
Analyses Required by Group[a]

Analyses	Group 1	Group 2	Group 3	Group 4
Organic COPCs				
SVOCs	--	--	X[b]	--
VOCs	--	--	X[b]	--
Inorganic COPCs				
RCRA Metals	--	--	X[b]	--
Radionuclide COPCs				
Gamma Spectroscopy	X	X	X[c]	X
Isotopic U	X	X	--	X
Isotopic Am	X	X	--	X
Isotopic Pu[d]	X	X	--	X
Pu-241[e]	X	X	--	X
Sr Analysis[f]	X	X	--	X
Tc Analysis[f]	X	X	--	X

[a]The analytical method has been determined based on the site-specific COPCs. Analytical methods numbers are shown in Table 3-2.
[b]Analyses for VOCs, SVOCs, or RCRA metals will only be run as PSM is located.
[c]Results of gamma analysis will be used to determine whether further isotopic analysis is warranted.
[d]Pu ratios used to determine whether analysis for Cm-244 is needed.
[e]Collect a single confirmatory sample at each Pu dispersal site, using a sample with a higher alpha FSR. Additional sampling based upon the 10% dose rule.
[f]Collect a single confirmatory sample at the expected location of the highest Cs-137 result. Additional sample based upon the 10% dose rule.

X = Required analytical method as described in Soils QAP (NNSA/NSO, 2012b)
-- = Not required

Am = Americium
Cm = Curium
FSR = Field-screening result
Pu = Plutonium
Sr = Strontium
SVOC = Semivolatile organic compound
Tc = Technetium
U = Uranium
VOC = Volatile organic compound

Table 3-2
Analytes Reported Per Method

VOCs		SVOCs		Metals	Radionuclides	
Method 8260[a]		**Method 8270[a]**		**Method 6010[a]**	**Method Ga-01[b]**	**Method U-02[b]**
1,1,1,2-Tetrachloroethane	Carbon tetrachloride	1,4-Dioxane	Bis(2-ethylhexyl)phthalate	Arsenic	Ac-228	U-234
1,1,1-Trichloroethane	Chlorobenzene	2,3,4,6-Tetrachlorophenol	Butyl benzyl phthalate	Barium	Ag-108m	U-235
1,1,2,2-Tetrachloroethane	Chloroethane	2,4,5-Trichlorophenol	Carbazole	Beryllium	Al-26	U-238
1,1,2-Trichloroethane	Chloroform	2,4,6-Trichlorophenol	Chrysene	Cadmium	Am-241	
1,1-Dichloroethane	Chloromethane	2,4-Dimethylphenol	Di-n-butyl phthalate	Chromium	Cm-243	**Method Sr-02**
1,1-Dichloroethene	Chloroprene	2,4-Dinitrotoluene	Di-n-octyl phthalate	Lead	Co-60	Sr-90
1,2,4-Trichlorobenzene	cis-1,2-Dichloroethene	2-Chlorophenol	Dibenzo(a,h)anthracene	Selenium	Cs-137	
1,2,4-Trimethylbenzene	Dibromochloromethane	2-Methylnaphthalene	Dibenzofuran	Silver	Eu-152	**Lab-Specific Methods[d]**
1,2-Dibromo-3-chloropropane	Dichlorodifluoromethane	2-Methylphenol	Dimethyl phthalate		Eu-154	Pu-241
1,2-Dichlorobenzene	Ethyl methacrylate	2-Nitrophenol	Fluoranthene	**Method 7471[a]**	Eu-155	Tc-99
1,2-Dichloroethane	Ethylbenzene	3-Methylphenol[c] (m-cresol)	Fluorene	Mercury	K-40	
1,2-Dichloropropane	Isobutyl alcohol	4-Methylphenol[c] (p-cresol)	Hexachlorobenzene		Nb-94	
1,3,5-Trimethylbenzene	Isopropylbenzene	4-Chloroaniline	Hexachlorobutadiene	**Method 7196[a]**	Pa-233	
1,3-Dichlorobenzene	Methacrylonitrile	4-Nitrophenol	Hexachloroethane	Chromium VI	Pb-212	
1,4-Dichlorobenzene	Methyl methacrylate	Acenaphthene	Indeno(1,2,3-cd)pyrene		Pb-214	
2-Butanone	Methylene chloride	Acenaphthylene	n-Nitroso-di-n-propylamine		Th-229	
2-Chlorotoluene	n-Butylbenzene	Aniline	Naphthalene		Th-234	
2-Hexanone	n-Propylbenzene	Anthracene	Nitrobenzene		Tl-208	
4-Isopropyltoluene	sec-Butylbenzene	Benzo(a)anthracene	Pentachlorophenol		U-235	
4-Methyl-2-pentanone	Styrene	Benzo(a)pyrene	Phenanthrene			
Acetone	tert-Butylbenzene	Benzo(b)fluoranthene	Phenol		**Method Am-01[b]**	
Acetonitrile	Tetrachloroethene	Benzo(g,h,i)perylene	Pyrene		Am-241	
Allyl chloride	Toluene	Benzo(k)fluoranthene	Pyridine		Am-243	
Benzene	Total xylenes	Benzoic acid	Diethyl phthalate			
Bromodichloromethane	Trichloroethene	Benzyl alcohol			**Method Pu-02[b]**	
Bromoform	Trichlorofluoromethane				Pu-238	
Bromomethane	Vinyl acetate				Pu-239/240	
Carbon disulfide	Vinyl chloride					

[a]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2012b)
[b]*The Procedures Manual of the Environmental Measurements Laboratory*, which includes HASL-300 Methods (DOE, 1997)
[c]May be reported as 3,4-Methylphenol or m,p-cresol.
[d]The most current EPA, DOE, or equivalent accepted analytical method may be used including; Laboratory Standard Operating Procedures approved by the contractor in accordance with industry standards and the contractor's Statement of Work (SOW) requirements.

HASL = Health and Safety Laboratory

Administrative Code (NAC) 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012a). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012b) requires the use of ASTM International (ASTM) Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

This RBCA process, summarized in Figure 3-3, defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- **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. Results from total petroleum hydrocarbons (TPH) analyses will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemical constituents of diesel reported from VOC and SVOC analyses will be compared to the SSTLs.

- **Tier 3 evaluation.** Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

This RBCA process includes a provision for conducting an interim remedial action if necessary and appropriate. The decision to conduct an interim action may be made at any time during the investigation and at any level (tier) of analysis. Concurrence of the decision makers listed in Section A.2.1 will be obtained before any interim action is implemented. Evaluation of DQO decisions will be based on conditions at the site after any interim actions are completed. Any interim actions conducted will be reported in the Corrective Action Decision Document (CADD).

If, after implementation of corrective actions, contamination remains in place that is less than the site-specific exposure scenario based FAL but exceeds 25 millirem per year (mrem/yr) based on the Industrial Area exposure scenario, an administrative use restriction will be implemented to prevent

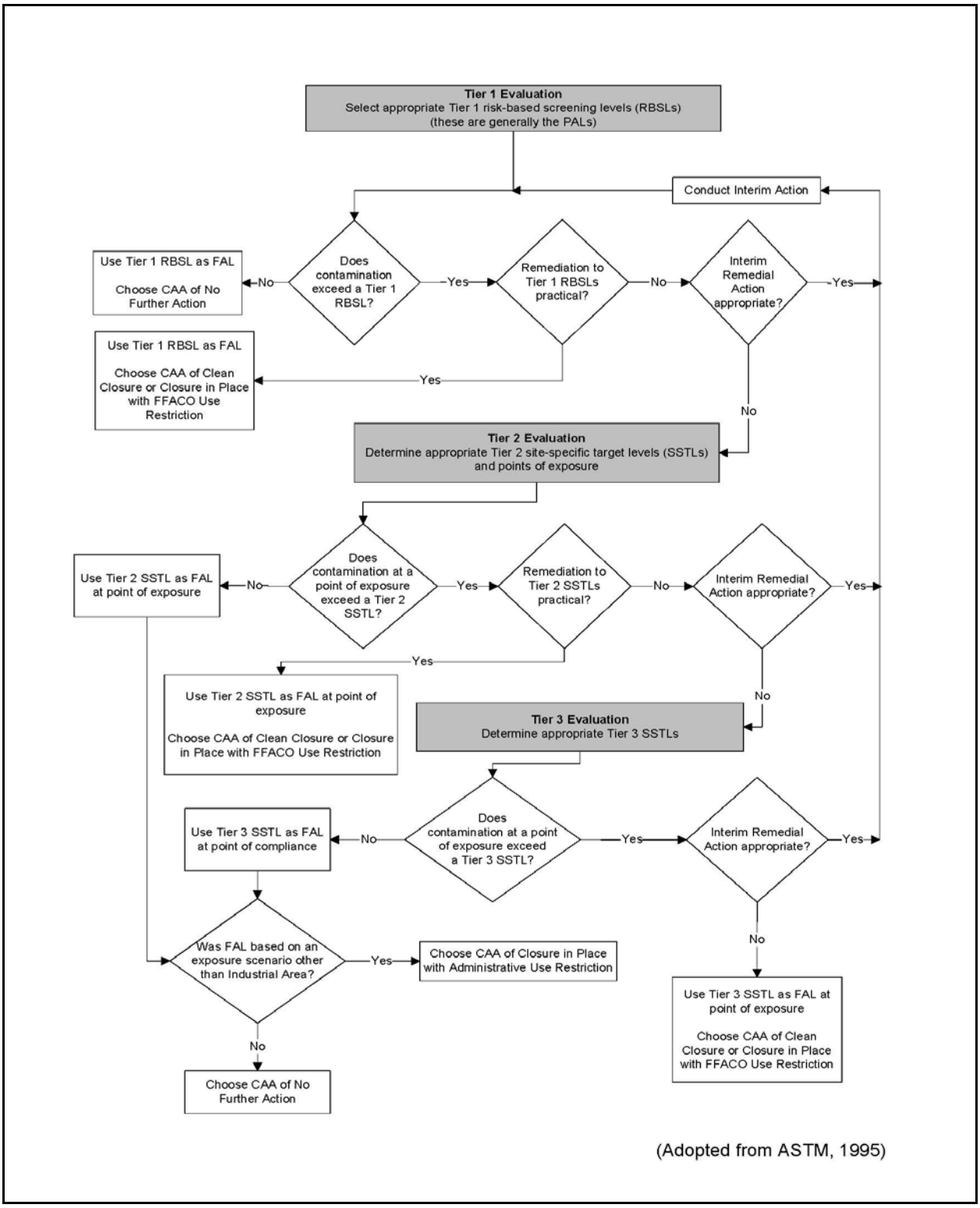

Figure 3-3
RBCA Decision Process

future industrial use of the area. For this reason, contamination at all sites will be evaluated against industrial exposure scenario based PALs and site-specific exposure scenario based FALs. The FALs (along with the basis for their selection) will be proposed in the CADD, where they will be compared to laboratory results in the evaluation of potential corrective actions.

3.3.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the U.S. Environmental Protection Agency (EPA) Region 9 Regional Screening Levels for chemical contaminants in industrial soils (EPA, 2012a). Background concentrations for RCRA metals will be used instead of screening levels when natural background concentrations exceed the screening level, as is often the case with arsenic on the NNSS. Background is considered the mean plus two standard deviations of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established screening levels, the protocol used by EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the CADD.

3.3.2 Radionuclide PALs

The PAL for radioactive contaminants is a TED of 25 mrem/yr, based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in the Soil RBCA document (NNSA/NSO, 2012c). For primary releases, the TED is calculated as the sum of external dose and internal dose. External dose is determined directly from TLD measurements. Internal dose is determined by comparing analytical results from soil samples to residual radioactive material guidelines (RRMGs) that were established using the Residual Radioactive (RESRAD) computer code (Yu et al., 2001). The RRMGs are radionuclide-specific values for radioactivity in surface soils. The RRMG is the value, in picocuries per gram (pCi/g) of surface soil, for a particular radionuclide that would result in an internal dose of 25 mrem/yr to a receptor (under the appropriate exposure scenario) independent of any other radionuclide (assuming that no other radionuclides contribute dose). The RRMGs are presented in the Soils RBCA document (NNSA/NSO, 2012c). RRMGs for site-specific possible but not suspected COPCs that are not listed in the Soils RBCA document are presented in Table A.6-1.

In the RESRAD calculation, several input parameters are not specified so that site-specific information can be used.

3.4 DQO Process Discussion

This section contains a summary of the DQO process that is presented in Appendix A. The DQO process is a strategic planning approach based on the scientific method that is designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend the recommendation of viable corrective actions (e.g., no further action, clean closure, or closure in place).

As presented in Section 4.1, it is assumed that TED within the default contamination boundary (i.e., HCA located east of the Eagle crater) exceeds the FAL as well as the subsurface at the Sugar site. For these areas, the DQO decision is resolved and corrective action is required. The DQO decisions will be resolved for the areas outside the default contamination boundaries.

As presented in Section 1.1.2, the DQOs address four groups or types of potential contaminant release scenarios. Depending on the group, releases will be investigated through a combination of probabilistic sampling, judgmental sampling, or a combination of both. Therefore, a discussion related to the release scenario of each group is presented separately.

The DQO strategy for CAU 570 was developed at a meeting on April 30, 2012. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and design a data collection program that will satisfy these purposes. During the DQO discussions for this CAU, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 570 is as follows: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 570.” To address this problem statement, resolution of the following decision statements is required:

- **Decision I.** “Is any COC present in environmental media within the CAU?” If a COC is detected, then Decision II must be resolved.

- **Decision II.** "Is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include the following:

  - The lateral and vertical extent of COC contamination
  - The information needed to determine potential remediation waste types
  - The information needed to evaluate the feasibility of remediation alternatives

The presence of a COC would require a corrective action. A corrective action may also be necessary if there is a potential for wastes (i.e., PSM) that are present at a site to introduce COCs into site environmental media. Several conservative assumptions were made to evaluate the potential for wastes to introduce a COC to the surrounding environmental media. These assumptions are detailed in Section A.3.1.

For each group's release scenario, it is unknown whether COCs are present outside the default contamination boundaries, and Decision I sampling for the respective group's release scenario will be conducted. If COCs are identified, Decision II must be resolved for the releases at CAU 570.

Decision II samples from each release scenario will be submitted as necessary to define the extent of unbounded COCs. In addition, samples will be submitted for analyses, as needed, to support waste management or health and safety decisions.

For the laboratory data, the data quality indicators (DQIs) of precision, accuracy, representativeness, completeness, comparability, and sensitivity needed to satisfy DQO requirements are discussed in Section 6.2. Laboratory data will be assessed in the CADD to confirm or refute the CSM, and to determine whether the DQO data needs were met.

4.0 Field Investigation

This section contains a description of the activities to be conducted to gather and document information from the CAU 570 field investigation.

4.1 Technical Approach

The information necessary to satisfy the DQO data needs will be generated for CAU 570 by collecting and analyzing samples generated during a field investigation. However, the investigation will not include the areas within the CAU that contain removable radioactivity that exceeds the criteria for establishing an HCA, as defined in the Soils RBCA document (NNSA/NSO, 2012c), as contamination exceeding FALs is assumed to be present within these areas. This assumption is based on the potential for a receptor in these areas to inhale, ingest, and transport removable contamination. The area inside the HCA associated with the Eagle test will, therefore, be considered a default contamination area and require corrective action.

The Sugar test created a blast crater 6.4 m deep and 28 m in diameter. By process knowledge, significant radioactivity would have been injected and deposited in the original crater that has been subsequently filled in by erosion of less contaminated soil. This buried contamination was determined to be impractical to adequately characterize. It was therefore decided in the DQOs to define the subsurface contamination within the crater as a default contamination boundary, as defined in the Soils RBCA document (NNSA/NSO, 2012c), that requires corrective action. For the areas outside the default contamination boundaries, information will be generated during a site investigation to resolve DQO decisions.

The presence and nature of contamination for each group will be evaluated using a judgmental approach or a combination of judgmental and probabilistic approaches. The locations of the sample plots required for Groups 1 and 2 will be selected and evaluated judgmentally, and the samples collected within the sample plots will be collected and evaluated probablistically. The samples required for Groups 3 and 4 will be identified and sample results evaluated based on judgmental criteria.

If it is determined that a COC is present at any group, the parameters of the investigation of that group will be further addressed by determining the extent of contamination before evaluating CAAs.

For probabilistic sampling of radiological contamination, DQO decisions will be based on the 95 percent UCL of the average TED for each sample plot. For judgmental sampling, DQO decisions will be based on a direct comparison of sample results to the FAL.

The TED will be determined by summing internal and external dose measurements at each sample location. Sample results for individual radionuclides will be used to calculate internal dose using the RRMGs presented in Section 3.3.2. The internal dose associated with any specific radionuclide would be established using the following equation:

$$\textit{Internal dose (mrem/yr)} = [\textit{Analytical results (pCi/g)} / \textit{RRMG}] \times 25 \textit{ mrem/yr}$$

When more than one radionuclide is present, the internal dose will be calculated as the sum of the internal doses for each radionuclide.

External dose will be determined by collecting *in situ* measurements using a TLD. The TLD will be installed at the approximate center of the sample plot at a height of approximately 1 m and be left in place for approximately 2,000 hours (equivalent to an annual industrial worker exposure). Each TLD contains three elements from which external dose measurements will be reported. The 95 percent UCL of the average TED for each plot will be the sum of the 95 percent UCL of the TLD element results for external dose and the 95 percent UCL of the sample results for internal dose.

Based on the low expected internal dose rates, TED rates at each TLD location where samples are not collected will be estimated by adding an estimate of internal dose to the TLD results. The conservative estimate of internal dose for each of these locations will be calculated based on a ratio of internal dose to external dose. This ratio will be conservatively established from the measured internal and external doses at the sample plot with the maximum internal dose rate. Use of this ratio will overestimate internal dose (and therefore TED) at all locations with lower dose rates. The TED for each of these TLD locations will be calculated as the total of the external dose measured by the TLD and the internal dose estimated using internal/external dose ratio from the selected sample plot (see Section A.8.1.1.1).

Modifications to the investigative strategy may be required should unexpected field conditions be encountered at any group. Significant modifications must be justified and documented before implementation. If an unexpected condition indicates that conditions are significantly different from the CSM, the activity will be rescoped and the identified decision makers will be notified.

4.2 Field Activities

Field activities at CAU 570 include site preparation, sample location selection, sample collection, and demobilization.

4.2.1 Site Preparation Activities

Site preparation activities to be conducted before the start of environmental sampling may include relocating or removing surface debris, equipment, and structures; constructing hazardous waste accumulation areas (HWAAs) and site exclusion zones; providing sanitary facilities; constructing decontamination facilities; and moving staged equipment.

Before mobilization for collecting investigation samples, the following preparatory activities will also be conducted:

- Perform radiological surveys to provide biasing information used in selecting sample locations.
- Install project-specific environmental monitoring TLDs (see Section 4.2.3 for additional information).
- Perform visual surveys at all CASs within CAU 570 to identify any staining, discoloration, disturbance of native soils, or any other indication of potential contamination.

4.2.2 Sample Location Selection

Rationale for selecting areas for sampling is discussed in the following sections. For all investigations, if a spatial boundary is reached, the CSM is shown to be inadequate, or the Site Supervisor determines that extent sampling needs to be reevaluated, then work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be reevaluated.

The sampling strategy and the estimated sample locations where bias is present are presented in Appendix A. The Task Manager or Site Supervisor may modify the number, location, and spacing of step-outs as warranted by site conditions to achieve DQO criteria stipulated in Appendix A. Where sampling locations are modified, the justification for these modifications will be documented in the CADD.

As presented in Section 4.1, it is assumed that corrective action is required within the default contamination boundaries (i.e., HCA at Eagle and subsurface at Sugar). Therefore, sampling of these areas is not necessary.

4.2.2.1 Group 1: Atmospheric Tests

Decision I will be evaluated by measuring TED within each sample plot (one in the area of B-9A and one in the area of Tesla) established within the area of the highest radiological values as determined a ground-based radiological survey. The highest radiological signature is an indicator of the greatest concentration of radiological contaminants. The objective is to locate the sample plot in the area with the highest radiological dose as described in Section 4.1.

At each location, one sample plot is planned for the collection of soil samples to determine internal dose. A TLD will be placed near the center of the sample plot to determine the external dose. If the 95 percent UCL of the TED at the Decision I sample plots exceeds the FAL, Decision II will be resolved. To assist in resolving the extent of contamination exceeding the FAL (part of Decision II), TLDs will be placed in a radial pattern around a central location to determine external dose. The method for determining internal dose at each Decision II TLD location is described in Section 4.1.

All soil samples collected at each sample plot and all TLDs placed at each sample plot will be sampled as described in Section 4.2.3.

4.2.2.2 Group 2: Safety/Low-Yield Tests

Group 2 Decision I will be evaluated by measuring TED within each sample plot (one in the area of Ganymede and one in the area of Sugar) established at the area of the highest radiological values as determined from the 1994 flyover survey (BN, 1999a) and a ground-based radiological survey conducted with a handheld FIDLER radiological instrument. Assuming a correlation between the

presence of low-energy gamma, as detected by the FIDLER, and the presence of Pu-239, the results of the FIDLER survey will be used to estimate the locations where the internal dose may contribute the greatest amount to TED. Therefore, one sample plot will be located in the area with the highest radiological survey values as determined with the FIDLER. A TLD will be placed near the center of each of the sample plots to determine the external dose.

It is not anticipated that the 95 percent UCL of the TED at the Decision I sample plots associated with Group 2 will exceed 25 mrem/IA-yr. Therefore, no Decision II sample locations are currently planned. If the results exceed the 25 mrem/IA-yr, a path forward will be planned and the decision makers contacted for input and concurrence of Decision II sample locations.

All soil samples collected at each sample plot and all TLDs placed at each sample plot will be sampled as described in Section 4.2.3.

4.2.2.3 Group 3: Debris/Spills

For releases investigated under Group 3, a judgmental sampling approach will be used to investigate the likelihood of the soil containing a COC. Biasing factors such as stains, radiological survey results, and wastes suspected of containing hazardous or radiological components will be used to select the most appropriate samples from a particular location for collection and analysis.

If a COC is determined to exist, Decision II will be satisfied by collecting soil samples to determine the extent of contamination or the waste may be removed and a verification sample collected to ensure the COC has not contaminated the surrounding environment. A minimum of one analytical result less than the action level from each lateral and vertical direction will be required to define the extent of COC contamination. The lateral and vertical extent of COCs will only be established based on validated laboratory analytical results (i.e., not field screening).

4.2.2.4 Group 4: Migration/Mechanical Disturbance

For releases investigated under Group 4, the method used to select sample locations will depend upon the type of release. The following subsections describe how sample locations will be selected for each type of release.

Migration in Drainages

For the investigation of sedimentation areas, a sampling location will be established at the center of the nearest two sediment accumulation areas outside the initial corrective action boundary. At each location, a sample will be collected from each 10-cm-depth interval until native material is encountered.

Windrows

For the windrows investigation, at least four judgmental sampling locations will be established based on bias from ground-based gamma and visual surveys. At each sample location, a sample composed of soil from the surface to the natural soil interface will be collected.

Soil Piles

For the investigation of soil piles, a judgmental sampling location will be established based on bias from ground-based gamma and visual surveys. At each location, a sample will be collected from the surface and each 30-cm-depth interval until native material is encountered.

Staked Areas

For the investigation of areas that are identified by rebar stakes driven to highlight an area, a judgmental sampling location will be established based on bias from the ground-based gamma survey. At each location, a sample will be collected from each 10-cm-depth interval, not to exceed 30 cm.

Determination of Buried Contamination

For the investigation of buried contamination, six judgmental sampling locations will be established in each of the two elevated gross count areas displayed in the flyover survey (Figure 2-1). At each location, a sample will be collected from the surface and each 10-cm-depth interval, not to exceed a total depth of 30 cm.

4.2.3 Sample Collection

The CAU 570 sampling program will consist of the following activities:

- Collect soil samples from locations as described in Section 4.2.2.
- Collect required QC samples.
- Collect waste management samples as necessary.
- Collect external dose measurements by hanging TLDs at the sample plots or extent locations.
- Record Global Positioning System (GPS) coordinates for each environmental sample location.

To determine internal dose for Groups 1 and 2 release scenarios, a probabilistic sampling approach will be implemented for collecting composite samples within the sample plots. Each composite sample will consist of soil collected from nine randomly located subsample locations within the plot. For each composite sample, the first location will be selected randomly; the remaining eight subsample locations will be established on a systematic triangular grid (see Section A.8.1). External dose will be sampled from a TLD installed at the approximate center of the sample plot at a height of approximately 1 m and left in place for approximately 2,000 hours (equivalent to an annual industrial worker exposure).

Decision I samples for Groups 3 and 4 will be collected from the locations described in Section 4.2.2. If biasing factors are present in soils below locations where Decision I samples were collected, subsurface soil samples will also be collected by augering, backhoe excavation, direct-push, or drilling techniques, as appropriate. Subsurface soil samples will be collected at depth intervals as described in Section 4.2.2 based on biasing factors to a depth where the biasing factors are no longer present.

Decision II sampling will not be conducted for the sedimentation areas or windrows. If a COC is present in the sediment or windrow, the entire sedimentation area or windrow associated with the sample will be assumed to contain the COC and will require corrective action.

4.2.4 Sample Management

The laboratory requirements (i.e., minimum detectable concentrations [MDCs], precision, and accuracy) to be used when analyzing the COPCs are presented in Table 6-1. The analytical program is presented in Table 3-1. All sampling activities and QC requirements for field and laboratory environmental sampling will be conducted in compliance with the Soils QAP (NNSA/NSO, 2012b) and other applicable, approved procedures.

4.3 Site Restoration

Upon completion of the CAI and waste management activities, the following actions will be implemented before closure of the site Real Estate/Operations Permit (REOP) or Work Control Package:

- All equipment, wastes, debris, and materials associated with the CAI will be removed from the site.
- All CAI-related signage and fencing (unless part of a corrective action) will be removed from the site.
- Site will be inspected to ensure restoration activities have been completed.

5.0 Waste Management

Waste generated during the CAU 570 field investigation will be managed in accordance with all applicable DOE orders, federal and state regulations, and agreements and permits between DOE and NDEP. Wastes will be characterized based on these regulations using process knowledge, FSRs, and analytical results from investigation and waste samples. Waste types that may be generated during the CAI include industrial, hazardous, hydrocarbon, TSCA regulated (e.g., polychlorinated biphenyls [PCBs], asbestos), low-level radioactive, or mixed wastes.

Disposable sampling equipment, personal protective equipment (PPE), and rinsate are considered potentially contaminated waste only by virtue of contact with potentially contaminated media (e.g., soil) or potentially contaminated debris (e.g., lead). These wastes may be characterized based on associated environmental sample results, waste characterization results, FSRs, or process knowledge.

Chemicals were not known to be used or present at this CAU in a manner that would generate listed hazardous waste; therefore, wastes will be characterized based on their chemical characteristics. The waste will be managed and disposed of accordingly.

Conservative estimates of total waste contaminant concentrations may be made based on the mass of the waste, the amount of contaminated media contained in the waste, and the maximum concentration of contamination found in the media.

The following sections discuss how the field investigation will be conducted to minimize the generation of waste, what waste streams are expected to be generated, and how IDW will be managed.

5.1 Waste Minimization

The CAI will be conducted in a manner that will minimize the generation of wastes using process knowledge, segregation, visual examination, and/or field screening (e.g., radiological survey and swipe results) to avoid cross-contaminating uncontaminated media or uncontaminated IDW that would otherwise be characterized and disposed of as industrial waste. As appropriate, media and debris will be returned to their original location. To limit unnecessary generation of hazardous or

mixed waste, hazardous materials will not be used during the CAI unless required and approved by Environmental Compliance and Health and Safety. Other waste minimization practices will include, as appropriate, avoiding contact with contaminated materials, performing dry decontamination or wet decontamination over source locations, and carefully segregating waste streams.

5.2 Potential Waste Streams

The following is a list of common waste streams that may be generated during the field investigation and that may require management and disposal:

- Disposable sampling equipment and field screening waste
- PPE
- Environmental media (e.g., soil)
- Surface debris (e.g., discarded chemicals, batteries, scrap metal)
- Decontamination rinsate

5.3 IDW Management

The onsite management of IDW will be determined based on regulations associated with the particular waste type (e.g., industrial, low level), or the combination of waste types. The following subsections describe how specific waste types will be managed.

5.3.1 Industrial Waste

Industrial solid waste, if generated, will be collected, managed, and disposed of in accordance with the solid waste regulations and the permits for operation of the NNSS Solid Waste Disposal Sites. The most commonly generated industrial solid waste includes disposable sampling equipment and PPE that will be collected in plastic bags, and marked in accordance with requirements. This waste, and other waste generated such as debris or soil that is characterized as industrial waste, may be placed in the roll-off box located adjacent to the field office in Mercury or in another approved container (e.g., drum).

5.3.2 Hazardous Waste

Suspected hazardous waste, if generated, will be containerized and managed in waste accumulation areas in accordance with 40 *Code of Federal Regulations* (CFR) 262.34 (CFR, 2012b).

5.3.3 Hydrocarbon Waste

Suspected hydrocarbon solid waste, if generated, will be managed on site in a drum or other appropriate container until fully characterized and in accordance with the State of Nevada regulations (NDEP, 2006).

5.3.4 Polychlorinated Biphenyls

The management of PCBs is governed by TSCA and its implementing regulations at 40 CFR 761 (CFR, 2012c), and agreements between EPA and NDEP. PCB contamination may be found as a sole contaminant or in combination with any of the types of waste discussed in this document. For example, PCBs may be a co-contaminant in soil that contains a RCRA "characteristic" waste (PCB/hazardous waste), or in soil that contains radioactive wastes (PCB/radioactive waste), or even in mixed waste (PCB/radioactive/hazardous waste). The IDW will initially be evaluated using analytical results for media samples from the CAI. If any type of PCB waste is generated, it will be managed in accordance with 40 CFR 761 (CFR, 2012c) as well as State of Nevada requirements (NAC, 2012b), guidance, and agreements with NNSA/NSO.

5.3.5 Low-Level Waste

Low-level radioactive waste, if generated, will be managed in accordance with the contractor-specific waste certification program plan, DOE orders, and the requirements of the current version of the *Nevada National Security Site Waste Acceptance Criteria* (NNSA/NSO, 2012a). Potential radioactive waste containers will be staged and managed at a designated radioactive material area (RMA).

5.3.6 Mixed Low-Level Waste

Mixed waste, if generated, will be managed in accordance with the requirements of RCRA (CFR, 2012b), agreements between NNSA/NSO and the State of Nevada, and DOE requirements for radioactive waste. Waste characterized as mixed will not be stored for a period of time that exceeds the requirements of RCRA unless subject to agreements between NNSA/NSO and the State of Nevada. The mixed waste must be transported via an approved hazardous waste/radioactive waste transporter to the NNSS transuranic waste storage pad for storage pending treatment or disposal.

6.0 Quality Assurance/Quality Control

The overall objective of the characterization activities described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for CASs in CAU 570. All characterization activities, including those related to TLD measurements, will be conducted in accordance with the Soils QAP (NNSA/NSO, 2012b). The data from the TLD measurements will also meet rigorous data quality requirements. The TLDs will be obtained from, and measured by, the Environmental Technical Services group at the NNSS. This group is responsible for a routine environmental monitoring program at the NNSS. The program includes a campaign of TLDs that are emplaced at pre-established locations across the NNSS for the monitoring of external dose. The TLDs are replaced and read quarterly. Details of this campaign can be found in the *Nevada Test Site Environmental Report 2006* (Wills, 2007). The TLDs will be submitted to the Environmental Technical Services group for inclusion in their routine quarterly read of the NNSS environmental monitoring TLDs. The TLDs will be analyzed using automated TLD readers that are calibrated and maintained by the National Security Technologies, LLC, Radiological Control Department in accordance with existing QC procedures for TLD processing. A summary of the routine environmental monitoring TLD QC efforts and results can be found in Section 5.2.1 of the *Nevada Test Site Environmental Report 2006*. Certification is maintained through the DOE Laboratory Accreditation Program for dosimetry.

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

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

2. *The use of a TLD to determine an individual’s external dose is the standard in radiation safety and serves as the “legal dose of record” when other measurements are available.* Specifically, 10 CFR Part 835.402 (CFR, 2012a) indicates that personal dosimeters must be provided to monitor individual exposures and that the monitoring program that uses the dosimeters must be accredited in accordance with a DOE Laboratory Accreditation Program.

Sections 6.1 and 6.2 discuss the collection of required QC samples in the field and QA requirements for soil samples.

6.1 QC Sampling Activities

Field QC samples will be collected in accordance with established procedures. Field QC samples are collected and analyzed to aid in determining the validity of environmental sample results. The number of required QC samples depends on the types and number of environmental samples collected. As determined in the DQO process, the minimum frequency of collecting and analyzing QC samples for this investigation is as follows:

- **Radiological samples**
  - Field duplicates (1 per 20 environmental grab samples, or 1 per investigation group per matrix if less than 20 collected)
  - Laboratory QC samples (1 per 20 environmental grab samples, or 1 per investigation group per matrix if less than 20 collected)
- **Chemical samples (if collected)**
  - Trip blanks (1 per sample cooler containing VOC environmental samples)
  - Equipment rinsate blanks (1 per sampling event for each type of decontamination procedure)
  - Source blanks (1 per lot of uncharacterized source material that contacts sampled media)
  - Field duplicates (1 per 20 environmental grab samples, or 1 per investigation group per matrix if less than 20 collected)
  - Field blanks
  - Laboratory QC samples (1 per 20 environmental grab samples, or 1 per investigation group per matrix if less than 20 collected)

Additional QC samples may be submitted based on site conditions at the discretion of the Task Manager or Site Supervisor. Field QC samples must be analyzed using the same analytical procedures implemented for associated environmental samples. Additional details regarding field QC samples are available in the Soils QAP (NNSA/NSO, 2012b).

6.2 Laboratory/Analytical Quality Assurance

As stated in the DQOs (see Appendix A), and except where noted, laboratory analytical quality data will be used for making DQO decisions. Rigorous QA/QC will be implemented for all laboratory samples, including documentation, data verification and validation of analytical results, and an assessment of DQIs as they relate to laboratory analysis.

6.2.1 Data Validation

Data verification and validation will be performed in accordance with the Soils QAP (NNSA/NSO, 2012b), except where otherwise stipulated in this CAIP. All chemical and radiological laboratory data from samples that are collected and analyzed will be evaluated for data quality in accordance with company-specific procedures. The data will be reviewed to ensure that all required samples were appropriately collected and analyzed, and that the results met data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine whether the data meet the DQO requirements of the investigation and the performance criteria for the DQIs. The results of this assessment will be documented in the CADD. If the DQOs were not met, corrective actions will be evaluated, selected, and implemented (e.g., refine CSM or resample to fill data gaps).

6.2.2 Data Quality Indicators

DQIs are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. DQIs are used to evaluate the entire measurement system and laboratory measurement processes (i.e., analytical method performance) as well as to evaluate individual analytical results (i.e., parameter performance). Significant DQI criteria variations from the Soil QAP (NNSA/NSO, 2012b) will be reported in the CADD. The quality and usability of data used to make DQO decisions will be assessed based on the following DQIs:

- Precision
- Accuracy/bias
- Representativeness
- Completeness
- Comparability
- Sensitivity

Table 6-1 provides the established analytical method/measurement system performance criteria for each of the DQIs and the potential impacts to the decision if the criteria are not met. The following subsections discuss each of the DQIs that will be used to assess the quality of laboratory data. The criteria for precision and accuracy in Table 6-1 may vary from corresponding information in the Soils QAP as a result of changes in analytical methodology and laboratory contracts (NNSA/NSO, 2012b).

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 570 DQIs

DQI	Performance Metric	Potential Impact on Decision If Performance Metric Not Met
Precision	At least 80% of the sample results for each measured contaminant are not qualified for precision based on the criteria for each analytical method-specific and laboratory-specific criteria presented in Section 6.2.3.	The affected analytical results from each affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Accuracy	At least 80% of the sample results for each measured contaminant are not qualified for accuracy based on the method-specific and laboratory-specific criteria presented in Section 6.2.4.	The affected analytical results from each affected CAS will be assessed to determine whether there is sufficient confidence in analytical results to use the data in making DQO decisions.
Representativeness	Samples contain contaminants at concentrations present in the environmental media from which they were collected.	Analytical results will not represent true site conditions. Inability to make appropriate DQO decisions.
Decision I Completeness	80% of the CAS-specific COPCs have valid results.	Cannot support/defend decision on whether COCs are present.
Decision II Completeness	100% of COCs used to define extent have valid results.	Extent of contamination cannot be accurately determined.
Comparability	Sampling, handling, preparation, analysis, reporting, and data validation are performed using standard methods and procedures.	Inability to combine data with data obtained from other sources and/or inability to compare data to regulatory action levels.
Sensitivity	MDCs are less than or equal to respective FALs.	Cannot determine whether COCs are present or migrating at levels of concern.

The TLDs will be analyzed using automated TLD readers that are calibrated and maintained in accordance with existing QC procedures for TLD processing (Section 6.0) by a laboratory that is certified through the DOE Laboratory Accreditation Program for dosimetry. The data from this system meet rigorous data quality requirements and will be assessed for the listed DQIs before inclusion in the CAU 570 datset. Therefore, a separate evaluation of the TLD data against the DQIs will not be conducted.

6.2.3 Precision

Precision is a measure of the repeatability of the analysis process from sample collection through analysis results and is used to assess the variability between two equal samples.

Determinations of precision will be made for field duplicate samples and laboratory duplicate samples. Field duplicate samples will be collected simultaneously with samples from the same source under similar conditions in separate containers. The duplicate sample will be treated independently of the original sample in order to assess field impacts and laboratory performance on precision through a comparison of results. Laboratory precision is evaluated as part of the required laboratory internal QC program to assess performance of analytical procedures. The laboratory sample duplicates are an aliquot, or subset, of a field sample generated in the laboratory. They are not a separate sample but a split, or portion, of an existing sample. Typically, laboratory duplicate QC samples may include matrix spike duplicate (MSD) and laboratory control sample (LCS) duplicate samples for organic, inorganic, and radiological analyses.

Precision is a quantitative measure used to assess overall analytical method and field-sampling performance as well as the need to “flag” (qualify) individual parameter results when corresponding QC sample results are not within established control limits. The validation criteria for precision are defined in the Soils QAP (NNSA/NSO, 2012b).

Any values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. The performance metric for assessing the DQI of precision on DQO decisions (Table 6-1) is that at least 80 percent of sample results for each measured contaminant are not qualified (estimated) due to duplicates exceeding the criteria. If this performance criterion is not met, an assessment will be conducted in the CADD on the impacts to DQO decisions specific to affected contaminants at specific CASs.

6.2.4 Accuracy

Accuracy is a measure of the closeness of an individual measurement to the true value. It is used to assess the performance of laboratory measurement processes.

Accuracy is determined by analyzing a reference material of known parameter concentration or by reanalyzing a sample to which a material of known concentration or amount of parameter has been added (spiked). Accuracy will be evaluated based on results from three types of spiked samples: matrix spike (MS), LCS, and surrogates (organics). The LCS is analyzed with the field samples using the same sample preparation, reagents, and analytical methods used for the samples. One LCS will be prepared with each batch of samples for analysis by a specific measurement. The validation criteria for accuracy are defined in the Soils QAP (NNSA/NSO, 2012b).

Any values outside the specified criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. Factors beyond laboratory control, such as sample matrix effects, can cause the measured values to be outside the established criteria. Therefore, the entire sampling and analytical process may be evaluated when determining the usability of the affected data.

The performance metric for assessing the DQI of accuracy on DQO decisions (Table 6-1) is that at least 80 percent of the sample results for each measured contaminant are not qualified (estimated) for accuracy. If this performance criterion is not met, an assessment will be conducted in the CADD on the impacts to DQO decisions specific to affected contaminants and CASs.

6.2.5 Representativeness

Representativeness is the degree to which sample characteristics accurately and precisely represent characteristics of a population or an environmental condition (EPA, 2002). Representativeness is ensured by carefully developing the CAI sampling strategy during the DQO process such that false negative and false positive decision errors are minimized. The criteria listed in DQO Step 6 (Specify Performance or Acceptance Criteria) are as follows:

- For Decision I judgmental sampling, having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS.
- For Decision I probabilistic sampling, having a high degree of confidence that the sample locations selected will represent contamination of the CAS.

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

- For Decision II, having a high degree of confidence that the sample locations selected will identify the extent of COCs.

These are qualitative measures that will be used to assess measurement system performance for representativeness. The assessment of this qualitative criterion will be presented in the CADD.

6.2.6 Completeness

Completeness is defined as generating sufficient data of the appropriate quality to satisfy the data needs identified in the DQOs. For judgmental sampling, completeness will be evaluated using both a quantitative measure and a qualitative assessment. The quantitative measurement to be used to evaluate completeness is presented in Table 6-1 and is based on the percentage of measurements made that are judged to be valid.

For the judgmental sampling approach, the completeness goal is 80 percent. If this goal is not achieved, the dataset will be assessed for potential impacts on making DQO decisions. For the probabilistic sampling approach, the completeness goal is a calculated minimum sample size required to produce a valid statistical comparison of the sample mean to the FAL.

The qualitative assessment of completeness is an evaluation of the sufficiency of information available to make DQO decisions. This assessment will be based on meeting the data needs identified in the DQOs and will be presented in the CADD. Additional samples will be collected if it is determined that the available information is not sufficient to resolve DQO decisions.

6.2.7 Comparability

Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared to another (EPA, 2002). The criteria for the evaluation of comparability will be that all sampling, handling, preparation, analysis, reporting, and data validation were performed and documented in accordance with approved procedures that are in conformance with standard industry practices. Analytical methods and procedures approved by DOE will be used to analyze, report, and

validate the data. These methods and procedures are in conformance with applicable methods used in industry and government practices. An evaluation of comparability will be presented in the CADD.

6.2.8 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest (EPA, 2002). If this criterion is not achieved, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives. This assessment will be presented in the CADD.

As presented in Section 3.4, the evaluation criterion for this parameter will be that the analytical methods must be sufficient to detect contamination that is present in the samples at concentrations less than or equal to the corresponding FALs. The target MDCs for each COPC are provided in Table 6-1.

Although the data quality for TLD measurements is assessed via the routine environmental monitoring program (Section 6.0), the sensitivity evaluation criterion for TLD measurements is 50 percent of the FAL (i.e., 12.5 net mrem/yr).

7.0 Duration and Records Availability

7.1 Duration

Field and analytical activities will require approximately 160 days to complete.

7.2 Records Availability

Historical information and documents referenced in this plan are retained in the NNSA/NSO activity files in Las Vegas, Nevada, and can be obtained through written request to the NNSA/NSO Soils Activity Lead. This document is available in the DOE public reading facilities located in Las Vegas and Carson City, Nevada, or by contacting the appropriate DOE Soils Activity Lead.

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Appendix A

Data Quality Objectives

A.1.0 Introduction

The DQO process described in this appendix is a seven-step strategic systematic planning method used to plan data collection activities and define performance criteria for the CAU 570, Yucca Flat Atmospheric Test Sites, field investigation. The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend recommended corrective actions (i.e., no further action, closure in place, or clean closure). Existing information about the nature and extent of contamination at the CASs in CAU 570 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

The CAU 570 CAI will be based on the DQOs presented in this appendix as developed by NDEP and NNSA/NSO representatives. The seven steps of the DQO process presented in Sections A.2.0 through A.8.0 were developed in accordance with *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

The DQO process presents a combination of probabilistic and judgmental sampling approaches. In general, the procedures used in the DQO process provide the following:

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

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

A.2.0 Step 1 - State the Problem

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

The problem statement for CAU 570 is as follows: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend CAAs for the CASs in CAU 570.”

A.2.1 Planning Team Members

The DQO planning team consists of representatives from NDEP and NNSA/NSO. The DQO planning team met on April 30, 2012, for the DQO meeting.

A.2.2 Conceptual Site Model

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

The CSM was developed for CAU 570 using information from the physical setting, potential contaminant sources, release information, historical background information, knowledge from similar sites, and physical and chemical properties of the potentially affected media and COPCs.

The CSM consists of the following:

- Potential contaminant releases, including media subsequently affected
- Release mechanisms (the conditions associated with the release)

- Potential contaminant source characteristics, including contaminants suspected to be present and contaminant-specific properties
- Site characteristics, including physical, topographical, and meteorological information
- Migration pathways and transport mechanisms that describe the potential for migration and where the contamination may be transported
- The locations of points of exposure where individuals or populations may come in contact with a COC associated with a CAS
- Routes of exposure where contaminants may enter the receptor

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

The applicability of the CSM to each group is summarized in Table A.2-1 and discussed below. Table A.2-1 provides information on CSM elements that will be used throughout the remaining steps of the DQO process. Figure A.2-1 depicts a representation of the conceptual pathways to receptors from CAU 570 sources. Figure A.2-2 depicts a graphical representation of the CSM.

A.2.2.1 Release Sources

The following identifies the release sources (DOE/NV, 2000) specific to CAU 570:

- CAS 02-23-07, Atmospheric Test Site - Tesla, is associated with the T-9b Tesla weapons-related tower test that was detonated on March 1, 1955, with a yield of 7 kt.
- CAS 09-23-10, Atmospheric Test Site T-9, is associated with the T-9 Sugar test, a 1-m platform weapons-effects test that was detonated on November 19, 1951, with a yield of 1.2 kt.
- CAS 09-23-11, Atmospheric Test Site S-9G, is associated with the Ganymede safety experiment (S-9G), a gravel-covered bunker test that was detonated on October 30, 1958, with no yield. The test was described as a successful containment of plutonium.
- CAS 09-23-14, Atmospheric Test Site - Rushmore, is associated with the B-9A Rushmore test, which was a weapons-related balloon experiment conducted on October 22, 1958. A

Table A.2-1
CSM Description of Elements for CAU 570

	Group 1	Group 2	Group 3	Group 4
Site Status	Sites are inactive and/or abandoned			
Exposure Scenario	Occasional Use			
Sources of Potential Soil Contamination	Atmospheric deposition of radionuclides from nuclear testing	Atmospheric deposition of radionuclides from nuclear testing	Spills, waste, infrastructure, and debris associated with test support	Migration by water flow, mechanical excavation
Location of Contamination/ Release Point	Surface soil in annular pattern surrounding GZs	Surface soil in vicinity of low-yield tests	Soil directly below debris	Windrows, soil piles, excavations
Amount Released	Unknown			
Affected Media	Surface soil	Surface soil	Debris such as concrete, metal, and wood	Surface and shallow subsurface soil
Potential Contaminants	Activation and fission products	Unfissioned material	RCRA metals, VOCs, SVOCs	Activation and fission products, unfissioned material
Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside the boundaries of the CAU. Infiltration of precipitation through subsurface media serves as a minor driving force for migration of contaminants.			
Migration Pathways	Vertical transport is expected to dominate over lateral transport due to infiltration.			
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries of the CAU.			
Exposure Pathways	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion, inhalation, and dermal contact (absorption) of soil and/or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials.			

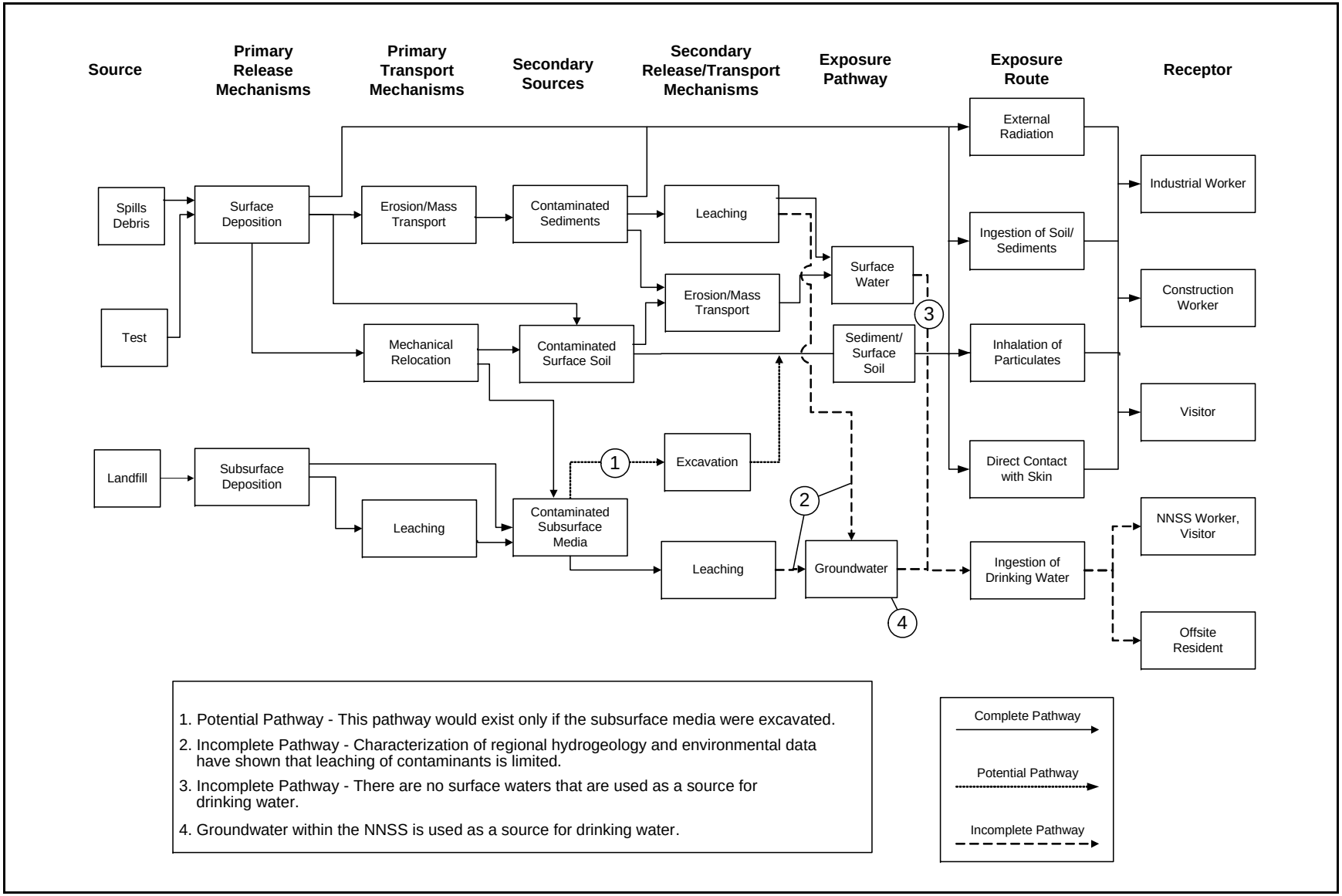

Figure A.2-1
CSM Diagram

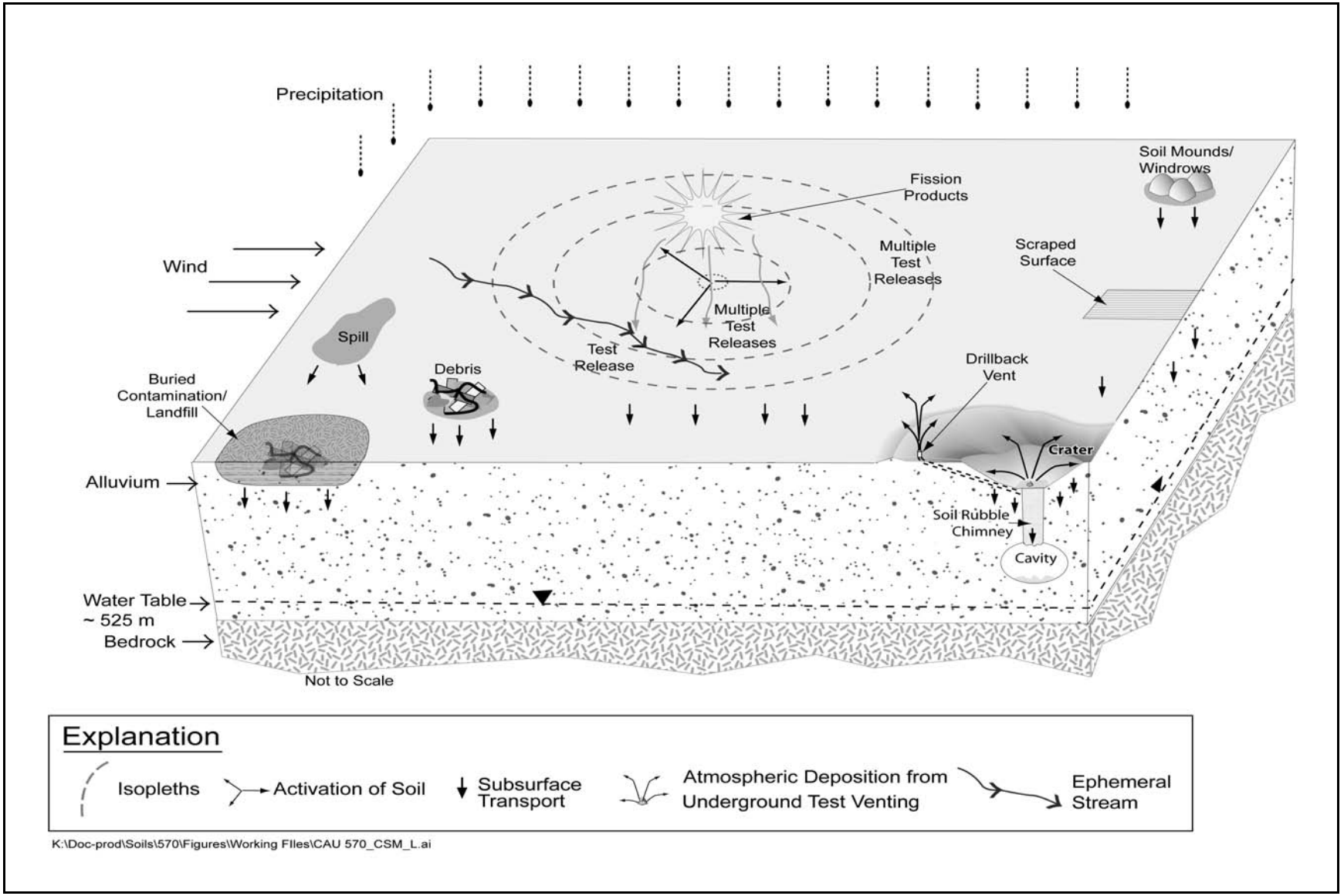

Figure A.2-2
CAU 570 CSM

UNCONTROLLED When Printed

balloon experiment is where a nuclear device is suspended from a balloon and detonated into the atmosphere. Rushmore was detonated at a height of 152.4 m with a yield of 188 tons.

- CAS 09-23-15, Eagle Contamination Area, is a contaminated soil and debris pile associated with the release of radionuclides to the surrounding soil from a line of site test rupture and post shot hole release from the U9av Eagle underground test conducted on December 12, 1963, with a yield of 5.3 kt. The soils/debris pile is located at the edge of the crater that resulted from the Eagle test, and is fenced and identified as an HCA.

- CAS 09-99-01, Atmospheric Test Site B-9A, is associated with seven weapons-related balloon tests where a nuclear device was suspended from a balloon and detonated into the atmosphere. The following tests contribute to this CAS:

  - The Lassen test was detonated on June 5, 1957, at a height of 152 m with a yield of 0.0005 kt.

  - The Wilson test was detonated on June 18, 1957, at a height of 152 m with a yield of 10 kt.

  - The Hood test was detonated on July 5, 1957, at a height of 457 m with a yield of 74 kt.

  - The Owens test was detonated on July 25, 1957, at a height of 152 m with a yield of 9.7 kt.

  - The Wheeler test was detonated on September 6, 1957, at a height of 152 m with a yield of 0.197 kt.

  - The Charleston test was detonated on September 28, 1957, at a height of 457 m with a yield of 12 kt.

  - The Morgan test was detonated on October 7, 1957, at a height of 152 m with a yield of 8 kt.

The DQOs for CAU 570 defined the following release scenarios to appropriately address the various types of releases that may be present at the CASs:

- **Group 1 (Atmospheric Tests).** This release category is specific to the atmospheric deposition of radionuclide contamination (specifically high energy fission products) onto the soil surface that has not been displaced through excavation or migration. The contamination associated with the this type of release is limited to the top 5 cm of soil.

- **Group 2 (Safety/Low-Yield Tests).** This release category is specific to the release and deposition of low-energy gamma, beta, and alpha radiation from low or zero yield tests onto the surface soil or gravel that has not been displaced through excavation or migration. The contamination associated with this type of release will be limited to the top 5 cm of soil.

- **Group 3 (Debris/Spills).** This release category is specific to the release of any chemical or radiological contamination associated with debris and/or spills including the debris itself. The debris to be investigated is not limited to debris remaining from the tests identified by the CASs, but includes all debris and spills present within the area of the CAU.

- **Group 4 (Migration/Mechanical Disturbance).** This release category investigates radionuclide contaminants that were initially deposited onto the soil surface, but have been displaced through erosion and sedimentation or subsequent area activities. This investigation will extend from the surface to the natural soil interface or 30 cm, whichever is less.

A.2.2.2 Potential Contaminants

The COPCs for CAU 570 are defined as the contaminants reasonably expected at the site that could contribute to a dose or risk exceeding FALs. Based on the nature of the releases identified in Section 2.4 and previous investigation results presented in Section 2.5, the following contaminants could reasonably be suspected to be present at CAU 570:

- Uranium isotopes (U-234, U-235, and U-238)
- Plutonium isotopes (Pu-238 and Pu-239/240)
- Am-241
- Cs-137
- Europium isotopes (Eu-152, Eu-154, and Eu-155)

These COPCs were identified during the planning process through the review of site history, process knowledge, personal interviews, past investigation efforts (where available), and inferred activities associated with the CASs and other releases (including those that may be discovered during the investigation). Other specific COPCs (and subsequently the analyses requested) will be determined for discovered potential releases based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

Although not suspected to be present, analysis for other COPCs will be performed to eliminate the possibility of their presence due to an incomplete history of site testing operations. The following site-specific COPCs are possible but not suspected for CAU 570:

- Co-60
- Sr-90
- Tc-99
- Np-237
- Pu-241

- Cm-243
- Cm-244
- Am-243
- Ag-108m
- Al-26
- Nb-94
- Th-232
- U-233

Cobalt is included on this list because it is an activation product in soil. Strontium and technicium are included in this list due to their historical presence as fission product radionuclides. Radionuclides such as Np-237, Pu-241, Cm-243, and Cm-244 are included as possible radiological COPCs based on their reported historical use as tracers and/or surrogates.

The COPCs applicable to Decision I environmental samples from each of the release types are listed in Table A.2-2. Table A.2-3 lists the analytical methods required for these COPCs, while Table A.2-4 lists all analytes that are reported for by the analytical laboratory for each of the analytical methods.

A.2.2.3 Contaminant Characteristics

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

The radionuclide contaminants in CAU 570 are all moderate to highly adsorbed on the alluvial materials present in CAU 570. A summary of the inherent vertical migration potential of these contaminants through the vadose zone due to their adsorption properties is presented in Table A.2-5. This table also presents the contaminant sorption coefficients (K_d) along with the equivalent retardation factor (based on an average bulk density of 1.5 grams per milliliter and porosity of 0.3 (SNJV, 2007). Based on these properties and the maximum estimated recharge rate of 50 m in 1,000 years (Section 3.1.4), the major radionuclide contaminants at CAU 570 are estimated to migrate no more than 1/10 of a meter in 1,000 years except for uranium, which could migrate up to 8 m in 1,000 years.

Table A.2-2
Contaminants of Potential Concern[a]

Analyses	Group 1	Group 2[b]	Group 3	Group 4
Organic COPCs				
SVOCs	--	--	X[c]	--
VOCs	--	--	X[c]	--
Inorganic COPCs				
RCRA Metals	--	--	X[c]	--
Expected Radionuclide COPCs				
Cs-137	X	X	--	X
Eu-152/154/155	X	X	--	X
Isotopic U Analytes	X	X	--	X
Isotopic Pu Analytes[d]	X	X	--	X
Isotopic Am (Am-241)	X	X	--	X
Possible Radionuclide COPCs				
Isotopic Am (Am-243)	X	X	--	X
Pu-241	X	X	--	X
Co-60	X	X	--	X
Np-237	X	X	--	X
Cm-243	X	X	--	X
Sr-90[e]	X	X	--	X
Ag-108m	X	X	--	X
Al-26	X	X	--	X
Nb-94	X	X	--	X
Th-232	X	X	--	X
U-233	X	X	--	X
Tc-99 [e]	X	X	--	X

[a]The COPCs are the constituents reported from the analytical methods listed.
[b]Collect a single confirmatory sample at each Pu dispersal site, using a sample with a higher alpha FSR. Additional sampling based upon the 10% dose rule.
[c]The required analysis will be dependent on the type of debris or spill being investigated.
[d]Pu ratios used to determine whether analysis for Cm-244 is needed.
[e]Collect a single confirmatory sample at the expected location of the highest Cs-137 result. Additional sampling based upon the 10% dose rule.

X = Required analytical method
-- = Not required

Table A.2-3
Analyses Required by Group[a]

Analyses	Groups 1	Group 2	Group 3	Group 4
Inorganic COPCs				
RCRA Metals	--	--	X[b]	--
Organic COPCs				
VOCs	--	--	X[b]	--
SVOCs	--	--	X[b]	--
Radionuclide COPCs				
Gamma Spectroscopy	X	X	X[c]	X
Isotopic U	X	X	--	X
Isotopic Pu[d]	X	X	--	X
Isotopic Am	X	X	--	X
Pu-241[e]	X	X	--	X
Sr Analysis[f]	X	X	--	X
Tc Analysis[f]	X	X	--	X

[a]The analytical method has been determined based on the site-specific COPCs. Analytical methods numbers are shown in Table A.2-4.
[b]Analyses for VOCs, SVOCs, or RCRA metals will only be run as PSM is located.
[c]Results of gamma analysis will be used to determine whether further isotopic analysis is warranted.
[d]Pu ratios used to determine whether analysis for Cm-244 is needed.
[e]Collect a single confirmatory sample at each Pu dispersal site, using a sample with a higher alpha FSR. Additional sampling based upon the 10% dose rule.
[f]Collect a single confirmatory sample at the expected location of the highest Cs-137 result. Additional sample based upon the 10% dose rule.

X = Required analytical method as described in Soils QAP (NNSA/NSO, 2012b)
-- = Not required

Am = Americium
Cm = Curium
FSR = Field-screening result
Pu = Plutonium
Sr = Strontium
SVOC = Semivolatile organic compound
Tc = Technetium
U = Uranium
VOC = Volatile organic compound

Table A.2-4
Analytes Reported Per Method

VOCs		SVOCs		Metals	Radionuclides	
Method 8260[a]		**Method 8270[a]**		**Method 6010[a]**	**Method Ga-01[b]**	**Method U-02[b]**
1,1,1,2-Tetrachloroethane	Carbon tetrachloride	1,4-Dioxane	Bis(2-ethylhexyl)phthalate	Arsenic	Ac-228	U-234
1,1,1-Trichloroethane	Chlorobenzene	2,3,4,6-Tetrachlorophenol	Butyl benzyl phthalate	Barium	Ag-108m	U-235
1,1,2,2-Tetrachloroethane	Chloroethane	2,4,5-Trichlorophenol	Carbazole	Beryllium	Al-26	U-238
1,1,2-Trichloroethane	Chloroform	2,4,6-Trichlorophenol	Chrysene	Cadmium	Am-241	
1,1-Dichloroethane	Chloromethane	2,4-Dimethylphenol	Di-n-butyl phthalate	Chromium	Cm-243	**Method Sr-02**
1,1-Dichloroethene	Chloroprene	2,4-Dinitrotoluene	Di-n-octyl phthalate	Lead	Co-60	Sr-90
1,2,4-Trichlorobenzene	cis-1,2-Dichloroethene	2-Chlorophenol	Dibenzo(a,h)anthracene	Selenium	Cs-137	
1,2,4-Trimethylbenzene	Dibromochloromethane	2-Methylnaphthalene	Dibenzofuran	Silver	Eu-152	**Lab-Specific Methods[d]**
1,2-Dibromo-3-chloropropane	Dichlorodifluoromethane	2-Methylphenol	Dimethyl phthalate		Eu-154	Pu-241
1,2-Dichlorobenzene	Ethyl methacrylate	2-Nitrophenol	Fluoranthene	**Method 7471[a]**	Eu-155	Tc-99
1,2-Dichloroethane	Ethylbenzene	3-Methylphenol[c] (m-cresol)	Fluorene	Mercury	K-40	
1,2-Dichloropropane	Isobutyl alcohol	4-Methylphenol[c] (p-cresol)	Hexachlorobenzene		Nb-94	
1,3,5-Trimethylbenzene	Isopropylbenzene	4-Chloroaniline	Hexachlorobutadiene	**Method 7196[a]**	Pa-233	
1,3-Dichlorobenzene	Methacrylonitrile	4-Nitrophenol	Hexachloroethane	Chromium VI	Pb-212	
1,4-Dichlorobenzene	Methyl methacrylate	Acenaphthene	Indeno(1,2,3-cd)pyrene		Pb-214	
2-Butanone	Methylene chloride	Acenaphthylene	n-Nitroso-di-n-propylamine		Th-229	
2-Chlorotoluene	n-Butylbenzene	Aniline	Naphthalene		Th-234	
2-Hexanone	n-Propylbenzene	Anthracene	Nitrobenzene		Tl-208	
4-Isopropyltoluene	sec-Butylbenzene	Benzo(a)anthracene	Pentachlorophenol		U-235	
4-Methyl-2-pentanone	Styrene	Benzo(a)pyrene	Phenanthrene			
Acetone	tert-Butylbenzene	Benzo(b)fluoranthene	Phenol		**Method Am-01[b]**	
Acetonitrile	Tetrachloroethene	Benzo(g,h,i)perylene	Pyrene		Am-241	
Allyl chloride	Toluene	Benzo(k)fluoranthene	Pyridine		Am-243	
Benzene	Total xylenes	Benzoic acid	Diethyl phthalate			
Bromodichloromethane	Trichloroethene	Benzyl alcohol			**Method Pu-02[b]**	
Bromoform	Trichlorofluoromethane				Pu-238	
Bromomethane	Vinyl acetate				Pu-239/240	
Carbon disulfide	Vinyl chloride					

[a] *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA, 2012b)
[b] *The Procedures Manual of the Environmental Measurements Laboratory*, which includes HASL-300 Methods (DOE, 1997)
[c] May be reported as 3,4-Methylphenol or m,p-cresol.
[d] The most current EPA, DOE, or equivalent accepted analytical method may be used including; Laboratory Standard Operating Procedures approved by the contractor in accordance with industry standards and the contractor's Statement of Work (SOW) requirements.

HASL = Health and Safety Laboratory

Table A.2-5
Vertical Migration Potential through the Vadose of the Major Radionuclide Contaminants

Contaminant of Concern	Approximate Range of K_d Values (mL/g)	Equivalent Retardation Factor	Migration Distance in 1,000 Years (m)
Uranium	1–10	6–50	1–8
Plutonium	100–10,000	500–50,000	0.001–0.1
Europium	1,000–100,000	5,000–500,000	0.0001–0.01
Thorium	100–10,000	500–50,000	0.001–0.1
Cesium	1,000–10,000	5,000–50,000	0.001–0.01
Americium	10,000–100,000	50,000–500,000	0.0001–0.001

mL/g = Milliliters per gram

The migration potential of radionuclides released from a nuclear detonation was demonstrated in a long-term radionuclide migration study of an underground nuclear test. A well installed into the groundwater 91 m away from the Cambric test GZ (and much closer to the nearest extent of the test cavity) was continuously pumped from 1975 to 1991 in order to draw radionuclides from the detonation cavity. The May 1965 Cambric test released a yield of 750 tons at a depth of 294 m below the land surface and 73 m below the water table. No radionuclides associated with nuclear fission tests (including the major contributing radionuclides plutonium, uranium, cesium, europium, strontium, or cobalt) other than tritium and krypton (which are considered to be conservative tracers in groundwater, as they do not interact with the geologic media through which the water moves) were detected in the pumped groundwater during the 16 years of pumping (Bryant, 1992; Hoffman, 1984). This test demonstrated the relative immobility of the fission radionuclides under conditions of very high mass flow (more than 1.5 billion gallons of water pumped) in a saturated matrix. Under unsaturated conditions (such as surface soil with atmospheric deposition from nuclear test releases), infiltrating water percolating through the vadose zone provides a small fraction of the migration potential (mass flow is less than 3 cm of recharge per year). Therefore, it can be assumed that while the major fission radionuclides are relatively immobile in saturated conditions with an artificial gradient (i.e., under pumping conditions), they will be even less mobile under unsaturated conditions with limited net infiltration of precipitation.

Based on this evidence, the major radionuclide potential contaminants (plutonium and uranium) are classified as adsorbing radionuclides with low solubilities that are located within unsaturated media. Therefore, these contaminants are expected to be found relatively close to release points.

A.2.2.4 Site Characteristics

Site characteristics are defined by the interaction of physical, topographical, and meteorological attributes and properties. Topographical and meteorological properties and attributes include slope stability, precipitation frequency and amounts, precipitation runoff pathways, drainage channels and ephemeral streams, and evapotranspiration potential. Meteorological data are presented in Section 2.1.

CAU 570 is located in Area 9 of the NNSS in Yucca Flat. The area is relatively flat with little slope. The area is sparsely vegetated with native plants. The soil at CAU 570 is made up of sand to gravel-sized alluvium of various lithologies and includes areas of disturbed soil (from excavation activities). No perennial streamflow exists in this region. The ephemeral streams in the area flow into existing craters.

A.2.2.5 Migration Pathways and Transport Mechanisms

Migration pathways include the lateral migration of potential contaminants across surface soils/sediments and vertical migration of potential contaminants through subsurface soils. Contaminants present in ephemeral washes are subject to much higher transport rates than contaminants present in other surface areas. These ephemeral washes are generally dry but are subject to infrequent stormwater flows. These stormwater flow events provide an intermittent mechanism for both vertical and lateral transport of contaminants. Contaminated sediments entrained by these stormwater events would be carried by the streamflow to locations where the flowing water loses energy and the sediments drop out. These locations are readily identifiable as sedimentation areas. Other migration pathways for contamination from the sites include windborne material and materials displaced from maintenance activities (e.g., moved during road maintenance). Contaminants may also be moved through mechanical disturbance due to maintenance or construction activities at the site. Specifically, this can include activities such as decontamination and demolition of facilities,

investigation and resolution of CASs, and disassembly and removal of equipment and support structures.

Migration is influenced by the chemical characteristics of the contaminants (presented in Section A.2.2.3) and the physical characteristics of the vadose material (presented in Section A.2.2.4). In general, the contaminants that are reasonably expected to be present at CAU 570 (i.e., americium, cesium, europium, plutonium, uranium) have low solubilities and high affinity for media. The physical characteristics of the vadose material generally include medium and high adsorbive capacities, low moisture contents (i.e., available water-holding capacity), and relatively long distances to groundwater (approximately 525 m). Based on these physical and chemical factors, contamination is expected to be found relatively close to release points.

Infiltration and percolation of precipitation serve as a driving force for downward migration of contaminants. However, due to high PET (annual PET at the Area 3 RWMS has been estimated at 157 cm [Yucel, 2009]) and limited precipitation for this region (16.21 per year at Station BJY [ARL/SORD, 2012]), percolation of infiltrated precipitation at the NNSS does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992).

Subsurface migration pathways at CAU 570 are expected to be predominately vertical, although spills or leaks at the ground surface may also have limited lateral migration before infiltration. The depth of infiltration (shape of the subsurface contaminant plume) will be dependent upon the type, volume, and duration of the discharge as well as the presence of relatively impermeable layers that could modify vertical or lateral transport pathways, both on the ground surface (e.g., concrete) and in the subsurface (e.g., caliche layers).

A.2.2.6 Exposure Scenarios

Human receptors may be exposed to COPCs through oral ingestion or inhalation of, or dermal contact (absorption) with, soil or debris due to inadvertent disturbance of these materials, or external irradiation by radioactive materials. The land-use and exposure scenarios for the CAU 570 CASs are listed in Table A.2-6. These are based on current and future land use at the NNSS (DOE/NV, 1996). Although all CAU 570 CASs are located in an area where structures from past activities exist, no facilities are present that would allow these to be used as an assigned work station for NNSS site

Table A.2-6
Land-Use and Exposure Scenarios

CAS	Record of Decision Land-Use Zone	Exposure Scenario
All	**Nuclear Test** This area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons-effects tests. This zone includes compatible defense and nondefense research, development, and testing activities.	**Occasional Use Area** Worker will be exposed to the site occasionally (up to 80 hours per year for 5 years). Site structures are not present for shelter and comfort of the worker.

personnel. However, as site personnel may periodically perform work at these sites, they are considered to be occasional use areas.

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

Step 2 of the DQO process states how environmental data will be used in meeting objectives and solving the problem, identifies study questions or decision statement(s), and considers alternative outcomes or actions that can occur upon answering the question(s).

A.3.1 Decision Statements

The Decision I statement is as follows: "Is any COC present in environmental media?" For judgmental sampling design, any analytical result for a COPC exceeding the FAL will result in that COPC being designated as a COC. For the probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple contaminant analysis (NNSA/NSO, 2006). If a COC is detected, then Decision II must be resolved.

The Decision II statement is as follows: "If a COC is present, is sufficient information available to evaluate potential CAAs?" Sufficient information is defined to include the following:

- The lateral and vertical extent of COC contamination
- The information needed to predict potential remediation waste types and volumes
- The information needed to evaluate the feasibility of remediation alternatives (bioassessment if natural attenuation or biodegradation is considered, and geotechnical data if construction or evaluation of barriers is considered)

A corrective action will be determined for any site containing a COC. The DQO process resulted in an assumption that corrective action is required within the radiologically posted Eagle HCA and the subsurface soils within the crater at Sugar. Therefore, a default contamination boundary will be established for the HCA (Section 3.4). Therefore, Decision I for the default contamination boundaries is resolved, and corrective action is necessary. Decision I will be resolved for the area outside the default contamination boundaries.

Decision I samples will be submitted to analytical laboratories to determine the presence of COCs. Decision II samples will be submitted to define the extent of unbounded COCs. In addition, samples will be submitted for analyses, as needed, to support waste management or health and safety decisions.

A corrective action may also be required if a waste, present within a CAS, contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point and release the contaminants to the surrounding media. The following will be used as the criteria for determining whether a waste is PSM:

- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.
- Based on process knowledge and/or professional judgment, some waste may be assumed not to be PSM if it is clear that it could not result in soil contamination exceeding a FAL.
- If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:
  - For non-liquid wastes, the concentration of any chemical contaminant in soil (after degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the waste. If the resulting soil concentration exceeds the FAL, then the waste will be considered to be PSM.
  - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (after degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004). If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.
  - For liquid wastes, the resulting concentration of contaminants in the surrounding soil would be calculated based on the concentration of contaminants in the waste and the liquid-holding capacity of the soil. If the resulting soil concentration exceeds the FAL, then the liquid waste would be considered to be PSM.

A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk (NNSA/NSO, 2006).

If sufficient information is not available to evaluate potential CAAs, then site conditions will be reevaluated, and additional samples will be collected (as long as the scope of the investigation is not exceeded and any CSM assumption has not been shown to be incorrect).

A.3.2 Alternative Actions to the Decisions

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

A.3.2.1 Alternative Actions to Decision I

If no COC associated with a release from the CAS is detected, then further assessment of the CAS is not required. If a COC associated with a release from the CAS is detected, then the extent of COC contamination will be determined, and additional information required to evaluate potential CAAs will be collected.

A.3.2.2 Alternative Actions to Decision II

If the lateral and vertical extent of COC contamination have not been defined by bounding sample results, then additional bounding samples will be collected. If sample analytical results are not sufficient to predict potential remediation waste types, then additional waste characterization samples will be collected. If available information is not sufficient to evaluate the potential for migration of COC contamination beyond the corrective action boundary, then additional information will be collected. If sufficient information is not available to evaluate potential CAAs, then additional samples will be collected. Otherwise, collection of additional information is not required.

A.4.0 Step 3 - Identify Information Inputs

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

A.4.1 Information Needs

To resolve Decision I (determine whether a COC is present at a CAS) for the areas outside the default contamination boundaries, samples will be collected and analyzed following these two criteria:

- Samples must either (a) be collected in areas most likely to contain a COC (judgmental sampling) or (b) properly represent contamination at the CAS (probabilistic sampling).
- The analytical suite selected must be sufficient to identify any COCs present in the samples.

To resolve Decision II for radioactive contamination outside the default contamination boundaries, TED rates need to be established at locations that bound the FAL dose rate and provide sufficient information to establish a high (greater than 0.8) correlation to radiation survey isopleths. A boundary will then be determined around the radiation survey isopleth that correlates to the 25-mrem/yr FAL.

To resolve Decision II for chemical contamination outside the default contamination boundaries (determine whether sufficient information is available to evaluate potential CAAs at each CAS), samples need to be collected and analyzed to meet the following criteria:

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

Decision II sampling will not be conducted for the drainage sedimentation areas or the windrows. If a COC is determined to be present, the entire volume of the sediment area or windrow will be assumed to contain the COC and will require corrective action.

A.4.2 Sources of Information

Information to satisfy Decision I and Decision II will be generated by collecting environmental samples. These samples will be submitted to analytical laboratories meeting the quality criteria stipulated in the Soils QAP (NNSA/NSO, 2012a). The TLDs will be submitted to the Environmental Technical Services group at the NNSS, which is certified by the DOE Laboratory Accreditation Program for dosimetry. Only validated data from analytical laboratories will be used to make DQO decisions. Sample collection and handling activities will follow standard procedures.

A.4.2.1 Sample Locations

Design of the sampling approaches for the CAU 570 CASs must ensure that the data collected are sufficient for selection of the CAAs (EPA, 2002b). To meet this objective, the samples collected from each site should either be from locations that most likely contain a COC, if present (judgmental), or from locations that properly represent overall contamination at the CAS (probabilistic). These sample locations, therefore, can be selected by means of either (a) biasing factors used in judgmental sampling (e.g., a stain, likely containing a spilled substance) or (b) randomly using a probabilistic sampling design. The implementation of a judgmental approach for sample location selection, and of a probabilistic sampling approach, for CAU 570 are discussed in Section A.8.0.

A.4.2.2 Analytical Methods

Analytical methods are available to provide the data needed to resolve the decision statements. The analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy) for soil samples are provided in the Soils QAP (NNSA/NSO, 2012a).

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

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

A.5.1 Target Populations of Interest

The population of interest to resolve Decision I ("Is any COC present in environmental media within the CAS?") is contaminant concentrations exceeding a FAL at any location or area within the site. The populations of interest to resolve Decision II ("If a COC is present, is sufficient information available to evaluate potential CAAs?") are as follows:

- For locations where radiological contamination is present, TED and corresponding radiation survey values from locations where TED varies from above the FAL to below the FAL
- For locations where chemical contamination is present, COC concentrations for each one of a set of locations bounding contamination in lateral and vertical directions
- Investigation waste and potential remediation waste characteristics

A.5.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination that can be supported by the CSM. These boundaries were agreed to in the DQO meeting with decision makers. Decision II spatial boundaries are as follows:

- **Vertical.** Contaminants attributable to the original test detonation: 1 ft below original ground surface
- **Vertical.** Contaminants attributable to the introduction of PSM, or the movement or migration of test-related contaminants: 15 ft bgs
- **Lateral.** All CAU-related contaminants: 1 mi from GZ

Contamination found beyond these boundaries may indicate a flaw in the CSM and may require reevaluation of the CSM before the investigation can continue.

A.5.3 Practical Constraints

Practical constraints (e.g., activities by other organizations at the NNSS, utilities, threatened or endangered animals and plants, unstable or steep terrain, and/or access restrictions) may affect the ability to investigate this site. Practical constraints that have been identified specific to CAU 570 include the presence of subsidence craters from underground testing that were conducted in the areas surrounding the atmospheric testing GZs.

A.5.4 Define the Sampling Units

The scale of decision making in Decision I is the CAS component (defined by a specific release). The presence of a COC associated with a CAS component will cause the determination that the CAS component is contaminated and needs further evaluation. The scale of decision making for Decision II is defined as a contiguous area containing a COC originating from the CAS component. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically.

A.6.0 Step 5 - Develop the Analytic Approach

Step 5 of the DQO process specifies appropriate population parameters for making decisions, defines action levels, and generates an "If … then … else" decision rule.

A.6.1 Population Parameters

Population parameters are defined for judgmental and probablistic sampling designs in the following sections. Population parameters are the parameters compared to action levels.

A.6.1.1 Judgmental Sampling Design

For chemical contaminants, the population parameter is the observed concentration of each contaminant from each individual analytical sample. For radiological contaminants, it is the calculated TED for each location. Each sample result will be compared to the FALs to determine the appropriate resolution to Decision I and Decision II. A single sample result for any contaminant exceeding a FAL would cause a determination that a COC is present within the CAS (for Decision I), or that the COC is not bounded (for Decision II).

A.6.1.2 Probabilistic Sampling Design

For probabilistic sampling results, the population parameter is the true TED over the area of the sample plot. Resolution of DQO decisions associated with the probabilistic sampling design requires determining, with a specified degree of confidence, whether the true TED at the site in question exceeds the FAL. Because a calculated TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the calculated TED were significantly different from the true TED, a decision based on the calculated TED could result in a decision error. To reduce the probability of making a false negative decision error, a conservative estimate of the true TED is used to compare to the FAL instead of the calculated TED. This conservative estimate (overestimation) of the true TED will be calculated as the 95 percent UCL of the average TED values (Section 4.1). By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED.

The computation of appropriate UCLs depends upon the data distribution, the number of samples, the variability of the dataset, and the skewness associated with the dataset. A statistical package will be used to determine the appropriate probability distribution (e.g., normal, lognormal, gamma) and/or a suitable nonparametric distribution-free method and then to compute appropriate UCLs. To ensure that the appropriate UCL computational method is used, the sample data will be tested for goodness-of-fit to all parametric and nonparametric UCL computation methods described in *Calculating the Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (EPA, 2002a).

Computation of an appropriate UCL for each of the calculated TED averages requires the following:

- A minimum number of samples are collected.
- The data originate from a symmetric, but not necessarily normally distributed, population.
- The estimation of the variability is reasonable and representative of the population being sampled.
- The population values are not spatially correlated.

A.6.2 Action Levels

The PALs presented in this section are to be used for site screening purposes. They are not necessarily intended to be used as cleanup action levels or FALs. However, they are useful in screening out contaminants that are not present in sufficient concentrations to warrant further evaluation and, therefore, streamline the consideration of remedial alternatives. The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NSO, 2012b). This process conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2012a). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2012b) requires the use of ASTM Method E1739 (ASTM, 1995) to “conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary.” For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

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

- **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 SSTLs using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total concentrations of TPH will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

- **Tier 3 evaluation.** Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

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

A.6.2.1 Chemical PALs

Except as noted herein, the chemical PALs are defined as the Region 9 Regional Screening Levels for chemical contaminants in industrial soils (EPA, 2012a). Background concentrations for RCRA metals will be used instead of screening levels when natural background concentrations exceed the screening level (e.g., arsenic on the NNSS). Background is considered the average concentration plus two standard deviations of the average concentration for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). For detected chemical COPCs without established screening levels, the protocol used by EPA Region 9 in establishing screening levels (or similar) will be used to establish PALs. If used, this process will be documented in the CADD.

A.6.2.2 Radionuclide PALs

The PAL for radioactive contaminants is a TED of 25 mrem/yr, based upon the Industrial Area exposure scenario. The Industrial Area exposure scenario is described in the Soils RBCA document (NNSA/NSO, 2012b). For primary releases, the TED is calculated as the sum of external dose and internal dose. External dose is determined directly from TLD measurements. Internal dose is determined by comparing analytical results from soil samples to RRMGs that were established using the RESRAD computer code (Yu et al., 2001). RRMGs are radionuclide-specific values for radioactivity in surface soils. The RRMG is the value, in picocuries per gram of surface soil, for a particular radionuclide that would result in an internal dose of 25 mrem/yr to a receptor (under the appropriate exposure scenario) independent of any other radionuclide (assuming that no other radionuclides contribute dose). The RRMGs are presented in the Soils RBCA document (NNSA/NSO, 2012b). RRMGs for site-specific possible but not suspected COPCs that are not listed in the Soils RBCA document are presented in Table A.6-1. The internal dose associated with any specific radionuclide would be established using the following equation:

$$\textit{Internal dose (mrem/yr)} = [\textit{Analytical result (pCi/g)} / \textit{RRMG}] \times 25\ \textit{mrem/yr}$$

When more than one radionuclide is present, the internal dose will be calculated as the sum of the internal doses for each radionuclide. In the RESRAD calculation, several input parameters are not specified so that site-specific information can be used. The default and site-specific input parameters used in the RESRAD calculation of RRMGs for each exposure scenario are listed in the Soils RBCA document (NNSA/NSO, 2012b).

Table A.6-1
RRMG Values

Radionuclide	Exposure Scenario (pCi/g)		
	Industrial Area	Remote Work Area	Occasional Use Area
Al-26	7,084,000	42,080,000	117,700,000
Am-243	9,958	59,150	157,500
Np-237	17,980	106,800	284,900
Tc-99	37,840,000	224,800,000	626,900,000
U-233	53,710	319,000	868,700

A.6.3 Decision Rules

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

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

The decision rules for Decision I are as follows:

- If the population parameter of any COPC in the Decision I population of interest (defined in Step 4) exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that COPC in that population.

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

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

The decision rules for Decision II are as follows:

- If the population parameter (the observed concentration of any COC) in the Decision II population of interest (defined in Step 4) exceeds the corresponding FAL or potential remediation wastes have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

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

A.7.0 Step 6 - Specify Performance or Acceptance Criteria

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

A.7.1 Decision Hypotheses

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

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

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

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

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

- Developing a CSM (based on process knowledge) that is agreed to by decision maker participants during the DQO process.
- Testing the validity of the CSM based on investigation results.
- Evaluating the quality of data based on DQI parameters.

A.7.2 False Negative Decision Error

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

A.7.2.1 False Negative Decision Error for Judgmental Sampling

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

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

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

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

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

These characteristics were considered during the development of the CSM and selection of sampling locations. The field-screening methods and biasing factors listed in Section A.4.2.1 will be used to further ensure that appropriate sampling locations are selected to meet these criteria. The CADD will present an assessment on the DQI of representativeness that samples were collected from those locations that best represent the populations of interest as defined in Section A.5.1.

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

To satisfy the third criterion, the entire dataset of soil sample results, as well as individual soil sample results, will be assessed against the DQIs of precision, accuracy, comparability, and completeness as defined in the Soils QAP (NNSA/NSO, 2012a) and in Section 6.2.2. The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as to assess the need to potentially "flag" (qualify) individual contaminant results when corresponding QC sample results are not within the established control limits for precision and accuracy. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the analyte performance criteria based on an assessment of the data. The DQI for completeness will be assessed to ensure that all data needs identified in the DQO have been met. The DQI of comparability will be assessed to ensure that all analytical methods used are equivalent to standard EPA methods so that results will be comparable to regulatory action levels that have been established using those procedures. Strict adherence to established procedures and QA/QC protocol protects against false negatives. Site-specific DQIs are discussed in more detail in Section 6.2.2.

To provide information for the assessment of the DQIs of precision and accuracy, the following QC samples will be collected as required by the Soils QAP (NNSA/NSO, 2012a):

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

A.7.2.2 False Negative Decision Error for Probabilistic Sampling

The false negative decision error rate goal was established by the DQO meeting participants at 5 percent. Upon validation of the analytical results, statistical parameters will be calculated for each

significant COPC identified at each site. Protection against a false negative decision error is contingent upon the following:

- Population distribution
- Sample size
- Actual variability
- Measurement error

Control of the false negative decision error for probabilistic sampling designs is accomplished by ensuring that the following requirements are met for each of the significant COPCs:

- The population distributions fit the applied UCL determination method.
- A sufficient sample size was collected.
- The actual standard deviation is calculated.
- Analyses conducted were sufficient to detect contamination exceeding FALs.

A.7.3 False Positive Decision Error

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

False positive results are typically attributed to laboratory and/or sampling/handling errors that could cause cross contamination. To control against cross contamination, decontamination of sampling equipment will be conducted in accordance with established and approved procedures, and only clean sample containers will be used. To determine whether a false positive analytical result may have occurred, the following QC samples will be collected as required by the Soils QAP (NNSA/NSO, 2012a):

- Trip blanks (1 per sample cooler containing VOC environmental samples)
- Equipment blanks (1 per sampling event)
- Source blanks (1 per uncharacterized source lot per lot)
- Field blanks (minimum of 1 per CAS, additional if field conditions change)

For probabilistic sampling, false positive decision error rate goal was established by the DQO meeting participants at 0.20 (or 20 percent probability). Protection against this decision error is also afforded by the controls listed in Section A.7.2 for probabilistic sampling designs.

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

Step 7 of the DQO process selects and documents a design that will produce data that exceed performance or acceptance criteria. Judgmental sampling schemes will be implemented to select sample plot locations to investigate Group 1 and 2 releases. Probabilistic sampling schemes will be implemented to select the sample locations within each of the sample plots. Judgmental sampling will also be used to investigate Group 3 and 4 releases as described in Section A.2.2.1. Investigation results will be compared to FALs to determine the need for corrective action. PSM sample results will be evaluated against the PSM criteria listed in Section A.3.1 to determine the need for corrective action.

A.8.1 Groups 1 and 2 Investigation - Sample Plot Locations

Sample plots for the release scenarios of Groups 1 and 2 will be determined judgmentally based on the highest result of the aerial and ground-based radiological surveys. This will be done in an effort to find locations where the internal dose contributes the greatest amount to TED. Atmospheric weapons-related tests will be investigated in Group 1, while safety or low-yield tests will be investigated in Group 2.

The Group 1 sample plots will be established at the locations of the highest gamma values as determined from the PRM-470 radiological survey. The Group 2 sample plots will be established at the locations of the highest FIDLER radiological survey values. The Group 1 sample plot locations are depicted in Figure A.8-1. The Group 2 sample plot locations are depicted in Figure A.8-2.

A.8.1.1 Sampling of Sample Plots

The probabilistic sampling scheme will be implemented to select sample locations within the sample plots and evaluate the analytical results. For each sample collected within the sample plot, randomly selected subsample locations will be chosen based on a random start, triangular pattern (see Figure A.8-3 for an example of this sampling scheme). If sufficient sample material cannot be collected at a specified location (e.g., rock, caliche, or buried concrete), the Site Supervisor will establish the location at the nearest place that a surface sample can be obtained.

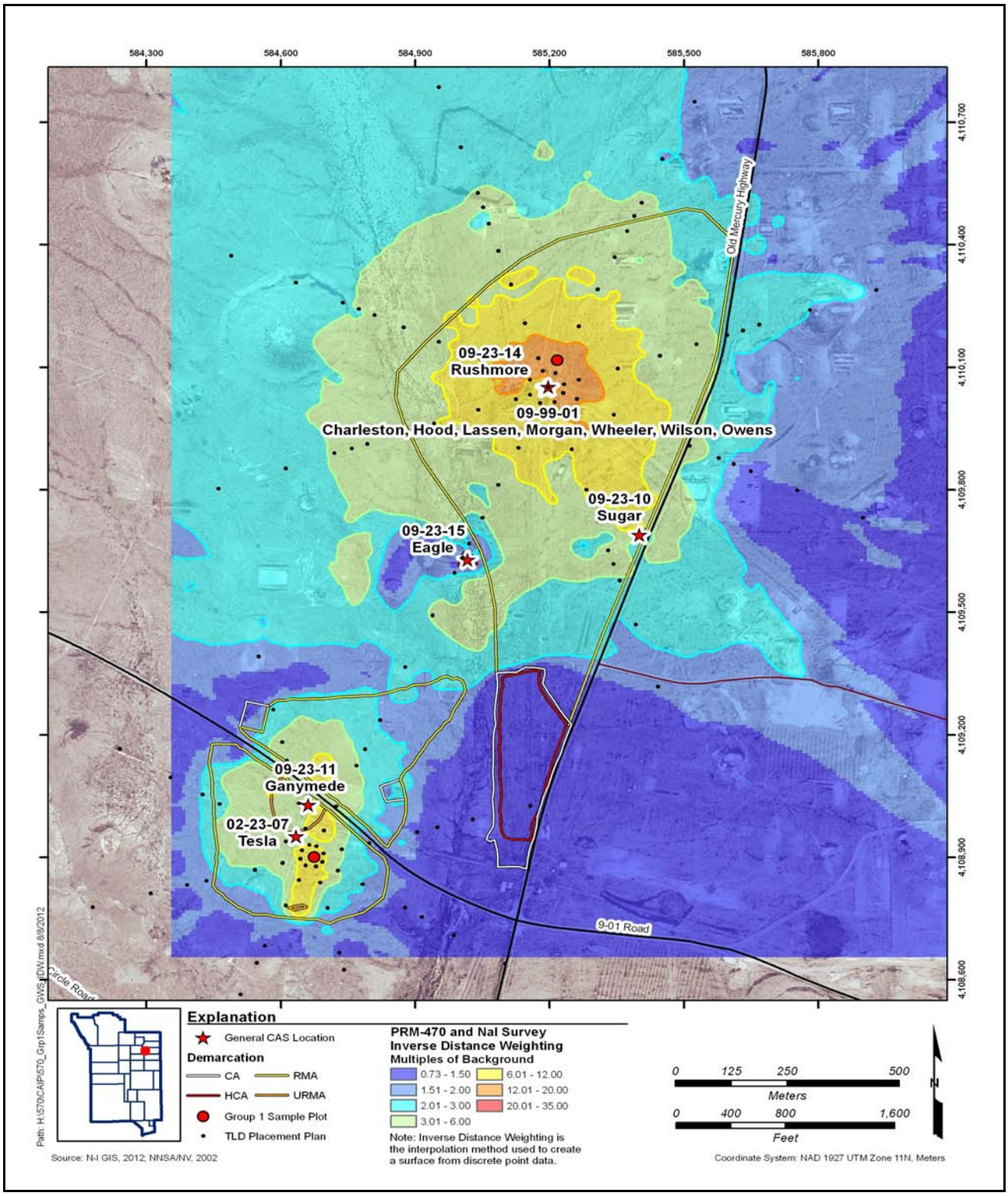

Figure A.8-1
CAU 570 Group 1 Sample Plots and TLD Locations

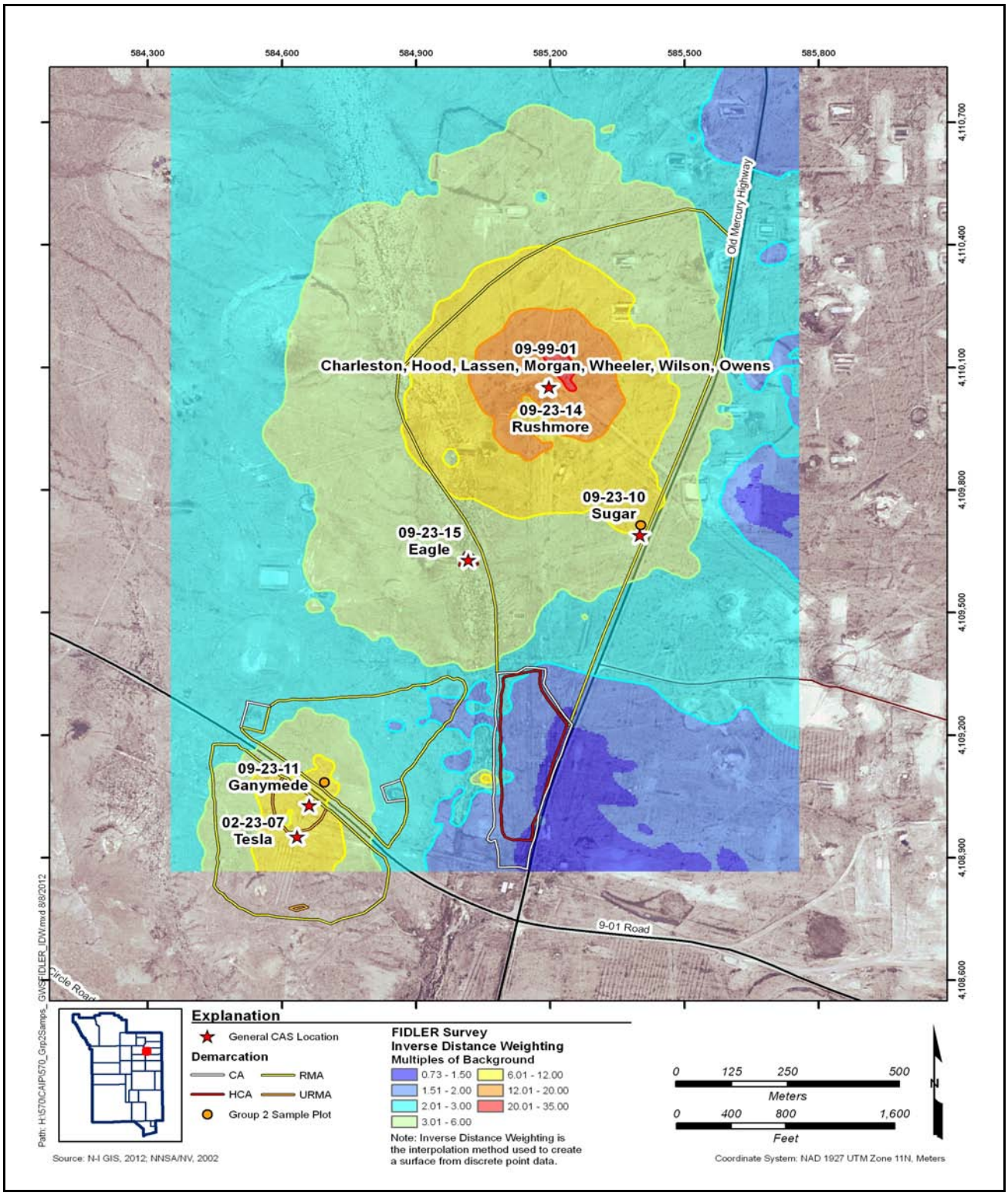

Figure A.8-2
CAU 570 Group 2 Sample Plots

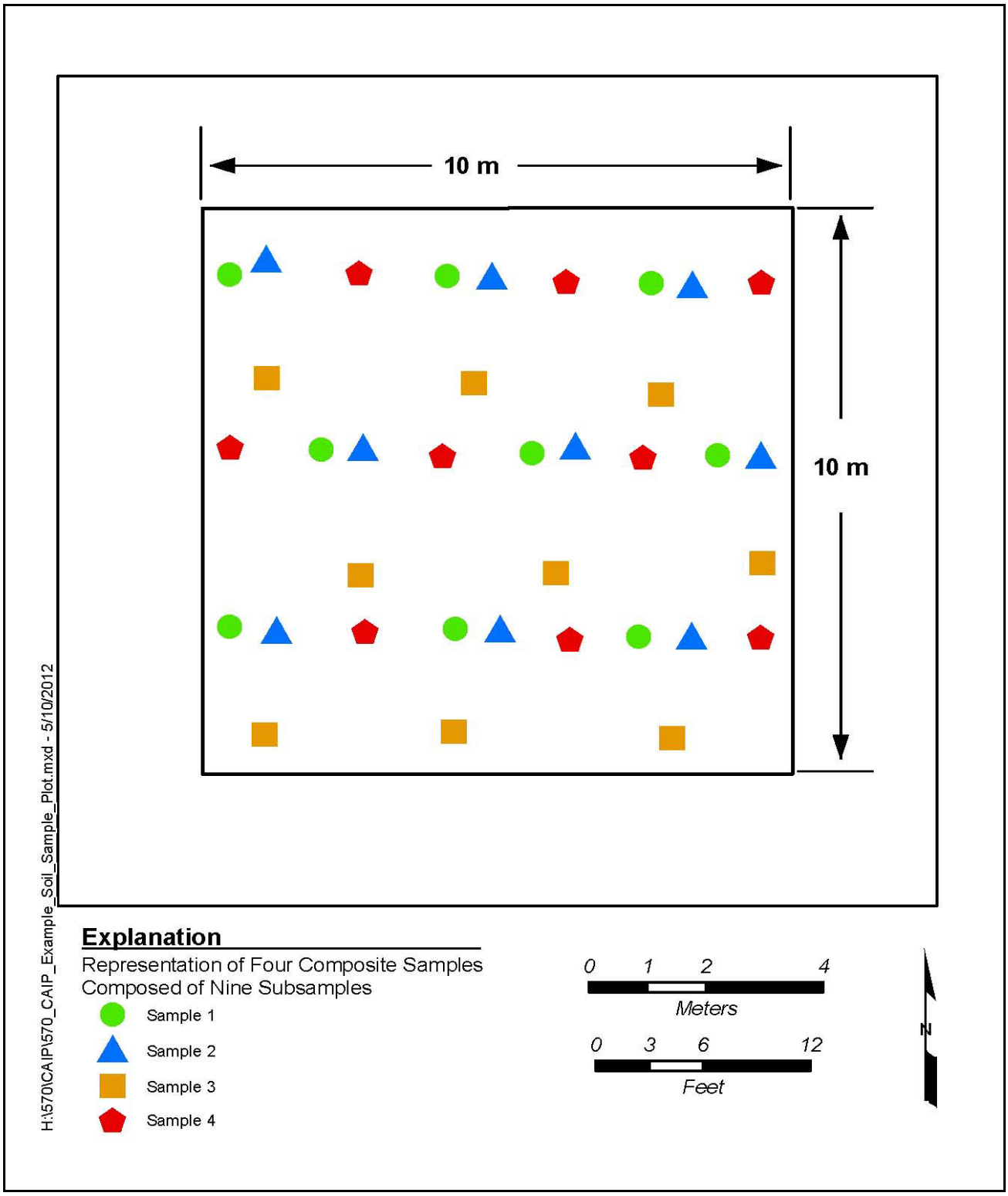

Figure A.8-3
Sample Plot Sample Collection Layout

A.8.1.1.1 Calculation of Internal Dose

Statistical methods that generate site characteristics will be used to establish internal dose estimates that represent the sample plot as a whole. Composite samples will be collected at each sample plot in the following manner:

- At least four composite samples will be collected from each established sample plot.
- Each composite sample will consist of nine aliquots taken from randomly selected locations within each plot. These locations will be predetermined using a random start with a triangular grid pattern.
- Samples may be sieved to eliminate material (e.g., Trinity glass) greater than 0.25-in. diameter that cannot effectively be inhaled or ingested.
- The entire volume of the composited material collected will be submitted to the laboratory for analysis.

An example of the predetermined sample locations at one plot is shown in Figure A.8-3.

As determination of the minimum sample size cannot be accomplished until after the data have been generated, the sufficiency of the number of samples collected will be evaluated. This will be evaluated based on TED results (composed of individual internal dose rates associated with each of the four composite samples added to the external dose rates from the TLD elements). The minimum number of samples required for each sample plot was calculated for both the internal (soil samples) and external (TLD elements) dose samples. The minimum sample size (n) was calculated using the following EPA sample size formula (EPA, 2006):

$$n = \frac{s^2(z_{.95} + z_{.80})^2}{(\mu - C)^2} + \frac{(z_{.95})^2}{2}$$

where

s = standard deviation
$z_{.95}$ = z score associated with the false negative rate of 5 percent
$z_{.80}$ = z score associated with the false positive rate of 20 percent
μ = dose level where false positive decision is not acceptable (12.5 mrem/yr)
C = FAL (25 mrem/yr)

The use of this formula requires the input of basic statistical values associated with the sample data. Data from a minimum of three samples is required to calculate these statistical values and as such, the least possible number of samples required to apply the formula is three. Therefore, in instances where the formula resulted in a value less than three, three is adopted as the minimum number of samples required.

All calculations for the determination of sample size sufficiency will be provided in the CADD. If the criteria established in this section result in a determination that the minimum sample size was not met for a plot, one of the following actions may be taken:

- Additional composite sample(s) may be collected.
- Conservatively assume that the TED for the plot exceeds the FAL.

If these criteria cannot be met, justifications for use of the resulting TED without meeting the criteria will be made in the CADD.

Sample results for individual radionuclides will be used to calculate internal dose using the RRMGs presented in Section 3.3.2. The internal dose associated with any specific radionuclide would be established using the following equation:

$$\textit{Internal dose (mrem/yr)} = \textit{[Analytical result (pCi/g) / RRMG]} \times \textit{25 mrem/yr}$$

When more than one radionuclide is present, the internal dose will be calculated as the sum of the internal doses for each radionuclide.

Based on the low internal dose rates expected to be present at this site, internal dose at each of the TLD locations where soil samples are not collected will be conservatively estimated. This will be accomplished using the external dose for the location to be estimated (calculated from the TLD at that location) and the internal dose to external dose ratio from the location of the highest internal dose using the following formula:

$$\textit{Internal dose(est)} = \textit{External dose(est)} \times \textit{[Internal dose / External dose](max)}$$

where

est = location for the estimate of internal dose
max = location of maximum internal dose

Use of this method to estimate internal dose will overestimate the internal dose (and therefore TED) as the internal to external dose ratio generally decreases with decreasing TED values.

A.8.1.2 Determination of External Dose

External dose (penetrating radiation dose for the purposes of this document) will be determined by collecting *in situ* measurements using TLDs. The TLD measurements will be taken at a height of approximately 1 m. For sample plots, the TLDs will be located in the approximate center of the plot. The TLDs to determine Group 1 extent will be located radially emanating from the sample plots (see Figure A.8-1).

The TLD placement and processing will follow the protocols established in *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003). TLDs will be in place for a targeted total exposure time of 2,000 hours, or the resulting data will be adjusted to be equivalent to an exposure time of 2,000 hours.

Estimates of external dose, in mrem/IA-yr, will be presented as net values (e.g., a background has been subtracted from the raw result). Naturally occurring terrestrial and cosmic radiation (i.e., background) will be registered on a TLD. These background radiation values can be significant in relation to action levels. For example, the background radiation values near the Sedan test location in Area 10 are approximately 31 mrem/IA-yr. Therefore, the FAL is only applicable to radiation dose from man-made sources at the NNSS and is a value in excess of what would be present if there were no nuclear activities at the site. Background TLDs will be placed for CAU 570 at locations shown in Figure A.8-4.

The project-specific TLDs are subjected to the same QA checks as the routine NNSS environmental monitoring TLDs, as described in Section 6.0. The Panasonic UD-814 TLD used in the NNSS environmental monitoring program contains four individual elements. The readings from each element are compared as part of the routine QA checks during the TLD processing. External dose at each TLD location is then determined using the readings from TLD elements 2, 3, and 4. Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose.

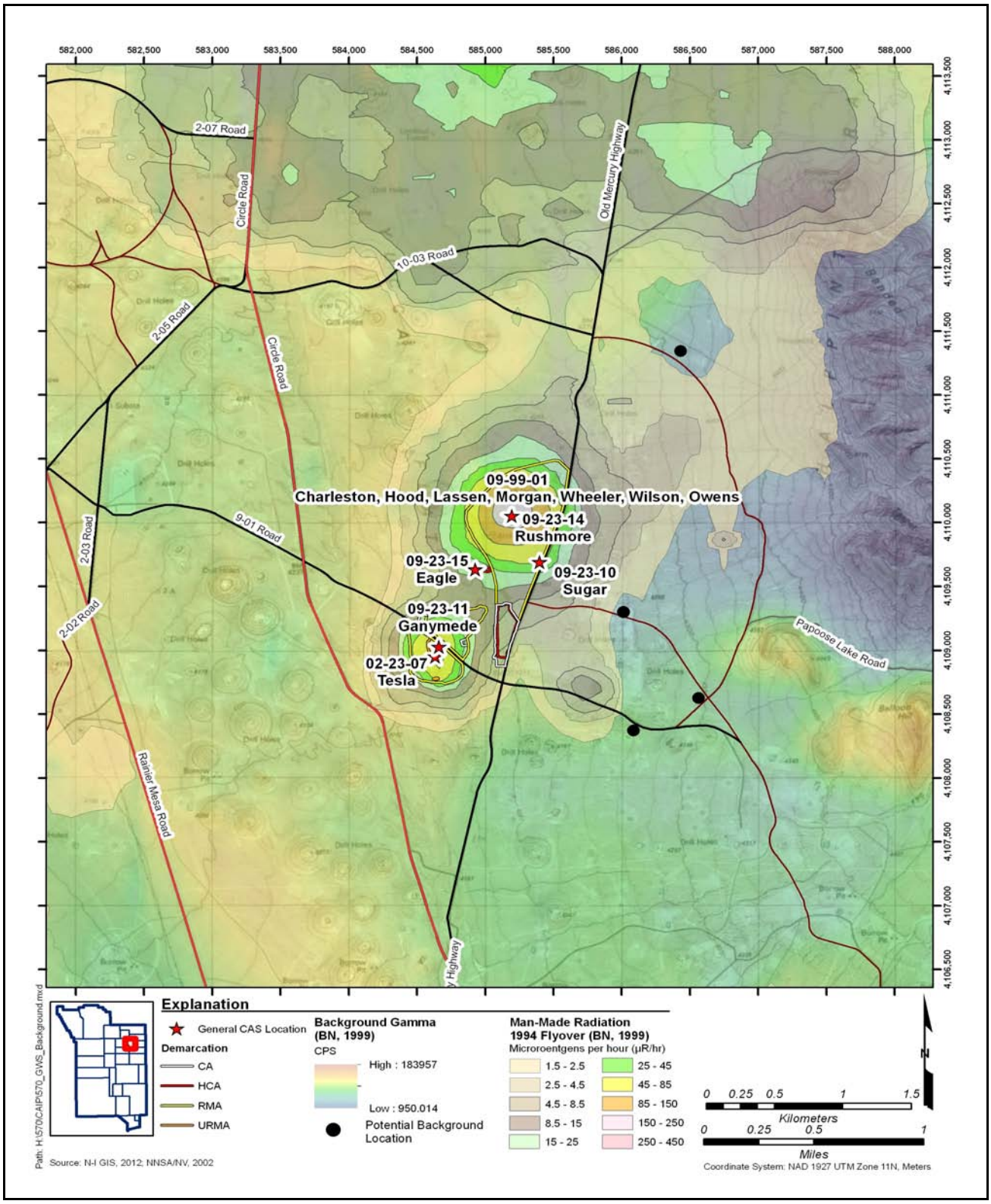

Figure A.8-4
CAU 570 Example Background TLD Locations

A.8.1.3 Calculation of TED and Corrective Action Boundary

The TED will be determined by summing internal and external dose measurements at each sample location. For probabilistic sampling of radiological contamination, DQO decisions will be based on the 95 percent UCL of the average TED for each sample plot. The 95 percent UCL of the TED for each sample location will be established as the sum of the 95 percent UCL of the internal dose and the 95 percent UCL of the external dose. These 95 percent UCL dose estimates will be calculated using the three external dose measurements from the TLD and the calculated internal dose estimates from the soil samples. For judgmental sampling, DQO decisions will be based on a direct calculation of TED from sample results.

As discussed in Section A.6.1.2, the TED from each sample location will be used to establish the corrective action boundary. The initial corrective action boundary area will be calculated using the TED from each sample location and a corresponding measurement from an appropriate radiation survey. These paired values will be used to establish a correlation for each radiation survey and identify the radiation survey that has the best correlation to TED values. This correlation will be used to establish a radiation survey value corresponding to the 25-mrem/yr FAL (using the appropriate exposure scenario). An isopleth of this value from the radiological survey will be used as the initial corrective action boundary.

A.8.2 Group 3 Investigation

For the Group 3 (Debris/Spills) investigation at CAU 570, a judgmental sampling approach will be used to investigate the likelihood of the soil containing a COC. Biasing factors such as stains, presence of lead bricks, broken lead-acid batteries, and wastes suspected of containing hazardous or radiological components including mud pits will be used to select the most appropriate Decision I samples. Specific analyses requested for these samples will be determined based on the nature of the potential release (e.g., hydrocarbon stain, lead bricks).

If a COC is present at any Group 3 sample location, Decision II sampling will be conducted to define either the extent of contamination where COCs have been confirmed or to confirm that no COCs remain in the case where contamination is removed. Decision II sampling locations will be selected based on the CSM, biasing factors, field-survey results, existing data, and the outer boundary sample

locations where COCs are detected. In general, extent sample locations will be arranged in a triangular pattern around areas containing a COC at distances based on site conditions, COC concentrations, process knowledge, and biasing factors. If COCs extend beyond extent locations, additional Decision II samples will be collected from locations farther from the source.

A.8.3 Group 4 Investigation

Sample locations to determine the presence of contamination for Group 4 releases will be based upon the likelihood of a contaminant release. The following factors will be considered in selecting locations for analytical samples for the Group 4 investigations:

- **Documented process knowledge on source and location of release** (e.g., volume of release).
- **Pre-selected areas based on process knowledge of the site.** Locations for which evidence such as the 1994 aerial radiological survey (BN, 1999) provides a basis upon which sample plots can be designated (e.g., man-made gross counts).
- **Radiological survey anomalies.** Radiological survey results that are significantly higher than the surrounding area.
- **Geophysical anomalies.** Geophysical survey results that are not consistent with the surrounding area (e.g., results indicating buried concrete or metal, surface metallic objects).
- **Lithology.** Locations where variations in lithology (soil or rock) indicate that different conditions or materials exist.
- **Preselected areas based on process knowledge of the site.** Locations for which evidence such as historical photographs, experience from previous investigations, or input from interviewee(s) exists that a release of hazardous or radioactive substances may have occurred.
- **Preselected areas based on process knowledge of the contaminant(s).** Locations that may reasonably have received contamination, selected on the basis of the chemical and/or physical properties of the contaminant(s) in that environmental setting.
- **Previous sample results.** Locations that may reasonably have been contaminated based upon the results of previous field investigations.
- **Experience and data from investigations of similar sites.**

- **Visual indicators,** such as textural discontinuities, disturbance of native soils, or any other indication of potential contamination.
- **Physical and chemical characteristics of contaminants.**
- **Other biasing factors.** Factors not previously defined for the CAI that become evident once the investigation of the site is under way.

A judgmental sampling design will be implemented for the Group 4 releases to establish sample locations and evaluate sample results. For the Group 4 releases, individual sample results, rather than an average concentration, will be used to compare to FALs. Therefore, statistical methods to generate site characteristics will not be needed. Adequate representativeness of the entire target population may not be a requirement in developing a sampling design. If good prior information about the target site of interest is available, then the sampling may be designed to collect samples only from areas known to have the highest concentration levels on the target site. If the observed concentrations from these samples are below the action level, then a decision can be made that the site contains safe levels of the contaminant without the samples being truly representative of the entire area (EPA, 2006).

A biased sampling strategy will be used to target areas with the highest potential to contain a contamination level exceeding a FAL. Sample locations will be determined based on process knowledge, previously acquired data, or the field-screening and biasing factors listed in Section A.4.2.1. If biasing factors are present in soils below locations where Decision I samples were removed, additional Decision I soil samples will be collected at depth intervals selected by the Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present. The Site Supervisor has the discretion to modify the judgmental sample locations, but only if the modified locations meet the decision needs and criteria stipulated in these DQOs.

Group 4 investigates five different methods of migration or mechanical disturbance. The following sections develop the plans for obtaining data for each method.

A.8.3.1 Migration in Drainages

Decision 1

For the investigation of drainages, sample locations will be selected from the center of the nearest two sediment accumulation areas. Judgmental samples will be collected as follows:

- At each sample location within the sediment accumulation area, a sample will be collected from each 10-cm-depth interval until native material is encountered.
- Each sample will be field screened with an alpha/beta contamination meter and compared to the established background field-screening level (FSL) for the site.
- If the depth sample with the highest FSR is not significantly different (at least 20 percent difference) than the FSR of the surface sample, then only the surface sample will be submitted for analysis. If the FSR is greater than 20 percent higher than the surface sample, then both the surface sample and the depth sample with the elevated FSR will be submitted for analysis.
- If the FSL is not exceeded in any depth sample, then only the surface sample will be submitted for analysis.

Decision II

If a contamination level exceeding a FAL is found in drainage at a sediment accumulation area sample location, additional sedimentation areas will be sampled until at least two consecutive sedimentation areas are found that do not contain contamination levels exceeding a FAL. Decision II will be resolved by the assumption that the entire volume of sediment in each sediment accumulation area where a contamination level exceeding a FAL was identified exceeds the FAL.

A.8.3.2 Windrows

Decision I

For the investigation of windrows, sample locations will be selected from the area with the highest reading as determined with a PRM-470. Judgmental samples will be collected as follows:

- At each sample location within a windrow, a sample will be collected that includes soil from the surface to the base or native material interface of the windrow.
- Each sample will be field screened with an alpha/beta contamination meter and compared to the established background FSL for the site.

Decision II

If a contamination level exceeding a FAL is found at a windrow sample location, Decision II will be resolved by the assumption that the entire volume of the windrow where the original sample was collected exceeds the FAL.

A.8.3.3 Soil Piles

Decision I

For the investigation of soil piles, sample locations will be selected from the surface location where the PRM-470 readings are the greatest. Judgmental samples will be collected as follows:

- At each sample location within a soil pile, a sample will be collected from each 30-cm-depth interval until native material is encountered.
- Each sample will be field screened with an alpha/beta contamination meter and compared to the established background FSL for the site.
- If the depth sample with the highest FSR is not significantly different (at least 20 percent difference) than the FSR of the surface sample, then only the surface sample will be submitted for analysis. If the FSR is greater than 20 percent higher than the surface sample, then both the surface sample and the depth sample with the elevated FSR will be submitted for analysis.
- If the FSL is not exceeded in any depth sample, then only the surface sample will be submitted for analysis.

Decision II

If a COC exceeding a FAL is found at depth within a soil pile, Decision II will be resolved by the assumption that the entire volume of the soil pile where the original sample was collected exceeds the FAL. If a COC exceeding a FAL is found only in the top 5 cm of soil, Decision II will be resolved as Group 1 Decision II extent is determined. No step out sampling will be necessary.

A.8.3.4 Staked Areas

Decision I

For the investigation of staked areas, sample locations will be selected at each staked area from the surface location where the PRM-470 readings are the greatest. Judgmental samples will be collected as follows:

- At each sample location within the staked area, a sample will be collected from each 10-cm-depth interval to a maximum depth of 30 cm or until native material is encountered, whichever is less.
- Each sample will be field screened with an alpha/beta contamination meter and compared to the established background FSL for the site.
- If the depth sample with the highest FSR is not significantly different (at least 20 percent difference) than the FSR of the surface sample, then only the surface sample will be submitted for analysis. If the FSR is greater than 20 percent higher than the surface sample, then both the surface sample and the depth sample with the elevated FSR will be submitted for analysis.
- If the FSL is not exceeded in any depth sample, then only the surface sample will be submitted for analysis.

Decision II

If a COC exceeding a FAL is found at depth within a staked area, Decision II will be resolved by collecting soil samples from locations beyond the boundaries of the staked area being investigated. If the level of contamination present within the Decision II sample is below FALs, it will be assumed that the entire volume of the staked area where the Decision I sample was collected exceeds the FAL. If contamination is only present in the top 5 cm of soil, Decision II will be resolved as Group 1 Decision II extent is determined.

A.8.3.5 Determination of Buried Contamination

Decision I

For the investigation of buried contamination, sample locations will be selected from the surface location where the PRM-470 readings are the greatest, are located in the proximity of the GZs, and evidence of excavation exists. Six judgmental samples will be collected in the proximity of the B-9A GZ and six judgmental samples in the proximity of the Tesla GZ as follows:

- At each identified sample location, a surface soil sample will be collected.
- At each sample location a sample from 10-cm-depth interval will be collected to a maximum depth of 30 cm.
- Each sample will be field screened with an alpha/beta contamination meter and compared to the established background FSL for the site.
- If the depth sample with the highest FSR is not significantly different (at least 20 percent difference) than the FSR of the surface sample, then only the surface sample will be submitted for analysis. If the FSR is greater than 20 percent higher than the surface sample, then both the surface sample and the depth sample with the elevated FSR will be submitted for analysis.
- If the FSL is not exceeded in any depth sample, then only the surface sample will be submitted for analysis.

Decision II

If a contamination level exceeding a FAL is found at a sample location, Decision II will be resolved by collecting soil samples from locations arranged in a triangular pattern around the area containing contamination levels exceeding a FAL at distances based on site conditions, process knowledge, and biasing factors. If contamination levels exceeding a FAL extend beyond the initial step-outs, Decision II samples will be collected from incremental step-outs. Initial step-outs will be at least as deep as the vertical extent of contamination defined at the Decision I location and the depth of the incremental step-outs will be based on the deepest contamination observed at all locations. A clean sample (i.e., contamination levels less than FALs) collected from each step-out direction (lateral or vertical) will define extent of contamination in that direction.

For locations where external dose measurements are not available (e.g., subsurface sample locations), a TLD-equivalent external dose will be calculated using the subsurface sample results. This will be accomplished by establishing a correlation between RESRAD-calculated external dose from surface samples and the corresponding TLD readings. The RESRAD-calculated external dose from the subsurface samples will then be adjusted to TLD-equivalent values using the following formula:

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

where

TLD = external dose based on TLD readings
RR = external dose based on RESRAD calculation from analytical soil concentrations

A.8.4 Establishment of Final Corrective Action Boundary

The final corrective action boundary will be established to include the default contamination boundary, the initial corrective action boundary, any additional areas that exceed the FALs based on radioactive contamination, and any COCs identified as a result of Groups 3 and 4 investigations (e.g., spills, waste, or migration of contamination).

A.9.0 References

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Appendix B

Project Organization

B.1.0 Activity Organization

The NNSA/NSO Soils Activity Lead is Tiffany Lantow. She can be contacted at (702) 295-7645.

The identification of the activity Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change, and it is suggested that the NNSA/NSO Soils Activity Lead be contacted for further information. The Task Manager will be identified in the FFACO Monthly Activity Report prior to the start of field activities.

Appendix C

Nevada Division of Environmental Protection Comments

(13 Pages)

Nevada Environmental Management Operations Activity
DOCUMENT REVIEW SHEET

1. Document Title/Number:	Draft Corrective Action Investigation Plan for Corrective Action Unit 570: Area 9 Yucca Flat Atmospheric Test Sites, Nevada National Security Site, Nevada	**2. Document Date:**	6/25/2012
3. Revision Number:	0	**4. Originator/Organization:**	Navarro-INTERA
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850 ext.	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1.) Pg ES-1, Paragraph 3		Add: “The site investigation process will also be conducted in accordance with the Soils Activity Quality Assurance Plan (Soils QAP), which establishes requirements, technical planning, and general quality practices to be applied to this activity.	Suggested sentence was added as edited: "The site investigation process will also be conducted in accordance with the Soils Activity Quality Assurance Plan, which establishes requirements, technical planning, and general quality practices to be applied to this activity."	
2.) Page 2, Figure 1-1		Add CAS names and road names	CAS names were added along with CAS numbers in all figures; the legend reference to the CASs will be changed to "general CAS location"; the CAS symbols in the figures were standardized; road names were added; demarcation lines not associated with CAU 570 were removed; remaining demarcation lines were identified as CA, HCA, RMA, etc.; The term "Focal Inverse Destance Weighting" was modified to "Inverse Distance Weighted"; and a note was added to the legend defining "Inverse Distance Weighted" as "interpolation method used to create a surface from discrete point data." A second figure, Figure 1.2, was created to identify the surface features of the area.	
3.) Page 2, Figure 1-1		Are the demarcation lines east of the north-south road part of CAU 570? Suggest label if yes, remove/modify if no.	See response for comment #2.	
4.) Page 2, Figure 1-1		Add “CAS” to the “Demarcation Line” legend item for clarity	The CAS is not associated with the demarcation lines. See response to comment #2.	
5.) Page 2, Figure 1-1		Enclosed polygons within the CAS demarcation zones: are these areas excluded from the CAS boundary? Unclear as presented.	The CAS boundaries are not defined or represented on the figure. See response to comment #2.	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
6.) Page 3, Section 1.1		Consistently use terminology from Soils RBCA & Soils QAP when referring to hazardous and radioactive contaminants, i.e.: "… because chemical and radiological contaminants of potential concern (COPC)…", or "contaminants of concern (COC) … "as appropriate.	Per discussion with NSO & NDEP staff, no change to the text is required.	
7.) Page 8, Section 2.1, Paragraph 2		Revise first sentence: "CAU 570 is located within the Yucca Flat Tributary Flow System, a part of regional carbonate aquifer flow system, and moves generally from northeast to southwest." The reference is: Groundwater Flow Systems at the Nevada Test Site, Nevada: A Synthesis of Potentiometric Contours, Hydrostratigraphy, and Geologic Structures, Professional Paper 1771. Fenelon, et al (USGS 2010).	The first sentence of the paragraph was replaced with the suggested sentence and reference, as edited: "CAU 570 is located within the Yucca Flat Tributary Flow System, a part of the regional carbonate aquifer flow system and moves generally from northeast to southwest (Fenelon et al., 2010)."	
8.) Page 11, Section 2.4, Paragraph 2		Clarify that there are not expected to be any off-NNSS human receptors; and that site worker exposure will be minimized by use of PPE.	The following sentence was added to the end of the paragraph: "Therefore, the CSM will include the potential for receptors to receive an internal dose from contaminated soil and an external dose from contaminated soil and debris."	
9.) Page 14, Section 2.5, Paragraph 2		Replace first sentence with, " In accordance with the graded approach described in the Soils QAP, the quality required of a dataset will be determined by its intended use in decision making. Ground-based and aerial radiological survey data are classified as decision-supporting, and are not used, by themselves, used to make corrective action decisions".	The sentence was replaced as suggested, as edited: " In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), the quality required of a dataset will be determined by its intended use in decision making. Ground-based and aerial radiological survey data are classified as decision-supporting, and are not used, by themselves, to make corrective action decisions."	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
10.) Page 14, Section 2.5, Paragraph 2, 2nd sentence		Replace “bias” with “guide the selection of (bias)”	The second sentence in the paragraph was changed to read, "However, the radiation surveys are used to identify bias used in the selection of sample locations and will be evaluated for use in defining corrective action boundaries in the Corrective Action Decision Document (CADD)." Similar statements throughout the document were also corrected.	
11.) Page 17, Section 2.5.1		The section could probably be entitled, “Aerial Radiological Surveys”	Multiple changes were made to the document. The first paragraph of Section 2.5.3 was added as the fourth paragraph of Section 2.5.1. The first sentence of the second paragraph was deleted. The final sentence of the fourth paragraph was modified to read, "Therefore, the 2012 ground-based gamma surveys from the PRM-470 have provided bias in determining sample locations for Group 1." The final sentence of the fifth paragraph was deleted and replaced with; "Therefore, the 2012 ground-based gamma survey from the FIDLER has provided bias in determining sample locations for Group 2. A sentence was added after the last sentence of the fourth paragraph that reads, "The radiation surveys will not be used to identify bias. (see Section 2.5.3)." The final sentence of the seventh paragraph was modified to read, "Ground-based gamma and visual surveys conducted during the field investigation will provide bias in determining sample locations."	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
12.) Page 17, Section 2.5.1, Paragraph 1, 2nd sentence		Change ‘surveys’ to ‘survey’	The sentence was revised to read, "Three aerial surveys and one ground-based radiological survey were conducted between 1994 and 2012.	
13.) Page 17, Section 2.5.1, First bullet		‘agl’ ; even though in the list of acronyms, suggest you spell out acronym anyway if first used in document	A search of the document was made and 'agl' was previously used and defined on page 16 in Table 2-3.	
14.) Page 17, Section 2.5.1, Paragraph 2, 1st sentence		Remove the word “method” if the intent is just to describe aerial surveys	The first sentence of the second paragraph was deleted.	
15.) Page 17, Section 2.5.1, Paragraph 3		Provide a brief discussion and analysis for each figure, comparing the results, describing apparent differences and similarities of spatial distribution and concentration of radionuclides.	paragraph 3 was replaced with the following: Figure 2-1 Shows the results of an aerial survey depicting the gross count data, and shows the two areas of concentration around the B-9A balloon pad and the Tesla tower site. Figure 2-2 displays the results of an aerial survey depicting the americium data. The areas of increased americium activity shown in the survey are not part of CAU 570 but will be investigated in CAU 571.The values in the lowest contour range (represented by the darkest areas in the figure) are not indicative of actual americium presence or absence (note the negative counts per second for this level in the legend). These negative values result from an algorithm that corrects the americium response for the presence of europium and are indicative of the inability of this method to detect americium at these locations.	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
16.) Page 18, Section 2.5.1, Paragraph 2, 2nd sentence		Suggest a follow-on sentence describing the use (if any) of radiological survey for this dataset to guide sampling	See comment #11 for resolution.	
17.) Page 18, Section 2.5.1, Paragraph 3, 2nd sentence		Suggest a follow-on sentence describing the use (if any) of radiological survey for this dataset to guide sampling	See comment #11 for resolution.	
18.) Page 18, Section 2.5.2		Suggest spelling out the RIDP acronym when used as a section heading	RIDP was spelled out in the Section 2.5.2 heading.	
19.) Page 18, Section 2.5.2, Paragraph 2		Add after last sentence: “In accordance with the graded approach described in the Soils QAP, RIDP data are classified as informational, and do not directly affect DQOs but provide information to support conceptual models and guide investigations.”	The last sentence of that paragraph was modified to read, "Although the RIDP data present a general distribution of contamination, there is not sufficient resolution to provide bias in selecting sample locations within CAU 570."	
20.) Page 19, Section 2.5.3		This section heading could probably be changed to, “Ground-Based Radiological Surveys”.	Section 2.5.3 was renamed "Visual Surveys" and includes the last paragraph of the current Section 2.5.3. The following sentence was added to the end of the paragraph, "Group 3 sample locations will be based on the results of the visual surveys to locate and identify debris and spills conducted throughout CAU 570."	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
21.) Page 19, Section 2.5.3, Paragraph 1		Add after last sentence: “In accordance with the graded approach described in the Soils QAP, ground-based radiological survey data are classified as decision-supporting, and will be used for sample location planning and preliminary corrective action boundary identification.”	The sentence was added into both Sections 2.5.1 and 2.5.2 based on the changes identified in previous comment responses as edited: “In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012b), ground-based radiological survey data are classified as decision-supporting, and will be used for sample location planning and preliminary corrective action boundary identification.”	
22.) Page 19, Section 2.5.3, Paragraph 1		Suggest adding after last sentence a brief discussion for each figure, comparing the results, describing apparent differences and similarities of spatial distribution and concentration of radionuclides	Figures 2-3 and 2-5 will be combined into a single Figure 2-3 displaying the results of the gamma ground-based survey. Sentences will be added to the beginning of the paragraph which say, "Figure 2-3 shows the results of a PRM-470 and NaI ground-based survey and identifies the areas of highest gamma readings around the B-9A and Tesla sites. Figure 2-4 shows the results of a FIDLER ground-based survey and demonstrates that the areas of highest readings are understandably in the areas of high gamma radiation as shown by the PRM-470 survey. The FIDLER survey data tend to be less effective in a strong gamma field inasmuch as a FIDLER is for the detection of low-energy gamma radiation."	
23.) Page 19, Section 2.5.4, Paragraph 1		Reference also the applicable section of the Draft Site-Wide EIS for the NNSS	We cannot reference a DRAFT document, so the reference was made to the 1996 SWEIS.	

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10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
24.) Page 20, 21, 22; Figures 2-3, 2-4, 2-5		Add 'CAS' to 'Demarcation Line"; somewhere in the text, explain the meaning of the legend phrase, "Focal Inverse Distance Weighting"; if a background count range is not shown on a figure, suggest omitting it from legend, i.e., Fig 1-1: 20.01 – 35.00; Fig 2-6: add similar legend detail from previous figures.	See response for comment #2.	
25.) Page 28, Section 3.1.3, Paragraph 1, 1st sentence		Sentence: change "is" to "was"	The sentence was changed to read, "The release mechanism for the contaminants in Group 1 is associated with the detontation…"	
26.) Page 28, Section 3.1.3, Paragraph 1, 2nd sentence		Change "is" to "was". Also, this sentence is run-on. Please reconstruct as two sentences.	The paragraph was changed to read, "The release mechanism for the contaminants in Group 2 is associated with the detonation of low-yield or safety experiments. In the case of low-yield experiments, the release mechanism dispersed unfissioned nuclear material to surface soils. In the case of Ganymede, the release mechanism dispersed radioactive material into a confining gravel bunker using high explosives."	
27.) Page 29, Section 3.1.3, Paragraph 1		Change "mechanism" to "mechanisms", and "are" to "were"	The paragraph was changed to read, "The release mechanism for the contaminants in Group 3 is associated with the placement of debris and spill materials onto surface soils from equipment, discarded debris, or stored materials."	

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3. Revision Number:	0	**4. Originator/Organization:**	Navarro-INTERA
5. Responsible NNSA/NSO Activity Lead:	Tiffany A. Lantow	**6. Date Comments Due:**	
7. Review Criteria:	Full		
8. Reviewer/Organization/Phone No:	Scott Page, NDEP, 486-2850 ext.	**9. Reviewer's Signature:**	

10. Comment Number/Location	11. Type*	12. Comment	13. Comment Response	14. Accept
28.) Page 29, Section 3.1.3, Paragraph 2		Change “mechanism” to “mechanisms”, and “is” to “was”; also, last phrase makes the sentence sound incomplete	The paragraph was changed to read, "The release mechanism for the contaminants in Group 4 is associated with the relocation of contaminants through the flow of surface waters to sedimentation areas; the scraping of contaminated surface soil into windrows; and the movement and deposition of contaminants by mechanical means (e.g., excavation) at depths exceeding 5 cm."	
29.) Page 29, Section 3.1.4, Paragraph 1		Suggest replacing “streams” with ephemeral drainage “channels” or “drainages”. Add the sentence from Section 2.1 that indicates drainage from this CAU appears to enter craters in the area. Is there evidence that surface contamination could be or has been transported via runoff to Yucca Flat? Clarify.	All references to "streams" in this paragraph were replaced with "drainages." The following sentences will be added to the end of the paragraph. "Several craters are present in and around the CAU, and preliminary evidence suggests that sheet flow runoff throughout the area may drain into these craters. Evidence is also present of runoff flow along the old Mercury Highway and flowing into the Sugar crater that deposited soils in the crater. The topography of the area is very flat, and visual surveys have not identified surface collection features as indicated by eroded sediment. This is supported by the 1994 flyover survey (BN, 1999a), which suggests that there is no migration away from the plume."	
30.) Page 30, Section 3.1.4, Paragraph 4		Add “zone” after “alluvium”	The phrase was changed from "vadose alluvium" to vadose zone alluvium."	

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31.) Page 30, Section 3.1.4		The discussion of vertical migration of contaminants into the subsurface and groundwater does not address the number of closely spaced collapse craters as preferential pathways on and near this CAU. Comment also applies to Sec. A.2.2.5	The following paragraph was added after the final paragraph of Section 3.1.4. "Underground test craters have associated chimneys of disturbed geologic material that may provide a preferential pathway. Collection of stormwater into these craters also provides additional localized infiltration that will enhance contaminant migration rates."	
32.) Page 33, Table 3-1		Suggest retitle table such as, “Analytical Method by COPC and Release Group”; ensure that all acronyms in this table have been defined in the table footer notes. Should this table contain the method number and/or name where the Xs are?	The table title was changed to "Analyses Required by Group" and the method number will be supplied by referencing Table 3-2, which will be modified to include the analytical method numbers.	
33.) Page 35, Figure 3-3		Highlight the Tier 1, 2, and 3 Evaluation boxes; change “ASTM, 1995” at right corner to “Adopted from ASTM, 1995”	The Tier 1, 2, and 3 Evaluation boxes were highlighted in gray and the figure reference will be modified to read, "Adopted from ASTM, 1995."	
34.) Page 43, Section 4.2.2.1, Paragraph 1		Clarify: “The objective is to ….. highest radiological dose in order to ….. (Properly estimate internal dose for other locations where samples are not taken based the rationale provided in Section 4.1)?	Reference to the 1994 flyover survey and the handheld instrument was removed from the first paragraph and a reference to Section 4.1 was added to the end of the first paragraph. The last sentence of the second paragraph was changed to read, "To assist in resolving the extent of contamination exceeding the FAL (part of Decision II), TLDs will be placed in a radial pattern around a central location to determine external dose. The method for determining internal dose at each Decision II TLD location is described in Section 4.1.	

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35.) Page 44, Section 4.2.2.2, Paragraph 2, 2nd sentence		Suggest replacing term “stakeholders” with “decision makers listed in Section A.2.1”	Comment was incorporated document-wide.	
36.) Page 52, Section 6, Paragraph 1		State before the TLD QA discussion that all characterization activities, including those related to TLD measurements will be conducted in accordance with the Soils Activity QAP	The following sentence was inserted after the first sentence of the paragraph. "All characterization activities, including those related to TLD measurements, will be conducted in accordance with the Soils QAP (NNSA/NSO, 2012b)."	
37.) Page 55, Section 6.2.2, Paragraph 1		After the 2nd sentence: suggest adding “Significant DQI criteria variations from the Soils QAP will be reported with the affected analytical results”.	After the second sentence of the paragraph, a sentence was added that reads, "Significant DQI criteria variations from the Soils QAP (NNSA/NSO, 2012b) will be reported in the CADD."	
38.) Page A-4, Section A.2.2, Last sentence		Re-label “Table A.2-2” as “Figure A.2-2”.	The reference to Table A.2-2 was changed to Figure A.2-2. The reference to Figure A.2-2 in the third sentence of the paragraph was changed to Figure A.2-1.	
39.) Page A-12, Table A.2-3		Suggest retitle table such as, “Analytical Method by COPC and Release Group”; ensure that all acronyms in this table have been defined in the table footer notes. Should this table contain the method number and/or name where the Xs are?	Same as comment 32 except reference was made to Table A.2-4.	
40.) Page A-16, Section A.2.2.6, Paragraph 1, 3rd sentence		Add reference (i.e., SWEIS)	A reference was added after the third sentence of the paragraph which is, "(DOE/NV, 1996)."	

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41.) Page A-22, Section A.4.2.2, Paragraph 1, 2nd sentence		Contrary to the sentence, Table 6-1 does not appear to contain information about analytical methods	In the last sentence, "Table 6-1" was replaced with " the Soils QAP (NNSA/NSO, 2012a)."	
42.) Page A-23, Section A.5.2, Paragraph 1		Suggest adding a brief discussion about how the vertical and lateral boundary distances were determined.	The first sentence of the first paragraph of Section A.5.2 was changed to read, "Spatial boundaries are the maximum lateral and vertical extent of expected contamination that can be supported by the CSM. These boundaries were agreed to in the DQO meeting with decision makers."	
43.) Page A-24, Section A.5.4		This paragraph is indecipherable (“components”, “scale of decision making”). Please re-write.	The paragraph was changed to read, "The scale of decision making in Decision I is the CAS component (defined by a specific release). The presence of a COC associated with a CAS component will cause the determination that the CAS component is contaminated and needs further evaluation. The scale of decision making for Decision II is defined as a contiguous area containing a COC originating from the CAS component. Resolution of Decision II requires this contiguous area to be bounded laterally and vertically."	
44.) Page A-25, Section A.6.1.2, Paragraph 1, 5th sentence		At the end of this sentence add, “The details of how this estimate will be made are discussed in Section 4.1”	The next to the last sentence in the paragraph was changed to read, "This conservative estimate (overestimation) of the true TED will be calculated as the 95 percent UCL of the average TED values (Section 4.1)."	

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45.) Page A-30, Section A.7.1, Paragraph 2, 3rd bullet		Replace “stakeholders” with “decision makers listed in Section A.2.1”	See response to comment #35.	
46.) Page A-31, Section A.7.2.1, Paragraph 4, 3rd sentence		Instrument calibration statement does not appear to be appropriate for this section.	This sentence was removed.	
47.) Page A-34, Section A.8.1, Paragraph, last sentence		Modify, “… depicted in Figure A.8-1, on a base map showing the PRM-470 survey results”.	Figure A.8-1 was divided into two separate figures. Figure A.8-1 addresses the Group 1 locations by use of the PRM-470. Figure A.8-2 addresses the Group 2 locations by use of the FIDLER.	
48.) Page A-35, Figure A.8-1		Legend: see previous comments nos. 3-5, 26; not clear how the data from the 1994 flyover are shown; retitle Figure to include “PRM-470”	All figures were revised to incorporate a common format.	
49.) Page A-37, Section A.8.1.1.1, Last paragraph		Add ‘n≥’ to the term list at the bottom of the page (minimum sample size).	(n) was placed in the last sentence of the paragraph after "minimum sample size" and the equation was modified to reflect an equality (=), not an inequality (≥).	
50.) Page A-39, Section A.8.1.2, Paragraph 4, last sentence		Change cited figure to “Figure A.8-3”.	Cited figure was changed from Figure A.8-1 to Figure A.8-4. The last sentence of the paragraph was moved to the end of the third paragraph, and the remainder of the paragraph was deleted because it adds nothing to the discussion.	

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51.) Page A-39, Section A.8.1.2, Paragraph 3, 3rd sentence		Suggest providing short explanation of why background radiation can be comparable with radiological FALs.	The sentence was modified to read, "These background radiation values can be significant in relation to action levels. For example, the background radiation values near the Sedan test location in Area 10 are approximately 31 mrem/IA-yr."	
52.) Page A-39, Section A.8.1.2, Paragraph 4		Are the proposed locations for background TLDs shown in Fig A.8-3 part of the ten locations identified in the NTS ER 2006? Unclear	The paragraph identifying the 10 NNSS background TLDs was deleted . See response to comment #50.	
53.) Page A-41, Section A.8.1.3		Suggest revising section title to: “Calculation of TED and Corrective Action Boundary”	Section A.8.1.3 title was changed to "Calculation of TED and Corrective Action Boundary."	

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