Nevada
Environmental
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Project

DOE/NV--962

NNSA
National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 552: Area 12 Muckpile and Ponds Nevada Test Site, Nevada

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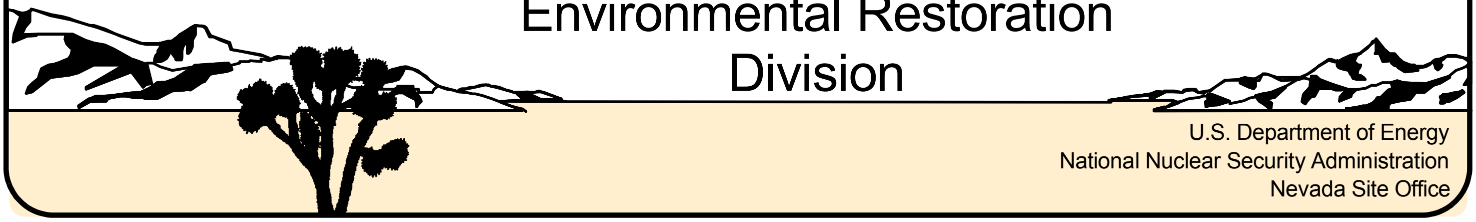

Environmental Restoration
Division

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

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CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 552: AREA 12 MUCKPILE AND PONDS NEVADA TEST SITE, NEVADA

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

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CORRECTIVE ACTION INVESTIGATION PLAN FOR
CORRECTIVE ACTION UNIT 552:
AREA 12 MUCKPILE AND PONDS
NEVADA TEST SITE, NEVADA

Approved by: Signature Approved Date: 3-31-04

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Environmental Restoration Division

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List of Acronyms and Abbreviations

A-E	Architect-Engineer
amsl	Above mean sea level
bgs	Below ground surface
BN	Bechtel Nevada
CADD	Corrective Action Decision Document
CAI	Corrective action investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COC	Contaminant of concern
COPC	Contaminant of potential concern
CRDL	Contract-required detection limit
CRQL	Contract-required quantitation limits
CSM	Conceptual site model
DNA	Defense Nuclear Agency
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
DTRA	Defense Threat Reduction Agency
EPA	U.S. Environmental Protection Agency

List of Acronyms and Abbreviations *(Continued)*

Eu	Europium
FADL	Field activity daily log
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level
FSR	Field-screening result
ft	Foot (feet)
ft/yr	Feet per year
GRASP	General Radiochemistry and Routine Analytical Services Protocol
GRO	Gasoline-range organics
HASP	Health and Safety Plan
HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inch
IRIS	Integrated Risk Information System
ISMS	Integrated Safety Management System
LCS	Laboratory control sample
LLW	Low-level radioactive waste
MDA	Minimum detectable activity
MDC	Minimum detectable concentration
MDL	Minimum detection limit
mg/kg	Milligram per kilogram
mg/L	Milligrams per liter
mi	Mile
MIBK	4-methyl-2 pentanone

List of Acronyms and Abbreviations *(Continued)*

M&O	Management and Operating
mrem	Millirem
MRL	Minimum reporting limit
MS	Matrix spike
MSD	Matrix spike duplicate
NAC	*Nevada Administrative Code*
NASA	National Aeronautics and Space Administration
NCRP	National Council on Radiation Protection and Measurement
ND	Normalized difference
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
NTS	Nevada Test Site
NTSWAC	*Nevada Test Site Waste Acceptance Criteria*
PA	Preliminary assessment
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
PID	Photoionization detector
PPE	Personal protective equipment
ppm	Parts per million
PRG	Preliminary remediation goal
QA	Quality assurance

List of Acronyms and Abbreviations *(Continued)*

QAPP	Quality Assurance Project Plan
QC	Quality control
RadCon	Radiological control
RCA	Radiologically controlled area
RCRA	*Resource Conservation and Recovery Act*
REECo	Reynolds Electric & Engineering Co., Inc.
RMA	Radioactive materials area
ROTC	Record of Technical Change
RPD	Relative percent difference
RT	Regulatory threshold
RWMS	Radioactive Waste Management Site
SD	Standard deviation
SDG	Sample delivery group
SDWS	*Safe Drinking Water Standard*
SNJV	Stoller-Navarro Joint Venture
SS	Site Supervisor
SSHASP	Site-specific health and safety plan
SSO	Site Safety Officer
SVOC	Semivolatile organic compound
TPH	Total petroleum hydrocarbon
TSCA	*Toxic Substance Control Act*
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
%R	Percent recovery

List of Acronyms and Abbreviations *(Continued)*

μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter

Executive Summary

This Corrective Action Investigation Plan for Corrective Action Unit (CAU) 552, Area 12 Muckpile and Ponds, Nevada Test Site, Nevada, has been developed in accordance with the *Federal Facility Agreement and Consent Order* that was agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense. The general purpose of the investigation is to ensure that adequate data are collected to provide sufficient and reliable information to identify, evaluate, and select technically viable corrective actions.

Corrective Action Unit 552 is comprised of the following two corrective action sites (CASs) in Area 12 of the Nevada Test Site:

- 12-06-04, Muckpile
- 12-23-05, Ponds

This Corrective Action Investigation Plan provides investigative details for CAU 552, whereas programmatic aspects of this project are discussed in the *Project Management Plan* (DOE/NV, 1994). General field and laboratory quality assurance and quality control issues are presented in the *Industrial Sites Quality Assurance Project Plan* (NNSA/NV, 2002). Health and safety aspects of the project are documented in the current version of the Environmental Architect-Engineer Services Contractor's Health and Safety Plan, and will be supplemented with a site-specific health and safety plan.

Corrective Action Site 12-06-04 consists of the G-Tunnel muckpile in Area 12 of the Nevada Test Site. The muck is a result of tunneling activities including drilling, tunnel development, cutback operations, and reentry mining. Corrective Action Site 12-23-05 consists of three dry ponds adjacent to the muckpile. The toe of the muckpile extends into one of the ponds, causing an overlap of the two CASs.

The sources of possible contamination include reentry mining following any of the five nuclear tests conducted in G-Tunnel, which may have produced radioactively contaminated muck, the release of possibly radioactively contaminated effluent to the ponds, and possible chemical spills as a result of equipment operating on the muckpile, or spills from products stored on the muckpile.

A conceptual site model was developed for the two CASs to address possible contamination migration pathways associated with CAU 552. The data quality objective (DQO) process was used to identify and define the type, quantity, and quality of data needed to complete the investigation phase of the corrective action process. The DQOs address the primary problem that sufficient information is not available to determine the appropriate corrective action for the CAU. To be able to determine the corrective action alternative, two critical decisions were identified.

- Is a contaminant present within a CAS at a concentration that could pose an unacceptable risk to human health and the environment?
- If a COC is present, is sufficient information available to determine to what extent the contamination has migrated to the surrounding area?

For determining distinct data needs, resolution of the first decision is addressed as Decision I and resolution of the second decision is addressed as Decision II. Decision I data will be generated and evaluated throughout the corrective action investigation. Decision II data will be generated and evaluated for each contaminant exceeding preliminary action levels in Decision I samples, as well as for all contaminants in certain biased sampling locations. Corrective action closure alternatives (i.e., no further action, close in place, or clean closure) will be recommended for CAU 552 based on an evaluation of all the DQO-required data.

Based on site history, process knowledge, and previous investigations of similar sites, contaminants of potential concern for CAU 552 collectively include radionuclides, total petroleum hydrocarbons, polychlorinated biphenyls, *Resource Conservation and Recovery Act* metals, beryllium, volatile organic compounds, and semivolatile organic compounds.

The general technical approach for investigation of CAU 552 consists of, but is not limited to, the following activities:

- Perform radiological land area surveys at CAU 552 to document the radiological condition of land within the site boundary.
- Collect surface and shallow subsurface soil samples from random as well as biased locations.
- Submit soil samples for laboratory analysis to aid in determining the nature and extent of potential contamination.

- Collect required quality control samples.
- Collect additional samples, as necessary, to estimate volumes and determine disposal options for potential corrective action waste streams.
- Collect samples from native soils and analyze for geotechnical/hydrologic parameters, if necessary.
- Collect and analyze bioassessment samples, if appropriate (e.g., if volatile organic compound concentrations exceed field-screening levels in a pattern that suggests that a plume may be present).
- Stake or flag sample locations and record coordinates.

Under the *Federal Facility Agreement and Consent Order*, the Corrective Action Investigation Plan will be submitted to the Nevada Division of Environmental Protection for approval. Field work will be conducted following approval of the plan. The results of the field investigation will support a defensible evaluation of corrective action alternatives that will be presented in the Corrective Action Decision Document.

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) 552: Area 12 Muckpile and Ponds, Nevada Test Site (NTS), Nevada.

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

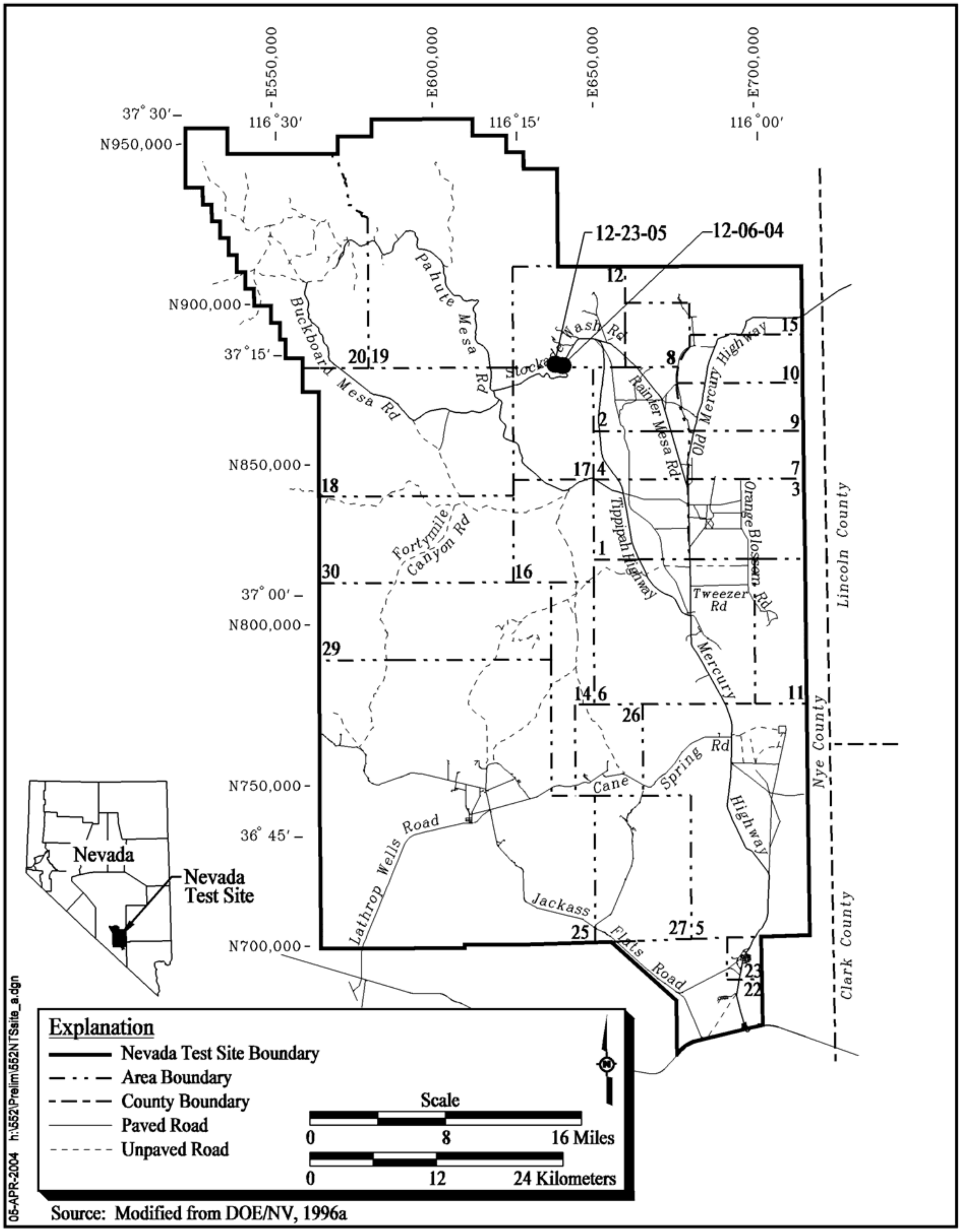
The NTS is approximately 65 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1). Corrective Action Unit 552 is comprised of the two Corrective Action Sites (CASs) listed below:

- 12-06-04, Muckpile
- 12-23-05, Ponds

These sites were first identified in the 1991 Reynolds Electrical & Engineering Co., Inc. document entitled, *Nevada Test Site Inventory of Inactive and Abandoned Facilities and Waste Sites*. Corrective Action Unit 552 is being investigated because existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives. Therefore, additional information will be obtained by conducting a corrective action investigation (CAI) prior to evaluating and selecting the corrective action alternatives for each CAS. The CAI will include field inspections, radiological surveys, and sampling of appropriate media. Data will also be obtained to support investigation-derived waste (IDW) disposal and potential future waste management decisions.

1.1 Purpose

The two CASs in CAU 552 are being investigated because man-made radionuclides and chemical contaminants may be present in concentrations that could potentially pose an unacceptable risk to human health and/or the environment.



Source: Modified from DOE/NV, 1996a

Figure 1-1
CAU 552 Location Map

The CAI will be conducted following the 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 the type, amount, and quality of data needed to define the nature and extent of contamination and identify and evaluate the most appropriate corrective action alternatives for CAU 552.

The primary problem statement for the investigation is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CASs 12-06-04 and 12-23-05." To address this problem statement, the resolution of the following two decisions statements is required:

- The Decision I statement is: "Is a contaminant present within a CAS at a concentration that could pose an unacceptable risk to human health and the environment?" Any contaminant detected at a concentration exceeding the corresponding preliminary action level (PAL), as defined in Section A.1.4.2, will be considered a contaminant of concern (COC). A COC is defined as a site-related constituent that exceeds the screening criteria (PAL). The presence of a contaminant within each CAS is defined as the analytical detection of a COC.

- The Decision II statement is: "Determine the extent of contamination identified above PALs." This decision will be achieved by the collection of data that are adequate to define the extent of COCs.

Decision II samples are used to determine the lateral and vertical extent of the contamination as well as the likelihood of COCs to migrate outside of the site boundaries. The migration pattern can be derived from the Decision II samples, since the analytical results of those samples will show how far the contamination has travelled in the time period since activities at the site ended.

Most of the data necessary to resolve the decisions will be generated from the analysis of environmental samples collected during the CAI for CAU 552. The general purpose of the investigation is to:

- Identify the presence and nature of COCs.

- Determine the vertical and lateral extent of identified COCs.

- Ensure sufficient data is collected to support the selection of a corrective action compliant with all NDEP, *Resource Conservation and Recovery Act* (RCRA), *Toxic Substance Control Act* (TSCA), and DOE requirements.

In addition, data will be obtained to support (IDW) disposal and potential future waste management decisions.

1.1.1 CAS Descriptions

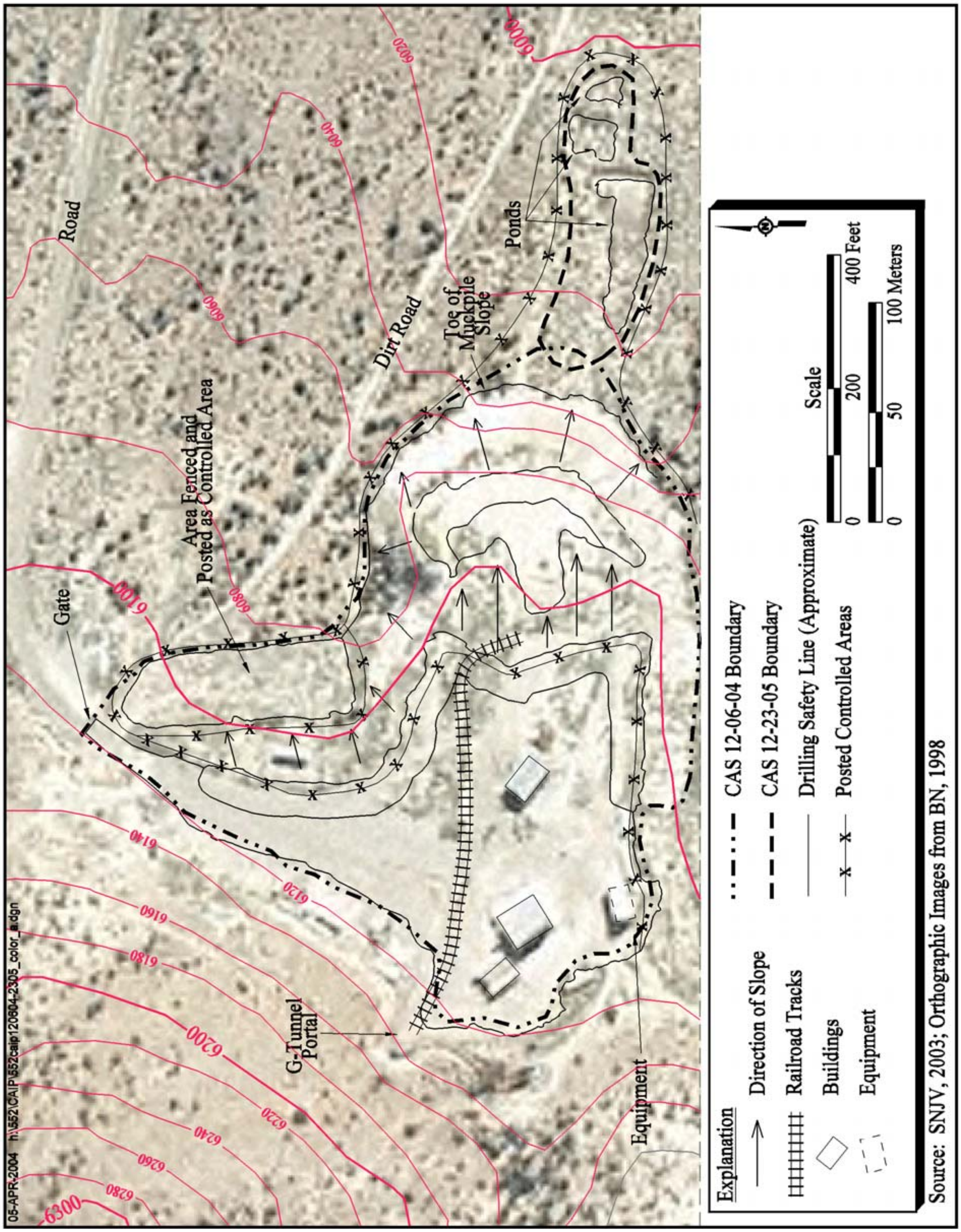
Corrective Action Unit 552 consists of CASs 12-06-04, Muckpile, and 12-23-05, Ponds, located adjacent to the G-Tunnel portal in Area 12 of the NTS as shown in Figure 1-2. Five documented nuclear tests were conducted inside G-Tunnel over a period of nine years, beginning in 1962. Testing at G-Tunnel consisted of one weapons-related test and four weapons-effects tests. Each test was less than 20 kilotons (DOE/NV, 2000a).

Corrective Action Site 12-06-04 consists of the muckpile located outside of the tunnel. The muck resulted from the activities conducted at the tunnel including drilling, tunnel development, cutback operations, and reentry mining. The reentry mining excavated debris produced during nuclear tests and potentially included radioactively contaminated muck.

Corrective Action Site 12-23-05 consists of three ponds located at the base of the muckpile. The ponds are a result of activities at G-Tunnel. Effluent was created during tunnel construction as a result of saturated fractures and perched water, which was present at the location of most of the G-Tunnel nuclear testing. According to sources interviewed during the Preliminary Assessment (PA) process, all three ponds have been dry since the mid-1980s. The toe of the muckpile extends into the uppermost of the three ponds causing an overlap of the two CASs.

1.1.2 DQO Summary

The CAU 552 investigation will be based on DQOs developed by representatives of NDEP and the NNSA/NSO. The DQOs were used to identify and define the type, quantity, and quality of information needed to identify, evaluate, and recommend potentially viable corrective actions. A two-decision approach has been selected to generate the data needed to satisfy the DQOs. Decision I data will be generated and evaluated to determine the presence of COCs. Contaminants of concern are defined as contaminants of potential concern (COPCs) that are present in samples at concentrations above PALs defined in Section 3.0. Decision II data will be generated and evaluated to define the extent of COCs identified during the Decision I sampling. Corrective action closure



Source: SNJV, 2003; Orthographic Images from BN, 1998

Figure 1-2
CAU 552, CAS 12-06-04 and CAS 12-23-05 Boundaries

alternatives (i.e., no further action, close in place, or clean closure) will be recommended for CAU 552 based on an evaluation of the DQO-required data.

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO processes, the scope of the CAI for each CAS in CAU 552 includes the following activities:

- Conduct land radiological surveys as necessary to provide information necessary to determine the radiological condition of the site and to identify potential biased sampling locations.
- Conduct Decision I sampling for hazardous and radiological parameters using laboratory analyses to determine the nature of contamination.
- Collect Decision II samples to define the horizontal and vertical extent of the contamination.
- Collect quality control (QC) samples for laboratory analyses to evaluate the performance of measurement systems and controls based on the requirements of the data quality indicators (DQIs).
- Comply with regulatory requirements for waste disposal through the collection and analysis of IDW samples, as needed. Collect samples of IDW and conduct inspections and surveys, as needed, to support waste management decisions.
- Collect soil samples for laboratory analysis of geotechnical parameters and/or bioassessment, as needed.

1.3 CAIP Contents

Section 1.0 presents the purpose and scope of this CAIP, while Section 2.0 provides background information about the CAU. The objectives, including the conceptual site models, are presented in Section 3.0. Field sampling activities are discussed in Section 4.0, and waste management for this project is discussed in Section 5.0. General field and laboratory quality assurance (QA) and QC requirements (including collection of QC samples) are presented in Section 6.0 and in the *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002). The project schedule and records availability are discussed in Section 7.0. Section 8.0 provides a list of references. Appendix A.1, Section A.1 provides a DQO summary, while Section A.2 contains information on the project organization, and Appendix A.3 contains NDEP comments. The health and safety aspects of this project will be documented in a site-specific health and safety plan written prior to the start of field work. Public involvement activities are documented in the "Public Involvement Plan" contained in Appendix V of the FFACO (1996). The managerial aspects of this project are discussed in the *Project Management Plan* (DOE/NV, 1994) and will be supplemented with a site-specific field management plan that will be developed prior to field activities.

2.0 Facility Description

Corrective Action Unit 552 is comprised of CASs 12-06-04, Muckpile, and 12-23-05, Ponds, that were first identified in the 1991 Reynolds Electrical & Engineering Co., Inc. document entitled, *Nevada Test Site Inventory of Inactive and Abandoned Facilities and Waste Sites*. The sources of potential contamination within the two CASs are the disposal of potentially contaminated muck from G-Tunnel drilling operations, possibly contaminated effluent in the ponds, and any potential chemical spills resulting from tunnel activities.

2.1 Physical Setting

Corrective Action Unit 552 is located adjacent to the G-Tunnel portal. The U-12g Tunnel, also known as G-Tunnel, is located in Area 12 of the NTS to the east of Rainier Mesa. The following sections provide a general overview of the topography, geology, and hydrogeology pertaining to Area 12. General background information pertaining to topography, geology, hydrogeology, and climatology are provided for this specific area of the NTS region as described in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996a). The locations of the CASs on the NTS are shown in Figure 1-1.

2.1.1 Area 12

Corrective Action Unit 552 is located at NTS Area 12 on the eastern slope of Rainier Mesa at an elevation of approximately 6,100 feet (ft) above mean sea level (amsl). It is situated in quaternary age alluvium tuff and composed of unconsolidated to moderately cemented boulders, cobbles, pebbles, and sand (RSN, 1991; DRI, 1996; USGS, 1999) that uncomfortably overlay dolomitic limestone. Stratigraphically, Rainier Mesa consists of a 2,000- to 5,000-ft thick sequence of Tertiary volcanic tuffs (composed welded ashflow tuffs, friable vitric bedded-tuff, and zeolitized-bedded tuffs) that uncomfortably overlay Cambrian/Precambrian schist and quartzite, Paleozoic carbonates, or Cretaceous granite rocks. Rainier Mesa is "capped" by a 100- to 400-ft section of moderately to densely-welded, vitric, ashflow tuff that overlies 200 to 800 ft of friable, vitric, ashflow, and bedded ashfall tuff. A section of approximately 600 to 3,000 ft of zeolitized bedded tuff (altered by groundwater of the vitric tuff) with one or two thin, interbedded welded to nonwelded ashflow tuff units are beneath the vitric tuffs (DNA, 1990). The nearest drill hole to CAU 552 is U12g.01-3s, which was completed in April 1962 and is currently abandoned (RSN, 1991).

Corrective Action Unit 552 is underlain by the Eleana Formation, which is Mississippian to Upper Devonian in age and composed chiefly of clastic rocks (e.g., quartzite, conglomerate, siltstone, and argillite) (DRI, 1996). The Eleana Formation unit can reach a thickness of 8,000 ft and forms the upper clastic aquitard. This upper clastic aquitard is the chief hydrogeologic unit within and above the zone of saturation beneath the ridges bordering western Yucca Flat (USGS, 1999). The Eleana confining unit in the Eleana Range separates Rainier Mesa from Yucca Flat. The unit lies beneath the west-dipping Tongue Wash fault.

Perched water is widespread, and is found throughout the mesas of the NTS (USGS, 1996 and 1999). No rain gauge stations were identified locally for CAU 552. Isohyetal maps indicate average annual precipitation rates in the Rainier Mesa between 8 and 12 inches (in.) (USGS, 1965). Precipitation falling on Rainier Mesa percolates downward through unsaturated rock, locally recharging the groundwater flow system (USGS, 1996). Recharge is estimated at 140-acre feet per year (ft/yr), based on a proportional percentage of the amount of precipitation. However, it should be noted that distribution, rate, and quantity of recharge are known only in general terms (USGS, 1996). Another potential source of recharge are the ponds that contain water drained from the tunnel during tunneling operations at Rainier Mesa. Much of the water impounded by these ponds evaporates to the atmosphere, but some may percolate downward, ultimately recharging the regional groundwater flow system. The infiltration of pond water would be a minor source of water to the regional flow system, but might provide a means by which surface contaminants contained in the ponds water could be transported into the subsurface environment (USGS, 1996).

Groundwater beneath Rainier Mesa may flow westward or southward within the Alkali Flat-Furnace Creek Ranch subbasin, or some part may flow eastward across or underneath the Eleana confining unit into the Ash Meadows subbasin. The regional and local hydrogeologic units within the Rainier Mesa are confined by variable welded ash-tuff commonly zeolitized. In addition, there are perched water tables throughout the nonwelded Rainier Mesa tuff (USGS, 1996).

The G-Tunnel muckpile diverts the outlet of the surrounding watershed that extends along the southern toe of the muckpile (DRI, 1990). There are three abandoned, dry ponds located downstream of the muckpile. Field investigations identified no designed channels or structures to protect the site from flood or fire damage. In general, the material in the muckpile is fine grained rock fragments and would be susceptible to transport during a 100-year flood event. The nearest water well to CAU 552 is Water Well 8, also referred to as HTH #8. This inactive well is located in Area 18 approximately 5.4 mi southwest of the CAU. The well was completed on January 7, 1963; was drilled to a depth of 5,499 ft below ground surface (bgs); and has a completed depth of 1,862 ft bgs. Depth to groundwater at this well is approximately 1,081 ft bgs (USGS and DOE, 2003a).

Well ER-12-1 is located near the base of the eastern slope of Rainier Mesa, alongside the U12e tunnel access road where it passes the base of Dolomite Hill in Area 12 approximately 1.4 mi from CAS 12-06-04. Well ER-12-1 was drilled to a depth of 3,588 ft in 1991 to determine the hydrogeology of Paleozoic carbonate rocks and of the Eleana Formation, a regional aquitard in an area potentially downgradient from underground nuclear testing (USGS and DOE, 2003b). Since 1997, Well ER-12-1 has been used as a monitoring well for the E-tunnel evaporation ponds. Only the uppermost sleeve (1,757 ft) within ER-12-1 is open and accesses formational groundwater for the purposes of sampling (DRI, 1996). Groundwater in Well ER-12-1 was measured in September 2003 at 1,526.41 ft bgs (USGS, 2003).

2.2 Operational History

The following subsections provide a description of the use and operational history of G-Tunnel and CAU 552. This summary is intended to illustrate the significant activities known to have been conducted at G-Tunnel that may have released contamination to the environment.

Five documented nuclear tests were conducted in G-Tunnel between the years of 1962 and 1971. Testing at G-Tunnel consisted of one weapons-related test and four weapons-effects tests. Each test was less than 20 kilotons. Three of these tests had documented releases breach the tunnel containment systems, and a fourth had a documented release during drill-back operations, potentially contaminating areas outside of the tunnel (DOE/NV, 1996b and 2000a). Corrective Action Site 12-06-04 consists of the potentially radioactively contaminated muck that is located outside of the tunnel. The muck contains debris from activities conducted at the tunnel including drilling, tunnel development, cutback operations, and reentry mining. Corrective Action Site 12-23-05 consists of three ponds located at the base of the muckpile. The ponds are a result of activities at G-Tunnel, and were constructed to collect effluent from G-Tunnel. Effluent was the result of encountering saturated fractures and perched water during tunnel construction and minebacks. Because of erosion and precipitation run-off, the base of the muckpile spreads out into the closest of the ponds, causing an overlap between these two CASs.

Activities associated with the nuclear tests conducted within G-Tunnel are the potential sources of chemical and radioactive contamination. Corrective Action Site 12-06-04, Muckpile, was created as a result of tunneling activities within the G-Tunnel. The muckpile also contains debris removed from the tunnel following nuclear weapon tests, resulting in the potential for buried radioactive material. In addition, there are several drums with unknown contents partially buried in the muckpile.

Corrective Action Site 12-23-05, Ponds, consists of three ponds constructed to contain the water leaving the G-Tunnel. It is believed the ponds may have also collected effluent produced during and following nuclear weapon testing, resulting in the potential for radioactive contamination.

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NTS practices were used to identify wastes that may be present. These sources did not indicate that this CAU was or was not used to dispose of material considered to be hazardous waste as defined by current standards. Although no known occurrences of waste disposal have been identified for CAU 552, materials remaining from past activities conducted at, or near, this CAU may be considered hazardous and/or radioactive waste by current standards. Both CASs are posted with “Radioactive Material Area” and “Underground Radioactive Material Area” signs. Available information was evaluated during the DQO process, and a list of potential contaminants was developed and is provided in Table 3-3.

There is potential for hydrocarbon contamination resulting from possible oil or fuel leaks from heavy equipment associated with G-Tunnel activities. There is also a potential for chemical contamination due to spills of chlorinated solvents possibly used in site operations.

The scope of this investigation is to determine the nature and extent of potential radiological and chemical contamination associated with tunneling activities that took place at G-Tunnel and the potential release of contaminants to the muckpile and ponds. Radiological analysis may be required to support waste management decisions and IDW disposal. Areas where potential mixed waste exists will be identified and delineated to the extent necessary to properly manage the IDW and address future waste management issues.

2.4 Release Information

The CAS-specific release information, migration routes, exposure pathways, and affected media are discussed in this section. Based on historical information and process knowledge, the primary sources of potential environmental contaminants released to the soil within CAU 552 include:

- Potentially contaminated muck disposed on the muckpile, CAS 12-06-04
- Potentially contaminated effluent collected in the ponds, CAS 12-23-05

No information exists documenting the presence of contamination at CAU 552. If contamination is present, it is expected that vertical migration of contaminants would be very limited due to the low annual rate of precipitation at the site. Also, process knowledge from previous muckpile and pond investigations shows the native material has been largely uncontaminated. Lateral migration is also expected to be limited by the physical and chemical properties of the potential contaminants and the surrounding soil. Additionally, the presence of relatively impermeable layers could modify vertical transport pathways.

Recharge to groundwater from precipitation is minimal at the NTS and does not provide a significant mechanism for migration of contaminants to groundwater. Lateral migration due to surface run-off of precipitation is also expected to be limited because of the limited amount of precipitation and the negative transpiration in the arid environment. Additional information on migration is presented in Section 3.1.3 and in Section A.1.2.3 of Appendix A.1.

Potentially affected media for CAU 552 include surface and shallow subsurface soil. Additional affected media information is given in Section A.1.2.3 of Appendix A.1.

2.4.1 Exposure Pathways

Site workers, industrial and construction personnel, as well as military personnel conducting training may be exposed to potentially contaminated soil at CAU 552 (DOE/NV, 1998). Exposure pathways include ingestion, inhalation of dust, and/or dermal contact (absorption) from disturbance of contaminated soils, debris, and/or structures. This exposure pathway in considered unlikely to result in significant exposure to potential receptors from contaminated soil from the site because of the expected limited use and the restricted access to the NTS and the G-Tunnel area.

2.5 Investigative Background

No previous sampling has been conducted at CAU 552. During the PA investigation, a letter was found detailing a soil investigation conducted in 1991 of the G- and T-tunnels at the NTS. This letter from O.L. Haworth (Reynolds Electrical & Engineering Co., Inc. [REECo]) to S.W. Goodin (Defense Nuclear Agency [DNA]) discusses the analysis of soil samples from the G- and T-Tunnel portals. The samples were analyzed for both chemical and radiological components. The analyses showed the soils at both tunnel portals contained trace amounts of organic chemicals and artificially introduced radioactive elements. The chlorinated organic chemicals found are possibly the result of spillage of degreasing compounds that contained methylene chloride, tetrachloroethane, and 1,1,1-trichloroethane. The nonchlorinated organic chemicals toluene, ethylbenzene, xylenes, and 4-methyl-2-pentanone (MIBK) may be the result of spillage of fuel, motor oil, or degreasing products. Acetone was also found in the portal soils; however, the presence of acetone in soil samples is often due to laboratory contamination of the sample. Both natural and artificially introduced radionuclides were present in the samples (Haworth, 1991). The actual analytical data was not located. The G-Tunnel portal is adjacent to the CAU 552 muckpile, but is not considered part of the CAU.

Several investigations of similar muckpiles and ponds have been completed at the NTS. Radiological contaminants found during the investigations of CAUs 475, 476, 477, 478, 480, 482, and 504 have been summarized in Table A.1-2.

The only chemical contaminants found during these investigations are total petroleum hydrocarbons (TPH)-diesel-range organics (DRO), lead, and arsenic. The TPH-DRO was found above the PAL in 18 samples at a maximum concentration of 10,000 parts per million (ppm); lead in 2 samples at a maximum concentration of 59,700 ppm; arsenic in over 40 samples at a maximum concentration of 38.8 ppm.

2.5.1 National Environmental Policy Act

In accordance with the NNSA/NSO's *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed prior to commencement of site investigation activities at CAU 552. This checklist requires NNSA/NSO project 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.

3.0 Objectives

This section presents an overview of the DQOs for CAU 552 and formulation of the conceptual site model (CSM). Also presented is information on the COPCs and PALs for the investigation.

3.1 Conceptual Site Model

The CSM demonstrates the possible contamination migration scenarios for CAU 552 and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. A single CSM has been developed for CAU 552 using the assumptions formulated from physical setting, potential contaminant sources/release mechanisms, process knowledge, historical background information, and knowledge from studies of similar sites. Section A.1.2.3 in Appendix A.1 provides more detailed information on the CSM as presented for DQO formulation.

If evidence of potential contamination that is outside the scope of the CSM is identified during investigation activities, the situation will be reviewed and recommendations will be made as to how best to proceed. In such cases, NNSA/NSO and NDEP will be notified prior to proceeding.

Figure 3-1 shows the CSM developed for current site conditions at the CAU 552. The CSM identifies site features and represents the potential migration pathways of possible contaminants.

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 552.

3.1.1 Future Land Use

The future land-use scenario limits uses of the CAU to various nonresidential uses (i.e., industrial uses) including defense and nondefense research, development, and testing activities (Table 3-1). The Nuclear Test Zone referenced in Table 3-1 is defined as “. . .reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests. . .” (DOE/NV, 1998).

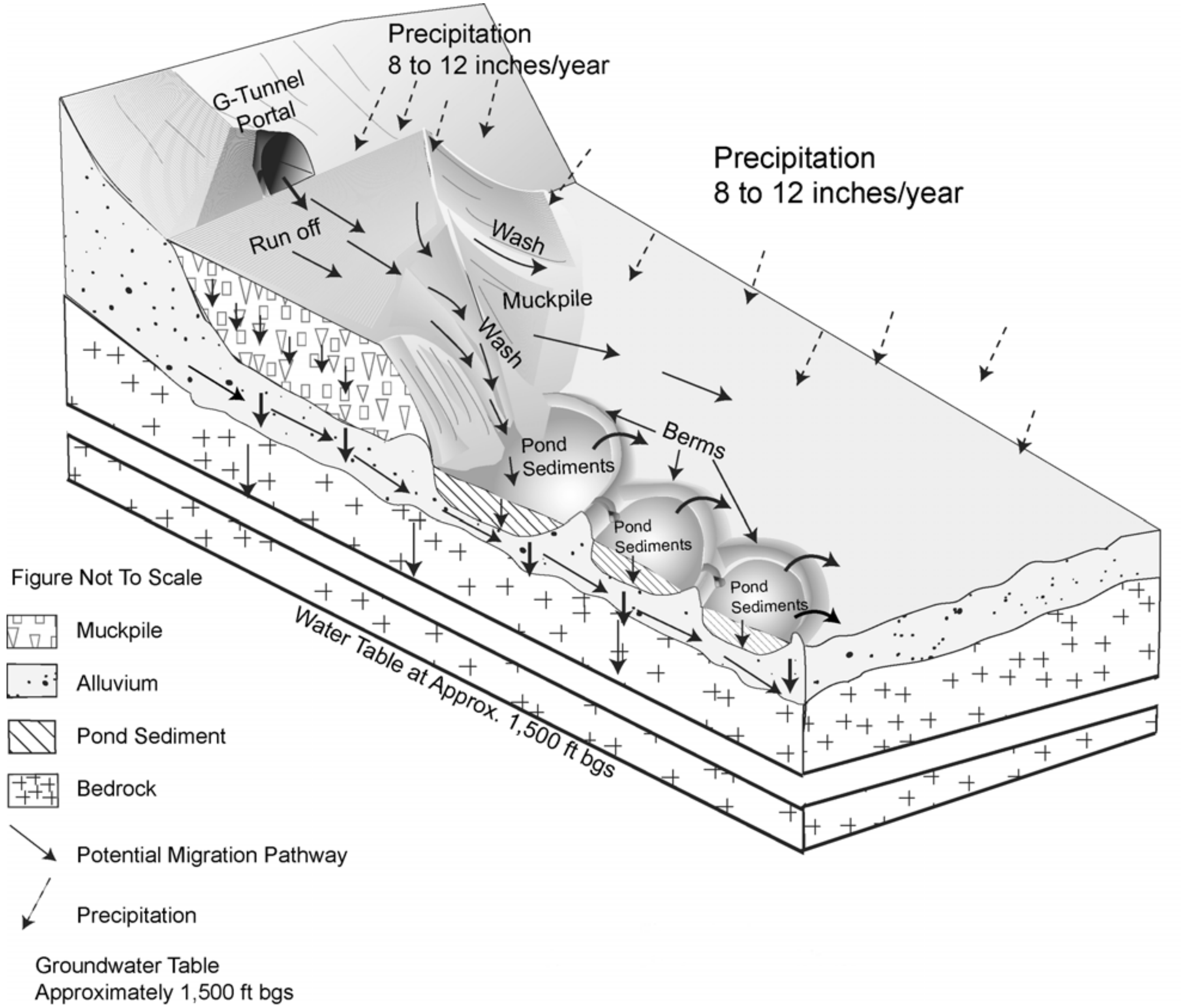


Figure 3-1
CAU 552 Conceptual Site Model

Table 3-1
Future Land-Use Scenarios for CASs 12-06-04 and 12-23-05 Within CAU 552

Land-Use Zone	Zone Description
Nuclear and High Explosives Test Zone	This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high explosives tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

3.1.2 Contaminant Sources and Release Mechanisms

Two primary contaminant sources are identified in the CSM and include:

- Potential contamination present within the muckpile
- Potential contamination present within the pond sediments

Release mechanisms for the COPCs at CAU 552 are the dumping of potentially contaminated muck on the muckpile and the release of potentially contaminated effluent into the ponds. When contaminants exist on the surface soil, release mechanisms for these sources include mixing during earthmoving activities (e.g., grading and construction) as well as limited leaching and lateral physical dispersal during precipitation events. No information exists that would indicate what parts of the muckpile may or may not contain COPCs.

3.1.3 Migration Pathways and Transport Mechanisms

An important element of the CSM in developing a sampling strategy is the expected fate and transport of contaminants. Fate and transport of contaminants are presented in the CSM as the migration pathways and transport mechanism that could potentially move the contaminants throughout the various media. Fate and transport are 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 saturation, 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 further from release points.

The degree of contaminant migration at this site is unknown but is assumed to be minimal based on the affinity of the COPCs for soil particles, and the low precipitation and high evapotranspiration rates typical of the NTS environment. Run-off from the muckpile down one of several washes could cause lateral migration of contaminants over the ground surface. Contaminants may also have been transported by infiltration and percolation of precipitation through soil, which would serve as the primary driving force for downward migration. Previous muckpile investigations have found little or no vertical migration into the native material underlying the muckpile. Mixing of the surface soil as a result of grading or construction activities would also move the contaminants into deeper intervals.

The migration of organic constituents (e.g., TPH, semivolatile organic compounds [SVOCs], and polychlorinated biphenyls [PCBs]) will be controlled by their respective affinity for adsorption to organic material present in the soil. However, the lack of organic material in the desert soil will reduce the effectiveness of this process. Migration of inorganic constituents (e.g., metals in waste oil) is controlled by geochemical processes, such as adsorption, ion exchange, soil pH, and precipitation of solids from solution.

Because of the low volatility of the suspected contaminants, an airborne release subsequent to the initial contaminant release is not considered a significant release pathway. The main process of migration through the air would be through windblown dust. If volatile organic compounds (VOCs), SVOCs, metals, radioactive contaminants, or petroleum hydrocarbons adsorbed to the fine soil particles, a small amount of migration could be expected via the airborne pathway. This process could allow for the deposition of contaminants beyond the site boundaries. Transport via the airborne pathway is expected to be minimal because it was general practice to place several feet of uncontaminated muck on top of contaminated muck (Metcalf, 2004; DOE, 1988).

Preferential pathways for contaminant migration at CAS 12-06-04 and CAS 12-23-05 are expected not to be present or have only had a minor impact on contaminant migration. The presence of relatively impermeable layers (e.g., caliche layers) modify transport pathways both on the ground surface and in the shallow subsurface. Small gullies and washes could channelize run-off and increase lateral transport prior to infiltration. Precipitation may wash contaminants from the muckpile down into the overlapping pond or the surrounding soil. Contamination could travel laterally to a small degree.

Contaminants could be transported into the subsurface and eventually to the groundwater by precipitation infiltration. However, potential evapotranspiration (the evaporative capacity of the atmosphere at the soil surface) at the NTS is significantly greater than precipitation, thus limiting vertical migration of contaminants. The annual average precipitation for this area of Rainier Mesa is is only 8 to 12 in. per year (USGS, 1965). The total potential evapotranspiration at the Area 3 (located about 10 mi southeast of Area 12) Radiological Waste Management Site (RWMS) has been estimated at 62.6 in. (Shott et al., 1997). Thus, the potential annual evapotranspiration is approximately 10 times greater than the annual precipitation. These data indicate that evaporation is the dominant factor influencing the movement of water in the upper unsaturated zone. Therefore, recharge to groundwater from precipitation is not significant at the NTS and does not provide a significant mechanism for the movement of contaminants to groundwater.

3.1.4 Exposure Points

Exposure points within CAU 552 are the locations where visitors, site workers, or military personnel will come in contact with potential contaminants within the CAU boundaries. The exposure points at CAU 552 would be the surface and shallow subsurface at locations where contamination is present.

3.1.5 Exposure Routes

Exposure routes to visitors, site workers, or military personnel include ingestion, inhalation, and/or dermal contact (absorption) from disturbance of contaminated soils, debris, and/or structures. Site workers may also be exposed to radiation by performing activities in proximity to radiologically contaminated materials.

3.1.6 Additional Information

Additional topographic information for CAU 552 will not be necessary because the data available is adequate to make determinations about the sites.

General surface and subsurface soil descriptions will be observed and recorded during the CAI.

Climatic conditions for the CAU are well documented for this area of the NTS and have been addressed in the DQO process and reflected in the CSM. No further information is required.

Groundwater data for the CAU is known and has been addressed in the CSM. The CAS-specific depth to groundwater data are presented in Section 2.1. No further information is required.

Specific structure descriptions will be observed and recorded during the CAI. The structures include the several buildings and equipment present on top of the muckpile near the G-Tunnel portal. The CAI will not compromise the structural integrity of the structures.

3.2 Contaminants of Potential Concern

Suspected contaminants for CAU 552 were identified through a review of site history documentation, process knowledge information, personal interviews, past investigation efforts, and inferred activities associated with the CASs. Contaminants suspected to be present at CAU 552 include TPH-DRO, TPH-gasoline-range organics (GRO), SVOCs, VOCs, metals, PCBs and man-made radionuclides. Chemical COPCs are defined as the analytes detected using the analytical methods listed in Table 3-2 for which the U.S. Environmental Protection Agency (EPA) Region IX has established Preliminary Remediation Goals (PRGs) (EPA, 2002a) or for which toxicity data are listed in the EPA Integrated Risk Information System (IRIS) database (EPA, 2002b). Radiological COPCs are defined as the radionuclides reported from the analytical methods also listed in Table 3-2. Potassium-40 is not considered to be a COPC due to its predominance in the environment. The only mechanism for Potassium-40 to be a contaminant is through concentration; there are no reported activities at the NTS that would have concentrated Potassium-40 or released it as a contaminant. The CAI will not be expanded to delineate the extent of Potassium-40, nor will Potassium-40 be evaluated in the Corrective Action Decision Document (CADD). The Decision I COPCs are presented in Table 3-3.

Suspected COPCs for Decision I samples are the potential chemical constituents that are reasonably suspected to be present at the site based on documented use, previous investigations of similar sites, or process knowledge. The suspected COPCs are given greater importance in the decision-making process relative to possible COPCs and have a completeness goal of 90 percent. For this reason, more stringent performance criteria are specified for suspected analyte DQIs (Section 6.2.2).

Possible COPCs are defined as classes of contaminants (e.g., VOCs) that include all the analytes reported from the respective analytical methods that have PALs. The possible COPCs also aid in reducing the uncertainty concerning the history and potential releases from the CAU and help in the

Table 3-2
Chemicals of Potential Concern and Analytical Requirements for CAU 552
(Page 1 of 3)

Parameter/Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision (RPD)[a]	Percent Recovery (%R)[b]
ORGANICS						
Total Volatile Organic Compounds (VOCs)	Aqueous	8260B[c]	Parameter-specific estimated quantitation limits[d]	Not applicable (NA)	Lab-specific[e]	Lab-specific[e]
	Soil					
Toxicity Characteristic Leaching Procedure (TCLP) VOCs						
Benzene	Aqueous	1311/8260B[c]	0.050 mg/L[d]	0.5 mg/L[f]	Lab-specific[e]	Lab-specific[e]
Carbon Tetrachloride			0.050 mg/L[d]	0.5 mg/L[f]		
Chlorobenzene			0.050 mg/L[d]	100 mg/L[f]		
Chloroform			0.050 mg/L[d]	6 mg/L[f]		
1,2-Dichloroethane			0.050 mg/L[d]	0.5 mg/L[f]		
1,1-Dichloroethene			0.050 mg/L[d]	0.7 mg/L[f]		
Methyl Ethyl Ketone			0.050 mg/L[d]	200 mg/L[f]		
Tetrachloroethene			0.050 mg/L[d]	0.7 mg/L[f]		
Trichloroethene			0.050 mg/L[d]	0.5 mg/L[f]		
Vinyl chloride			0.050 mg/L[d]	0.2 mg/L[f]		
Total Semivolatile Organic Compounds (SVOCs)	Aqueous	8270C[c]	Parameter-specific estimated quantitation limits[d]	NA	Lab-specific[e]	Lab-specific[e]
	Soil					
TCLP SVOCs						
o-Cresol	Aqueous	1311/8270C[c]	0.10 mg/L[d]	200 mg/L[f]	Lab-specific[e]	Lab-specific[e]
m-Cresol			0.10 mg/L[d]	200 mg/L[f]		
p-Cresol			0.10 mg/L[d]	200 mg/L[f]		
Cresol (total)			0.30 mg/L[d]	200 mg/L[f]		
1,4-Dichlorobenzene			0.10 mg/L[d]	7.5 mg/L[f]		
2,4-Dinitrotoluene			0.10 mg/L[d]	0.13 mg/L[f]		
Hexachlorobenzene			0.10 mg/L[d]	0.13 mg/L[f]		
Hexachlorobutadiene			0.10 mg/L[d]	0.5 mg/L[f]		
Hexachloroethane			0.10 mg/L[d]	3 mg/L[f]		
Nitrobenzene			0.10 mg/L[d]	2 mg/L[f]		
Pentachlorophenol			0.50 mg/L[d]	100 mg/L[f]		
Pyridine			0.10 mg/L[d]	5 mg/L[f]		
2,4,5-Trichlorophenol			0.10 mg/L[d]	400 mg/L[f]		
2,4,6-Trichlorophenol			0.10 mg/L[d]	2 mg/L[f]		
Polychlorinated Biphenyls (PCBs)	Aqueous	8082[c]	Parameter-specific (CRQL)[g]	NA	Lab-specific[e]	Lab-specific[e]
	Soil					
Total Petroleum Hydrocarbons (TPH) (C_6-C_{38})	Aqueous GRO	8015B modified[c]	0.1 mg/L[h]	NA	Lab-specific[e]	Lab-specific[e]
	Soil GRO		0.5 mg/kg[h]			
	Aqueous DRO		0.5 mg/L[h]			
	Soil DRO		25 mg/kg[h]			

Table 3-2
Chemicals of Potential Concern and Analytical Requirements for CAU 552
(Page 2 of 3)

Parameter/Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision (RPD)[a]	Percent Recovery (%R)[b]
INORGANICS						
Total Metals						
Arsenic	Aqueous	6010B[c]	10 µg/L[h, i]	NA	20[i]	Matrix Spike Recovery 75-125[i] Laboratory Control Sample Recovery 80 - 120[i]
	Soil		1 mg/kg[h, i]		35[h]	
Barium	Aqueous	6010B[c]	200 µg/L[h, i]		20[i]	
	Soil		20 mg/kg[h, i]		35[h]	
Beryllium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil		0.5 mg/kg[h, i]		35[h]	
Cadmium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil		0.5 mg/kg[h, i]		35[h]	
Chromium	Aqueous	6010B[c]	10 µg/L[h, i]		20[i]	
	Soil		1 mg/kg[h, i]		35[h]	
Lead	Aqueous	6010B[c]	3 µg/L[h, i]		20[i]	
	Soil		0.3 mg/kg[h, i]		35[h]	
Mercury	Aqueous	7470A[c]	0.2 µg/L[h, i]		20[i]	
	Soil	7471A[c]	0.1 mg/kg[h, i]		35[h]	
Selenium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil		0.5 mg/kg[h, i]		35[h]	
Silver	Aqueous	6010B[c]	10 µg/L[h, i]		20[i]	
	Soil		1 mg/kg[h, i]		35[h]	
Zinc	Aqueous	6010B[c]	20 µg/L[h, i]		20[i]	
	Soil		2 mg/kg[h, i]		35[h]	
TCLP RCRA Metals						
Arsenic	Aqueous	1311/6010B[c] 1311/7470A[c]	0.10 mg/L[h, i]	5 mg/L[f]	20[i]	Matrix Spike Recovery 75-125[i] Laboratory Control Sample Recovery 80 - 120[i]
Barium			2 mg/L[h, i]	100 mg/L[f]		
Cadmium			0.05 mg/L[h, i]	1 mg/L[f]		
Chromium			0.10 mg/L[h, i]	5 mg/L[f]		
Lead			0.03 mg/L[h, i]	5 mg/L[f]		
Mercury			0.002 mg/L[h, i]	0.2 mg/L[f]		
Selenium			0.05 mg/L[h, i]	1 mg/L[f]		
Silver			0.10 mg/L[h, i]	5 mg/L[f]		
RADIOCHEMISTRY						
Gamma-Emitting Radionuclides	Aqueous	EPA 901.1[j]	The Minimum Reporting Limits and Minimum Detectable Activities for Radionuclides are given in Table 3-4	NA	Relative Percent Difference (RPD[a]) 20% (Water)[h] 35% (Soil)[h] Normalized Difference (N D) -2<ND<2[k]	Laboratory Control Sample Recovery 80-120[i]
	Soil	HASL-300[l]				
Isotopic Uranium	Aqueous	HASL-300[l] ASTM D3972-02[m]		NA		Chemical Yield 30-105[n] Laboratory Control Sample Recovery 80-120[i]
	Soil	HASL-300[l] ASTM C1000-00[m]				
Isotopic Plutonium	Aqueous	ASTM D3865-02[m]		NA		
	Soil	HASL-300[l]				
Strontium - 90	Aqueous	ASTM D5811-00[m]		NA		
	Soil	HASL-300[l]				

Table 3-2
Chemicals of Potential Concern and Analytical Requirements for CAU 552
(Page 3 of 3)

Parameter/Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision (RPD)[a]	Percent Recovery (%R)[b]

[a] Relative percent difference (RPD) is used to calculate precision.
Precision is estimated from the relative percent difference of the concentrations measured for the matrix spike and matrix spike duplicate or of laboratory, or field duplicates of unspiked samples. It is calculated by: RPD = 100 x $\{(|C_1-C_2|)/[(C_1+C_2)/2]\}$, where C_1 = Concentration of the parameter in the first sample aliquot,
C_2 = Concentration of the parameter in the second sample aliquot.

[b] %R is used to calculate accuracy.
Accuracy is assessed from the recovery of parameters spiked into a blank or sample matrix of interest, or from the recovery of surrogate compounds spiked into each sample. The recovery of each spiked parameter is calculated by: percent recovery (%R) = 100 x (C_s-C_u/C_n), where C_s = Concentration of the parameter in the spiked sample,
C_u = Concentration of the parameter in the unspiked sample, C_n = Concentration increase that should result from spiking the sample

[c] U.S. Environmental Protection Agency (EPA) *Test Methods for Evaluating Solid Waste*, 3rd Edition, Parts 1-4, SW-846 CD ROM, Washington, DC (EPA,1996)

[d] Estimated Quantitation Limit as given in SW-846 (EPA, 1996)

[e] In-House Generated RPD and %R Performance Criteria
It is necessary for laboratories to develop in-house performance criteria and compare them to those in the methods. The laboratory begins by analyzing 15 to 20 samples of each matrix and calculating the mean %R for each parameter. The standard deviation (SD) of each %R is then calculated, and the warning and control limits for each parameter are established at ± 2 SD and ± 3 SD from the mean, respectively. If the warning limit is exceeded during the analysis of any sample delivery group (SDG), the laboratory institutes corrective action to bring the analytical system back into control. If the control limit is exceeded, the sample results for that SDG are considered unacceptable. These limits are reviewed after every quarter and are updated when necessary. The laboratory tracks trends in both performance and control limits by the use of control charts. The laboratory's compliance with these requirements is confirmed as part of an annual laboratory audit. Similar procedures are followed in order to generate acceptance criteria for precision measurements.

[f] Title 40 *Code of Federal Regulations* Part 261, "Identification and Listing of Hazardous Waste" (CFR, 2003)

[g] EPA *Contract Laboratory Program Statement of Work for Organic Analysis* (EPA, 1988b; 1991; and 1994c)

[h] *Industrial Sites Quality Assurance Project Plan* (NNSA/NV, 2002)

[i] EPA *Contract Laboratory Program Statement of Work for Inorganic Analysis* (EPA, 1988a; 1994b; and 1995)

[j] *Prescribed Procedures for Measurements of Radioactivity in Drinking Water*, EPA-600/4-80-032 (EPA, 1980)

[k] Normalized Difference is not RPD, it is another measure of precision used to evaluate duplicate analyses. The normalized difference is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties. *Evaluation of Radiochemical Data Usability* (Paar and Porterfield, 1997)

[l] *Manual of Environmental Measurements Laboratory Procedures*, HASL-300 (DOE, 1997)

[m] American Society for Testing and Materials

[n] *General Radiochemistry and Routine Analytical Services Protocol (GRASP)* (EG&G Rocky Flats, 1991)

Definitions:
mg/L = Milligrams per liter
mg/kg = Milligrams per kilogram
µg/L = Micrograms per liter
CRQL = Contract-required quantitation limits

accurate evaluation of potential contamination. Each COPC that is detected in a sample at concentrations exceeding the corresponding PAL becomes a COC for subsequent sampling (Decision II) to define the extent of contamination. These follow-up samples will be collected and analyzed only for the COCs determined to be present by Decision I sampling. However, if extent samples are collected prior to nature-of-contamination data becoming available, the extent samples will be analyzed for the full list of parameters in Table 3-3.

Table 3-3
Contaminants of Potential Concern for CAU 552

Chemical		**Radiological**	
Suspected Contaminants of Potential Concern	Arsenic	Suspected Contaminants of Potential Concern	Cesium-137
	Barium		Cobalt-60
	Beryllium		Plutonium-238
	Lead		Plutonium-239/240
	4-Methyl 2-Pentanone		Strontium-90
	1,1,1-Trichloroethane		
	Ethylbenzene		
	Methylene Chloride		
	Tetrachloroethane		
	Toluene		
	Xylenes		
	TPH-DRO		
Possible Contaminants of Potential Concern	RCRA Metals	Possible Contaminants of Potential Concern	Other Man-Made Radionuclides
	VOCs		
	SVOCs		
	PCBs		
	TPH-GRO		

3.3 *Preliminary Action Levels*

Laboratory analytical results for COPCs in soil samples will be compared to the following PALs to evaluate the presence of COCs:

- EPA *Region 9 Risk-Based Preliminary Remediation Goals* for chemical constituents in industrial soils (EPA, 2002a).

- Background concentrations for RCRA metals will be used instead of PRGs when natural background exceeds the PRG, as is often the case with arsenic on the NTS. 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).

- The TPH action limit of 100 ppm per the *Nevada Administrative Code* (NAC) 445A (NAC, 2003).

- The PALs for radiological contaminants are based on the National Council on Radiation Protection and Measurement (NCRP) Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled from 25- to 15-millirem (mrem) per year dose and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).

- For detected chemical COPCs without established PRGs, a similar protocol to that used by the EPA Region 9 will be used in establishing an action level for those COPCs listed in the EPA IRIS database (EPA, 2002b).

Solid media such as concrete may pose a potential radiological exposure risk to site workers if contaminated. The radiological PAL for the surface of solid media will be defined as the unrestricted-release criteria defined in the *NV/YMP Radiological Control Manual* (RadCon) (DOE/NV, 2000b).

The comparison of laboratory results to PALs will be discussed in the CADD. Laboratory results above PALs indicate the presence of COCs that will require further evaluation. The evaluation of potential corrective actions and the justification for a preferred action will be included in the CADD based on the results of this field investigation. Proposed cleanup levels will be presented in the CADD, if applicable.

3.4 DQO Process Discussion

The DQO process is a strategic planning approach based on the scientific method that is used to prepare for site characterization data collection. The DQOs are 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 or close in place).

Details of the DQO process are presented in Appendix A.1. During the DQO discussion for this CAU, the informational inputs and data needs to resolve the problem statements and decision statements were documented. Criteria for data collection activities were assigned. The analytical methods and reporting limits prescribed through the DQO process, as well as the DQIs for laboratory analysis such as precision and accuracy requirements, are provided in more detail in Section 6.2.2 of this CAIP. Laboratory data will be assessed to confirm or refute the CSM, and determine if the DQOs were met based on the DQIs of precision, accuracy, representativeness, completeness, and comparability. Other DQIs, such as sensitivity, may also be used.

The DQO strategy for CAU 552 was developed at a meeting on December 11, 2003, to identify data needs, clearly define the intended use of the environmental data, and to 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 the investigation is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CASs 12-06-04 and 12-23-05.” To address unknown contamination, resolution of two decisions statements is required:

- Decision I is to “Identify the contamination” by identifying contaminant concentrations above PALs. Analytical data must be collected from areas most likely to contain contamination resulting from site activities, and parameters must be selected that represent the types of potential contamination present. If PALs are not exceeded, the investigation is complete. If PALs are exceeded, Decision II must be resolved.

- Decision II is “Determine the extent of contamination identified above PALs.” This decision will be achieved by the collection of data that are adequate to define the extent of COCs.

In addition, data will be obtained to support waste management decisions.

For the CAU 552 DQOs, one CSM has been developed for the two CASs using historical background information, knowledge from studies at similar sites, and data from previous sampling efforts. The CSM includes potential contamination migration pathways.

Laboratory analysis of environmental soil samples will provide the means for quantitative measurement of the COPCs. Decision I chemical and radiological parameters of interest have been selected for CAU 552 and are listed in Table 3-2. The table includes the analytical methods for CAU 552, minimum reporting limits (MRLs), and precision and accuracy requirements for each method. The analytical methods are capable of generating data that meet the project needs determined through the DQO process. Specifically, the MRLs are set so that laboratory analyses will generate data with the necessary resolution for comparison to PALs. The MRLs for radiological analytes have been developed considering both the MDCs and PALs. As shown in Table 3-4 the MRL for each radiological analyte is less than or equal to the corresponding PAL.

Table 3-4
Minimum Detectable Concentrations and Preliminary Action Levels for Suspected COPCs at CAU 552

Isotope	Soil and Sludge		Liquid	
	MDC[a] (pCi/g)[c]	PAL[b] (pCi/g)[c]	MDC[a] (pCi/L)[d]	PAL[b] (pCi/L)[d]
Cesium-137	0.5[e]	7.3	10	10
Cobalt-60	0.5[e]	1.61	10[e]	10
Strontium-90	0.5	503	1.0	1.0
Plutonium-238	0.05	7.78	0.1	0.16
Plutonium-239/240	0.05	7.62	0.1	9.0

[a] MDC is the minimum detectable concentration: detection limits required for the measurement of Shaw samples. MDC vary depending on the presence of other gamma-emitting radionuclides in the sample.
[b] PAL is the preliminary action level and are based on the NCRP Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenario (NCRP, 1999) scaled from 25- to 15-mrem per year dose and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).
[c] pCi/g is picocuries per gram.
[d] pCi/L is picocuries per liter.
[e] MDC for gamma-emitting radionuclides is relative to cesium-137.

4.0 Field Investigation

This section of the CAIP contains the approach for investigating CAU 552.

4.1 Technical Approach

The technical approach for the CAI for CAU 552, CASs 12-06-04 and 12-23-05, consists of the following activities:

- Conduct the radiological land-area surveys to identify potential biased sampling locations and to document the radiological condition of the site.
- Collect and analyze samples from random and biased locations as described in this section.
- Collect additional samples, as necessary, to resolve Decision II.
- Collect required QC samples.
- Collect additional samples, as necessary, to support the characterization of potential corrective action waste streams.
- Collect samples from native soils and/or muck and analyze for geotechnical/hydrologic parameters and bioassessment, if necessary.
- Stake or flag sample locations and record coordinates (in North American Datum 1927 Universal Transverse Mercator [UTM] coordinate system).

4.2 Field Activities

This section provides a description of the field activities for CASs 12-06-04 and 12-23-05 at CAU 552. If contamination is identified, it will be found within the spatial boundaries of the CAS as defined in the DQO process and the CSM. If while defining the nature of contamination, the investigation determines that COCs are present, the CAS will be further addressed by determining the lateral and vertical extent of contamination before evaluating corrective action alternatives. Decision II samples may be collected only for unbounded COCs except where indicated otherwise (e.g., at locations where apparent run-off has occurred).

Modification to the investigative strategy may be required should unexpected field conditions be encountered. Significant modification will be documented and justified in a record of technical change (ROTC). The ROTC is required prior to proceeding with investigation activities significantly different from those described in this document. If contamination is more extensive than anticipated (e.g., the maximum investigation depth is limited by the capabilities of the equipment used to collect subsurface soil samples), the investigation may be rescoped.

Soil samples will be collected from random and biased locations using various drilling methods (e.g., rotosonic, hollow-stem auger, or other applicable methods), direct-push, hand/power auger, hand tools, and/or excavation, as appropriate. Table 3-2 provides the analytical methods to be used when analyzing for the COPCs. All sampling activities and QA/QC requirements for field and laboratory environmental sampling will be conducted in compliance with the Industrial Sites QAPP (NNSA/NV, 2002) and other applicable procedures. Other governing documents include a current version of the Environmental Services Architect-Engineer (A-E) Contractor's Health and Safety Plan (HASP) and an approved site-specific health and safety plan (SSHASP) prepared prior to the field effort.

4.2.1 Site Preparation Activities

Site preparation will be conducted by the NTS Management and Operating (M&O) contractor prior to the investigation. Site preparation may include, but not be limited to: removal and proper disposal of surface debris (e.g., surface metal, wood debris, and concrete) that may interfere with sampling as well as providing access to sample points (e.g., fence removal).

4.2.2 Decision I Activities

The objective of the Decision I strategy is to determine if COCs are present within the CAU boundary. Decision I sampling strategy targets locations and media most likely to be contaminated with COCs. The initial activities planned for CAU 552 will include site radiological surveys and random and biased soil sampling. The radiological surveys will include safely accessible areas of the muckpile, ponds, and drainage(s). The results of the radiological surveys for CASs 12-06-04 and 12-23-05 will be used to determine biased sampling locations, identify potential areas of elevated radiological activity, and radiological health hazards, and provide safety information to protect workers and the environment during the CAI at CAU 552.

The presence of COCs will be determined by random and biased sampling and laboratory analyses. A comparison of laboratory analytical results from Decision I samples to PALs will be used to confirm the presence or absence of COCs.

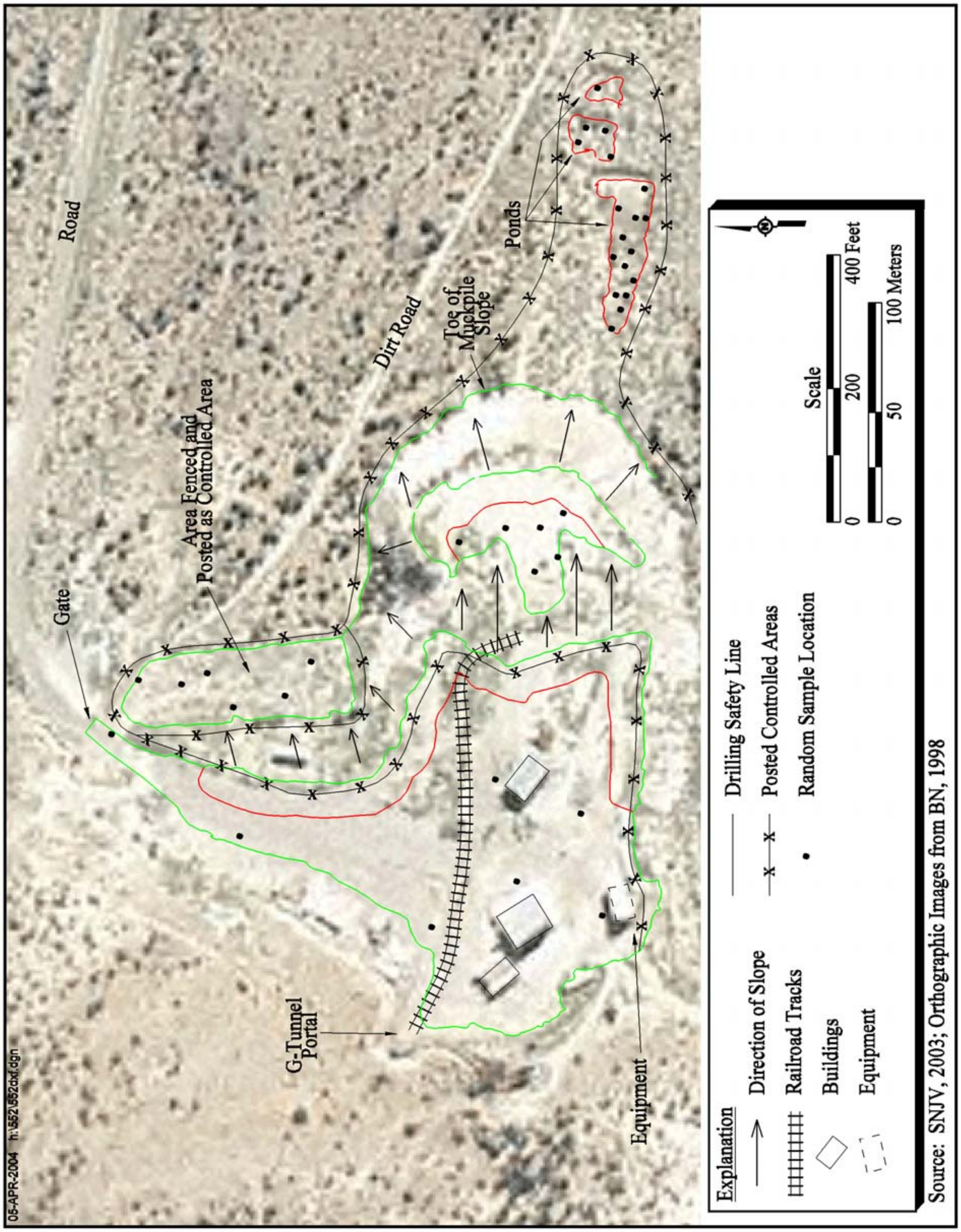
Random sampling locations will be determined in accordance with the DQO process. Approved statistical methods defined in Chapter 9 of EPA SW-846 were used to arrive at the minimum number of samples required for the investigation of the muckpile and ponds (EPA, 1996). These numbers were plugged into a random sampling location generating software in order to produce an example of proposed random sampling locations, as presented in Figure 4-1. The method and results are presented in Section A.1.7.3 of Appendix A.1.

Biased sampling locations will be determined based on the results of the radiological land-area surveys and other biasing factors, such as the presence of drums, terrain features, and/or stained soil. The Site Supervisor has the authority to modify these locations and minimize samples submitted for laboratory analyses, but only if the decision needs and criteria stipulated in Section A.1.3 of Appendix A.1 are satisfied.

Appendix A.1 lists the target populations for Decision I and identifies information needs in selecting data collection locations for Decision I. The following are the biasing factors that currently have been identified for consideration in the selection of the surface soil sample locations:

- Aerial photograph review and evaluation
- Walk-over and drive-over radiological surveys
- Areas with elevated radiation readings
- Visual indicators (e.g., staining, topography, areas of preferential surface run-off)
- Known or suspected sources and locations of release (e.g., drums)
- Process knowledge and experience at similar sites
- Geologic and/or hydrologic conditions
- Physical and chemical characteristics of suspected contaminants

Contaminants determined not to be present in Decision I samples may be eliminated from Decision II analytical suites.



Source: SNJV, 2003; Orthographic Images from BN, 1998

Figure 4-1
CAU 552 Example of Potential Random Sampling Locations

4.2.3 Decision II Activities

Decision II (step-out) sampling locations at CAU 552 will be selected based on the outer boundary sample locations where a COC is detected in the initial soil samples. The lateral step-out locations will be based on professional judgement and site-specific conditions. Generally, step-out locations will be approximately 15 ft from positive (contaminated) Decision I locations. However, site-specific strategies (e.g., scale of decision making defined as the muckpile) and/or site-specific conditions such as easily identifiable contamination, may be used to increase or decrease this distance, as necessary. The sampled depth intervals at subsurface locations will be based on biasing factors such as presence of debris, staining, odor, field-screening results (FSRs), or professional judgement. For subsurface sampling locations, generally two consecutive soil samples with results below field-screening action levels are used to define the vertical extent of contamination. Generally, the uppermost "clean" sample from each location will be submitted for laboratory analysis. Sample locations may be changed based on current site conditions, obvious debris or staining of soils, FSRs, or professional judgement. Decision II locations will also be selected based on pertinent features of the CSM and the other biasing factors. If biasing factors indicate a COC potentially extends beyond planned Decision II sample locations, locations may be modified or additional Decision II samples may be collected from incremental step-out locations. Both surface and subsurface soil samples may be collected and analyzed to determine the extent of a COC.

Some Decision II locations will be sampled regardless of the outcome of Decision I sampling. Examples of such locations are the berms of the ponds, and locations at the foot of the muckpile where apparent run-off has occurred.

Due to the nature of buried features possibly present (e.g., structures, buried debris, and utilities), sample locations may be relocated, based upon the information obtained during the site visit. However, the new locations will meet the decision needs and criteria stipulated in Section A.1.4.1 of Appendix A.1.

Decision II subsurface soil samples will be collected at biased locations by hand augering, direct-push, excavation, or drilling techniques, as appropriate. Subsurface soil sample depth intervals will be selected based on biasing factors. Section 3.0 provides the analytical methods and laboratory requirements (i.e., detection limits, precision, and accuracy requirements) to be used when analyzing the COPCs. The analytical program for CAU 552 is presented in Table 3-2.

The following outlines the CAS-specific activities for the CAU 552 investigation.

4.2.4 CAS 12-06-04, Muckpile

The initial activities to be conducted will be a visual inspection and photodocumentation of CAS 12-06-04. The visual inspection will focus on identifying areas of apparent staining and possible run-off from the muckpile. The information generated during these initial activities will be used to identify potential biasing factors (i.e., elevated radiological data, stained soil) for the placement of biased soil samples.

Following the initial activities, a minimum of 38 soil samples will be collected from 19 randomly generated locations at the muckpile, with samples being taken at 2 depths at each location. The depths include a randomly picked z-depth within the muckpile and a native soil sample between approximately 0 and 5 ft below the muckpile/native soil interface. The z-depth will be determined after the muck/native soil interface is reached and the total depth of the muckpile at the location is known. Random percentage values will be generated at each location to determine the depth at which the sample will be taken.

The random location soil sample analytical data will be used to resolve Decision I (nature of contamination). If COCs are detected in the analytical data above PALs, Decision II (extent of contamination) will need to be resolved.

Samples will also be collected at approximately 4 to 6 locations at the foot of the muckpile in places where apparent run-off has occurred.

Figure 4-1 depicts proposed random soil sampling locations for CAU 552. Actual sample locations may be changed due to field conditions (e.g., equipment or buildings obstructing location). All changes will be thoroughly documented in the field activity daily logs (FADL). Sufficient random sampling points will be generated in order to account for the fact that some locations may be inaccessible to the drill rig. If such a location is found, a sample will be collected at the next random location instead. Biased sample locations will be determined from current site conditions based on biasing factors. Samples will be submitted for laboratory analysis as discussed in Section 3.0.

Decision II samples will be collected at the edge of the muckpile if Decision I data determines that contamination is present within the muckpile. If COCs are found in Decision II samples, further step-outs will continue approximately 25 to 50 ft away from a contaminated location until the extent of COC concentrations greater than the PALs is delineated.

Samples of waste or debris may also be collected for analysis to support IDW disposal and potential future waste management decisions.

4.2.5 CAS 12-23-05, Ponds

The initial activities to be conducted will be a walk-over radiological survey, visual inspection, and photodocumentation of CAS 12-23-05. The visual inspection will focus on finding areas of apparent staining and possible over-flow from the ponds. The information generated during these initial activities will be used to provide additional biasing factors (i.e., elevated radiological data, stained soil) for the placement of biased soil samples.

Following the initial activities, a minimum of 36 samples will be collected from 18 randomly generated locations within the three ponds in CAS 12-23-05, with samples being taken at 2 depths at each location, including a randomly picked z-depth within the pond sediment and a native soil sample taken directly below the sediment/native soil interface. The z-depth will be determined after the sediment/native soil interface is reached and the total depth of the sediment at the location is known. Random percentage values will be generated at each location to determine the depth at which the sample will be taken. If no sediment is present, a surface sample at a depth of 0 to 6 in. will replace the sediment sample. Additionally, two samples will be taken at one location near the inlet pipe in each pond at the depths mentioned above. Two additional samples will be collected at the low-point within each pond at the depths mentioned above.

An additional 4 to 6 samples will be taken near the berm of each pond to help determine the lateral extent of any existing contamination. These samples will be collected on the north and south sides of the two ponds closest to the muckpile and on the north, south, and east sides of the third pond.

Proposed random sample locations are presented in Figure 4-1.

4.3 Field-Screening Levels

Field screening, along with other biasing factors, may help guide the selection of the most appropriate sampling location for collection of laboratory samples. The following field-screening levels (FSLs) may be used for on-site field screening:

- The radiological (alpha and beta/gamma) FSL of the mean background activity plus two times the standard deviation of the mean background activity collected from undisturbed locations within the vicinity of the site (Adams, 1998).
- The VOC FSL is established as 20 ppm or 2.5 times background, whichever is greater.
- The TPH FSL is established as 75 ppm.

Field-screening concentrations exceeding FSLs indicate potential contamination at that sample location. This information will be documented and the investigation may collect additional samples to delineate the extent of the contamination. Additionally, these data may be used to select confirmatory samples for submission to the laboratory.

4.4 Additional Sampling to Define Extent of Contamination

If COCs are detected, step-out sampling may be necessary to properly define the extent of contamination (i.e., contaminant boundaries). Sample locations may be determined by the vertical and/or lateral extent of initial contamination and will be based on process knowledge, site observations, field-screening data, and analytical results (if available) from Decision I samples. The target populations at step-out locations may be limited to COC concentrations above PALs for the samples that defined the nature of contamination.

For Decision I locations within the muckpile and/or pond sediments with COC concentrations above PALs, step-outs (Decision II locations) will be placed at the toe of the muckpile and/or the berms of the ponds. Decision II locations will also be selected based on pertinent features of the CSM and the other biasing factors. If biasing factors indicate a COC potentially extends beyond planned Decision II sample points, locations may be modified or additional Decision II samples may be collected from incremental step-out locations. Both surface and subsurface soil samples may be collected and analyzed to determine the extent of a COC. As field data are generated, Decision II locations may be modified, but only if the modified locations meet the decision needs and criteria stipulated in the DQOs. Laboratory analysis is the only acceptable verification that extent has been determined. In general, samples submitted for laboratory analysis will be those that define the lateral and vertical extent of COCs.

If the nature and/or extent of contamination is inconsistent with the CSM, or if contamination extends beyond the spatial boundaries identified in Section A.1.4.2 of Appendix A.1, identified decision makers will be notified and the investigation strategy will be reevaluated. As long as contamination is consistent with the CSM and is within spatial boundaries, sampling will continue to define extent.

4.5 Geotechnical/Hydrological Analysis and Bioassessment Tests

It may be necessary to measure the geotechnical/hydrological parameters of the CAS. Bioassessment samples may be collected if biasing factors suggests a petroleum plume may be present. Samples to be analyzed for these parameters will be collected within brass sleeves (or other containers, as appropriate) to maintain the natural physical characteristics of the soil. Table 4-1 lists general geotechnical and hydrological parameters of interest. The testing methods shown are minimum standards, and other equivalent or superior testing methods may be used. In some cases, bioassessment will also be performed on the sample material.

Results from geotechnical and hydrological analyses may be used to aid in the evaluation and selection of potential corrective action alternatives and/or to design engineering controls for potential corrective actions.

Bioassessment is a series of tests designed to evaluate the physical, chemical, and microbiological characteristics of a site. Bioassessment tests include determinants of nutrient availability, pH, microbial population density, and the ability of the microbial population to grow under enhanced conditions. This type of analysis is most appropriate for hydrocarbon contamination sites where bioremediation is a potential corrective action.

Table 4-1
General Geotechnical and Hydrological Analysis

Geotechnical Parameter	Methods
Initial moisture content	ASTM[a] D 2216-92
Dry bulk density	ASTM[a] D 2937-94
Calculated porosity	EM[b]-1110-2-1906 or MOSA[c] Chp. 18
Saturated hydraulic conductivity	ASTM[a] 2434-68(74) MOSA[c] Chp. 28
Unsaturated hydraulic conductivity	van Genuchten[d]
Particle-size distribution	ASTM[a] D 422-63(90)
Water-release (moisture retention) curve	MOSA[c] Chp. 26 ASTM[a] D 2325-68(94) MOSA[c] Chp. 24 Karathanasis and Hajek[e]

[a] ASTM, 1996
[b] USACE, 1970
[c] Methods of Soil Analysis (MOSA) (SSSA, 1986)
[d] van Genuchten, 1980
[e] Karathanasis and Hajek, 1982

4.6 Safety

A current version of the Environmental Services A-E Contractor's HASP will accompany the field documents, and a SSHASP will be prepared and approved prior to the field effort. As required by the DOE Integrated Safety Management System (ISMS) (DOE/NV, 1997), these documents outline the requirements for protecting the health and safety of the workers and the public, and the procedures for protecting the environment. The ISMS program requires that site personnel will reduce or eliminate the possibility of injury, illness, or accidents, and to protect the environment during all project activities. The following safety issues will be taken into consideration when evaluating the hazards and associated control procedures for field activities discussed in the SSHASP:

- Potential hazards to site personnel and the public include, but are not limited to: radionuclides, chemicals (e.g., RCRA metals, VOCs, SVOCs, and petroleum hydrocarbons), adverse and rapidly changing weather, remote location, and motor vehicle and heavy equipment operations.

- Properly train all site personnel to recognize and mitigate the anticipated hazards.

- Work controls to reduce or eliminate the hazards including engineering controls, substitution of less hazardous materials, administrative controls, and use of appropriate personal protective equipment (PPE).

- Occupational exposure monitoring to prevent overexposures to hazards such as radionuclides, chemicals, and physical agents (e.g., thermal stress, adverse weather).

- Radiological surveying for alpha/beta and gamma emitters to minimize and/or control personnel exposures; use of the "as-low-as-reasonably-achievable" principle when dealing with radiological hazards.

- Emergency communications and contingency planning, including medical care and evacuation, decontamination, spill control measures, and appropriate notification of project management.

- An engineering study will be conducted on the stability of the soil near the slope of the muckpile to ensure a safe distance for drilling. Previously conducted studies indicate that an approximately 50-ft exclusion zone will be necessary near the steep slopes. Below grade samples will not be collected within this zone.

5.0 Waste Management

Management of IDW will be based on regulatory requirements, process knowledge, field observations, and the results of laboratory analysis of CAU 552 investigation samples.

Disposable sampling 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., construction materials). Therefore, sampling and analysis of IDW, separate from analysis of site investigation samples, may not be necessary. However, if associated investigation samples are found to contain contaminants above regulatory levels, direct samples of IDW may be taken to support waste characterization.

Sanitary, hazardous, radioactive, and/or mixed waste, if generated, will be managed and disposed of in accordance with DOE Orders, U.S. Department of Transportation (DOT) regulations, state and federal waste regulations, and agreements and permits between DOE and NDEP.

In summary, all waste from CAU 552 will be evaluated as potentially characteristic, as no listed wastes have been identified. Waste generated will be characterized and disposed of using process knowledge, field observations, and analytical results in accordance with regulatory requirements.

5.1 Waste Minimization

Investigation activities are planned to minimize IDW generation. This will be accomplished by incorporating the use of process knowledge, visual examination, and/or radiological survey and swipe results. When possible, disturbed media (such as soil cuttings removed during drilling) or debris will be returned to its original location. Contained media (e.g., soil managed as waste) as well as other IDW will be segregated to the greatest extent possible to minimize generation of hazardous, radioactive, or mixed waste. Hazardous material used at the sites will be controlled in order to limit unnecessary generation of hazardous or mixed waste. Administrative controls, including decontamination procedures and waste characterization strategies, will minimize waste generated during investigations.

5.2 Potential Waste Streams

Process/historical knowledge was reviewed during the DQO process to identify suspect contaminants that may have been released at a particular site and to identify waste types that may be generated during the investigation process. The types of IDW that may be generated include low-level radioactive waste (LLW), mixed waste (LLW and hazardous waste), radioactive waste, hydrocarbon waste, hazardous waste, and sanitary waste. Investigation-derived wastes typically generated during investigation activities may include one or more of the following:

- Media (e.g., soil)
- PPE and disposable sampling equipment (e.g., plastic, paper, sample containers, aluminum foil, spoons, bowls)
- Decontamination rinsate
- Field-screening waste (e.g., soil, spent solvent, rinsate, disposable sampling equipment, and PPE contaminated by field-screening activities)
- Construction or other nonhazardous debris

Each waste stream generated will be segregated and further segregation may occur within each waste stream. Waste will be traceable to its source and associated environmental media samples.

5.3 Investigation-Derived Waste Management

The on-site management and ultimate disposition of IDW may be guided by several factors, including, but not limited to: the analytical results of samples either directly or indirectly associated with the waste, historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, and/or radiological survey/swipe results. Table 4-2 of the NV/YMP RadCon Control Manual (DOE/NV, 2000b) shall be used to determine if such materials may be declared nonradioactive. On-site IDW management requirements by waste type are detailed in the following sections. Applicable waste management regulations and requirements are listed in Table 5-1.

Table 5-1
Waste Management Regulations and Requirements

Waste Type	Federal Regulation	Additional Requirements
Solid (nonhazardous)	NA	NRS 444.440 - 444.650[a] NAC 444.570 - 444.7499[b] NTS Landfill Permit SW13.097.04[c] NTS Landfill Permit SW13.097.03[d]
Liquid/Rinsate (nonhazardous)	NA	Water Pollution Control General Permit GNEV93001, Rev. 3iii[e]
Hazardous	RCRA[f] 40 CFR 260 - 268	NRS 459.400 - 459.600[g] NAC 444.842 - 444.980[h] POC[i]
Low-Level Radioactive	NA	DOE Orders and NTSWAC[j]
Mixed	RCRA[f] 40 CFR 260 - 268	NTSWAC[j] POC[i]
Hydrocarbon	NA	NAC 445A[k] NTS Landfill Permit SW13.097.02[l]
Polychlorinated Biphenyls	TSCA[m] 40 CFR 761	NRS 459.400 - 459.600[g] NAC 444.842 - 444.980[h]
Asbestos	TSCA[n] 40 CFR 763	NRS 618.750-618.801[o] NAC 444.842 - 444.980[h]

[a] *Nevada Revised Statutes* (2003a)
[b] *Nevada Administrative Code* (2002a)
[c] Area 23 Class II Solid Waste Disposal Site (NDEP, 1997a)
[d] Area 9 Class III Solid Waste Disposal Site (NDEP, 1997c)
[e] Nevada Test Site Sewage Lagoons (NDEP, 1999)
[f] *Resource Conservation and Recovery Act* (CFR, 2003)
[g] *Nevada Revised Statutes* (2003b)
[h] *Nevada Administrative Code* (2002b)
[i] *Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995)
[j] *Nevada Test Site Waste Acceptance Criteria*, Revision 5 (NNSA/NSO, 2003)
[k] *Nevada Administrative Code* (2003)
[l] Area 6 Class III Solid Waste Disposal Site for Hydrocarbon (NDEP, 1997b)
[m] *Toxic Substance Control Act* (CFR, 2003)
[n] *Toxic Substance Control Act* (CFR, 2003)
[o] *Nevada Revised Statutes* (2003c)

NA = Not applicable
NAC = *Nevada Administrative Code*
NRS = *Nevada Revised Statutes*
NTS = Nevada Test Site
RCRA = *Resource Conservation and Recovery Act*
NTSWAC = Nevada Test Site Waste Acceptance Criteria
TSCA = *Toxic Substance Control Act*
POC = *Performance Objective for the Certification of Nonradioactive Hazardous Waste*

5.3.1 Sanitary Waste

Office trash and lunch waste will be sent to the sanitary landfill by disposal in the dumpster for future disposal at an NTS landfill.

5.3.1.1 Special Sanitary Waste

Hydrocarbon waste is defined as waste containing more than 100 milligrams per kilogram (mg/kg) of TPH contamination (NAC, 2003). Hydrocarbon waste will be managed on site in a drum or other appropriate container until fully characterized. Hydrocarbon waste may be disposed of at a designated hydrocarbon landfill (NDEP, 1997b), an appropriate hydrocarbon waste management facility (e.g., recycling facility), or other method in accordance with Nevada regulations.

Asbestos-containing materials that may be encountered or generated during this investigation will be managed and disposed of in accordance with appropriate federal (CFR, 2003) and State of Nevada (NAC, 2002b) regulations.

5.3.2 Hazardous Waste

Corrective Action Unit 552 will have waste storage areas established according to the needs of the project. Satellite accumulation areas and hazardous waste accumulation areas (HWAAs) will be managed consistent with the requirements of federal and state regulations (CFR, 2003; NAC, 2002b). The HWAAs will be properly controlled for access and equipped with spill kits and appropriate spill containment. Suspected hazardous wastes will be placed in DOT-compliant containers, and marked "Hazardous Waste Pending Analysis." All containerized waste will be handled, inspected, and managed in accordance with Title 40 Code of Federal Regulations (CFR) 265, Subpart I (CFR, 2003). These provisions include managing the waste in containers compatible with the waste type, and segregating incompatible waste types so that in the event of a spill, leak, or release, incompatible wastes shall not contact one another.

The HWAAs will be covered under a site-specific emergency response and contingency action plan until such time that the waste is determined to be nonhazardous or all containers of hazardous waste have been removed from the storage area. Hazardous wastes will be characterized in accordance with the requirements of Title 40 CFR 261. *Resource Conservation and Recovery Act* "listed" waste has not been identified at CAU 552. Any waste determined to be hazardous will be managed and transported in accordance with RCRA and DOT to a permitted treatment, storage, and disposal facility (CFR, 2003).

Management of Personal Protective Equipment - PPE and disposable sampling equipment will be visually inspected for stains, discoloration, and gross contamination as the waste is generated to determine if the waste is potentially contaminated. The PPE/equipment that is not visibly stained, discolored, or grossly contaminated will be managed as nonhazardous sanitary waste. At the discretion of the Site Supervisor (SS) and Site-Safety Officer (SSO), any IDW that is determined to be potentially contaminated will be segregated and managed as potentially "characteristic" hazardous waste. This segregated population of waste will either be: (1) assigned the characterization of the soil/sludge that was sampled, (2) sampled directly, or (3) undergo further evaluation using the soil/sludge sample results to determine how much soil/sludge would need to be present in the waste to exceed regulatory levels. Waste that is determined to be hazardous will be entered into an approved waste management system, where it will be managed and dispositioned according to RCRA requirements or subject to agreements between NNSA/NSO and the State of Nevada.

Management of Decontamination Rinsate - Rinsate at this CAU will not be considered hazardous waste unless there is evidence that the rinsate would display a RCRA characteristic. Evidence may include such things as the presence of a visible sheen, pH, or association with equipment/materials used to respond to a release/spill of a hazardous waste/substance. Decontamination rinsate that is potentially hazardous (using associated sample results and/or process knowledge) will be managed as "characteristic" hazardous waste (CFR, 2003). The regulatory status of the potentially hazardous rinsate will be determined through the application of associated sample results or through direct sampling. If determined to be hazardous, the rinsate will be entered into an approved waste management system, where it will be managed and dispositioned according to RCRA requirements or subject to agreements between NNSA/NSO and the State of Nevada. If the associated samples do not indicate the presence of hazardous constituents, then the rinsate will be considered to be nonhazardous.

The disposal of nonhazardous rinsate will be consistent with guidance established in current NNSA/NSO Fluid Management Plans for the NTS as follows:

- Rinsate that is determined to be nonhazardous and contaminated to less than 5x *Safe Drinking Water Standards* (SDWS) is not restricted as to disposal. Nonhazardous rinsate which is contaminated at 5x to 10x SDWS will be disposed of in an established infiltration basin or solidified and disposed of as sanitary waste or low-level waste in accordance with the respective sections of this document.

- Nonhazardous rinsate which is contaminated at greater than 10x SDWS will be disposed of in a lined basin or solidified and disposed of as sanitary waste or LLW in accordance with the respective sections of this document.

Management of Soil - This waste stream consists of soil produced during soil sampling, excavation, and/or drilling. This waste stream is considered to have the same COPCs as the material remaining in the ground. The preferred method for managing this waste stream is to place the material back into the borehole/excavation in the same approximate location from which it originated. If this cannot be accomplished, the material will either be managed on site by berming and covering next to the excavation, or by placement in a container(s). Containerized soil determined to be hazardous will be subject to RCRA and associated storage time requirements.

Management of Debris - This waste stream can vary depending on site conditions. Debris that requires removal for the investigation activities (e.g., soil sampling, excavation, and/or drilling) must be characterized for proper management and disposition. Historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, radiological survey/swipe results and/or the analytical results of samples either directly or indirectly associated with the waste will be used to characterize the debris. Debris will be visually inspected for stains, discoloration, and gross contamination. Debris may be deemed reusable, recyclable, sanitary waste, hazardous waste, PCB waste, or LLW. Debris determined to be hazardous will be subject to RCRA and associated storage time requirements. Waste that is not sanitary will be entered into an approved waste management system, where it will be managed and dispositioned according to federal, state requirements, and agreements between NNSA/NSO and the State of Nevada. The debris will either be managed on site by berming and covering next to the excavation or by placement in a container(s).

Field-Screening Waste - The use of field test kits and/or instruments may result in the generation of small quantities of hazardous wastes. If hazardous waste is produced by field screening, it will be segregated from other IDW and managed in accordance with the hazardous waste regulations. (CFR, 2003). On radiological sites, this may increase the potential to generate mixed waste; however, the generation of a mixed waste will be minimized as much as practicable. In the event a mixed waste is generated, the waste will be managed in accordance with the mixed waste section of this document.

5.3.3 Polychlorinated Biphenyls

The management of PCBs is governed by the TSCA and its implementing regulations at 40 CFR 761 (CFR, 2003). Polychlorinated biphenyls 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 investigation. If any type of PCB waste is generated, it will be managed according to 40 CFR 761 (CFR, 2003) as well as State of Nevada requirements (NAC, 2002b), guidance, and agreements with NNSA/NSO.

5.3.4 Low-Level Waste

Radiological swipe surveys and/or direct-scan surveys may be conducted on reusable sampling equipment and the PPE and disposable sampling equipment waste streams exiting a radiologically controlled area. This allows for the immediate segregation of radioactive waste from waste that may be unrestricted regarding radiological release. Removable contamination limits, as defined in Table 4-2 of the current version of the NV/YMP RadCon Manual (DOE/NV, 2000b), will be used to determine if such waste may be declared unrestricted regarding radiological release versus being declared radioactive waste. Direct sampling of the waste may be conducted to aid in determining if a particular waste unit (e.g., drum of soil) contains LLW, as necessary. Waste that is determined to be below the values of Table 4-2, by either direct radiological survey/swipe results or through process knowledge, will not be managed as potential radioactive waste but will be managed in accordance with the appropriate section of this document. Wastes in excess of Table 4-2 values will be managed as potential radioactive waste and be managed in accordance with this section and any other applicable sections of this document.

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 Test Site Waste Acceptance Criteria* (NTSWAC) (NNSA/NSO, 2003). Potential radioactive waste drums will be marked "Radioactive Waste Pending Analysis," and may contain soil, PPE, disposable sampling equipment, and/or rinsate may be staged at a designated radioactive materials area (RMA) when full or at the end of an investigation phase. These waste drums will remain at the RMA pending certification and disposal under NTSWAC requirements (NNSA/NSO, 2003).

5.3.5 Mixed Waste

Mixed waste, if generated, shall be managed and dispositioned according to the requirements of RCRA (CFR, 2003) or subject to agreements between NNSA/NSO and the State of Nevada, as well as DOE requirements for radioactive waste. The waste will be marked "Hazardous Waste Pending Analysis" and "Radioactive Waste Pending Analysis." 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 shall be transported via an approved hazardous waste/radioactive waste transporter to the NTS transuranic waste storage pad for storage pending treatment or disposal. Mixed waste with hazardous waste constituents below Land Disposal Restrictions may be disposed of at the NTS Area 5 RWMS if the waste meets the requirements of the NTSWAC (NNSA/NSO, 2003). Mixed waste not meeting Land Disposal Restrictions will require development of a treatment and disposal plan under the requirements of the Mutual Consent Agreement between DOE and the State of Nevada (NDEP, 1995).

6.0 Quality Assurance/Quality Control

The primary objective of the corrective action investigation described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for CASs 12-06-04 and 12-23-05 in CAU 552. Section 6.1 and Section 6.2 discuss the collection of required QC samples in the field and QA requirements for laboratory/analytical data to achieve closure. Section 6.2.9 provides QA/QC requirements for radiological survey data. Data collected during the corrective action investigation will be evaluated against DQI-specific performance criteria to verify that the DQOs established during the DQO process (Appendix A.1) have been satisfied.

Unless otherwise stated in this CAIP or required by the results of the DQO process (Appendix A.1), this investigation will adhere to the Industrial Sites QAPP (NNSA/NV, 2002).

The discussion of the DQIs, including the data sets, will be provided in the CAU 552 CADD to be developed at the completion of the corrective action investigation.

6.1 Quality Control Field 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 sample results. The number of required QC samples depends on the types and number of environmental samples collected. The minimum frequency of collecting and analyzing QC samples for this investigation, as determined in the DQO process, include:

- Trip blanks (one per sample cooler containing VOC environmental samples)
- Equipment blanks (one per sampling event for each type of decontamination procedure)
- Source blanks (one per lot of source material that contacts sampled media)
- Field duplicates (minimum of 1 per matrix per 20 environmental samples)
- Field blanks (minimum of 1 per 20 environmental samples)
- Matrix spike (MS)/matrix spike duplicate (MSD) (minimum of 1 each per matrix per 20 environmental samples), as required by method.

Additional QC samples may be submitted based on site conditions at the discretion of the Site Supervisor. Field QC samples shall be analyzed using the same analytical procedures implemented for associated environmental samples. Additional details regarding field QC samples are available in the Industrial Sites QAPP (NNSA/NV, 2002).

6.2 Laboratory/Analytical Quality Assurance

Criteria for the investigation, as stated in the DQOs (Appendix A.1) and except where noted, require laboratory analytical quality data be used for making critical 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 Industrial Sites QAPP (NNSA/NV, 2002), except where otherwise stipulated in this CAIP. All nonradiological laboratory data from samples collected and analyzed will be evaluated for data quality according to *EPA Functional Guidelines* (EPA, 1994a and 1999). Radiological laboratory data from samples that are collected and analyzed will be evaluated for data quality according to company-specific procedures. The data will be reviewed to ensure that all critical samples were appropriately collected, analyzed, and the results passed data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine if they 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

Data quality indicators are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. The principal DQIs are precision, accuracy, representativeness, comparability, and completeness. A sixth DQI, sensitivity, has also been included for the CAU 552 investigation. Data quality indicators 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).

Precision and accuracy are quantitative measures used to assess overall analytical method and field sampling performance as well as to assess the need to "flag" (qualify) individual parameter results when corresponding QC sample results are not within established control limits. Therefore, performance metrics have been established for both analytical methods and individual analytical results. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the parameter performance criteria based on assessment of the data.

Representativeness and comparability are qualitative measures, and completeness is a combination of both quantitative and qualitative measures. Representativeness, comparability, and completeness are used to assess the measurement system performance. The DQI parameters are individually discussed in Section 6.2.3 through Section 6.2.8.

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 Industrial Sites QAPP (NNSA/NV, 2002) documents the actions required to correct conditions that adversely affect data quality both in the field and the laboratory. All DQI performance criteria deficiencies will be evaluated for data usability and impacts to the DQO decisions. These evaluations will be discussed and documented in the data assessment section of the CADD. The following subsections discuss each of the DQIs that will be used to assess the quality of laboratory data.

6.2.3 Precision

Precision is used to assess the variability of a population of measurements with the variability of the analysis process. It is used to evaluate the performance of analytical methods as well as to evaluate the usability of individual analytical results. Precision is a measure of agreement among a replicate set of measurements of the same property under similar conditions. This agreement is expressed as the relative percent difference (RPD) between duplicate measurements. The method used to calculate RPD is presented in the Industrial Sites QAPP (NNSA/NV, 2002).

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 is treated independently of the original sample in order to assess field impacts and laboratory performance on precision

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 552 Data Quality Indicators

Data Quality Indicator	Performance Criteria	Potential Impact on Decision if Performance Criteria Not Met
Precision	Variations between duplicates (laboratory and field) and original sample should not exceed analytical method-specific criteria discussed in Section 6.2.3.	Data that do not meet the performance criteria will be evaluated for purposes of completeness. Decisions may not be valid if analytical method performance criteria for precision are not met.
Accuracy	Laboratory control sample results, matrix spike results, and surrogate results should be within specified acceptance windows.	Data that do not meet the performance criteria will be evaluated for purposes of completeness. Decisions may not be valid if analytical method performance criteria for accuracy are not met.
Sensitivity	Detection limits of laboratory instruments must be less than or equal to respective PALs.	Cannot determine if COCs are present or migrating at levels of concern; therefore, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives.
Comparability	Equivalent samples analyzed using the same analytical methods, the same units of measurement and detection limits must be used for like analyses.	Inability to combine data with data obtained from other sources and/or inability to compare data to regulatory action levels.
Representativeness	Correct analytical method performed for appropriate COPC; valid data reflects appropriate target population.	Cannot identify COC or estimate concentration of COC; therefore, cannot make decision(s) on target population.
Nature Completeness	80% of the CAS-specific possible analytes identified in the CAIP have valid results. 90% of suspected analytes are valid.	Evaluate whether a decision can be made on whether COCs are present.
Extent Completeness	90% of identified COCs used to define extent of contamination are valid.	Extent of contamination cannot be determined.
Clean Closure Completeness	100% of identified COCs are valid.	Cannot determine if COCs remain in soil.

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 include MSD and laboratory control sample (LCS) duplicate samples for organic, inorganic, and radiological analyses.

6.2.3.1 Precision for Chemical Analysis

The RPD criteria to be used for assessment of precision are the parameter-specific criteria listed in Table 3-2. When laboratory-specific control limits are indicated, they are based on the evaluation at the laboratory on a quarterly basis by monitoring the historical data and performance for each method. No review criteria for field duplicate RPD comparability have been established; therefore, the laboratory sample duplicate criteria will be applied to the review of field duplicates.

The parameter performance criteria for precision will be compared to RPD results of duplicate samples. This will be accomplished as part of the data validation process. Precision values for organic and inorganic analyses that are within the established control criteria indicate that analytical results for associated samples are valid. The RPD values that are outside the criteria for organic analysis 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. For the purpose of data validation of inorganic analyses, precision is measured in two ways. The RPD is calculated when the sample and its duplicate results are greater than five times the contract-required detection limit (CRDL). The absolute difference is calculated and applied to the CRDL when the results are less than five times the CRDL. Inorganic laboratory sample duplicate RPD values outside the established control criteria result in the qualification of associated analytical results as estimated; however, qualified data does not necessarily indicate that the data are not useful for the purpose intended. This qualification is an indication that data precision should be considered for the overall assessment of the data quality and potential impact on data applicability in meeting site characterization objectives.

The criteria to evaluate analytical method performance for precision (Table 3-2) will be assessed based on the analytical method-specific (e.g., VOCs) precision measurements. The analytical method-specific precision measurement is calculated by taking the number of analyses meeting the RPD criteria, dividing that by the total number of analyses with detectable concentrations, and multiplying by 100. Each analytical method-specific precision measurement will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.3.2 Precision for Radiochemical Analysis

The parameter performance criteria for precision will be compared to the RPD or normalized difference (ND) results of duplicate samples. The criteria for assessment of the radiochemical precision are parameter-specific criteria (see Table 3-2). This assessment will be accomplished as part of the data validation process. Precision values that are within the established control criteria indicate that analytical results for associated samples are valid. Out of control RPD or ND values do not necessarily indicate that the data are not useful for the purpose intended; however, it is an indication that data precision should be considered for the overall assessment of the data quality and the potential impact on data applicability in meeting site characterization objectives.

If the RPD or ND criteria are exceeded, samples will be qualified. Field duplicates will be evaluated, but field samples will not be qualified based on their results. The MSD results outside of the control limits may not result in qualification of the data. An assessment of the entire analytical process, including the sample matrix, is conducted to determine if qualification is warranted.

The evaluation of precision based on duplicate RPD requires that both the sample and its duplicate have concentrations of the target radionuclide exceeding five times their MDC. This excludes many measurements because the samples contain nondetectable or low levels of the target radionuclide. However, the ND method may be used for evaluating duplicate data where the results are less than five times their MDCs. This is based on the measurement uncertainty associated with low-level results. The ND test is calculated using the following formula:

Normalized Difference = $$S - D / \sqrt{(TPU_S)^2 + (TPU_D)^2}$$

Where:

S = Sample Result
D = Duplicate Result
TPU = Total Propagated Uncertainty
TPUs = 2 sigma TPU of the sample
TPUd = 2 sigma TPU of the duplicate

The control limit for the normalized difference is -1.96 to 1.96, which represents a confidence level of 95 percent.

The criteria to evaluate analytical method performance for precision (Table 3-3) will be based on the analytical method-specific (e.g., gamma spectrometry) precision measurements. Analytical method-specific precision measurement is calculated by taking the number of analyses meeting the RPD or ND criteria, dividing that by the total number of analyses, and multiplying by 100. Each analytical method-specific precision measurement will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.4 Accuracy/Bias

Accuracy is a measure of the closeness of an individual measurement or the average of a number of measurements to the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that result from sampling and analytical operations. It is used to assess the performance of laboratory measurement processes as well as to evaluate individual groups of analyses (i.e., sample delivery groups).

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). The measure of accuracy is expressed as the %R (NNSA/NV, 2002). This is calculated by dividing the measured sample concentration by the true concentration and multiplying the quotient by 100.

6.2.4.1 Accuracy for Chemical Analyses

The %R criteria to be used for assessment of accuracy are the parameter-specific criteria listed in Table 3-2. Accuracy for chemical analyses will be evaluated based on results from three types of spiked samples: MS, LCS, and surrogates. Matrix spike samples are prepared by adding a known concentration of a target parameter to a specified amount of matrix sample for which an independent estimate of the target parameter concentration is available. Laboratory control samples are prepared by adding a known concentration of a target parameter to a “clean” sample matrix (does not contain the target parameter). Surrogate samples are prepared by adding known concentrations of specific organic compounds to each sample analyzed for organic analyses (including QC samples).

For organic analyses, laboratory control limits are used for evaluation of %R. They are reevaluated quarterly at the laboratory by monitoring the historical data and performance for each method. The acceptable control limits for inorganic analyses are established in the EPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 1994a).

The %R parameter performance criteria for accuracy will be compared to %R results of spiked samples. This will be accomplished as part of the data validation process. Accuracy values for organic and inorganic analysis that are within the established control criteria indicate that analytical results for associated samples are valid. The %R values that are outside the 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 the laboratory's control, such as sample matrix effects, can cause the measured values to be outside of the established criteria. Therefore, the entire sampling and analytical process must be evaluated when determining the quality of the analytical data provided.

The criteria to evaluate analytical method performance for accuracy (Table 3-2) will be based on the analytical method-specific (e.g., VOCs) accuracy measurements. The analytical method-specific accuracy measurement is calculated by taking the number of analyses meeting the %R criteria, dividing that by the total number of analyses, and multiplying by 100. Each analytical method-specific accuracy measurement will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.4.2 Accuracy for Radiochemical Analysis

Accuracy for radiochemical analyses will be evaluated based on results from LCS and MS samples. The LCS is prepared by adding a known concentration of the radionuclide being measured to a sample that does not contain radioactivity (i.e., distilled water). This sample is analyzed with the field samples using the same sample preparation, reagents, and analytical methods employed for the samples. One LCS is prepared with each batch of samples for analysis by a specific measurement.

The MS samples are prepared by adding a known concentration of a target parameter to a specified field sample with a measured concentration. The MS samples are analyzed to determine if the measurement accuracy is affected by the sample matrix. The MS samples are analyzed with sample batches when requested.

The %R criteria to be used for assessment of accuracy will be the control limits for radiochemical analyses listed in Table 3-2. These criteria will be used to assess qualification of data associated with each spiked sample. This will be accomplished as part of the data validation process. Accuracy values that are within the established control criteria indicate that analytical results for associated samples are valid.

The criteria to evaluate analytical method performance for accuracy (Table 6-1) will be assessed based on the analytical method-specific (e.g., gamma spectrometry) accuracy measurements. The analytical method-specific accuracy measurement is calculated by taking the number of analyses meeting the %R criteria, dividing that by the total number of analyses, and multiplying by 100. Each analytical method-specific accuracy performance will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.5 Representativeness

Representativeness is a qualitative evaluation of measurement system performance. It is the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition (EPA, 1987). Representativeness is assured by a carefully developed sampling strategy, collecting the specified number of samples from proper sampling locations, and analyzing them by the approved analytical methods. An evaluation of this qualitative criterion will be presented in the CADD.

6.2.6 Completeness

Completeness is a quantitative and qualitative evaluation of measurement system performance. The criterion for meeting completeness is defined as generating sufficient data of the appropriate quality to satisfy the data needs identified in the DQOs. 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. Percent completeness is determined by dividing the total number of valid analyses by the total number of analyses required to meet DQO data needs and multiplying by 100. Problems that may affect completeness include the total number of samples sent to the laboratory but not analyzed due to problems with samples (e.g., broken bottles, insufficient quantity, insufficient preservation), samples that were collected and sent but never received by the laboratory, and rejected data. If these criteria are not achieved, the dataset will be assessed for potential impacts on meeting site characterization objectives, and additional samples will be collected if determined necessary to meet the characterization objectives.

The qualitative criterion for evaluation of measurement system performance is that sufficient data of the appropriate quality have been generated to satisfy the data needs identified in the DQOs. An evaluation of this qualitative criterion will be presented in the CADD.

6.2.7 Comparability

Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared to another (EPA, 1987). To ensure comparability, all samples will be subjected to the same sampling, handling, preparation, analysis, reporting, and validation criteria. Approved standard methods and procedures will also be used to analyze and report the data (e.g., Contract Laboratory Program [CLP] and/or CLP-like data packages). This approach ensures that the data from this project can be compared to regulatory action levels. An evaluation of this qualitative criterion 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, 2001). The evaluation criteria for this parameter will be that measurement sensitivity (detection limits) will be less than or equal to the corresponding PALs. To ensure that the MRLs are consistent with the corresponding PALs, the MRLs from requested analytical methods for each COPC are compared to the EPA Region 9 PRGs. Equally, the MDC from radiochemistry analytical methods are compared with the accepted established PALs based on NCRP (1999) and DOE (1993) established levels. If this criterion is not achieved, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives.

6.2.9 Radiological Survey Quality Assurance

Radiological surveys will be performed and data collected in accordance with approved standard operating procedures.

7.0 Duration and Records Availability

7.1 Duration

After the submittal of the CAIP to NDEP (FFACO milestone is April 6, 2004), the following is a tentative schedule of activities (in calendar days):

- Day 0: Preparation for field work will begin.
- Day 120: The field work will commence. Samples will be shipped to meet laboratory holding times.
- Day 200: The field investigation will be completed.
- Day 260: The quality-assured laboratory analytical data will be available for NDEP review.
- The FFACO date for the CADD is September 16, 2004.

7.2 Records Availability

Historic information and documents referenced in this plan are retained in the NNSA/NSO project files in Las Vegas, Nevada, and can be obtained through written request to the NNSA/NSO Project Manager. This document is available in the DOE public reading rooms located in Las Vegas and Carson City, Nevada, or by contacting the DOE Project Manager. The NDEP maintains the official Administrative Record for all activities conducted under the auspices of the FFACO.

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Appendix A.1

Data Quality Objectives

A.1 Seven-Step DQO Process for CAU 552 Investigation

The DQO process described in this appendix is a seven-step strategic planning approach based on the scientific method that was used to plan data collection activities at CAU 552, Area 12 Muckpile and Ponds, located adjacent to G-Tunnel. The DQOs are designed to ensure the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend the recommended corrective actions (i.e., no further action, close in place, or clean closure). Existing information about the nature and extent of contamination at the two CASs in CAU 552 is insufficient to evaluate and select preferred corrective actions; therefore, a CAI will be conducted.

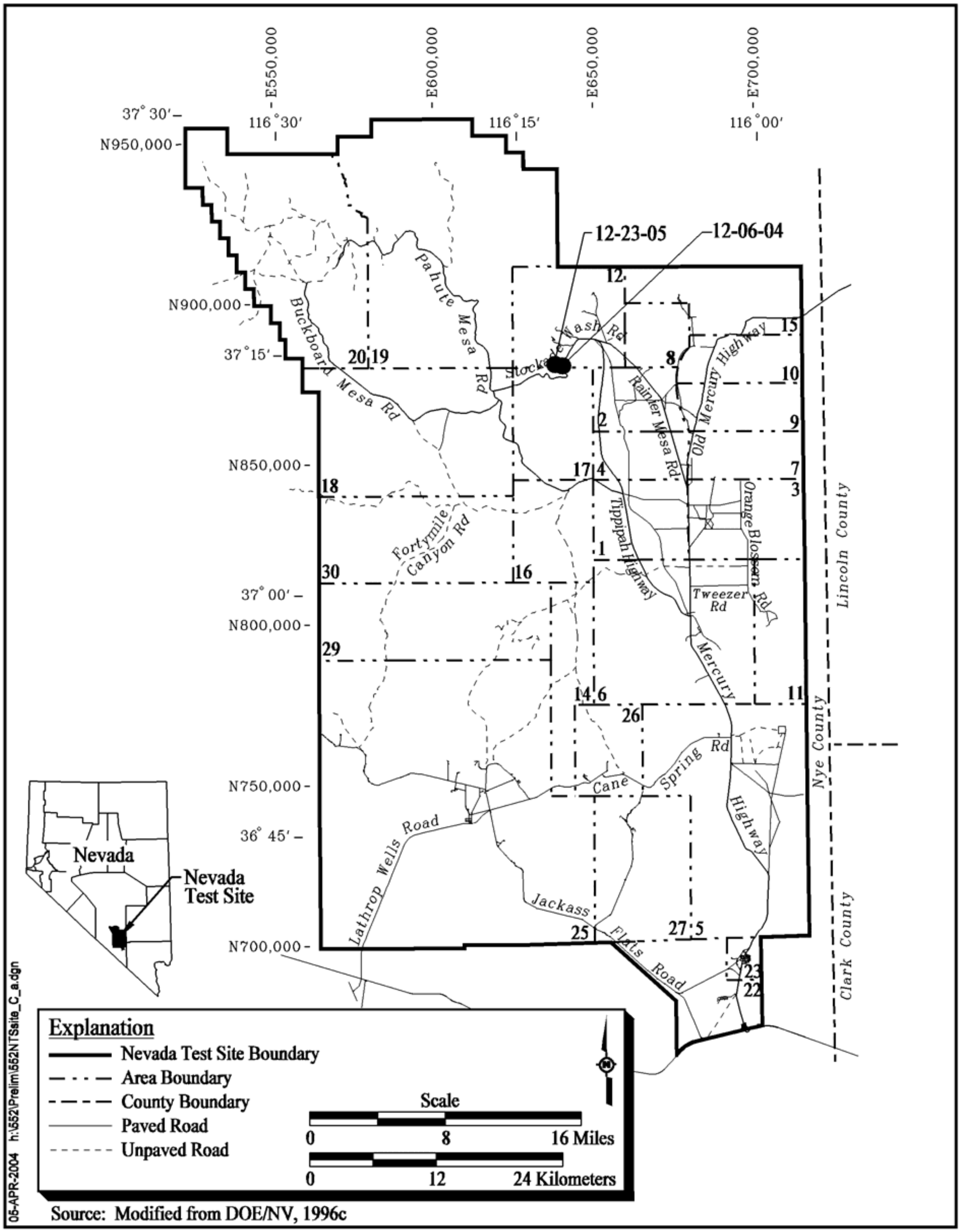
The CAU 552 investigation will be based on the DQOs presented in this appendix as developed by representatives of NDEP and NNSA/NSO. The seven steps of the DQO process developed for CAU 552 and presented in Sections A.1.2 through A.1.8, were developed based on the CAS-specific information presented in Section A.1.1 and in accordance with *EPA Guidance for Quality Assurance Project Plans EPA QA/G-5* (EPA, 2002a). This document identifies and references the associated EPA Quality System Documents entitled *Data Quality Objectives Process for Hazardous Waste Site Investigations* (EPA, 2000a) and *Guidance on Choosing a Sampling Design for Environmental Data Collect* (EPA, 2000b) upon which the DQO process presented herein is based.

A.1.1 CAS-Specific Information

Corrective Action Unit 552 is located east of the G-Tunnel portal in Area 12 of the NTS as shown in Figure A.1-1. Corrective Action Unit 552 consists of the following two CASs:

- 12-06-04, Muckpile
- 12-23-05, Ponds

Five documented nuclear tests were conducted in G-Tunnel over a period of nine years, beginning in 1962. The CAS-specific COPCs are described in the following CAS descriptions and listed in Table A.1-1. Suspected COPCs are defined as those contaminants that are known or expected to be present within a CAS. Possible COPCs are defined as classes of contaminants (e.g., VOCs) that include all the analytes reported from the respective analytical methods that have PALs listed in Section A.1.4.2. The possible COPCs also aid in reducing the uncertainity concerning the history and



Source: Modified from DOE/NV, 1996c

Figure A.1-1
CAU 552 Location Map

Table A.1-1
Contaminants of Potential Concern for CAU 552

Chemical		Radiological	
Suspected Contaminants of Potential Concern	Arsenic	Suspected Contaminants of Potential Concern	Cesium-137
	Barium		Cobalt-60
	Beryllium		Plutonium-238
	Lead		Plutonium-239/240
	4-Methyl 2-Pentanone		Strontium-90
	1,1,1-Trichloroethane		
	Ethylbenzene		
	Methylene Chloride		
	Tetrachloroethane		
	Toluene		
	Xylenes		
	TPH-DRO		
Possible Contaminants of Potential Concern	RCRA Metals	Possible Contaminants of Potential Concern	Man-Made Radionuclides
	VOCs		
	SVOCs		
	PCBs		
	TPH-GRO		

potential release from the CAS and help in the accurate evaluation of potential contamination. If any COPC is detected in a sample at a concentration above a PAL, the COPC will be identified as a COC. If a COC is identified, the CAS containing that COC will be further investigated to determine the extent of contamination. Due to the interconnection of the two CASs at CAU 552, the same COPCs are assumed to exist in both CASs.

A.1.1.1 CAS 12-06-04, Muckpile

Corrective Action Site 12-06-04 consists of the muckpile located outside of the tunnel. The muck resulted from the activities conducted at the tunnel including drilling, tunnel development, cutback operations, and reentry mining. The reentry mining was conducted following nuclear tests, and excavated muck produced by the underground detonations, thus introducing potentially radioactively contaminated muck into the muckpile. It is not clear from historical documentation which parts of the muckpile contain this potentially contaminated muck.

A.1.1.2 CAS 12-23-05, Ponds

Corrective Action Site 12-23-05 consists of three ponds located at the base of the muckpile. The ponds are a result of activities at G-Tunnel. Effluent was the result of encountering saturated fractures and perched water during tunnel construction and minebacks. According to sources interviewed during the PA process, all three ponds have been dry since the mid-1980s. The toe of the muckpile extends into one of the three ponds causing an overlap of the two CASs.

No prior sampling of the muckpile or ponds has been conducted. However, it is possible that the muckpile and ponds may contain radioactive material from testing activities conducted within G-Tunnel. There is also the potential for buried material to exist in the muckpile.

Scope of CAS - The scope of each of these CASs consists of the muckpile or ponds and potential contamination that may be migrating from the muck or pond sediment into the surrounding area. The scope of these CASs does not include the areas within the tunnel portals and/or support areas that are not on the muckpile, except where specifically called out. The determination of the nature and extent of possible contamination will be limited to releases from sources within the CAS boundary (i.e., footprint of the muckpile and berms of the ponds). The investigation of widespread radiological contamination associated with fallout from activities conducted at the NTS, including radiological contamination beyond the footprint of the muckpile and ponds for which the source of contamination is breaches of tunnel containment systems, will not be a part of this investigation.

Physical Setting and Operational History - Corrective Action Unit 552 was first identified in the 1991 REECo document entitled, *Nevada Test Site Inventory of Inactive and Abandoned Facilities and Waste Sites*.

The U-12g Tunnel, also known as G-Tunnel, is located in Area 12 of the NTS to the east of Rainier Mesa. Five nuclear tests, spanning a period of nine years, were conducted in G-Tunnel. The first test was conducted in 1962. Testing at G-Tunnel consisted of one weapons-related test and four weapons-effects tests. Each test was less than 20 kilotons. Three of these tests had documented releases breach the tunnel containment systems, and a fourth had a documented release during drill-back operations, potentially contaminating areas outside of the tunnel (DOE/NV, 1996a and 2000).

Sources of Potential Contamination - Activities associated with the nuclear tests conducted within G-Tunnel are the sources of potential chemical and radioactive contamination. Corrective Action Site 12-06-04, Muckpile, was created as a result of tunneling activities within G-Tunnel. The muckpile also contains debris removed from the tunnel following nuclear weapon tests, resulting in the potential for buried radioactive material. In addition, there are several drums with unknown contents partially buried in the muckpile. Corrective Action Site 12-23-05, Ponds, consists of three ponds constructed to contain the water from G-Tunnel. It is possible the ponds also collected radioactive effluent produced during and following nuclear weapons testing, resulting in the potential for radioactive contamination. Because of erosion and precipitation run-off, the base of the muckpile has spread into the closest pond, causing an overlap between these two CASs. There is potential for hydrocarbon contamination resulting from possible oil or fuel leaks from heavy equipment associated with G-Tunnel activities. There is also a potential for chemical contamination due to spills during site operations.

Previous Investigation Results - No previous sampling has been conducted at CAU 552. During the PA investigation, a letter was found detailing a soil investigation conducted in 1991 of the G- and T-tunnels at NTS. The letter from O.L. Haworth (REECo) to S.W. Goodin (DNA) discusses the analysis of soil samples from the G- and T-Tunnel portals. The samples were analyzed for both chemical and radiological components. The analyses showed the soils at both tunnel portals contained trace amounts of organic chemicals and artificially introduced radioactive elements. The chlorinated organic chemicals found are most likely the result of spillage of degreasing compounds that contained methylene chloride, tetrachloroethane, and 1,1,1-trichloroethane. The nonchlorinated organic chemicals toluene, ethylbenzene, xylenes, and 4-methyl-2-pentanone, may be the result of fuel or motor oil spillage. Acetone was also found in the portal soils; however, the presence of acetone in soil samples is often due to laboratory contamination of the sample. Both natural and artificially introduced radionuclides were present in the samples (Haworth, 1991). The actual analytical data was not located. The G-Tunnel portal is adjacent to the CAU 552 muckpile.

Several investigations of similar muckpiles and ponds have been completed at NTS. The radiological results of the investigations of CAUs 475, 476, 477, 478, 480, 482, and 504 are summarized in Table A.1-2. The only chemical contaminants found during these investigations are TPH-DRO, lead, and arsenic. TPH-DRO was found above PAL in 18 samples at a maximum concentration of 10,000 ppm; lead in 2 samples at a maximum concentration of 59,700 ppm; arsenic in over 40 samples at a maximum concentration of 38.8 ppm.

Another document entitled, *Radiological Effluents Released from U.S. Continental Tests 1961 through 1992* (DOE/NV, 1996a)*,* describes several containment breaches of radioactive isotopes through the portal and tunnel vent system. The document provides data on the amounts and types of radioactive material released in breaches or during drill-back operations that occurred during four of the five tests at G-Tunnel. The fission products released during these breaches, krypton, xenon-133 and -135, iodine-131/133/135, rhodium-106, and rubidium-103 and -106, are all short lived and have decayed to undetectable levels since their release.

Potential Contamination - Due to the interconnection of the two CASs (12-06-04 and 12-23-05) within CAU 552, the same COPCs are assumed to exist in both areas. The chemical COPCs are metals, TPH, VOCs, SVOCs, and PCBs. These chemicals may exist at the site as a result of industrial activities associated with G-Tunnel. Debris and effluent from the five documented nuclear weapons tests in G-Tunnel are the potential sources of the radiological COPCs. The scope of this investigation is to determine the nature and extent of contamination at CAU 552.

A.1.2 Step 1 – State the Problem

This initial step of the DQO process identifies the planning team members and decision-makers, describes the problem that has initiated the CAU 552 CAI, and develops the CSMs.

A.1.2.1 Planning Team Members

The DQO planning team consists of representatives from NDEP, NNSA/NSO, the Stoller-Navarro Joint Venture (SNJV), and Bechtel Nevada (BN). The primary decision-makers include NDEP and NNSA/NSO representatives. Table A.1-3 lists representatives from each organization in attendance at the December 11, 2003, DQO planning meeting.

Table A.1-2
Previous Investigation Results

CAU	Actinium-228		Americium-241		Bismuth-212		Cobalt-60		Cesium-137		Lead-212		Lead-214		Plutonium-238		Plutonium-239	
	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]	# of Samples above PALs	Maximum Concentration[b]
475	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
476	1	5.8	0	NA	1	5.6	1	1.76	6	382	0	NA	0	NA	0	NA	1	9.6
477	0	NA	0	NA	0	NA	0	NA	1	1,340	1	31.3	2	6.9	0	NA	0	NA
478	0	NA	1	11	3	6.2	0	NA	41	366	0	NA	0	NA	0	NA	13	79
480	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
482	0	NA	3	182	0	NA	0	NA	23	3050	0	NA	0	NA	0	NA	0	NA
504	0	NA	0	NA	0	NA	1	5.3	35	1770	0	NA	0	NA	1	20.2	5	122
Total/ max[a]	1	5.8	4	182	4	6.2	2	5.3	106	3050	1	31.3	2	6.9	1	20.2	19	122

[a] The first row for each COC represents the total number of samples found above PAL in all CAUs for that particular COC. The second row contains the overall maximum concentration in all investigations.

[b] All Concentrations are in pCi/g

Table A.1-3
DQO Meeting Participants

Participant	Affiliation
Kevin Cabble	NNSA/NSO
Mike Kinney	SNJV
Dave Schrock	SNJV
Joe Hutchinson	SNJV
Brian Hoenes	SNJV
Marko Suput	SNJV
Shaughn Burnison	BN
Rob Boehlecke	SNJV
Jeanne Wightman	SNJV
Greg Raab	NDEP

BN – Bechtel Nevada
SNJV – Stoller-Navarro Joint Venture
NDEP – Nevada Division of Environmental Protection
NNSA/NSO – U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office

A.1.2.2 Describe the Problem

Corrective Action Unit 552 is being investigated because the two CASs within the CAU may contain chemical and radiological contaminants, which could potentially pose a threat to human health and the environment.

The problem statement for CAU 552 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CASs 12-06-04 and 12-23-05."

A.1.2.3 Develop Conceptual Site Models

One CSM has been developed for CAU 552 using information from the physical setting, potential contaminant sources, knowledge from similar sites, release information, historical background information, and physical and chemical properties of the potentially affected media and COPCs. The applicability of the following CSM to each of the two overlapping CASs is discussed below. A CSM describes the most probable scenario for current conditions at a CAS and defines the assumptions that are the basis for identifying appropriate sampling strategies and data collection methods. It is the basis for assessing how contaminants could reach receptors both in the present and future by addressing contaminant nature and extent, transport mechanisms and pathways, potential receptors, and potential exposures to those receptors. Accurate CSMs are important because they serve as the starting point for all subsequent inputs and decisions throughout the DQO process. The two CASs in CAU 552 were originally constructed side-by-side; however, part of the muckpile (CAS 12-06-04) has eroded into one of the three ponds at CAS 12-23-05. This interconnection suggests that shared potential migration pathways exist for both CASs. Therefore, a single CSM has been developed for both CASs within CAU 552.

An important element of a CSM is the expected fate and transport of contaminants, which infers how contaminants move through site media and where they can be expected in the environment. The expected fate and transport is based on distinguishing physical and chemical characteristics of the suspected contaminants and media. Contaminant characteristics include solubility, density, and particle size. Media characteristics include permeability, saturation, sorting, chemical composition, and adsorption coefficients. In general, contaminants with low solubility and high density can be expected to be found relatively close to release points. Contaminants with high solubility and low density are more susceptible to factors that can move them through various media; therefore, they can be expected to be found further from release points.

Contaminants migrating to regional aquifers are not considered a likely scenario at CAU 552 based on the low annual average precipitation rates, high potential evapotranspiration, and low mobility of expected COPCs.

The CSM is shown in Figure A.1-2 and discussed in the following paragraphs.

If additional areas or elements are identified during the CAI that go beyond the area or situation identified for investigation in the CSM, the situation will be reviewed and recommendations will be made to revise Step 4 (Define the Study Boundaries) of the DQO process and/or revise the sampling approach. The DQOs will be reviewed and any significant deviation from the planned approach will be presented to the decision makers for approval.

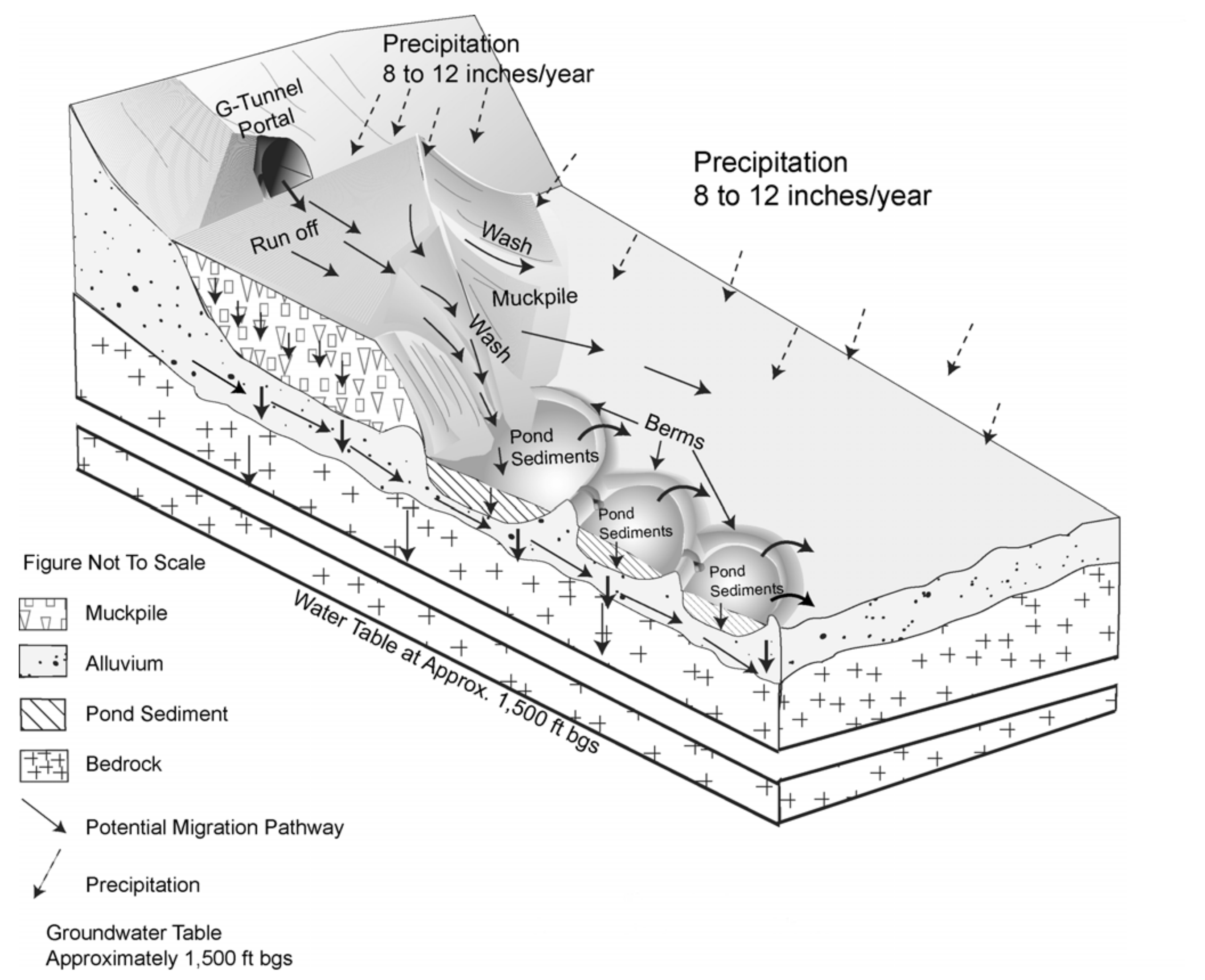


Figure A.1-2
CAU 552 Conceptual Site Model

The following discussion of the CSM parameters provides additional details to supplement this model.

Exposure Scenario - The potential for exposure to contamination at the CAU 552 CASs is limited to industrial and construction workers as well as military personnel conducting training (DOE/NV, 1998). These human receptors may be exposed to COPCs through ingestion, inhalation, dermal contact (absorption) from soil and/or debris (e.g., equipment, concrete) due to inadvertent disturbance of these materials. The future land-use scenario limits uses of the CAU to various nonresidential uses (i.e., industrial uses) including defense and nondefense research, development, and testing activities (Table A.1-4). The Nuclear Test Zone referenced in the table is defined as: ". . . reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests" (DOE/NV, 1998).

Table A.1-4
Future Land-Use Scenarios for CASs 12-06-04 and 12-23-05 Within CAU 552

Land-Use Zone	Zone Description
Nuclear and High Explosives Test Zone	This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high explosives tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

Affected Media - The potentially affected media at CASs 12-06-04 and 12-23-05 are the muckpile, surface soils, and shallow subsurface soils. Deep subsurface soils and groundwater are not believed to have been affected by the COPCs.

Contamination/Release - Contamination could potentially be found in any part of the muckpile (CAS 12-06-04) and in the surface and shallow subsurface sediments/soils of the ponds (CAS 12-23-05). There is also a potential for contamination in the shallow subsurface soils at the muckpile/native soil interface, and at the base of the muckpile, due to erosion and contaminant transport. The muckpile was constructed on top of native soil.

Transport Mechanisms - The degree of contaminant migration at this site is unknown but is assumed to be minimal based on the affinity of the COPCs for soil particles, and the low precipitation and high evapotranspiration rates typical of the NTS environment. Run-off from the muckpile down one of several washes could cause lateral migration of contaminants over the ground surface. Contaminants may also have been transported by infiltration and percolation of precipitation through soil, which would serve as the primary driving force for downward migration. The migration of organic constituents (e.g., petroleum hydrocarbons, chlorinated solvents) can be controlled to some extent by their affinity for organic material present in soil. However, this mechanism is considered insignificant because of the lack of organic carbon in the muck and the desert soil in Area 12. Migration of certain inorganic constituents (e.g., metals in waste oil) is controlled by geochemical processes such as adsorption, ion exchange, and precipitation of solids from solution.

Because of the low volatility of the suspected contaminants, an airborne release subsequent to the initial contaminant release is not considered a significant release pathway. The main process of migration through the air would be through windblown dust. If VOCs, SVOCs, metals, or petroleum hydrocarbons adsorbed to the fine soil particles, a small amount of migration could be expected via the airborne pathway. This process could allow for the deposition of contaminants beyond the site boundaries. For all transport mechanisms, it would be expected that contaminant levels decrease with distance from the point of release.

Preferential Pathways - Preferential pathways for contaminant migration at CASs 12-06-04 and 12-23-05 are not expected to be present or only have had a minor impact on contaminant migration. The presence of relatively impermeable layers (e.g., caliche layers) modify transport pathways both on the ground surface and in the shallow subsurface. Small gullies and washes could channelize run-off and increase lateral transport prior to infiltration. Precipitation may wash contaminants from the muckpile down into the overlapping pond or the surrounding soil. Contamination could travel laterally to a small degree. Although the preferential pathways for contaminant migration were considered in the development of sampling schemes and sampling contingencies discussed in the CAIP, primary consideration was given to the release and transport mechanisms.

Lateral and Vertical Extent of Contamination - If contamination is present, it is expected to be confined to the surface and shallow subsurface at the site. Concentrations of contamination are expected to decrease with distance (both horizontally and vertically) from the release points. Surface migration may occur as a result of storm events when precipitation rates exceed infiltration (stormwater run-off). However, these events are infrequent. Surface migration is a biasing factor considered in the selection of sampling points. As stated previously, downward contaminant transport is expected to be limited but is unknown because the quantities of hazardous material released are unknown.

Migration of contamination for any potential release scenarios would be expected to be primarily downward through the muckpile and ponds, with horizontal migration to a much lesser extent. Minor amounts of lateral migration may occur due to periodic stormwater run-off and due to muckpile material migrating down washes during precipitation events.

Groundwater contamination is not considered a likely scenario at CAU 552, due to minimal precipitation, high evapotranspiration, strong attenuation of suspected contaminants in the soil, and significant depths to groundwater. For example, depth to groundwater in nearby Well E-12-1 has been recorded at a depth of 1,526.71 ft bgs (USGS, 2003).

Previous investigations of similar muckpiles and ponds have not identified vertical migration of contaminants beyond 4.5 ft below the muck and/or sediment interface with native soil.

A.1.3 Step 2 – Identify the Decision

Step 2 of the DQO process identifies the decision statements and defines alternative actions. Also presented in this section is the decision logic for the entire process.

A.1.3.1 Develop Decision Statements

The primary problem statement is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CASs 12-06-04 and 12-23-05." Because existing information at this CAU is insufficient to resolve the problem statement, the following two decision statements have been established as criteria for determining the adequacy of the data collected during the CAI.

- Decision I is to "Identify the contamination" by identifying contaminant concentrations above PALs. Analytical data must be collected from areas most likely to contain contamination resulting from site activities, and parameters must be selected that represent the types of potential contamination present. If PALs are not exceeded, the investigation is complete. If PALs are exceeded, Decision II must be resolved.

- Decision II is to “Determine the extent of contamination identified above PALs.” This decision will be achieved by the collection of data that are adequate to define the extent of COCs.

Decision II samples are used to determine the lateral and vertical extent of the contamination as well as the likeliness of COCs to migrate outside of the site boundaries. The migration pattern can be derived from the Decision II samples, since the analytical results of those samples will show how far the contamination has travelled in the time period since activities at the site ended.

A.1.3.2 Alternative Actions to the Decision

If a COPC is not present, further assessment of that COPC in the CAS is not required. If a COC is present, resolve Decision II.

The alternatives for Decision II are: “If the extent and migration of a COC is defined in both the lateral and vertical direction, further assessment of the CAS is not required. If the extent of a COC is not defined, reevaluate site conditions and collect additional samples.”

A.1.4 Step 3 – Identify the Inputs to the Decisions

This step identifies the information needed, determines sources for information, determines the basis for establishing action levels, and identifies sampling and analysis methods that can meet the data requirements. To determine if a COC is present, each sample result or population parameter (Section A.1.6.1) is compared to a PAL (Section A.1.4.2). If any sample result exceeds the PAL, then the CAS is advanced to Decision II (define the lateral and vertical extent) for that analyte.

A.1.4.1 Information Needs and Information Sources

In order to determine if a COC is present at the CAS, Decision I sample data must be collected and analyzed following these two criteria: (1) samples must be collected in areas most likely to contain a COC, and (2) the analytical suite selected must be sufficient to detect any COCs present in the samples. Biasing factors to support criteria #1 include:

- Documented process knowledge on source and location of release
- Field observations
- Field-screening results (radiological and chemical)

- Experience and data from investigations of similar sites
- Professional judgement

In order to determine the extent of a COC for Decision II, samples will be collected from locations to bound the lateral and vertical extent. For Decision II sampling, analytical suites may be limited to those COCs that exceed PALs in prior samples. The data required to satisfy the information needs for Decision II for each COC is a sample concentration that is below the corresponding PAL. Step-out locations will be selected based on the CSM, biasing factors, and Decision I analytical results. If COCs are found in any sample within the muckpile, the initial lateral step-out (Decision II) samples for that COC will be collected at the edge of the muckpile. When analytical results or other biasing factors suggest that the COC concentrations at the step-out location(s) may still exceed the PAL, an additional step-out distance may be used to define the lateral extent of contamination.

If a location where the PAL is exceeded is surrounded by clean locations, lateral step-outs may not be necessary. In that case, sampling may consist only of sampling from deeper intervals at or near the original location to determine the vertical extent of contamination. Vertical extent samples will be collected from depth intervals that will meet DQO objectives and in a manner that will conserve resources during possible remediation. Biasing factors to support these information needs may include the factors previously listed and Decision I analytical results. Sampling locations may be moved due to access problems, underground utilities, or safety issues; however, the modified locations must meet the decision requirements and criteria necessary to fulfill the information needs.

Table A.1-5 lists the information needs, the source of information for each need, and the proposed methods to collect the data needed to resolve Decisions I and II. The last column addresses the QA/QC data type and associated metric. The data type is determined by the intended use of the resulting data in decision making.

Data types are discussed in the following text. All data to be collected are classified into one of three measurement quality categories: quantitative, semiquantitative, and qualitative. The categories for measurement quality are defined below.

Table A.1-5
Information Needs to Resolve Decisions I and II
(Page 1 of 3)

Information Need	Information Source	Collection Method	Biasing Factors to Consider	Data Type/Metric
Decision I: Determine if a COC is present. Criteria I: Samples must be collected in areas most likely to contain a COC.				
Source and Location of Release Points	Process knowledge, historical documentation, and previous investigations of similar sites	Information documented in CSM and public reports – no additional data needed	None	Qualitative – CSM has not been shown to be inaccurate
	Field observations	Conduct site visits and document field observations	Visible evidence of contamination, topographic lows, gullies	Qualitative – CSM has not been shown to be inaccurate
	Aerial photographs	Review and interpret aerial photographs	Disturbed areas, visible evidence of contamination, location of possible sources	Semiquantitative - Sampling based on biasing criteria stipulated in DQO Step 3
	Field screening	Review and interpret FSRs	Bias sample locations/ intervals based on elevated FSRs	Semiquantitative - Sampling based on biasing criteria stipulated in DQO Step 3
Nature of Contamination	Biased and random samples	Collect samples from locations/depths based on biasing factors and statistical model	Send samples for analysis to laboratory	Quantitative - Sampling based on statistical modeling and biasing factors
	Biased samples	Collect samples from additional locations near CAS features	Worst-case locations such as stained areas	Quantitative - Sampling based on CAS features
	Process knowledge, historical documentation, and previous investigations of similar sites	Information documented in CSM and public reports – no additional data needed	None	Qualitative – CSM has not been shown to be inaccurate

Table A.1-5
Information Needs to Resolve Decisions I and II
(Page 2 of 3)

Information Need	Information Source	Collection Method	Biasing Factors to Consider	Data Type/Metric
Decision I: Determine if a COC is present. Criteria 2: Analyses must be sufficient to detect any COCs in samples.				
Identification of All Potential Contaminants	Process knowledge and previous investigations of similar sites; use analytical suite in Table A.1-8.	Information documented in CSM and public reports – no additional data needed; comprehensive analytical suite developed to account for uncertainty.	None	Qualitative – CSM has not been shown to be inaccurate
Analytical Results	Data packages from biased samples	Appropriate sampling techniques and approved analytical methods will be used; MRLs are sufficient to provide quantitative results for comparison to PALs	None	Quantitative - Validated analytical results will be compared to PALs
Decision II: Determine the extent of a COC. Criteria: Sample collection and analysis methods must be sufficient to bound extent of COC.				
Identification of Applicable COCs	Data packages of Decision I samples	Review analytical results and compare to PALs to select COCs	None	Quantitative - Only COCs identified will be analyzed in future sampling events
Extent of Contamination	Field observations	Document field observations	Visible evidence of contamination	Qualitative - CSM has not been shown to be inaccurate
	Field screening	Conduct field screening using appropriate methods	Bias sample locations/ intervals based on FSRs	Semiquantitative - FSRs will be compared to field screening levels
	Step-out samples	Generate locations based on previous sampling results and biasing factors	Locations selected based on the initial sampling results for both horizontal and vertical sampling and surface flow patterns	Semiquantitative - Sampling based on previous results and biasing factors
	Data packages of analytical results	Appropriate sampling techniques and approved analytical methods will be used to bound COCs; MRLs are sufficient to provide quantitative results for comparison to PALs	None	Quantitative - Validated analytical results will be compared to PALS to determine COC extent

Table A.1-5
Information Needs to Resolve Decisions I and II
(Page 3 of 3)

Information Need	Information Source	Collection Method	Biasing Factors to Consider	Data Type/Metric
Decision: Determine if sufficient information exists to characterize waste. Criteria: Analyses must be sufficient to allow disposal options to be accurately identified and estimated.				
Analytical Results	Data packages of analytical results; Use analytical suite in Table A.1-8; TCLP results may be required if total results are > 20X TCLP limits	Appropriate sampling techniques and approved analytical methods will be used; MRLs and minimum detectable activities are sufficient to provide quantitative results for comparison to disposal requirements	Sufficient material must be available for analysis	Quantitative – Validated analytical results will be compared to disposal criteria

Quantitative Data

Quantitative data results from direct measurement of a characteristic or component within the population of interest. These data require the highest level of QA/QC in collection and measurement systems because the intended use of the data is to resolve primary decisions (i.e., Decision I or Decision II) and/or verifying closure standards have been met. Laboratory analytical data are generally considered quantitative.

Semiquantitative Data

Semiquantitative data is generated from a measurement system that indirectly measures the quantity or amount of a characteristic or component. Inferences are drawn about the quantity or amount of a characteristic or component because a correlation has been shown to exist between the indirect measurement and the results from a quantitative measurement. The QA/QC requirements on semiquantitative collection and measurement systems are high but not as rigorous as a quantitative measurement system. Semiquantitative data contribute to decision making but are not generally used alone to resolve primary decisions. Field-screening data are generally considered semiquantitative. The data are often used to guide investigations toward quantitative data collection.

Qualitative Data

Qualitative data identify or describe the characteristics or components of the population of interest. The QA/QC requirements are the least rigorous for data collection methods and measurement systems. The intended use of the data is for information purposes, to refine conceptual models, and guide investigations rather than resolve primary decisions. This measurement of quality is typically assigned to historical information and data where QA/QC may be highly variable or not known. Professional judgement is often used to generate qualitative data.

Metrics provide a tool to determine if the collected data support decision making as intended. Metrics tend to be numerical for quantitative and semiquantitative data, and descriptive for qualitative data.

A.1.4.2 Determine the Basis for the Preliminary Action Levels

Industrial site workers, construction/remediation workers, and military personnel (i.e., ground troops) may be exposed to contaminants through ingestion, inhalation, external (radiological), or dermal contact (absorption) of soil. Laboratory analytical results for soils will be compared to the following PALs to determine if COCs are present:

- EPA Region 9 Risk-Based PRGs for chemical constituents in industrial soils (EPA, 2002b)
- For detected COPCs without established PRGs, a similar protocol to that used by EPA Region 9 will be used in establishing an action level for those COPCs listed in IRIS (EPA, 2002c)
- Background concentrations for RCRA metals will be used instead of PRGs when natural background exceeds the PRG, as is often the case with arsenic on the NTS. Background is considered the mean plus two times the standard deviation of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).
- The TPH action limit of 100 ppm per the NAC 445A.2272 (NAC, 2002)
- The PALs for radiological contaminants are based on the NCRP Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled from 25- to 15-mrem per year dose and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).

The specific radiological PALs for CAU 552 are listed in Table A.1-6.

Table A.1-6
Preliminary Action Level Concentrations for Radionuclides

Isotope	PAL (pCi/g)	Isotope	PAL (pCi/g)
Co-60	1.61	Ac-228[b]	5/15
Sr-90	503	Th-230[a]	5/15
Nb-94	2.43	Th-232[b]	5/15
Cs-137	7.3	Th-234	63.2
Eu-152	3.4	U-234	85.9
Eu-154	3.24	U-235	10.5
Eu-155	81.1	U-238	63.2
Bi-212[b]	5/15	Pu-238	7.78
Pb-212[b]	5/15	Pu-239/240	7.62
Pb-214[a]	5/15	Pu-241	259
Ra-226[a]	5/15	Am-241	7.62

[a] Thorium (Th)-230 and its daughters Radium (Ra)-226 and lead (Pb)-214 are considered to be in equilibrium and will use the DOE 5400.5 general guidance of 5 picocuries per gram (pCi/g) for surface samples and 15 pCi/g for subsurface samples.
[b] Th-232 and its daughters actinium (Ac)-228, bismuth (Bi)-212, and Pb-212 are considered to be in equilibrium and will use the DOE Order 5400.5 general guidance of 5 pCi/g for surface samples and 15 pCi/g for subsurface samples.

References: (NCRP, 1999) and (DOE, 1993)

The selected PALs are based on the EPA Region 9 Industrial Land Use PRGs. The PRGs are risk-based tools for evaluating and cleaning up contaminated sites that estimate contaminant concentrations in environmental media (e.g., soil, air, and water) that EPA considers protective of humans (including sensitive groups) over a lifetime. The toxicity based PALs have been calculated for an industrial-use scenario. The industrial-use scenario is applicable to sites at the NTS based on future land-use scenarios as presented in Section A.1.2.3 and agreements between NDEP and NNSA.

The level of 100 ppm for TPH is based on a regulatory mandate from the State of Nevada and is used as a “clean-up” level.

Radiochemistry PALs are based on a scaling of the NCRP 25 mrem/yr dose-based levels (NCRP, 1999) to a conservative 15 mrem/year and the recommended levels for certain radionuclides in DOE Order 5400.5, Change 2 (DOE, 1993), as listed in Table A.1-6. The NCRP 15 mrem PALs are based the construction, commercial, industrial land-use scenarios provided in the guidance and are appropriate for the NTS based on future land-use scenarios as presented in Section A.1.2.3. These established PALs have been accepted by the regulatory agency for use.

A.1.4.3 Potential Sampling Techniques and Appropriate Analytical Methods

As discussed in Section A.1.4.1, the collection, measurement, and analytical methods will be selected so the results will be generated for all COPCs at CAS 12-06-04 and CAS 12-23-05. This effort will include field screening, soil sampling, and laboratory analysis to determine the presence of COPCs and extent of identified COCs.

Waste characterization sampling and analysis has been included to support the decision-making process for waste management, and to ensure an efficient field program. Specific analyses required for the disposal of IDW are identified in Section 5.0 of the CAIP.

A.1.4.3.1 Field Screening

Based on site conditions and available analytical data, field-screening activities may be conducted for the following analytes and/or parameters:

- Alpha and Beta/Gamma Radiation - a handheld radiological survey instrument or method may be used based on the possibility that radiologically contaminated soil or muck may be present at CASs 12-06-04 and/or 12-23-05. If determined appropriate, on-site gamma spectrometry may also be used to screen samples. The FSLs for radionuclides are CAS-specific and will be calculated prior to sample collection based on background levels.

- VOCs - a photoionization detector (PID), or an equivalent instrument or method, may be used to conduct headspace analysis because VOCs are a common concern at the NTS and have not been ruled out based upon process knowledge at CAU 552. The FSL for VOCs is established as 20 ppm or 2.5 times background, whichever is greater.

- TPH - a gas chromatograph, or equivalent equipment or method, may be used because TPH is a common concern at the NTS and has not been ruled out based upon process knowledge. The FSL for TPH is established as 75 ppm.

Based on the results of previous CAU investigations and common NTS practices, the aforementioned field-screening techniques may be applied during the Decision I and II sampling at CAU 552. These field-screening techniques will provide semiquantitative data that can be used to guide confirmatory soil sampling and waste management activities. Field screening will not be used to arrive at corrective action decisions.

A.1.4.3.2 Soil Sampling and Measurement Methods

Hand sampling, augering, direct-push, excavation, drilling, or other appropriate sampling methods will be used to collect soil samples. Sample collection and handling activities will only be conducted in accordance with approved procedures. It may be appropriate to use excavation in selected areas to determine if contaminated soil has been covered with clean fill.

A.1.4.3.3 Analytical Program

The analytical program for CAU 552 shown in Table A.1-7 has been developed based on the suspected-contamination information presented in Section A.1.1.

The suspected COPCs for CAU 552 are TPH and certain VOCs, RCRA metals and man-made radionuclides. The suspected COPCs are given greater importance in the decision-making process relative to possible COPCs. For this reason, more stringent performance criteria are specified for suspected analyte DQIs (Section 6.0 of the CAIP). Possible COPCs are defined as classes of contaminants that include all the analytes reported from the respective analytical methods that have PALs. The possible COPCs also aid in reducing the uncertainty concerning the history and potential releases from the CASs and help in the accurate evaluation of potential contamination. If a COPC, either suspected or possible, is detected in any sample at a concentration above the respective PAL, the COPC will be identified as a COC. During Decision II sampling and analysis, all COCs are considered suspected parameters. Sections 3.0 and 6.0 of the CAIP provide the analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy) to be followed during this CAI. Sample volumes are laboratory- and method-specific and will be determined in accordance with laboratory requirements. Analytical requirements (e.g., methods, detection limits, precision, and accuracy) are specified in the Industrial Sites QAPP (NNSA/NV, 2002), unless superseded by the CAIP. These requirements will ensure that laboratory analyses are sufficient to detect contamination in samples at concentrations exceeding the MRL. Specific analyses, if any, required for the disposal of IDW are identified in Section 5.0 of the CAIP.

Table A.1-7
Analytical Program for CAU 552

Analytical Parameter	Analytical Method	
	Liquid	**Soil/Sediment/Sludge**
Total Volatile Organic Compounds	SW-846 8260B[a]	SW-846 8260B[a]
Total Semivolatile Organic Compounds	SW-846 8270C[a]	SW-846 8270C[a]
Total RCRA Metals, plus Beryllium	SW-846 6010B[a] (mercury - 7470A[a])	SW-846 6010B[a] (mercury - 7471A[a])
Polychlorinated Biphenyls	SW-846 8082[a]	SW-846 8082[a]
Total Petroleum Hydrocarbons, GRO and DRO (C_6 - C_{38})	SW-846 8015B[a] (modified)	SW-846 8015B[a] (modified)
Gamma Spectrometry (gamma emitters, e.g., Cs-137)	EPA Procedure 901.1[b]	HASL-300[c]
Strontium-90	ASTM D5811-00[d]	HASL-300[c]
Isotopic Plutonium	ASTM D3865-97[e]	ASTM C1001-90[f]
Isotopic Uranium	ASTM D3972-97[g]	ASTM E1000-90[h]

ASTM = American Society of Testing and Materials
RCRA = *Resource Conservation and Recovery Act*
SW = Solid Waste

[a] *EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* 3rd Edition, Parts 1-4, SW-846 (EPA, 1996)
[b] *Prescribed Procedure for Measurements of Radioactivity in Drinking Water* (EPA, 1980)
[c] *The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997)
[d] *Standard Test Method for Strontium-90 in Water* (ASTM, 2000c)
[e] *Standard Test Method for Plutonium in Water* (ASTM, 2000b)
[f] *Standard Test Method for Radiochemical Determination of Plutonium in Soil by Alpha Spectroscopy* (ASTM, 2000a)
[g] *Standard Test Method for Isotopic Uranium in Water by Radiochemistry* (ASTM, 2002)
[h] *Standard Test Method for Radiochemical Determination of Uranium Isotopes in Soil by Alpha Spectrometry* (ASTM, 2000b)

Note: All Decision I samples will be analyzed for gamma-emitting isotopes. Isotopic Uranium analysis will be conducted if any Uranium is detected in the Gamma Spectrometry. Isotopic Plutonium analysis will be conducted if any Americium-241 is detected in the Gamma Spectrometry. Strontium-90 analysis will be conducted if any Cesium-137 is detected above the PAL in the Gamma Spectrometry.

Table A.1-8 lists the analytes reported by the various analytical methods that are considered to be COPCs.

For sampling performed to define the extent of contamination (Decision II) at CAS 12-06-04 and CAS 12-23-05, samples may be collected and analyzed only for COCs identified in samples collected to resolve Decision I. However, if extent samples are collected prior to nature-of-contamination data becoming available, the extent samples will be analyzed for the full list parameters given in Table A.1-8. For samples collected to define the extent of contamination, suspected analytes are the COCs identified during Decision I activities that exceed PALs.

Table A.1-8
List of Analytes Included in Each Analytical Method for CAU 552

Volatile Organic Compounds	Semivolatile Organic Compounds	Total Petroleum Hydrocarbons	Polychlorinated Biphenyls	Metals	Radionuclides
1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethane 1,1-Dichloroethene cis-1,2-Dichloroethene cis-1,3-Dichloropropene trans-1,2-Dichloroethene 1,2-Dichloroethane 1,2-Dichloropropane 2-Butanone 4-Methyl-2-pentanone Acetone Benzene Bromochloromethane Bromodichloromethane Bromoform Bromomethane Carbon disulfide Carbon tetrachloride Chlorobenzene Chloroethane Chloroform Chloromethane Dibromochloromethane Ethylbenzene Methyl tertiary butyl ether Methylene chloride Styrene Tetrachloroethene Toluene trans 1,3-Dichloropropene Trichloroethene Vinyl acetate Vinyl chloride Xylenes (m,p,o) 1,1,1,2-Tetrachloroethane 1,2,3-Trichloropropare 1,2,4-Trimethyl-benzene 1,2-Dibromo-3-chloropropane 1,2-Dibromoethane 1,3,5-Trimethylbenzene Trichlorofluoromethane Trichlorotrifluoroethane n-propyl benzene 2-chloltoluene Bromobenzene Dichlorodifluoromethane Iodomethane Isopropyl Benzene n-Butylbenzene sec-butylbenzene Tert-butylbenzene Dibromomethane	1,2,4-Trichlorobenzene[a] 1,2-Dichlorobenzene[a] 1,3-Dichlorobenzene[a] 1,4-Dichlorobenzene[a] 2,4,5-Trichlorophenol 2,4,6-Trichlorophenol 2,4-Dichlorophenol 2,4-Dimethylphenol 2,4-Dinitrophenol 2,4-Dinitrotoluene 2,6-Dinitrotoluene 2-Chloronaphthalene 2-Chlorophenol 2-Methylphenol 2-Nitroaniline 3,3'-Dichlorobenzidine 4-Bromophenyl phenyl ether 4-Chloroaniline 4-Methylphenol 4-Nitrophenol Acenaphthene Acenaphthylene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Bis(2-chloroethoxy) methane Bis(2-chloroethyl)ether Bis(2-chloroisopropyl)ether Bis(2-ethylhexyl) phthalate Butyl benzyl phthalate Chrysene Dibenzo(a,h)anthracene Dibenzofuran Diethyl Phthalate Dimethyl Phthalate Di-n-butyl Phthalate Di-n-octyl Phthalate Fluoranthene Fluorene Hexachlorobenzene Hexachlorobutadiene[a] Hexachlorocyclopentadiene Hexachloroethane Indeno(1,2,3-cd)pyrene Isophorone Naphthalene[a] Nitrobenzene N-Nitroso-di-n-propylamine N-Nitrosodimethylamine N-Nitrosodiphenylamine Pentachlorophenol Phenanthrene Phenol Pyrene Pyridine Aniline Benzoic Acid Benzyl Alcohol Carbazole	Total Petroleum Hydrocarbons [C_6-C_{38}] DRO, GRO	Aroclor-1016 Aroclor-1221 Aroclor-1232 Aroclor-1242 Aroclor-1248 Aroclor-1254 Aroclor-1260	Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver Beryllium	Americum-241 Cesium-137 Plutonium-238 Plutonium-239/240 Strontium-90 Uranium-234 Uranium-235 Uranium-238 Cobalt-60

[a] May be reported with VOCs.

RCRA = *Resource Conservation and Recovery Act*

A.1.5 Step 4 - Define the Study Boundaries

The purpose of this step is to define the target population of interest, specify the spatial and temporal features of that population that are pertinent for decision making, determine practical constraints on data collection, and define the scale of decision making relevant to target populations for Decision I and Decision II.

A.1.5.1 Define the Target Population

Decision I target populations represent locations within the CASs that contain COCs, if present. Decision II target populations are areas within the CASs where COC concentrations are less than PALs and are contiguous to areas of COC contamination. The target populations are dependent upon the CSM developed for CAU 552. These target populations represent locations within the CAS that, when sampled, will provide sufficient data to resolve the primary problem statement (Section A.1.3.1).

The target populations for the Decision I samples are:

- The material in the muckpile and sediment within the ponds, and areas where run-off is evident

The target populations for the Decision II samples are:

- The native material underlying the muckpile and ponds
- The native material in lateral areas contiguous to the muckpile and ponds

A.1.5.2 Identify the Spatial and Temporal Boundaries

Spatial (geographic) boundaries are defined as the vertical or horizontal boundaries beyond which the CSM and/or the scope of the investigation will require reevaluation. The horizontal boundaries of the study are the edges of the muckpile including all visible drainage and run-off to surrounding soil, and the berms surrounding the ponds, with an additional buffer zone of 200 ft around each. The spatial boundary (lateral) for run-off areas will be limited to the area defined on the east side by Rainier Mesa Road and on the south side by the entrance road to the G-Tunnel area. The vertical boundary is a maximum of 50 ft below the bottom of the muckpile and pond sediment or until drill refusal (defined as requiring more than 15 minutes to drill 1 ft). The spatial boundaries for CAS 25-27-03 are listed in TableA.1-9.

Table A.1-9
Spatial Boundaries for CAU 552, CAS 25-27-03

Spatial Boundary	
Horizontal	**Vertical**
Edges of muckpile and berms of ponds with a buffer zone of 200 ft around both	A maximum of 50 ft below the interface with native material or until drill refusal

Temporal boundaries are time constraints due to time-related phenomena, such as weather conditions, seasons, and activity patterns. Significant temporal constraints due to weather conditions are not expected; however, snow events may affect site activities during winter months. Moist weather may place constraints on sampling and field screening of contaminated soils because of the attenuating effect of moisture on radiological field measurements. There are no time constraints on collecting samples.

A.1.5.3 Identify Practical Constraints

The primary practical constraints to be encountered at CASs12-06-04 and 12-23-05 would be the capability of the drill to penetrate the muckpile native material, the presence of underground utilities, and the ability to drill at locations within the muckpile and/or ponds due to safety considerations (e.g.,unstable soil). Utility constraints are subject to change as additional information is collected prior to the commencement of investigation activities and will be appropriately documented. Locations where intrusive activities are planned will be surveyed for utilities prior to field activities in accordance with the SSHASP.

Drilling will not be conducted so close to the slopes of the muckpile as to present a hazardous condition for the field crew. The minimum distance the drill rig must remain from the slopes (“safety line”) will be determined by an engineering study of soil stability near the slopes, taking into account the material that makes up the muckpile, specifications of the drill rig, and slope stability. In previous investigations, the safety line was no greater than 50 ft from the top edge of any slope. Drilling will not be done inside of the safety line.

Nevada Test Site-controlled activities being conducted nearby these CASs may affect the ability to investigate the CASs.

A.1.5.4 Define the Scale of Decision Making

The scale of decision making is defined as the muckpile, consisting of CAS 12-06-04 as one unit, and each of the three ponds in CAS 12-23-05 as separate units. Dividing the units in this manner allows the corrective actions to be tailored to the different media that may be contaminated.

A.1.6 Step 5 – Develop a Decision Rule

This step integrates outputs from the previous steps, with the inputs developed in this step into a decision rule (*"If..., then..."*) statement. This decision rule describes the conditions under which possible alternative actions would be chosen.

A.1.6.1 Specify the Population Parameter

The population parameter for Decision I data collected from biased sample locations is the maximum observed concentration of each COPC within the target population. For radiological surveys, the maximum observed concentration of each COPC will be the population parameter. If radiological sampling and analysis is performed to support the radiological survey results, the maximum observed concentration of each COC identified in the sample will be the population parameter. Radiological sampling and analysis will supersede radiological survey results.

The population parameter for Decision II data will be the observed concentration of each unbounded COC in any sample.

A.1.6.2 Choose an Action Level

Action levels are defined as the PALs, which are specified in Section A.1.4.2.

A.1.6.3 Decision Rule

If the concentration of any COPC in a target population exceeds the PAL in a Decision I sample, then that COPC is identified as a COC and the extent of contamination sampling will be conducted. If the

Site Supervisor determines that an indicator of contamination is present, Decision II sampling may be conducted before the results of Decision I sampling are available. If all COPC concentrations are less than the corresponding PALs, the decision will be no further action.

If the observed population parameter of any COC in a Decision II sample exceeds the PALs, additional samples will be collected to complete the Decision II evaluation. If all observed COC population parameters are less than PALs, the decision will be that the extent of contamination has been defined in the lateral and vertical directions.

If contamination is inconsistent with the CSM or extends beyond the identified spatial boundaries, work will be suspended and the investigation strategy will be reevaluated. If contamination is consistent with the CSM and is within spatial boundaries, the decision will be to continue sampling to define extent.

A.1.7 Step 6 – Specify the Tolerable Limits on Decision Errors

Only validated analytical results (quantitative data) will be used to determine which COCs are present (Decision I) or the extent of a COC (Decision II), unless otherwise stated. The baseline condition (i.e., null hypothesis) and alternative condition for Decision I are:

- Baseline condition – A COC is present in the muckpile and/or ponds.
- Alternative condition – A COC is not present in the muckpile or ponds.

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

- 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 an alpha (false negative) or beta (false positive) error associated with their determination (discussed in the following subsections). This CAIP has been designed to minimize both types of errors.

A.1.7.1 False Negative (Rejection) Decision Error

The false negative (rejection of the null hypothesis or alpha error) decision error would mean either of the following:

- 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 actually has not (Decision II).

In both cases, this would result in an increased risk to human health and environment.

For Decision I, a false negative decision error (where the consequences are more severe) is controlled by meeting the following criteria:

- Having a high degree of confidence that the sample locations selected will identify COCs if present anywhere within the CAS

- Having a high degree of confidence that analyses selected (both field screening and confirmatory laboratory) will be sufficient to detect any COCs present in the sampled media and that the detection limits are adequate to ensure an accurate quantification of the COCs

For Decision II, the false negative decision error is reduced by:

- 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 for both decisions, Decision I samples will be collected in accessible areas most likely to be contaminated by any COPCs, and Decision II samples will be collected in areas that represent the lateral and vertical extent of contamination. The following characteristics are considered during both decisions to accomplish the first criterion:

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

These characteristics were considered during the development of the CSMs. The biasing factors listed in Table A.1-5 and Section A.1.8.1 will be used to further ensure that these criteria are met.

To satisfy the second criterion for Decision I, all samples used to define the nature of contamination will be analyzed for the parameters listed in Section A.1.4.3.3 using analytical methods that are capable of producing quantitative data at concentrations equal to or below PALs (unless stated otherwise in the CAIP). To satisfy the second criterion for Decision II, samples will be analyzed for those parameters that identified unbounded COCs.

To satisfy the third criterion for Decision II, the entire dataset, as well as individual sample results, will be assessed against the DQIs of precision, accuracy, comparability, completeness, and representativeness defined in the Industrial Sites QAPP (NNSA/NV, 2002). The goal for the completeness DQI is 80 percent for the entire dataset. The goal is 90 percent completeness for suspected COCs at biased sample locations (e.g., TPH at a hydrocarbon-stained location). The goal is also 90 percent completeness for identified COCs in Decision II locations (e.g., step-out locations used to determine the extent of a COC identified in a Decision I sample). The dataset and individual sample results will be evaluated to determine if these goals have been met and/or if the data is sufficient to make a decision (e.g., has the extent of contamination been defined). A discussion of this evaluation will be included in the CADD. In addition, sensitivity has been included as a DQI for laboratory analyses. Site-specific DQIs are discussed in more detail in Section 6.0 of the CAIP. Strict adherence to established procedures and QA/QC protocols also protects against false negatives.

A.1.7.2 False Positive Decision Error

The false positive (acceptance of the null hypothesis or beta) decision error would mean:

- Deciding that a COC is present when it actually is not (Decision I)
- Accepting that the extent of a COC has not been defined when it really has (Decision II)

These errors result in increased costs for unnecessary characterization or corrective actions.

The false positive decision error is controlled by protecting against false positive analytical results. False positive results are typically attributed to laboratory and/or sampling/handling errors. Quality assurance/Quality Control samples such as field blanks, trip blanks, laboratory control samples, and method blanks minimize the risk of a false positive analytical result. Other measures include proper decontamination of sampling equipment and using certified clean sample containers to avoid cross-contamination.

A.1.7.3 Statistical Model

In the absence of biasing factors for subsurface contamination, sampling locations need to be determined with the use of a randomization technique. Chapter 9 of EPA SW-846 defines the methodology suggested to determine the sufficient number of samples to be taken to ensure a 90 percent confidence level in the COPC concentration. This method is used here to determine the number of random sampling locations required at CAU 552. SW-846 makes the following assumptions:

- A regulatory threshold for the contaminant of concern has been defined.
- The COPC is uniformly distributed throughout the waste form.
- The concentration of the COPC is normally distributed.
- There is a positive analytical result for the contaminant of concern in each sample.
- The regulatory threshold exceeds the mean concentration of the contaminant.

Based on the results of prior muckpile characterizations, the first four assumptions are not true for the radiological contaminants likely to be found in the Area 12 G-Tunnel (12g) Muckpile and Ponds. However, the EPA SW-846 method can still be used to predict the number of samples required to reach the 90 percent confidence level. The following sections discuss the assumptions and demonstrate the EPA SW-846 Method can be used to determine the number of samples needed to achieve the 90 percent confidence level for the 12g Muckpile and Ponds.

Regulatory Threshold

The SW-846 Chapter 9 Method is used to determine if the upper limit of the confidence interval in the concentration of a chemical contaminant exceeds the regulatory threshold (RT). The RTs are defined by the EPA in mass units such as milligrams of contaminant per kilograms of soil. If the 90 percent confidence level of the mean concentration of the contaminant exceeds the RT, the solid waste is assumed to contain the contaminant of concern at a hazardous level. The EPA has defined RTs for many chemicals and metals in soil; however, RTs for radionuclides in soil have only been defined for radium-226, radium-228, thorium-230, and thorium-232 (EPA, 1983). None of these radionuclides have been found at any of the muckpiles characterized by the Defense Threat Reduction Agency (DTRA). The radiological COPC that will be used to determine the number of samples to be collected at the 12g Muckpile and Ponds is cesium-137. This radionuclide was the most commonly identified radionuclide in past muckpiles and ponds investigations, and will provide a basis for the number of samples to be taken at CAU 552. The RT for cesium-137 is the PAL of 7.3 picocuries per gram (pCi/g).

Uniform Distribution

The EPA SW-846 Chapter 9 Method assumes the COPC is uniformly distributed throughout the solid waste. That is, it assumes that the contaminants are not clumped or stratified within the solid waste form being sampled. If it is known that the contaminants are clumped or stratified, the SW-846 Chapter 9 Method requires that the volume being sampled be divided into subvolumes of uniform distribution and that samples are collected from random locations within each stratified volume.

Radioactive contamination in soil rarely has a uniform distribution. Even samples collected at undisturbed background locations are composited, mixed, pulverized, sieved, and ground several times to ensure that the mean concentration measured in the samples is representative of the true average concentration of the radionuclides in the soil (McArthur and Miller, 1989). The distribution of radioactive contaminants in soil is usually clumped or stratified. Characterization of radiological contaminated soil sites at the Nevada Test Site, Tonopah Test Range, and Nevada Test and Training Range (formerly the Nellis Air Force Range) demonstrate that the concentration of a radionuclide in samples taken just a few feet apart may differ by up to five orders of magnitude (DOE/NV, 1996b and 1997). Assuming a uniform distribution for the radionuclides will result in the calculated mean and standard deviation of the radionuclide concentrations being skewed to higher values. Using a higher calculated mean and variance in the EPA SW-846 Method will also result in a larger number of samples being required to meet the 90 percent confidence level.

Based on process knowledge from previous investigations of NTS tunnel muckpiles and ponds, the radionuclides are not uniformly distributed which is why the stratified random sampling method has been selected to characterize the 12g Muckpile and Ponds.

Normal Distribution

The EPA SW-846 Method assumes the concentration of the COPC is normally distributed. Typically, the concentrations of radioactive contaminants in soil are best described as a skewed normal or log-normal distribution. For example, the cesium-137 concentration in surface soil samples collected at 324 undisturbed background locations in Nevada does not fit either a normal or log normal distribution (McArthur and Miller, 1989). However, if the samples with the four highest cesium-137 concentrations are deleted from the dataset, the cesium-137 concentration fits a lognormal distribution. If the mean and standard deviation of the cesium-137 concentration in the Nevada soil samples is assumed to be a normal distribution, the calculated 90th percentile concentration will exceed the true 90th percentile. The details on the cesium-137 concentration calculation are found in McArthur and Miller (1989). A statistical analysis of the cesium-137 concentrations in the 324 surface soil samples demonstrated the following:

- Mean concentration of cesium-137 in 324 soil samples is 0.43 pCi/g
- The true 90th percentile concentration for cesium-137 is 0.94 pCi/g
- The standard deviation of the cesium-137 concentration is 0.63 pCi/g
- Assuming a normal distribution, the 90th percentile is defined as 1.64 standard deviations plus the mean, which is equal to a cesium-137 concentration of 1.46 pCi/g
- The calculated 90th percentile of the cesium-137 concentration (1.46 pCi/g) is 61 percent greater than the true 90th percentile cesium-137 concentration of 0.94 pCi/g

The W test developed by Shapiro and Wilk (1965) is used to test whether a COPC's concentration in a sample is normally distributed for COPCs that are detected in less than 50 samples. Furthermore, by conducting the test on the logarithms of the data, it is an effective way of evaluating the hypothesis of a lognormal distribution. Inferences about the mean of the radionuclide concentration are still possible if the number of samples collected exceeds 30, since in that case the sample mean is approximately normally distributed (Gilbert, 1987). Furthermore, the arithmetic mean and standard deviation are statistically unbiased estimators of the true population mean, regardless of the underlying distribution (e.g., lognormal, normal), Weibull, etc. (Gilbert, 1987). When a COPC is detected in 50 or more samples, the D'Agostino's Test is used to test the null hypothesis of normality or lognormality (Gilbert, 1987).

Positive Analytical Results

The EPA SW-846 Method assumes that each sample collected will result in a measured concentration that is positive, and each contaminant will be present at a concentration that exceeds the contaminant's minimum detectable concentration. This is not true for the man-made radionuclide

COPC concentrations in soil samples. In applying the EPA SW-846 Chapter 9 Method, the number of samples required to ensure a 90 percent confidence level is calculated using only the data for samples with radionuclide concentrations exceeding the minimum detectable concentration. The number of samples required to meet the 90 percent confidence level increases as the number of samples decreases. Using data from the positive samples, instead of the data for all samples collected, will result in calculating a maximum value for the number of samples required to ensure a 90 percent confidence level.

Mean Concentration Exceeds the RT

The EPA SW-846 Method assumes that the concentration of the COPC is positive in all samples, but the mean concentration is less than the RT. The method was designed to ensure the 90 percent confidence interval of the mean does not exceed the RT. No RT is defined for the man-made radionuclide COPCs; therefore, the PAL will be used as the RT for calculating the number of required samples.

Testing for the Number of Required Samples

The radionuclide analytical data from several muckpiles and ponds previously investigated by DTRA, including the N-Tunnel Muckpile (CAU 477), the 15a/e Muckpile and Ponds (CAU 482), T-Tunnel Muckpile (CAU 476), and the 16a Muckpile (CAU 504) characterizations will be used to make an estimation of the number of samples that need to be collected at the 12g Muckpile and Ponds. This is necessary since no analytical data is available from the muckpile or ponds on which to make a determination. After the investigation is completed, the procedure described in Chapter 9 of the EPA SW-846 Method will again be used to confirm that sufficient samples were collected to characterize the site at the 90 percent confidence level (EPA, 1996). The number of samples to collect is defined in equation (8) of Table 9-1 in SW-846.

$$n = t_{.20}^{2} \times s^{2} / (RT - 0)^{2}$$

Where:

n = Minimum number of samples to ensure a 90 percent confidence level
$t_{.20}^{2}$ = The square of the "t" value in Table 9-2, SW-846 for a one-tailed 90 percent confidence interval

s^2 = Variance in the concentration measured in the samples collected during characterization
RT = Regulatory threshold and is set to the POC or background, whichever is greater, for each radionuclide
0 = The mean concentration of the COPC in the collected samples

The minimum number of samples required to ensure a 90 percent confidence level is directly proportional to the $t_{.20}^2$ value. As shown in Table 9-2 of EPA SW-846 Method, the value of $t_{.20}$ increases as the number of samples decreases. Therefore, $t_{.20}^2$ is inversely proportional to the number of samples collected. The value of $t_{.20}^2$ for 13 samples is 1.839, while the value of $t_{.20}^2$ for 41 samples is 1.698. As the number of samples collected increases from 13 to 41, an increase of > 315 percent, the value of $t_{.20}^2$ decreases by only 8.5 percent. Therefore, the number of samples taken during characterization has very little effect on the number of samples required to demonstrate a 90 percent confidence level. It should be noted that EPA SW-846 Method does not list any $t_{.20}$ value except for the 90 percent value. It is not possible to quantify the precise confidence level in the number of samples using the EPA SW-846 Method. This method can only be used to confirm whether or not the confidence level is less than or greater than 90 percent.

The minimum number of samples required to ensure a 90 percent confidence level is also directly proportional to the variance, s^2, in the concentration of the COPC. The s^2 is a quantification of the amount of internal fluctuation in the concentration from sample to sample. It is an absolute measure of the amount of internal scatter in the concentration data and does not, to a first approximation, depend on the number of samples collected (Gilbert, 1987). It may seem intuitive that as the amount of fluctuation in the concentration increases, the number of samples required to define the mean concentration with high precision increases. However, as demonstrated previously for the value of $t_{.20}^2$, after a relatively large number of samples are collected, collecting additional samples will not result in a substantially different value in the s^2.

The minimum number of samples required to ensure a 90-percent confidence level is inversely proportional to the square of the difference between the RT and the mean concentration, 0. As the 0 concentration of the contaminant of concern in the samples increases and approaches the value of the RT, the number of required samples increases. If the 0 concentration of the contaminant of concern is insignificant in comparison to the RT, very few samples are required to demonstrate compliance. In this analysis, the W and the D'Agostino test are used to determine whether the arithmetic or geometric mean and variance of the positive samples should be used to calculate "n." Since these values may be skewed by the high concentration outliers, the calculated number of samples required to be collected, n, will be a maximum.

Since there is no soil sampling data available for the 12g Muckpile and Ponds, the cesium-137 results from characterization of the Muckpiles at CAUs 475, 476, 477, 482, and 504 will be used to calculate the number of samples to be collected at the 12g Muckpile. The cesium-137 results from characterization of the buried ponds at CAUs 477, 478, 480, and 482 will be used to calculate the number of samples to be collected at the 12g ponds. Cesium-137 is used in these calculations due to the fact that it has been the most commonly found isotope at NTS, and sufficient analytical data is available to arrive at the mean and variance values required for the equation.

Calculation of the Number of Samples

Determine the number of samples required to obtain a 90-percent confidence interval for the 12g Muckpile using the cesium-137 data from the muckpiles at CAUs 475, 476, 477, 482, and 504:

$$n = t_{.20}^{2} \times s^{2} / (RT - 0)^{2}$$

Where

Required number of samples for the 12g muckpile using cesium-137 data:

n = Minimum number of samples to ensure a 90-percent confidence level in the calculated mean concentration in the COPC

$t_{.20}^{2}$ = 1.680, the square of 1.296, the $t_{.20}$ value for 60 degrees of freedom, 90 percent confidence level, Table 9-2, SW-846

s^{2} = Variance of the cesium-137 concentration in the positive samples from CAUs 475, 476, 477, 482, and 504: 271,961 pCi/g

RT = 7.3 pCi/g

0 = Mean cesium-137 concentration in the positive samples from CAUs 475, 476, 477, 482 and 504: 228.6 pCi/g

n = $t_{.20}^{2} \times s^{2} / (RT - 0)^{2} = (1.680 \text{ x } 271{,}961)/(7.3 - 228.6)^{2} = 9.33$ samples

Required number of samples for the 12g ponds, using cesium-137 data:

n = Minimum number of samples to ensure a 90-percent confidence level in the calculated mean concentration in the COPC

$t_{.20}^2$ = 1.698, the square of 1.303, the $t_{.20}$ value for 40 degrees of freedom, 90-percent confidence level, Table 9-2, SW-846

s^2 = Variance of the cesium-137 concentration in the positive samples from the ponds at CAUs 477, 478, 480, and 482: 20,064 pCi/g

RT = 7.3 pCi/g

0 = Mean cesium-137 concentration in the positive samples from the ponds at CAUs 477, 478, 480 and 482: 69.32 pCi/g

n = $t_{.20}^2 \times s^2 / (RT - 0)^2 = (1.698 \times 20{,}064)/(7.3 - 69.32)^2 = 8.86$ samples

In addition to the calculated number of required samples, decision performance curve graphs were prepared using the same data from the previous muckpile and pond characterizations. The number of samples was calculated using a simple stratified random sampling strategy. The action level (the lower limit on the graph) was set at the POC or background whichever was greater. The upper bound of the gray area was set at the action level plus one standard deviation of the data from CAUs 475, 476, 477, 478, 480, 482, and 504. The graphs are presented in Figure A.1-3, and Figure A.1-4. The decision performance curves are in agreement with the results from the 90-percent confidence level calculations.

The numbers of samples required for the muckpiles and ponds at the Area 12 G-Tunnel were multiplied by a factor of safety of 2 to provide additional assurance that the 90-percent confidence level would be reached:

n+ (muckpile) = 9.33 samples x 2 = 18.66 samples (round up) = 19 samples

n+ (ponds) = 8.86 samples x 2 = 17.72 samples (round up) = 18 samples

The sampling program for CAU 552 was designed to provide sufficient data to allow a statistical determination of whether a sufficient quantity of samples were collected to adequately describe the site. This determination will be made using the procedures described in Chapter 9 of the EPA publication SW-846, *Test Methods for Evaluating Solid Waste* (EPA, 1996). The mean concentration (or activity) and standard deviation of cesium-137 concentration in the muckpile and pond soils will

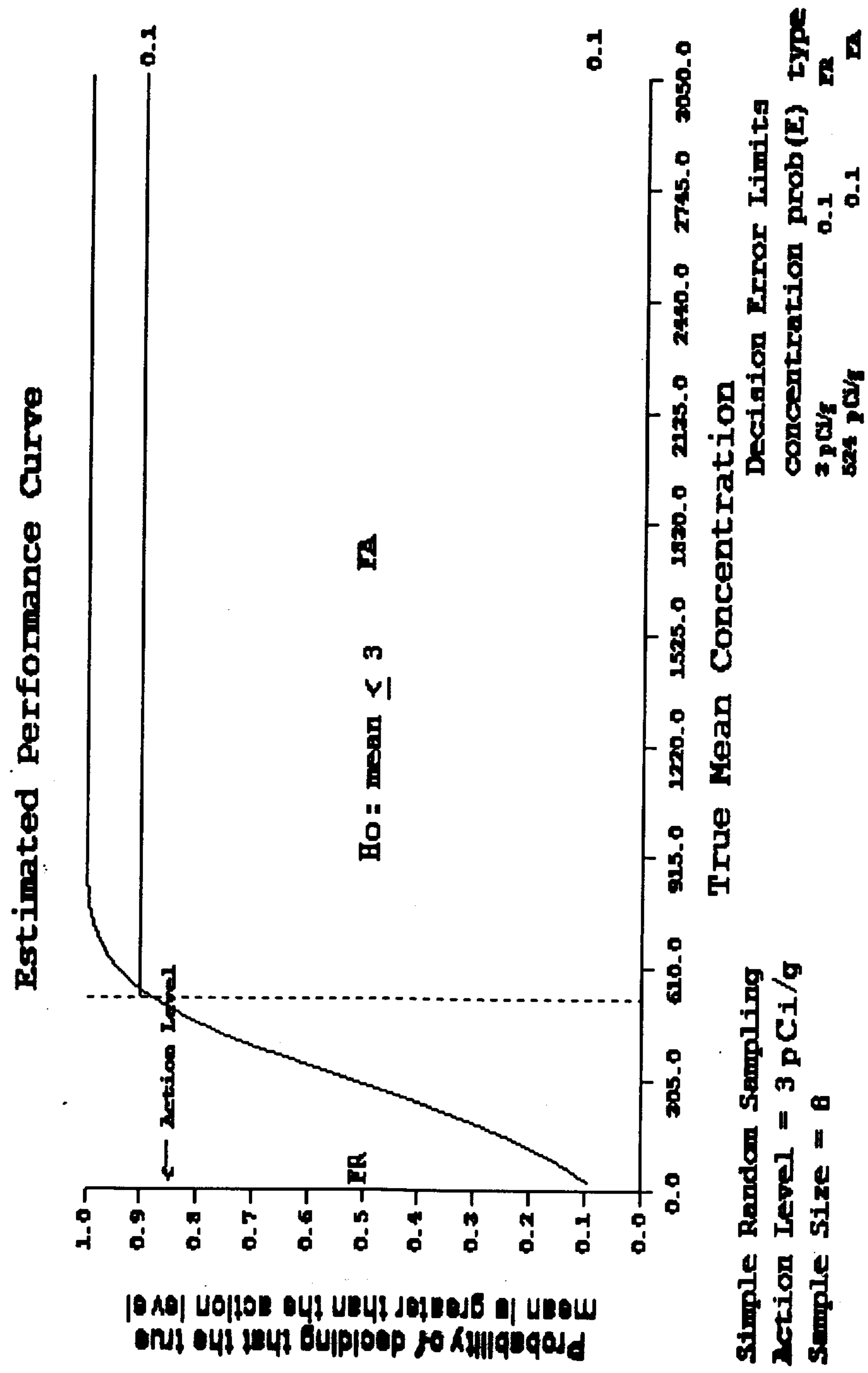


Figure A.1-3
Decision Performance Curve for Cesium-137 From Muckpile Samples

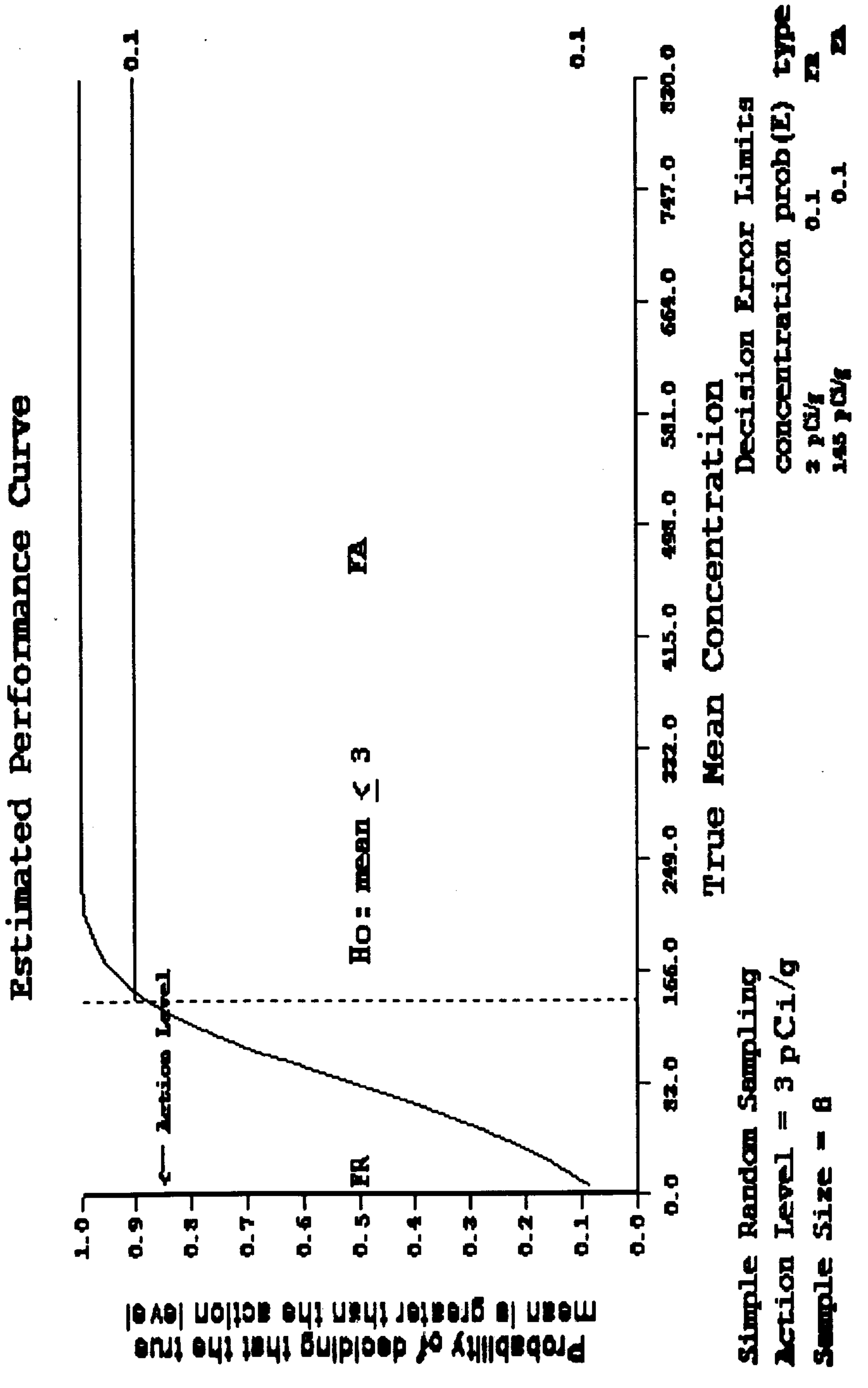


Figure A.1-4
Decision Performance Curve for Cesium-137 From Pond Samples

be used to calculate the number of samples necessary to make the determination with a 90-percent confidence level.

A.1.7.4 Quality Assurance/Quality Control

Radiological survey instruments, as well as field-screening equipment will be calibrated and checked in accordance with the manufacturer's instructions or approved procedures.

Quality control samples will be collected as required by the Industrial Site QAPP (NNSA/NV, 2002) and in accordance with established procedures. These procedures apply to both the quick-turnaround and standard analyses. The required QA field samples include:

- Trip blanks (1 per sample cooler containing environmental VOC samples)
- Equipment blanks (1 per sampling event for each type of decontamination procedure)
- Source blanks (1 per source lot per sampling event)
- Field duplicates (minimum of 1 per matrix per 20 environmental samples or 1 per CAS if less than 20 collected)
- Field blanks (minimum of 1 per 20 environmental samples)
- Matrix spike/matrix spike duplicate (minimum of 1 per matrix per 20 environmental samples or 1 per CAS if less than 20 collected), not required for some radioanalytical measurements (e.g., gamma spectrometry)

Additional QC samples may be submitted based on site-specific conditions.

A.1.8 Step 7 – Optimize the Design for Obtaining Data

This section presents an overview of the resource-effective strategy planned to obtain the data required to meet the project DQOs developed in the previous six steps. Section A.1.8.1 provides general investigation strategy, and Section A.1.8.2 provides the detailed sampling approach to resolve the decision statements for CAU 552. As additional data or information is obtained, this step will be reevaluated and refined, if necessary, to reduce uncertainty and increase the confidence that the nature and extent of contamination is accurately defined.

A.1.8.1 General Investigation Strategy

The initial activities to be conducted will be a visual inspection and photodocumentation of the area of CASs 12-06-04 and 12-23-05, as well as a walk-over/drive-over radiation survey. The visual inspection and radiation survey will provide biasing factors for locating soil samples and will be used to identify any potential conditions that may affect sampling and sample locations.

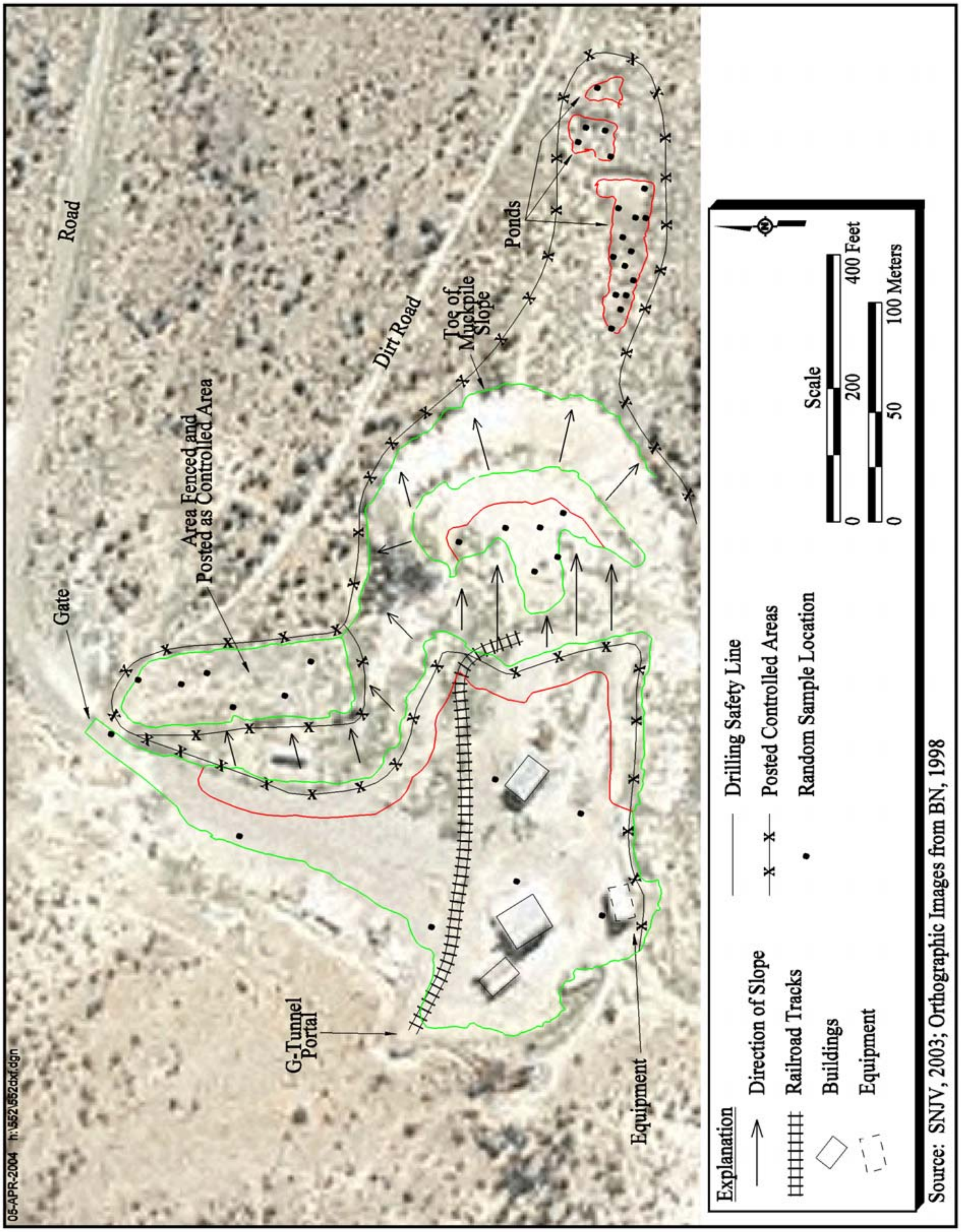
Following visual inspection and radiation survey, the following samples will be collected from the Muckpile:

- A minimum of 38 soil samples will be collected from 19 randomly generated locations at the muckpile CAS 12-06-04, with samples being taken at 2 depths at each location, including a randomly picked depth within the muckpile and a native soil sample between 0 and 5 ft below the muckpile/native soil interface.
- An additional 4 to 6 samples will be taken at the foot of the muckpile in places where apparent run-off has occurred.

The following samples will be collected in and around the ponds:

- A minimum of 36 samples will be collected from 18 randomly generated locations within the three ponds in CAS 12-23-05.
- In addition, two samples will be taken at one location near the inlet pipe in each pond. The two samples taken at each location within the ponds will include a surface sample of pond sediment, or if no sediment is present a sample at a depth of 0 to 6 in, and a shallow subsurface sample. The subsurface sample will be collected directly below the pond sediment - native soil interface if sediment exists. Two samples will also be taken at the low point of each pond, at the depths described above.
- An additional 4 to 6 samples will be taken near the berm of each pond to help determine the lateral extent of any existing contamination. These samples will be collected on the north and south sides of the two ponds closest to the muckpile and on the north, south and east sides of the third pond.

All proposed sample locations are shown in the sample location drawing, Figure A.1-5. The results of the laboratory analysis of these samples will be used to select locations where additional Decision I confirmatory samples may be necessary. Decision I surface and shallow subsurface soil samples will be submitted for laboratory analysis of the parameters identified in Section A.1.4.3.3. Any COCs



Source: SNJV, 2003; Orthographic Images from BN, 1998

Figure A.1-5
CAU 552 Example of Potential Random Sampling Locations

found in a Decision I sample in the muckpile or the pond sediments will be assumed to exist in the entire muckpile or pond.

Decision II (step-out) sampling locations at CAU 552 will be selected based on the outer boundary sample locations where a COC is detected in the Decision I confirmatory samples. For COCs found in the muckpile or pond sediment, the initial step-out locations will be at the toe of the muckpile or the berms of the ponds. If COCs are identified in any of these initial step-outs, further step-out locations will be placed 25 to 50 ft away from the positive (contaminated) Decision II locations. Decision II locations will also be selected based on pertinent features of the CSM and the other biasing factors. If biasing factors indicate a COC potentially extends beyond planned Decision II sample points, locations may be modified or additional Decision II samples may be collected from incremental step-out locations. Both surface and subsurface soil samples may be collected and analyzed to determine the extent of a COC.

Contaminants determined not to be present in Decision I samples may be eliminated from Decision II analytical suites. In general, samples submitted for off-site analysis will be those that define the nature (Decision I) and extent (Decision II) of COCs. This effort will apply to the lateral and vertical extent of the COCs.

A.1.8.2 Detailed Investigation Strategy

The initial activities to be conducted will be a visual inspection and photodocumentation of CASs 12-06-04 and 12-23-05, and a walk-over/drive-over radiological survey of both CASs. The visual inspection will focus on identifying evidence of contamination in the muckpile and ponds, including any visible staining of the soil. The visual inspection will be conducted by walking transects spaced a maximum of 40 ft apart. The survey will mark areas with elevated radioactivity. The information generated during these initial activities will be used to provide additional biasing factors for the placement of field screening and confirmatory soil samples.

Following the visual inspection and survey, the biased soil sample locations will be established.

The following are the biasing factors that currently have been identified for consideration in the selection of the surface soil field-screening sample locations:

- Aerial photograph review and evaluation
- Walk-over and drive-over radiological surveys
- Visual indicators (e.g., staining, topography, areas of preferential surface run-off)
- Known or suspected sources and locations of release
- Process knowledge and experience at similar sites
- Geologic and/or hydrologic conditions
- Physical and chemical characteristics of suspected contaminants

In addition, random locations will be selected as outlined above in the statistical method and in Section A.1.8.1. A number of extra random locations will be generated in the event that a given location is inaccessible (underneath a structure, etc.). In such an event, the next accessible random location will be sampled until the number of locations required by the method is reached.

The analyses outlined in Section A.1.4.3.3 will accurately determine the concentrations of detected COPCs and identify the COCs. Samples will be submitted to support Decision I (from worst-case locations) and to support Decision II (confirm the horizontal extent of contamination). Data collected from initial sampling results and the other biasing factors listed above will be used to select locations where the presence of COCs is or is not suspected (Decision I and Decision II, respectively). If necessary, additional surface soil samples will be submitted for laboratory analysis to ensure that the extent of contamination is defined using quantitative data. Lateral step-out locations will be selected as discussed earlier, but can be adjusted by the Site Supervisor based on site-specific information obtained during the initial sampling effort.

Where COPCs exceed the PALs in surface soil based on initial analyses, shallow subsurface soil samples will be collected to define the vertical extent of contamination.

The bias sampled depth intervals at subsurface locations will be based on biasing factors such as presence of debris, staining, odor, FSRs, or professional judgement. For subsurface sampling locations, generally two consecutive soil samples with results below field-screening action levels are required to define the vertical extent of contamination. Generally, the uppermost “clean” sample from each location will be submitted for laboratory analysis.

At locations where Decision I analytical results show COC concentrations in soil equal to or greater than PALs, step-out (both vertical and horizontal) samples will be collected during the Decision II sampling to delineate the extent of the potential hot spots. Step-outs from COC hot spots will continue until the extent of the concentrations greater than the PAL is delineated.

Surface soil samples will be collected by hand. Sonic drilling, hollow-stem auger drilling, direct-push, handheld augers, or excavation will be used, as appropriate, to collect subsurface and muckpile samples. Samples for IDW and waste characterization purposes may also be collected at CASs 12-06-04 and 12-23-05.

Due to the nature of buried features possibly present in the muckpile (e.g., structures, buried debris, and utilities), sample locations may be relocated, based upon the information obtained during the site visit. However, the new locations will meet the decision needs and criteria stipulated in Section A.1.4.1.

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Appendix A.2

Project Organization

A.2 Project Organization

The NNSA/NSO Project Manager is Janet Appenzeller-Wing, and her telephone number is (702) 295-0461.

The identification of the project 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 appropriate DOE or DTRA Project Manager be contacted for further information. The Task Manager will be identified in the FFACO Biweekly Activity Report prior to the start of activities.

Appendix A.3

Response to NDEP Comments

MAR.25.2004 9:54AM DOE NVOO ERD NO.851 P.2/3

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Air Quality
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DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL PROTECTION
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March 18, 2004

Ms. Janet Appenzeller-Wing
Acting Director, Environmental Restoration Division
Nevada Nuclear Security Administration
Nevada Site Office
P. O. Box 98518
Las Vegas, NV 89193-8518

RE: Review of the draft Corrective Action Investigation Plan for the Corrective Action Unit 552, Area 12 Muckpile and Ponds, Nevada Test Site, Nevada

Dear Ms. Appenzeller-Wing:

This letter replaces the two letters dated February 27, 2004, concerning the draft Corrective Action Investigation Plan (CAIP) for the Corrective Action Unit (CAU) 552. The Nevada Division of Environmental Protection staff, Bureau of Federal Facilities (NDEP) has received and reviewed the draft CAIP for the CAU 552, Area 12 Muckpile and Ponds provided by the Nevada Nuclear Security Administration/Nevada Site Office. As noted in the February 27th letters, NDEP has no comments related to the draft CAIP.

Address any questions regarding this matter to either Greg Raab at (702) 486-2867, or me at (702) 486-2874.

Sincerely,

Don Elle

Don Elle, Ph.D.
Supervisor, Las Vegas
Bureau of Federal Facilities

ACTION	ERD IESAD TD WMD ASD/M&O
INFO	✓
NSO/MGR	✓
AMEM	
AMNS	
AMSO	✓
AMSSP	

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