RECORD OF TECHNICAL CHANGE

Technical Change No. ✓1 — Page 1 of 1

Project/Job No. IS04 - 010 — Date 12/02/03

Project/Job Name Corrective Action Decision Document for CAU 005: Areas 5, 6, 12, 20, and 23 Landfills

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

Al Wickline (Name) — Task Manager (Title)

(Description of change)

1. **Section 3.3.3 Alternative 3 – Close-in-Place with Administrative Controls and Construction of Covers**, page 43. Change the next to last sentence in the first paragraph from "Covers will be constructed as needed to bring the final cover thickness to a minimum of 2 ft and will be graded to a minimum 2 percent slope" to " Covers will be constructed as needed to bring the final cover thickness to a minimum of 2 ft and will be graded to a minimum 3 percent slope."

   Change the second sentence of the second paragraph from "After the fifth year, inspections will be conducted every five years for 20 years" to, "After the fifth year, inspections will be conducted every five years for 25 years."

2. **Section 3.3.3.7 – CAS 20-15-01, Landfill**, page 46. Change the second sentence in the first paragraph from "Appropriate material will be added and graded to bring the final grade to a minimum 2 percent slope", to "Appropriate material will be added and graded to bring the final grade to a minimum 3 percent slope."

3. **Section 3.3.2 Alternative 2 – Close in Place with Administrative Controls.** Page 38. Change the second sentence of the second paragraph of the section from "After the fifth year, inspections will be conducted every five years for 30 years" to, "After the fifth year, inspections will be conducted every five years for a total of 30 years. "

4. **Appendix H, Section H.1.2 Risk Evaluation.** Page H-1. Correct the typographical in the second sentence of the first paragraph of the section. Text should read "Nuclear and High Explosive Test Land -Use Zone"

(Justification of Change)

These changes have been made in response to NDEP comments on the final CAU 05 CADD.

Changes 1 and 2.

Although Alternative 3 - Close-in-Place with Administrative Controls and Construction of Covers was not proposed, the changes have been made to be consistent with the Nevada Administrative Code.

Change 3. The years of inspection have been changed from the suggested 35 years to a total of 30 to be consistent with the Nevada Administrative Code.

Change 4. This change is made to correct a typographical error and make the text easier to understand.

The project time will be (Increased)(Decreased)(**Unchanged**) by approximately 0 days.

Applicable Project-Specific Document(s): CADD

CC:

Approved By: (signature) Date 12-8-03
Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

(signature) Date 12-8-03
Runore C. Wycoff, Division Director
Environmental Restoration Division

NDEP Concurrence Yes___ No___ Date ______

NDEP Signature ______

Contract Change Order Required Yes___ No ___

Contract Change Order No. ______

RECORD OF TECHNICAL CHANGE

Technical Change No. ✓1 Page 1 of 1

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CC:

Approved By: (signature) Date 12-8-03

Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

(signature) Date 12-8-03

Runore C. Wycoff, Division Director
Environmental Restoration Division

NDEP Concurrence Yes ___ No ___ Date 12/8/03

NDEP Signature (signature)

Contract Change Order Required Yes ___ No ___

Contract Change Order No. ___

Nevada
Environmental
Restoration
Project

DOE/NV--930

National Nuclear Security Administration

Corrective Action Decision Document for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

October 2003

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Division

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CORRECTIVE ACTION DECISION DOCUMENT FOR CORRECTIVE ACTION UNIT 5: LANDFILLS, NEVADA TEST SITE, NEVADA

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

Controlled Copy No.: ___

Revision No.: 0

October 2003

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CORRECTIVE ACTION DECISION DOCUMENT FOR CORRECTIVE ACTION UNIT 5: LANDFILLS, NEVADA TEST SITE, NEVADA

Approved by: Signature Approved Date: 10/21/03

Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

Approved by: Signature Approved Date: 10/21/03

Runore C. Wycoff, Division Director
Environmental Restoration Division

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List of Acronyms and Abbreviations

AA	Anomaly A
Ac	Actinium
bgs	Below ground surface
Bi	Bismuth
BN	Bechtel Nevada
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAP	Corrective Action Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm/sec	Centimeters per second
cm^2	Square centimeter
COC	Contaminants of concern
CONUS	Continental United States
COPC	Contaminants of potential concern
CSM	Conceptual site model
CWA	Conductive waste area
DOE	U.S. Department of Energy
dpm	Disintegrations per minute
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EI	Electrical imaging
EM	Electromagnetic

List of Acronyms and Abbreviations *(Continued)*

EPA	U.S. Environmental Protection Agency
ERD	Environmental Restoration Division
FADL	Field activity daily log
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level
ft	Foot (feet)
ft^2	Square feet
FSR	Field-screening result
GC	Gas chromatograph
g/cm^3	Grams per cubic centimeter
GPS	Global positioning system
GRO	Gasoline-range organics
HCA	High conductivity area
HWAA	Hazardous waste accumulation area
ICP	Inductively coupled plasma
IDW	Investigation-derived waste
in.	Inch
K	Potassium
LCS	Laboratory control spike
LCSD	Laboratory control sample duplicate
LD	Laboratory duplicate
mg/kg	Milligrams per kilogram
mi	Mile
MRL	Minimum reporting limit
MS	Matrix spike
MSD	Matrix spike duplicate

List of Acronyms and Abbreviations *(Continued)*

MWA	Metallic waste area
NAC	*Nevada Administrative Code*
NAD	North American Datum
NBMG	Nevada Bureau of Mines and Geology
NDEP	Nevada Division of Environmental Protection
NIST	National Institute for Standards and Technology
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NRS	*Nevada Revised Statutes*
NTS	Nevada Test Site
NTTR	Nevada Test and Training Range
PACM	Potentially asbestos-containing material
PAL	Preliminary action level
Pb	Lead
PCB	Polychlorinated biphenyls
pCi/g	Picocuries per gram
PPE	Personal protective equipment
ppm	Parts per million
PT	Potential trench
PRG	Preliminary Remediation Goal
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	*Resource Conservation and Recovery Act*
REOP	Real Estate/Operations Permit
RPD	Relative percent difference

List of Acronyms and Abbreviations *(Continued)*

RRF	Relative response factor
RWMS	Radioactive Waste Management Site
SDG	Sample delivery group
Shaw	Shaw Environmental, Inc.
SMT	Subsurface metallic target
Sr	Strontium
SSHASP	Site-Specific Health and Safety Plan
SVOC	Semivolatile organic compounds
T	Trench
TCLP	*Toxicity Characteristic Leaching Procedure*
Tl	Thallium
TL	Trench/landfill
TPH	Total petroleum hydrocarbons
TPU	Total propagated uncertainty
VOC	Volatile organic compounds
WSI	Wackenhut Services, Inc.
yd^3	Cubic yards
µg/kg	Micrograms per kilogram
%R	Percent recovery

Executive Summary

This Corrective Action Decision Document (CADD) has been prepared for Corrective Action Unit (CAU) 5, Landfills. The purpose of the CADD is to identify and provide a rationale for the recommendation of a corrective action alternative for each corrective action site (CAS) within CAU 5. The corrective action investigation was conducted in accordance with the *Corrective Action Investigation Plan for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada* (NNSA/NV, 2002a), as developed under the *Federal Facility Agreement and Consent Order* (FFACO, 1996). Corrective Action Unit 5 is located in Areas 5, 6, 12, 20, and 23 of the Nevada Test Site, Nevada, and includes the following CASs:

- 05-15-01, Sanitary Landfill
- 05-16-01, Landfill
- 06-08-01, Landfill
- 06-15-02, Sanitary Landfill
- 06-15-03, Sanitary Landfill; Burn Pit
- 12-15-01, Sanitary Landfill
- 20-15-01, Landfill
- 23-15-03, Disposal Site

Corrective Action Site 23-15-03 has two areas of interest. The first is a disposal area to the north of the site with abundant surface debris and no evidence of subsurface disposal features, and is referred to as the Disposal Area. The second area is at the south of the site with multiple subsurface disposal features, and is referred to as the Landfill. Because of these two areas being distinctly different with respect to the source and type of potential contamination, the CADD will discuss the nature and extent of contaminants for each area of CAS 23-15-03.

Analytes detected during the corrective action investigation were evaluated against appropriate preliminary action levels to determine contaminants of concern for each CAS. Excavation and drilling provided information about the physical and geotechnical/hydrological characteristics of disposal features. Topographic surveys provided information about the slope of existing disposal feature covers. Assessment of the data generated from investigation activities revealed the following:

- Contaminants of concern (COCs) were only identified outside disposal feature boundaries at CAS 12-15-01. The COCs included total petroleum hydrocarbons and volatile organic compounds. The COCs were bounded laterally and vertically. The COCs have not migrated

outside the lateral boundaries of the disposal feature but have migrated approximately 15 feet below the vertical boundary of the disposal feature.

- Contaminants of concern have not migrated outside disposal feature boundaries at the remaining CASs.
- Observed surface and subsurface waste consisted primarily of general construction debris.
- Excavation revealed the boundaries of landfill disposal features generally correlate with boundaries determined from geophysical surveys.
- Generally, disposal feature covers ranged from 1- to 3-feet thick. However, at some excavation locations covers were several inches thick, and at other locations covers were as thick as 6 feet.

Close in Place with Administrative Controls is the recommended alternative for all of the CASs in CAU 5. This recommendation is based on the evaluation of analytical data from the corrective action investigation; review of current and future operations in Areas 5, 6, 12, 20, and 23 of the Nevada Test Site; written directives from the Nevada Division of Environmental Protection; and the detailed and comparative analysis of the potential corrective action alternatives.

The preferred corrective action alternatives were evaluated on technical merit focusing on performance, reliability, feasibility, and safety. The alternatives were judged to meet all requirements for the technical components evaluated. The alternatives meet all applicable state and federal regulations for closure of the site and will eliminate inadvertent intrusion into the disposal features of CAU 5.

1.0 Introduction

This Corrective Action Decision Document (CADD) has been prepared for Corrective Action Unit (CAU) 5, Landfills, Nevada Test Site (NTS), Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada, U.S. Department of Energy (DOE), and the U.S. Department of Defense (FFACO, 1996). This CADD provides or references the specific information necessary to recommend corrective actions for the eight corrective action sites (CASs) located within CAU 5, as provided in the FFACO.

The NTS is approximately 65 miles (mi) northwest of Las Vegas, Nevada. The CASs within CAU 5 are located in Areas 5, 6, 12, 20, and 23 of the NTS, in Nye County, Nevada. Table 1-1 identifies each CAS and its associated facility, and Figure 1-1 shows the location of the CASs on the NTS.

Table 1-1
CAU 5 Corrective Action Sites and Associated Facilities

NTS Area	CAS Number	CAS Description[a]	Facility Association
Area 5	05-15-01	Sanitary Landfill	None
	05-16-01	Landfill	Area 5 Radioactive Waste Management Site
Area 6	06-08-01	Landfill	Area 6 Equipment Yard
	06-15-02	Sanitary Landfill	None
	06-15-03	Sanitary Landfill; Burn Pit	
Area 12	12-15-01	Sanitary Landfill	Area 12 Camp Sewage System[b]
Area 20	20-15-01	Landfill	None
Area 23	23-15-03	Disposal Site	Area 23 Sanitary Landfill and Wackenhut Services, Inc. Protective Forces Training Complex

[a]CAS description from the FFACO (1996)
[b]Includes leachfield, sewage line, manhole, sewage meter, and dump pad within CAS boundary.

1.1 Purpose

This CADD develops and evaluates potential corrective action alternatives and provides a rationale for the selection of a recommended corrective action alternative for each CAS within CAU 5. The corrective action alternatives evaluation is based on process knowledge and the results of investigative activities conducted in accordance with the *Corrective Action Investigation Plan (CAIP) for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada* (NNSA/NV, 2002a).

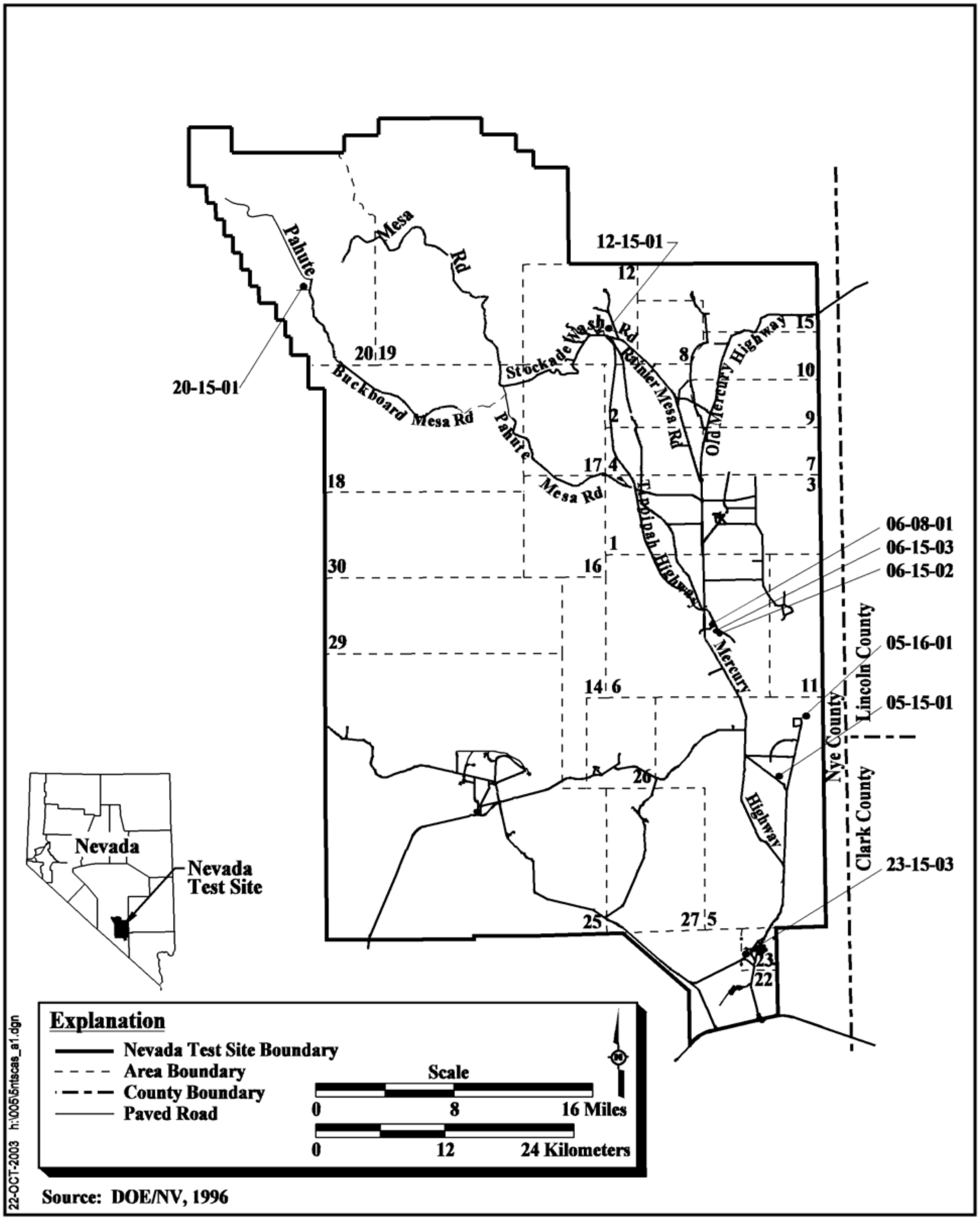

Figure 1-1
Nevada Test Site and CAU 5 Site Map

The NTS has been used for various research and development projects including nuclear weapons testing. The eight CASs in CAU 5 consist of unlined landfills where disposal operations occurred between 1952 and 1992. Large volumes of solid waste were produced from these projects. The practice on the NTS was to dispose of solid waste in the vicinity of the project. Additional CAS-specific information is provided in Section 2.0, Section 3.0, and Appendix A of the CAU 5 CAIP, and Section A.3.0 through Section A.10.0 of this CADD.

Corrective Action Site 23-15-03 has two areas of interest. The first is a disposal area to the north of the site with abundant surface debris and no evidence of subsurface disposal features, and is referred to as the Disposal Area. The second area is at the south of the site with multiple subsurface disposal features, and is referred to as the Landfill. Because of the two areas being distinctly different with respect to the source and type of potential contamination, the CADD will discuss the nature and extent of contaminants for each area of CAS 23-15-03.

1.2 Scope

The scope of this CADD consists of the following:

- Evaluate current site conditions including the presence of buried waste, the physical and hydrological/geotechnical characteristics of existing disposal feature covers, and the concentration and extent of any migrating contaminants of concern (COCs).
- Develop corrective action objectives.
- Identify corrective action alternative screening criteria.
- Develop corrective action alternatives.
- Perform detailed and comparative evaluations of corrective action alternatives in relation to corrective action objectives and screening criteria.

1.3 CADD Contents

This CADD is divided into the following sections and appendices:

Section 1.0 - Introduction: Summarizes the purpose, scope, and contents of this CADD.

Section 2.0 - Corrective Action Investigation Summary: Summarizes the field investigation activities, results of the investigation, and the need for corrective action.

Section 3.0 - Evaluation of Alternatives: Describes, identifies, and evaluates the steps taken to determine a preferred corrective action alternative for each CAS.

Section 4.0 - Recommended Alternatives: Presents the preferred corrective action alternative for each CAS and the rationale for its selection based on the corrective action objectives and screening criteria.

Section 5.0 - References: Provides a list of sources and documents used in the preparation of this CADD.

Appendix A - *Corrective Action Investigation Results*: Provides a description of the project objectives, field investigation and sampling activities, investigation results, waste management, and quality assurance.

Appendix B - *Data Assessment*: Provides an assessment of data obtained during the CAU 5 investigation. Summarizes and compares investigation results to the requirements set forth during the Data Quality Objective (DQO) process.

Appendix C - *Cost Estimates*: Presents cost estimates for the construction, installation, operation, and maintenance of each corrective action alternative chosen for each CAS.

Appendix D - *Investigation Location Coordinates:* Provides coordinates for pertinent investigation locations.

Appendix E - *Project Organization:* Identifies the CAU 5 DOE Project Manager and other appropriate personnel involved with the characterization and closure activities for each CAS.

Appendix F - *Geotechnical Data*: Provides a summary of geotechnical analytical data.

Appendix G - *Topographic Maps*: Provides topographic maps for each of the CASs in CAU 5.

Appendix H - *Evaluation of Risk:* Evaluates the risk and exposure to COCs that may remain in soil after closure.

Appendix I - Provides a discussion of the Radiological PALs used in this document.

Appendix J - Provides the responses to the Nevada Division of Environmental Protection (NDEP) comments.

The field investigation was performed in accordance with the following documents:

- *Corrective Action Investigation Plan for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada* (NNSA/NV, 2002a)
- *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002b)
- *Federal Facility Agreement and Consent Order* (FFACO, 1996)
- *Project Management Plan* (DOE/NV, 1994)

2.0 Corrective Action Investigation Summary

As described in the CAIP, corrective action investigation activities were conducted at CAU 5, between October 7, 2002 through January 30, 2003. Geophysical surveys were completed from March 6 through May 8, 2002, and topographic surveys were conducted from March 11 through April 29, 2003.

The following sections summarize the CAU 5 investigation activities and results, and assess the need for corrective action at each CAS. Detailed investigation activities and results are presented in Appendix A of this document.

2.1 Investigation Activities

The primary objectives of the investigation were to:

- Collect data to identify, evaluate, and defend appropriate corrective action alternatives
- Determine if buried waste is present in the various disposal features
- Determine the nature of disposal feature covers (i.e., thickness, permeability, and slope)
- Determine if COCs have migrated from disposal features
- If migration has occurred, determine the vertical and lateral extent of contamination

Sufficient information was obtained to develop and evaluate corrective action alternatives for each CAS within CAU 5. Excavations were performed to confirm the lateral boundaries of disposal features, determine the presence of subsurface waste, and characterize existing disposal feature covers. Sampling was performed outside disposal feature boundaries to determine if contaminants of potential concern (COPCs) identified in the CAIP migrated beyond disposal feature boundaries at concentrations exceeding preliminary action levels (PALs). If PALs were exceeded, the COPC then became a COC and the vertical and horizontal extent of the contamination was determined at the affected CAS.

The CASs were characterized with several methods. Geophysical surveys located subsurface metallic or nonmetallic (conductive) waste and backhoe excavations confirmed or determined the presence and nature of disposal features, including the thickness of covers over disposal features. Rotary sonic drilling was used to observe subsurface features and collect soil samples outside identified disposal feature boundaries for off-site laboratory analysis of chemical and radiological parameters. Geotechnical samples were collected via rotary sonic drilling from cover material and from native soil beneath disposal features for comparative analysis of physical and hydrologic parameters. Topographic surveys were conducted to determine the slope of existing disposal feature covers.

Selected drill core intervals were field screened for volatile organic compounds (VOCs), alpha and beta/gamma radiation, and total petroleum hydrocarbons (TPH). The results were compared against field-screening levels (FSLs) to guide the investigation. Samples were shipped to off-site laboratories and analyzed for appropriate chemical and radiological parameters. Based on historical data, analytical parameters were categorized into five datasets, as follows:

- Set 1 - total VOCs, total semivolatile organic compounds (SVOCs), ethylene glycol, total *Resource Conservation and Recovery Act* (RCRA) metals, nickel, zinc, TPH gasoline-range organics (GRO), TPH diesel-range organics (DRO), polychlorinated biphenyls (PCBs)

- Set 2 - moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, moisture characteristics

- Set 3 - total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, pesticides, gamma-emitting radionuclides, isotopic plutonium (Pu), Strontium (Sr)-90, dioxins

- Set 4 - total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, gamma-emitting radionuclides, isotopic plutonium

- Set 5 - total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, pesticides

In accordance with the CAIP, analysis for Sr-90 and dioxins were conditional. Samples were analyzed for Sr-90 if beta/gamma field-screening results (FSRs) of the sample exceeded beta/gamma FSLs. Samples were analyzed for dioxins if PCBs were detected in the sample at concentrations exceeding minimum reporting levels (MRLs).

Gamma spectrometry was performed on all samples collected at CAS 06-15-02 and CAS 06-15-03 because the CAIP identified gamma-emitting radionuclides as COPCs at these CASs. Gamma-emitting radionuclides were not identified as COPCs at the remaining CASs, and gamma spectrometry was performed on 25 percent of the samples collected at these CASs for disposition of investigation-derived waste (IDW). Polychlorinated biphenyls were detected in two samples from CAS 23-15-03. Therefore, in accordance with the CAIP, these samples were analyzed for dioxins and furans.

The following sections summarize investigation activities at each CAS.

2.1.1 CAS 05-15-01, Sanitary Landfill

No variations to the conceptual site model (CSM) were identified at this CAS. The following investigative field work was conducted at CAS 05-15-01:

- Conducted a geophysical survey to identify lateral and vertical extent of disposal features.
- Excavated 12 backhoe trenches at locations based on the geophysical survey to confirm the presence of disposal features, determine cover thickness, determine the nature of buried waste, and verify the lateral boundaries of disposal features.
- Staked drilling locations based on excavation observations.
- Collected 12 site characterization soil samples via rotary sonic drilling from intervals corresponding to the base of disposal features; submitted samples for off-site laboratory analysis (Set 1).
- Collected six geotechnical soil samples via rotary sonic drilling from cover material and native soil beneath disposal features; submitted samples for off-site laboratory analysis (Set 2).
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

2.1.2 CAS 05-16-01, Landfill

No variations to the CSM were identified at this CAS. The following investigative field work was conducted at CAS 05-16-01:

- Conducted a geophysical survey to identify lateral and vertical extent of disposal features.
- Excavated 10 backhoe trenches at locations based on the geophysical survey to confirm the presence of disposal features, determine cover thickness, determine the nature of buried

waste, verify the lateral boundaries of disposal features, and determine the base of the subsurface metallic target (SMT).

- Staked drilling locations based on excavation observations.
- Collected 10 site characterization soil samples via rotary sonic drilling from intervals corresponding to the base of disposal features; submitted samples for off-site laboratory analysis (Set 1).
- Collected six geotechnical soil samples via rotary sonic drilling from cover material and native soil beneath disposal features; submitted samples for off-site laboratory analysis (Set 2).
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

2.1.3 CAS 06-08-01, Landfill

No variations to the CSM were identified at this CAS. The following investigative field work was conducted at CAS 06-08-01:

- Conducted a geophysical survey to identify lateral extent of disposal features.
- Excavated 26 backhoe trenches at locations based on the geophysical survey to confirm the presence of disposal features, determine cover thickness, determine the nature of buried waste, verify the lateral boundaries of disposal features, and determine disposal feature bases.
- Determined by excavation that two potential trenches identified in aerial photographs were not used for waste disposal.
- Staked drilling locations based on excavation observations.
- Collected 27 site characterization soil samples via rotary sonic drilling from intervals corresponding to the base of disposal features; submitted samples for off-site laboratory analysis (Set 1).
- Collected six geotechnical soil samples via rotary sonic drilling from cover material and native soil beneath disposal features; submitted samples for off-site laboratory analysis (Set 2).
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

2.1.4 CAS 06-15-02, Sanitary Landfill

No variations to the CSM were identified at this CAS. The following investigative field work was conducted at CAS 06-15-02:

- Conducted a geophysical survey to identify lateral and vertical extent of disposal features.
- Excavated nine backhoe trenches at locations based on the geophysical survey to confirm the presence of disposal features, determine cover thickness, determine the nature of buried waste, verify the lateral boundaries of disposal features, and determine the base of a conductive waste area (CWA) identified by the geophysical survey.
- Staked drilling locations based on excavation observations.
- Collected 14 site characterization soil samples via rotary sonic drilling from intervals corresponding to the base of disposal features and from other intervals determined by biasing factors (e.g., field screening, visual observation of drill core); submitted samples for off-site laboratory analysis (Set 4).
- Collected six geotechnical soil samples via rotary sonic drilling from cover material and native soil beneath disposal features; submitted samples for off-site laboratory analysis (Set 2).
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

2.1.5 CAS 06-15-03, Sanitary Landfill; Burn Pit

No variations to the CSM were identified at this CAS. The following investigative field work was conducted at CAS 06-15-03:

- Conducted a geophysical survey to identify the lateral and vertical extent of disposal features.
- Excavated 21 backhoe trenches at locations based on the geophysical survey to confirm the presence of disposal features, determine cover thickness, determine the nature of buried waste, and verify the lateral boundaries of disposal features.
- Staked drilling locations based on excavation observations.
- Collected 36 site characterization soil samples via rotary sonic drilling from intervals corresponding to the base of disposal features and from other intervals determined by biasing

factors (e.g., presence of caliche hardpan); submitted samples for off-site laboratory analysis (Set 4).

- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

2.1.6 CAS 12-15-01, Sanitary Landfill

No variations to the CSM were identified at this CAS. The following investigative field work was conducted at CAS 12-15-01:

- Conducted a geophysical survey to identify the lateral and vertical extent of disposal features.
- Excavated nine backhoe trenches at locations based on the geophysical survey to confirm the presence of disposal features, determine cover thickness, determine the nature of buried waste, verify the lateral boundaries of disposal features, and determine bases of certain disposal features.
- Staked drilling locations based on excavation observations.
- Collected 26 site characterization soil samples via rotary sonic drilling from intervals corresponding to the base of disposal features and from other intervals determined by biasing factors (e.g., field screening, visual observation of drill core); submitted samples for off-site laboratory analysis (Set 1).
- Based on visual examination of drill core and FSRs, drilled six step-out borings and collected 11 soil samples to determine the lateral and vertical extent of potential contamination; submitted samples for off-site laboratory analysis (Set 2).
- Collected six geotechnical soil samples via rotary sonic drilling from cover material and native soil beneath disposal features; submitted samples for off-site laboratory analysis (Set 2).
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

2.1.7 CAS 20-15-01, Landfill

No variations to the CSM were identified at this CAS. The following investigative field work was conducted at CAS 20-15-01:

- Conducted a geophysical survey to identify the lateral and vertical extent of the disposal feature.
- Excavated four backhoe trenches at locations based on the geophysical survey to confirm the presence of the disposal feature, determine cover thickness, determine the nature of buried waste, and verify the lateral boundary of the disposal feature.
- Staked drilling locations based on excavation observations.
- Collected five site characterization soil samples via rotary sonic drilling from intervals corresponding to the base of disposal features; submitted samples for off-site laboratory analysis (Set 1).
- Collected six geotechnical soil samples via rotary sonic drilling from cover material and native soil beneath disposal features; submitted samples for off-site laboratory analysis (Set 2).
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

2.1.8 CAS 23-15-03, Disposal Site

No variations to the CSM were identified at this CAS. The following investigative field work was conducted at CAS 23-15-03:

- Conducted a geophysical survey to identify the lateral and vertical extent of disposal features.
- Excavated 38 backhoe trenches (six at the Disposal Area and 32 at the Landfill) at locations based on the geophysical survey to confirm the presence of disposal features, determine cover thickness, determine the nature of buried waste, verify the lateral boundaries of disposal features, and determine bases of certain disposal features.
- Determined by excavation that no subsurface disposal features exist at the Disposal Area.
- Identified three distinct surface debris fields and two surface debris piles at the Disposal Area; determined the lateral extent of surface debris with Global Positioning System (GPS) equipment.

- Staked drilling locations based on excavation observations.
- Collected six site characterization soil samples at the Disposal Area via rotary sonic drilling from beneath surface debris; submitted samples for off-site laboratory analysis (Set 5). Because PCBs were detected in two samples at concentrations greater than the MRL, these two samples were also analyzed for dioxin/furans.
- Drilled four step-out borings and collected five soil samples at the Disposal Area to delineate the lateral extent of possible debris or contamination to the east; submitted samples for off-site laboratory analysis (Set 5).
- Collected 30 site characterization soil samples at the Landfill via rotary sonic drilling from intervals corresponding to the base of disposal features and from other intervals determined by biasing factors (visual observation of drill core); submitted samples for off-site laboratory analysis (Set 5).
- Drilled five step-out borings and collected five soil samples at the Landfill to delineate the lateral extent of possible debris or contamination to the west; submitted samples for off-site laboratory analysis (Set 5).
- Collected six geotechnical soil samples at the Landfill via rotary sonic drilling from cover material and native soil beneath disposal features; submitted samples for off-site laboratory analysis (Set 2).
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO).
- Conducted a topographic survey to determine the slope of disposal feature covers.

During the investigation, surface debris was removed from the southern end of the Disposal Area. The activity was suspended when it was determined that the removal activity had removed soil that was not intended for removal. Seven truckloads (approximately 190,200 pounds) of debris and soil had already been disposed of at the Area 9 U10C Landfill. The activity also generated two piles of soil containing abundant asphalt and concrete.

The soil piles and the waste at the Area 9 U10C Landfill were sampled for waste characterization purposes. Sixteen samples and a duplicate were collected from the disposed waste and analyzed for *Toxicity Characteristic Leaching Procedure* (TCLP) VOCs, TCLP SVOCs, TCLP metals, PCBs, TCLP pesticides, and TPH - diesel and gasoline. Analytical results show extremely low-level concentrations of barium (in the background range), low-level concentrations of PCBs (in the parts per billion range), and TPH concentrations ranging from nondetectable levels to 400 milligrams per kilogram (mg/kg). Field notes show the presence of asphalt construction debris in all of the samples. The petroleum hydrocarbon results for these samples were all in the oil range which is typical for samples collected near asphalt or samples containing asphalt. Thus, the elevated TPH concentrations do not represent contamination in the samples.

Twelve samples and a duplicate were collected from the stockpiled soil piles and analyzed for TPH. Analytical results showed concentrations of TPH ranged from less than detection limits (40 mg/kg) to 830 mg/kg. Field notes show the presence of asphalt construction debris in all the samples. As discussed above, the TPH concentrations do not represent contamination.

2.2 Results

Section 2.2.1 summarizes characterization data collected during the investigation. Section 2.2.2 summarizes the assessment made in Appendix B, which demonstrates the correlation between the investigation results and the DQOs. Results of the investigation validated the CSM presented in the CAIP (NNSA/NV, 2002a).

2.2.1 Summary of Characterization Data

Characterization data were collected to establish disposal feature boundaries and determine the thickness, slope, and hydrologic/geotechnical characteristics of disposal feature covers. Analytical data from samples were used to determine if COCs are present (nature) and determine if they have migrated beyond disposal feature boundaries (extent). Section 2.2.1.1 through Section 2.2.1.8 summarize these various data for each CAS.

The PALs for the CAU 5 investigation were determined during the DQO process. The PALs for chemical COPCs are U.S. Environmental Protection Agency (EPA) *Region 9 Industrial Preliminary Remediation Goals* (PRGs) (EPA, 2000), background concentrations for arsenic, and 100 mg/kg for TPH (NAC, 2003). For radiological COPCs, the PALs are isotope-specific and defined as the maximum background concentrations for that isotope from undisturbed locations in the vicinity of the NTS (US Ecology and Atlan-Tech, 1991). A summary of the selection, use, and identification of PALs for radioactive material on the NTS is presented in Appendix I.

Details of the methods used and results found during the investigation are presented in Appendix A. Based on these results, the COC nature and extent, physical properties of the disposal features (i.e., cover thickness, permeability, and slope), and presence of buried waste have been adequately identified to develop and evaluate corrective action alternatives.

2.2.1.1 CAS 05-15-01, Sanitary Landfill

The geophysical survey identified four disposal features, Trench (T)1 through T4. Excavation confirmed the presence of the trenches and showed the boundaries to be generally consistent with those indicated by the geophysical survey. No COCs were found migrating from this CAS.

The cover at T2 ranged from 2- to 3-feet (ft) thick. The covers at the remaining disposal features were less than 2-ft thick and ranged from nonexistent over a portion of T1 to 1.5-ft thick over portions of T3 and T4. Debris encountered included metal, burned and unburned wood, and lesser amounts of concrete and transite pipe.

Based on interpretation of geotechnical data, the average permeability of the cover soil, $9.1X10^{-5}$ centimeters per second (cm/sec), is lower than native soil beneath the disposal features (hereinafter referred to as subcell soil), at $4.3X10^{-4}$ cm/sec. Soil is well below saturation with the highest percent moisture at 11.4 percent. Cover soil had higher densities than subsurface soils. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface. This information satisfies the *Nevada Administrative Code* (NAC) 444.743 and 444.6894 requirements (NAC, 2002a).

The ground surface at CAS 05-15-01 slopes gently from the northwest to southeast at approximately 1.3 percent. This slope will limit the run-on and run-off of surface water and limit the potential erosion of the current cover. Topographic highs at the site include two soil mounds in the northwest corner, adjacent to T1.

2.2.1.2 CAS 05-16-01, Landfill

The geophysical survey identified one disposal feature (T1) and an SMT. Excavation confirmed the presence of these features. The extent of T1 was generally consistent with the geophysical survey and the SMT was found to be smaller than indicated by the survey. No COCs were identified to be migrating from this CAS.

The covers at T1 and the SMT ranged from 1.5- to 4.5-ft thick and 1- to 2-ft thick, respectively. Metallic waste was consistently found in both disposal features, with lesser amounts of paper and glass.

Based on interpretation of geotechnical data, the average permeability of the cover soil is $4.47 X 10^{-5}$ cm/sec and is lower than the average permeability of the native subcell soil of the disposal features of $2.84 X 10^{-4}$ cm/sec and only slightly above the regulatory requirement of $1.0 X 10^{-5}$ cm/sec meeting the requirements of NAC 444.743 and 444.6894 (NAC, 2002a). Soil is well below saturation with the highest percent moisture at 9.8 percent in the cover soil and 9.5 percent in the subcell soil. Cover and subcell soil had nearly equal densities and porosities, suggesting that the construction of the flood dike may have removed the native surface soil.

The ground surface at CAS 05-16-01 slopes gently from the northeast to southwest at approximately 1.8 percent. The flood dike transecting the eastern third of the site rises approximately 8 ft above the surrounding surface and the sinkhole east of the flood dike is approximately 1.5-ft deep. The dike will serve to control surface water run-on for the Trench and limit the potential for surface water to stand on the site.

2.2.1.3 CAS 06-08-01, Landfill

The geophysical survey identified two disposal features (T1 and T2) and a circular anomaly (Anomaly A [AA]). Aerial photographs identified two potential disposal trenches (PT1 and PT2). Excavation confirmed the presence of T1 and T2 and showed the boundaries to be generally consistent with the boundaries indicated by the geophysical survey. Anomaly A was shown to be a linear disposal feature and it was determined that PT1 and PT2 do not contain buried waste. No COCs were found migrating from this CAS.

The cover at AA was more than 2-ft thick. The covers at T1 and T2 generally were not more than 1-ft thick. The extent of AA, T1, and T2 were established except for the southern ends. The southern ends of T1 and T2 do not extend into the Area 6 support facility parking lot and probably terminate under Road 6-01 or the utility corridor that parallels Road 6-01. The southern extent of AA could not be established due to the presence of utilities and numerous concrete pads and other structures. Debris encountered during excavation included various combinations and amounts of burned and unburned wood, charcoal, ash, metallic scrap, glass, brick, cement, and asphalt. The debris was sparse and discontinuous and conclusions about disposal feature edges and bases were often made based on subtle lithologic and structural changes.

Based on interpretation of geotechnical data, the average permeability of the cover soil is $1.9X10^{-4}$ cm/sec and is nearly equal to the average permeability of the native subcell soil of $1.8X10^{-4}$ cm/sec, suggesting that infiltrating water would move into and out of the waste or debris at about the same rate and would not accumulate in the waste material. Cover soil at T1 and T2 have slightly higher permeabilities than subcell soil, and cover soil at AA has lower permeabilities than subcell soil. Soil is well below saturation with the highest percent moisture being 19.7 percent in the subcell soil and 8.1 percent in the cover soil. Cover soil densities are generally higher than the subcell soil. The porosities of the surface soil also is less than the subcell soil, suggesting that water would not accumulate in the waste material. These data support the NDEP requirements for porosity (NAC, 2002a). These data also suggest relatively more compaction on the surface than subsurface, which is consistent with the area being used as an equipment yard.

The ground surface at CAS 06-08-01 slopes gently from the southwest to northeast at approximately 2.3 percent. The gravelled bench in the northwest corner of the site rises approximately 4 ft above the surrounding ground surface. There are numerous flat concrete pads at the site.

2.2.1.4 CAS 06-15-02, Sanitary Landfill

The geophysical survey identified two trench/landfill (TL) and CWA combinations (TL3/CWA7 and TL4/CWA9) and two CWAs (CWA6 and CWA7). Excavation confirmed the presence and extent of TL3/CWA7 and TL4/CWA9 based on encountered debris and obvious trench sidewalls. Excavations were made inside the geophysical boundaries of CWA6 and CWA8 and thus did not contribute to establishing lateral boundaries of these disposal features. The presence of CWA6 was confirmed by minor debris encountered in one of the excavations. No debris was noted in CWA8 and excavation could not confirm the presence of a disposal feature. No COCs were found migrating from this CAS.

The covers at all the disposal features in this CAS were consistently found to be 1-ft thick. Debris was encountered at all the disposal features except CWA8 where cover thickness was determined by lithologic changes. Debris encountered included metallic waste with lesser amounts of plastic and wood.

Based on interpretation of geotechnical data, the average permeability of the cover soil, $1.47X10^{-5}$ cm/sec, is lower than native subcell soil at $4.05X10^{-4}$ cm/sec. Soil is well below saturation with the highest percent moisture at 11.4 percent. Cover soil had higher densities than subsurface soils. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface. The data support the NDEP landfill cover requirement (NAC 444.6891 Subsection 2 [NAC, 2002a]).

Based on interpretation of geotechnical data, cover soil has lower permeabilities than subcell soil. Moisture content measurements show that the soil is well below saturation. Cover soil had higher densities than subcell soil and cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

The ground surface at CAS 06-15-02 slopes from the southwest to the northeast at approximately 4.1 percent. This meets the slope requirement of NAC 444.6891 Subsection 3 (NAC, 2002a). The Area 6 Hydrocarbon Landfill, located at the east end of the site, rises approximately 8 ft above the surrounding surface. The study conducted to support the permit for the Area 6 Hydrocarbon Landfill demonstrated that the landfill and adjacent areas are not within the 100-year flood plain. It was further demonstrated that a 100-year, 6-hour rainfall would not raise the water level on the lake above 5 ft and CAS 06-15-02 is approximately 10 ft above the level of the lakebed. Therefore, it would take a significantly more intense rainfall than the 100-year, 6-hour event to cause flood water to inundate the site. In addition, there are no well-defined drainage channels in the vicinity which could generate run-on to CAS 06-15-02 (NNSA/NSO, 2003).

2.2.1.5 CAS 06-15-03, Sanitary Landfill; Burn Pit

The geophysical survey identified one TL/CWA combination (TL1/CWA5), one TL (TL2), and four CWAs (CWA1 through CWA4). The presence of the disposal features was confirmed by excavation and lateral boundaries were shown to be generally consistent with boundaries indicated by the survey. No COCs were found migrating from this CAS.

The covers at CWA2, CWA4, and TL1/CWA5 were at least 2-ft thick. The cover at TL2 was consistently 1-ft thick. The covers at CWA1 and CWA3 were only a few inches thick. At CWA3, asphalt debris was noted from just below the surface to 1 ft below ground surface (bgs) in a 500-square ft (ft^2) area within the geophysical boundaries of the feature. There was no debris observed at CWA1, CWA2, or CWA4. Covers at these disposal features were based on variations in structure and lithology. Debris at TL1/CWA5 and TL2 included minor amounts of metal and plastic.

Based on interpretation of geotechnical data, the average permeability of the cover soil, $2.57X10^{-4}$ cm/sec, is lower than native subcell at $1.06X10^{-3}$ cm/sec, meeting the NDEP landfill requirement of NAC 444.6891, Subsection 1(a) (NAC, 2002a). Soil is well below saturation with the highest percent moisture at 23.3 percent in the surface soil and 20.6 in the subcell soil. Cover soil had higher average densities than subsurface soils, 1.77 g/cm^3 and 1.56 g/cm^3, respectively. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

Based on interpretation of geotechnical data, cover soil has lower permeabilities than subcell soil at TL1/CWA5 and at CWA4. At CWA3, cover soil has a higher permeability than subcell soil. Moisture content measurements show that the soil is well below saturation. Cover soil had higher densities than subcell soil and cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

The ground surface at CAS 06-15-03 slopes from the southwest to the northeast at approximately 5 percent. This slope meets the landfill requirement of NAC 444.6891 Subsection 3 (NAC, 2002a). There is a low linear mound, less than 1 ft in height, over most of CWA4. The ground surface at most of CWA3 is generally flat. The Area 6 Hydrocarbon Landfill, located at the east end of the site, rises approximately 8 ft above the surrounding surface. The study conducted to support the permit for the Area 6 Hydrocarbon Landfill demonstrated that the landfill and adjacent areas are not within the 100-year flood plain. It was also demonstrated that a 100-year, 6-hour rainfall would not raise the water level on the lake above 5 ft and CAS 06-15-03 is approximately 10 ft above the level of the lakebed. Therefore, it would take a significantly more intense rainfall than the 100-year, 6-hour event to cause flood water to inundate the site. In addition, there are no well-defined drainage channels in the vicinity which could generate run-on to CAS 06-15-03 (NNSA/NSO, 2003).

2.2.1.6 CAS 12-15-01, Sanitary Landfill

The geophysical survey identified three trenches (T1 through T3) and two CWAs (CWA1 and CWA5). Excavation confirmed the presence of the disposal features and showed the lateral boundaries to be generally consistent with the geophysical survey, except that T2 and CWA5 were shown to connect as a single disposal feature.

Covers at all the disposal features were greater than 2-ft thick, except T3 where the cover was 1-ft thick. Debris encountered during excavation included various combinations and amounts of kitchen rubbish, burned material, bones, grease, antifreeze, glass, concrete, rebar, miscellaneous metallic scrap, burned paper, plastic, and grease.

The COCs at this CAS are the VOCs 1,2-dichlorobenzene and 1,4-dichlorobenzene, and TPH (DRO and GRO). The COCs were detected in two samples collected from boring F05 located toward the western edge of CWA1. The VOCs were detected at 14 to 15 ft bgs at concentrations of 390 mg/kg for 1,2-dichlorobenzene (PAL = 370 mg/kg), and 160 mg/kg for 1,4-dichlorobenzene (PAL = 8.1 mg/kg).

The TPH was detected at 14 to 15 ft bgs and 25 to 26 ft bgs. The TPH (GRO) was detected only in the upper sample at an estimated concentration of 740 mg/kg. The TPH (DRO) was detected in both samples at estimated concentrations of 7,600 and 180 mg/kg, respectively. The PAL for TPH is 100 mg/kg.

The core at and between 14 to 26 ft bgs was described as medium green gravelly sand with a strong hydrocarbon odor. Field screening and analytical results from samples collected above 14 ft bgs and below 26 ft bgs show the contamination is vertically confined from 9 to 30 ft bgs. This interval extends below the base of CWA1, determined by excavation to vary from 7.5 to 11 ft bgs. Samples from four step-out borings were free of contamination, indicating the lateral extent of contamination is confined to an area of about 220 by 160 ft around the immediate vicinity of boring F05. This is within the lateral boundaries of CWA1, as determined by the geophysical survey and excavation.

Based on interpretation of geotechnical data, the average permeability of the cover soil is $1.41X10^{-4}$ cm/sec, which is higher than the average permeability of the subsurface soil at $1.71X10^{-4}$ cm/sec. However, the permeabilities of the surface soil within the T1 and CWA1 areas, $1.1X10^{-4}$ cm/sec and $4.1X10^{-6}$ cm/sec, respectively, are less than or equal to the subcell soil permeabilities, $1.1X10^{-4}$ cm/sec and $5.X10^{-5}$ cm/sec, respectively and meet the landfill cover requirement of NAC 444.6891, Subsection 1(a) (NAC, 2002a). The permeability of the cover soil ($3.01X10^{-4}$ cm/sec) within T2/CWA5 is not less than that of the subcell soil ($6.7X10^{-6}$ cm/sec). The T1 and CWA1 represent a large portion of the CAS area and meet the regulatory criteria. The soil is well below saturation with the highest percent moisture at 14.2 percent in the cover soil and 11.6 percent in the subcell soil. Subcell soil had higher average densities than subsurface soils, 1.72 g/cm^3 and 1.58 g/cm^3, respectively. The cover soil average percent porosity (44.97 percent) was higher than average subcell porosities (39.33 percent), suggesting less compaction on the surface than subsurface.

The ground surface at CAS 12-15-01 is gently undulating, though generally slopes from the west to east at approximately 4.9 percent and meets the landfill requirement for slope (NAC, 2002a). Washes parallel the site to the north and south; each wash is about 8- to 10-ft deep. The topography at the northern end of the site where the access road crosses the north wash is irregular.

2.2.1.7 CAS 20-15-01, Landfill

The geophysical survey identified one disposal feature (T1) with an outer perimeter of conductive waste. Excavation confirmed the presence and lateral extent of T1. The outer perimeter of conductive waste was not explored. No COCs were found migrating from this CAS. The cover at T1 was found to be 2-ft thick at all excavation locations. Plastic waste was encountered at all excavations. Scarce metal and wood was also found at excavation G03.

Based on interpretation of geotechnical data, the average permeability of the cover soil, $3.96X10^{-4}$ cm/sec, is lower than native subcell at $7.8X10^{-4}$ cm/sec and meets the landfill cover requirement of NAC 444.6891 (NAC, 2002a). Soil is well below saturation with the highest percent moisture at 24.4 percent in the surface soil and 27.2 percent in the subcell soil. The average density for both the surface and subcell soil was equal, 1.6 g/cm^3. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

The ground surface at CAS 20-15-01 is relatively flat, sloping from the northeast to southwest at approximately 1.6 percent. There are no noticeable topographic highs or lows at the site and run-on and run-off would be limited by the topographic position.

2.2.1.8 CAS 23-15-03, Disposal Site

This CAS had two areas of interest. There is a disposal area to the north of the site with abundant surface debris (Disposal Area), and an area to the south of the site with multiple disposal features (Landfill).

Disposal Area

The geophysical survey identified three metallic waste areas (MWAs) (MWA1, MWA2, and MWA4) and two CWAs (CWA1 and CWA2). Subsequent investigation trenching and field observations showed that construction debris was not buried here; rather it was dumped on the surface. As such, no covers were identified. Excavation and drilling identified a caliche hardpan at 1.5 to 2.5 ft bgs throughout the area. No COCs were found migrating from the Disposal Area.

Debris in the Disposal Area is on the surface with negligible to no covers. Most of the debris is concentrated in three large debris fields. The first area covers most of MWA1 and MWA4, toward the north. Here, the debris consists of mostly asphalt, with some areas of burned material and many coiled rolls of thin wire. The volume of waste in this field is estimated at 1,160 cubic yards (yd^3).

The second large debris field is located in the central portion of the site between the white tower and MWA2. Here, the debris is irregular piles and areas of disturbed soil containing concrete, rebar, and miscellaneous metallic scrap. The volume of waste in this field is estimated at 260 yd^3.

The third debris field contains the "green ooze" around CWA2. This material was identified as soap used by the tire shop when changing tires. The debris is covered with several inches of dirt and extends to a maximum depth of 3 ft bgs. This debris field is the source of two soil piles containing concrete and asphalt that was scraped up during the investigation. One of the piles consists of soil, concrete, and asphalt, and has an estimated volume of 375 yd^3. The other pile consists of mostly concrete and soil, and has an estimated volume of 485 yd^3. The remaining volume of waste in this field is estimated at 2,100 yd^3.

There are two washes in the Disposal Area. One wash predominates the northern portion of this area and the other wash defines the southern portion. Exclusive of these washes, the ground surface in this area slopes from the north to the south at approximately 6.4 percent. Topographic highs include two 7-ft tall soil mounds at the south end of the area. Disposal features and covers are not present at the Disposal Area, so no geotechnical samples were collected.

Landfill

The geophysical survey identified six disposal features (T1 through T6) and one high conductivity area (HCA) (HCA5). Excavation confirmed the presence of these features and showed the lateral boundaries to be generally consistent with boundaries identified by the survey. The northern edges of T2, T3, and T4 were not definitively established, although they are believed to be beneath the Wackenhut Services, Inc. (WSI) firing range berm, or just to the south of the berm. The southern boundaries of T4, T5, and T6 were not established because of the CAU 112 use restrictions. No COCs were found migrating from the Landfill.

Covers were identified at each disposal feature, except HCA5. At T1, the cover ranged in thickness from 3 in. to 3 ft. The covers at T2 and T4 were generally about 0.5-ft thick, although they were a little thicker at some locations. The cover at T3 ranged from 1- to 1.5-ft thick. The covers at T5 and T6 ranged from 0.5- to 2-ft thick and 0.5- to 4-ft thick, respectively. At HCA5, fill material was noted from the surface to 3 ft bgs.

In general, fill material containing varying amounts and types of debris were encountered at all the Landfill disposal features. Waste included burned material and ash, metal, concrete, glass, and miscellaneous metallic scrap. At several excavations, including the single excavation at HCA5, debris was not encountered and cover thicknesses were based on variations in lithology and structure.

There is waste covered with several inches of soil in an area extending to the west from T1 to the east edge of a north/south-trending wash. This is based on excavations in the described area and the presence of a linear pile of concrete debris along the east edge of the wash.

Based on the geotechnical data collected at the Landfill, cover soil at T1 and T3 have lower permeabilities than subcell soil, $3.9X10^{-5}$ cm/sec versus $1.9X10^{-4}$ cm/sec and $7.5X10^{-5}$ cm/sec versus $2.2X10^{-5}$ cm/sec, respectively. Cover soil at T2 has a lower permeability than subcell soil. Moisture content measurements show that the soil is well below saturation with the highest percent moisture being 7 percent in the surface cover at T1. The densities of the surface soil and subcell soil are relatively the same with the subsurface density being slightly more than the surface cover. The average cover soil porosity (31.6 percent) was higher than the subcell porosities (28.2 percent), although the differences were minor.

The ground surface at the Landfill slopes from the northeast to southwest at approximately 4.3 percent. The primary topographic high at this area is the WSI firing range berm to the north. There is a shallow wash trending northeast to southwest that parallels the western edge of the area.

2.2.2 Data Assessment Summary

An assessment of CAU 5 investigation results determined that the data collected met the DQOs and support their intended use in the decision-making process. The assessment, provided in Appendix B, includes an evaluation of the data quality indicators (DQIs) to determine the degree of acceptability and usability of the reported data in the decision-making process. Additionally, a reconciliation of the data with the CSM established for this project was conducted. Conclusions were based on the results of the quality control measurements and are discussed in Section A.12.0 of Appendix A and also discussed in Appendix B.

The overall results of the assessment indicate that the DQI goals for precision, accuracy, completeness, representativeness, and comparability have been achieved. Precision and accuracy of the datasets were demonstrated to be within acceptable limits for a high percentage of the data.

Completeness objectives for this CAU have been achieved with one exception. The Sr-90 analysis (Method SR7500) of two quality control (QC) water samples from CAS 06-15-03 (equipment rinsate sample 005E302 and field blank sample 005E306) was not completed due to laboratory oversight. Strontium-90 was not detected above the MRL in the single soil sample analyzed for this analyte so it is not likely to be present in the QC samples. Thus, the characterization of the site was not impacted and the 78 percent Sr-90 completeness is acceptable. Rejected data were thoroughly reviewed and questions concerning these data have been addressed in Appendix B.

Representativeness of site characteristics was demonstrated with the CAU 5 data. An evaluation of comparability provides high confidence that the datasets for this project are comparable to all other datasets generated by accepted industry standards. The evaluation also ensures that project data are comparable to PALs and regulatory disposal limits. Data were analyzed per specifications noted in the CAIP. Achieving all of the DQI goals support acceptance of the CAU 5 datasets, thereby meeting the DQOs established for this project and the subsequent use of these data in the decision-making process.

The CSM described in the CAIP was the basis for the sample collection designs used for the investigation. The reconciliation of CAU 5 investigation results to the established CSM supports the assumptions documented in the models and demonstrates completeness, representativeness, and comparability. The sampling design generated sufficient information required to support the corrective action decisions presented in this CADD.

2.3 Need for Corrective Action

The need for corrective action at each CAU 5 CAS is based on the identification of COCs and/or subsurface waste that may pose a threat to human health and the environment. Subsurface waste at these CASs must be addressed in accordance with NAC Sections 444.743 and 444.6894 (NAC, 2002a). Site-specific characteristics which may impact remediation are also provided.

2.3.1 CAS 05-15-01, Sanitary Landfill

Analytical results from sampling activities showed no COCs have migrated outside disposal feature boundaries at CAS 05-15-01. However, the investigation confirmed the presence of buried waste that may pose unacceptable risk to human health and the environment. Therefore, corrective action alternatives must be evaluated.

Results of the geophysical survey and excavation showed the lateral extent of T1 to be 6,250 ft^2; T2 and T3 to be 7,500 ft^2 each; and T4 to be 16,875 ft^2. Subsurface waste encountered included metal, burned and unburned wood, and lesser amounts of concrete and transite pipe. Surface debris consisting of brick, steel scrap, concrete, transite pipe chips, and wood is present over 8,730 ft^2

within the lateral boundaries of T4. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal features was not investigated.

The average permeability of the cover soil, $9.1X10^{-5}$ cm/sec, is lower than native soil beneath bases of the disposal features (hereinafter referred to as subcell soil) at $4.3X10^{-4}$ cm/sec. The soil cover thicknesses range from 0 to 3.5 ft. The ground surface at CAS 05-15-01 slopes gently from the northwest to southeast at approximately 1.3 percent with some localized depressions and highs. Therefore, corrective action must include elimination of depressions and preventing run-on during precipitation events.

Nearby desert tortoise habitat may impact closure at this CAS.

2.3.2 CAS 05-16-01, Landfill

Analytical results from sampling activities showed no COCs have migrated outside disposal feature boundaries at CAS 05-16-01. However, the investigation confirmed the presence of buried waste that may pose unacceptable risk to human health and the environment. Therefore, corrective action alternatives must be evaluated.

Results of the geophysical survey and excavation showed the lateral extent of T1 to be 17,500 ft^2 and the SMT to be 7,500 ft^2. Metallic waste was consistently found in both disposal features, with lesser amounts of paper and glass. There is 60 ft of wire rope present on the surface at T1. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal features was not investigated.

The Area 5 Radioactive Waste Management Site (RWMS) is a nuclear facility and operates under extensive administrative and health and safety protocol. Corrective Action Site 05-16-01 is located within the permit boundary of the RWMS. Thus, close coordination with site personnel will be required to comply with RWMS permitting requirements, and to plan and implement closure activities. The procedures necessary to maintain the integrity of the flood dike transecting the CAS must be included in the closure planning. In addition, the potential impact to the nearby desert tortoise habitat also must be identified and a mitigation strategy implemented during the closure activities.

2.3.3 CAS 06-08-01, Landfill

Analytical results from sampling activities showed no COCs have migrated outside disposal feature boundaries at CAS 06-08-01. However, the investigation confirmed the presence of buried waste that may pose unacceptable risk to human health and the environment. Therefore, corrective action alternatives must be evaluated.

Results of the geophysical survey and excavation showed the lateral extent of T1 to be 40,000 ft^2; T2 to be 30,000 ft^2; and AA to be 12,500 ft^2. Buried waste, when encountered, consisted of ash, metal, burned and unburned wood, glass, cement, asphalt, and other miscellaneous construction debris. Excavation determined that two potential disposal trenches identified in aerial photographs do not contain buried waste. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal features was not investigated.

There are numerous underground utilities at this site that may have significant impacts on closure activities, particularly active water utilities and an associated fire hydrant. The Area 6 Equipment Yard, Road 6-01, and the utility corridor, including fire protection systems, are all active which will complicate remediation. Heavy equipment and supplies will need to be relocated outside the Equipment Yard to implement remediation.

2.3.4 CAS 06-15-02, Sanitary Landfill

Analytical results from sampling activities showed no COCs have migrated outside disposal feature boundaries at CAS 06-15-02. However, the investigation confirmed the presence of buried waste that may pose unacceptable risk to human health and the environment. Therefore, corrective action alternatives must be evaluated.

Results of the geophysical survey and excavation showed the lateral extent of TL3/CWA7 to be 52,500 ft^2; TL4/CWA9 to be 100,000 ft^2; CWA6 to be 55,000 ft^2; and CWA8 to be 10,000 ft^2. Buried waste, when encountered, consisted of metallic waste with lesser amounts of plastic and wood. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal features was not investigated.

The Area 6 Hydrocarbon Landfill is within 100 ft of the site but ongoing activities there should have minimal impact on corrective actions. The Area 6 Hydrocarbon Landfill, located at the east end of the site, rises approximately 8 ft above the surrounding surface. The study conducted to support the permit for the Area 6 Hydrocarbon Landfill demonstrated that the landfill and adjacent areas are not within the 100-year flood plain. It was further demonstrated that a 100-year, 6-hour rainfall would not raise the water level on the lake above 5 ft and CAS 06-15-02 is approximately 10 ft above the level of the lakebed. Therefore, it would take a significantly more intense rainfall than the 100-year, 6-hour event to cause flood water to inundate the site. In addition, there are no well-defined drainage channels in the vicinity which could generate run-on to CAS 06-15-02 (NNSA/NSO, 2003). A utility corridor along the northern perimeter of the site and nearby desert tortoise habitat may impact remediation.

2.3.5 CAS 06-15-03, Sanitary Landfill; Burn Pit

Analytical results from sampling activities showed no COCs have migrated outside disposal feature boundaries at CAS 06-15-03. However, the investigation confirmed the presence of buried waste that may pose unacceptable risk to human health and the environment. Therefore, corrective action alternatives must be evaluated.

Results of the geophysical survey and excavation showed the lateral extent of CWA1 to be 7,500 ft^2; CWA2 to be 7,500 ft^2; CWA3 to be 45,000 ft^2; CWA4 to be 150,000 ft^2; TL1/CWA5 to be 10,000 ft^2; and TL2 to be 45,000 ft^2. There was no debris observed at CWA1, CWA2, or CWA4. Debris at TL1/CWA5 and TL2 included minor amounts of metal and plastic. Debris at CWA3 included asphalt over 500 ft^2 within the boundary of this disposal feature. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal features was not investigated.

The Area 6 Hydrocarbon Landfill is adjacent to the site but ongoing activities there should have minimal impact on closure activities. The Area 6 Hydrocarbon Landfill, located at the east end of the site, rises approximately 8 ft above the surrounding surface. The study conducted to support the permit for the Area 6 Hydrocarbon Landfill demonstrated that the landfill and adjacent areas are not within the 100-year flood plain. It was further demonstrated that a 100-year, 6-hour rainfall would not raise the water level on the lake above 5 ft and CAS 06-15-02 is approximately 10 ft above the level of the lakebed. Therefore, it would take a significantly more intense rainfall than the 100-year, 6-hour event to cause flood water to inundate the site. In addition, there are no well-defined drainage channels in the vicinity which could generate run-on to CAS 06-15-02 (NNSA/NSO, 2003). A utility corridor along the northern perimeter of the site and nearby desert tortoise habitat may impact remediation.

2.3.6 CAS 12-15-01, Sanitary Landfill

Analytical results from sampling activities showed COCs (TPH and VOCs) are present within CWA1. The COCs have not migrated beyond the lateral boundary of CWA1 but have migrated approximately 15 ft below the base of the disposal feature, as determined by excavation. The investigation also confirmed the presence of buried waste that may pose unacceptable risk to human health and the environment. Therefore, corrective action alternatives must be evaluated.

Results of the geophysical survey and excavation showed the lateral extent of T1 to be 7,500 ft^2; T2/CWA5 to be 25,000 ft^2; T3 to be 2,500 ft^2; and CWA1 to be 105,000 ft^2. Varying amounts and types of debris were encountered and included miscellaneous burned material, metallic scrap, and kitchen garbage. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal features was not investigated.

There is an active sewer line that transects the site, a monitoring station, and a nearby leachfield. The presence of this septic system and other underground utilities may have impacts on closure activities. An access road and an overhead power line are also present which will complicate implementation of use restrictions. The access road and a short stretch of the sewer line are within features that will undergo corrective action. It is expected that the access road could be relocated to allow for the use restriction to be emplaced. The sewer line runs adjacent to Trench 1 but does not run directly through the feature. Because it is not known exactly what mitigation strategies will be incorporated in the closure activities, these utilities must be discussed and a mitigation strategy for possible impacts must be included in the Corrective Action Plan (CAP). The CAS is located between two deep washes and any earthwork associated with corrective actions must not detrimentally impact existing surface flow patterns. The mitigation strategy for any potential impact to the surface drainage also must be included in the CAP.

2.3.7 CAS 20-15-01, Landfill

Analytical results from sampling activities showed no COCs have migrated outside the disposal feature boundary at CAS 20-15-01. However, the investigation confirmed the presence of buried waste that may pose unacceptable risk to human health and the environment. Therefore, corrective action alternatives must be evaluated.

Results of the geophysical survey and excavation showed the lateral extent of T1 to be 6,250 ft^2. Plastic debris was consistently encountered with lesser amounts of wood and metal. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal feature was not investigated.

There are no known site-specific characteristics that would constrain remediation at CAS 20-15-01.

2.3.8 CAS 23-15-03, Disposal Site

Analytical results from sampling activities showed no COCs have migrated outside disposal feature boundaries at CAS 23-15-03. However, the investigation confirmed the presence of extensive surface debris at the Disposal Area and buried waste at the Landfill. As discussed in Section 2.1.8, two soil piles containing asphalt and concrete in the southern portion of the Disposal Area were sampled for waste characterization purposes. Analytical results show elevated concentrations of TPH, consistent with the presence of asphalt construction debris in the piles. The TPH concentrations do not indicate contamination and the surface debris may be removed as a best management practice. The buried waste at the Landfill may pose unacceptable risk to human health and the environment; thus, corrective action alternatives must be evaluated.

Excavation and visual observation determined that most of the surface debris at the Disposal Area is found in three large debris fields with a combined volume of approximately 3,520 yd^3. The debris consists of asphalt, concrete, metallic scrap, wood, small arms shell casings, burned material, and other miscellaneous construction debris. There are two piles of potentially asbestos-containing material (PACM) at the south end of the area with a combined volume of 3 yd^3. The two soil/asphalt/concrete piles discussed above have a combined volume of 860 yd^3.

Results of the geophysical survey and excavation at the Landfill showed the lateral extent of T1 to be 48,750 ft^2; T2 to be 60,000 ft^2; T3 to be 32,500 ft^2; T4 to be 17,500 ft^2; T5 to be 3,750 ft^2; T6/HCA4 to be 3,750 ft^2; and HCA5 to be 15,000 ft^2. In general, fill material containing varying amounts and types of debris were encountered at all the Landfill disposal features. Waste included burned material and ash, metal, concrete, glass, and miscellaneous metallic scrap. At several excavations, including the single excavation at HCA5, debris was not encountered. In accordance with the CAIP, the lateral and vertical extent of buried waste within the disposal features was not investigated.

There are significant ongoing activities at this CAS, particularly WSI training exercises and routine operations at the Area 23 Sanitary Landfill. These activities, the presence of well-used travel corridors, the CAU 112 use restriction, and underground utilities will have significant impacts on remediation. There are also ephemeral drainages throughout the area, so any earthwork must not detrimentally impact surface flow patterns. The Disposal Area is located within a live-fire training area so stringent health and safety protocol must be observed as part of any best management practices. Desert tortoise habitat may be of concern at portions of the CAS not subject to heavy vehicle use. Close coordination between WSI and the Area 23 Sanitary Landfill personnel will be required prior to and during remediation. A detailed discussion and a mitigation strategy for the potential impacts of heavy vehicle use at CAS 23-15-03 must be presented in the CAP.

3.0 Evaluation of Alternatives

The purpose of this section is to present the corrective action objectives for CAU 5, describe the general standards and decision factors used to screen the corrective action alternatives, and develop and evaluate a set of corrective action alternatives that could be used to meet the corrective action objectives.

3.1 Corrective Action Objectives

The corrective action objectives are media-specific goals for protecting human health and the environment. Based on potential exposure pathways, the following corrective action objectives have been identified for CAU 5:

- Prevent or mitigate exposure to media that contains or may contain COCs at concentrations exceeding regulatory and risk-based PALs, as defined in the CAIP.
- Prevent the spread of COCs beyond the boundaries of each CAS.

As identified in the CAIP, the future use for the CAU is assumed to be industrial, similar to current use (DOE/NV, 1998). A CSM was developed as part of the CAIP. The model identified the potential exposure mechanism as disturbance (excavation) of contaminated soil or debris by site workers. This implies a potential exposure pathway through ingestion, inhalation, and/or dermal contact with contaminated media under industrial scenarios.

Migration of COCs to groundwater is not considered to be an exposure pathway due to the extreme depth to groundwater, low average annual precipitation (3 to 6 inches [in.] on the valleys and less than 10 in. on the mesas and ridges), high annual potential evapotranspiration (60 to 82 in. or roughly 5 to 25 times the annual precipitation) (Winograd and Thordarson, 1975), and the lack of COCs outside disposal feature boundaries, except at CAS 12-15-01. At CAS 12-15-01, COCs have migrated about 15 ft beneath the base of CWA1 but sampling and analysis bounded the vertical extent of contamination. Groundwater information is provided in the CAIP and summarized in the following subsections.

Area 5 Groundwater

Water Well 5b is located approximately 3 mi southwest of CAS 05-16-01 and was drilled 900 ft into the alluvium. The static water level is approximately 684 ft bgs (DOE/NV, 1996). An unknown quantity of water recharges annually from the surface and shallow alluvium into the deeper Paleozoic carbonate rocks of the regional aquifer. The groundwater flows at depth to the southwest eventually discharging at Ash Meadows southwest of the NTS (DOE/NV, 1996).

Area 6 Groundwater

Area 6 is located in the Ash Meadows Groundwater Basin. Given the type of stratigraphy of the Yucca Lake Playa, groundwater moves slowly through the playa deposits and nonfractured volcanic rocks (DOE/NV, 1996). The groundwater flow rate within valley-fill deposits is dependent on the amount of clay and mineralization and on the degree of consolidation (DOE/NV, 1996). The groundwater generally moves downward through alluvium and bedrock to the aquifer, flowing southwest and discharging at Ash Meadows (DOE, 1988). The nearest water table data is from Well C-1, which is located about one mile to the southwest. The water level at Well C-1 is about 1,540 ft bgs (DOE/NV, 1996).

Area 12 Groundwater

The static composite water level in the vicinity of CAS 12-15-01 is approximately 1,540 ft bgs. This depth is based on information from Well ER-12-1 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.
Well ER-12-1 is located 2.3 mi from CAS 12-15-01 (DRI, 1996).

Area 20 Groundwater

Local stratigraphy isolates surface impoundment water, producing an aquifer at a depth of 1,956 ft bgs (REECo, 1993). Surface water run-off from the edges of CAS 20-15-01 is directed away from the landfill by the natural slope of the terrain (Davis, 1988).

Area 23 Groundwater

A monitoring well located about 0.7 mi from the Area 23 Sanitary Landfill revealed two perched water layers. These layers were encountered at 500 ft bgs and 1,080 ft bgs and were 1-ft and 11-ft thick, respectively. The static water level was at 1,150 ft bgs (BN, 1997). The nearest potable water well, Army Well 1, is located approximately 3.5 mi to the southwest. The static water level depth at this well is 690 ft bgs (DOE/NV, 1996).

3.2 Screening Criteria

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

Corrective action alternatives will be evaluated based on four general corrective action standards and five remedy selection decision factors. All corrective action alternatives must meet the general standards to be selected for evaluation using the remedy selection decision factors.

The general corrective action standards are as follows:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control the source(s) of the release
- Compliance with applicable federal, state, and local standards for waste management

The remedy selection decision factors are as follows:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

3.2.1 Corrective Action Standards

The following text describes the corrective action standards used to evaluate the corrective action alternatives.

Protection of Human Health and Environment

Protection of human health and the environment is a general mandate of the RCRA statute (EPA, 1994). This mandate requires that the corrective action include any necessary protective measures. These measures may or may not be directly related to media cleanup, source control, or management of wastes. The corrective action alternatives are evaluated for the ability to meet corrective action objectives as defined in Section 3.1.

Compliance with Media Cleanup Standards

Each corrective action alternative must have the ability to meet the proposed media cleanup standards as set forth in applicable state and federal regulations, and as specified in the CAIP. For this CAU, the EPA Region 9 PRGs (EPA, 2000) that are derived from the Integrated Risk Information System are the PALs for chemical contaminants under *Nevada Administrative Code* (NAC) 445A.2272 (NAC, 2003). Background concentrations for metals that exceed PRGs may be substituted for the PRGs. The PAL for petroleum substances in soil is 100 mg/kg in accordance with NAC 445A.2272 (NAC, 2003). The PALs for radiological contaminants are based on area background concentrations. Laboratory results above PALs indicate the presence of COCs at levels that may require corrective action. Subsurface waste at these CASs must be addressed in accordance with NAC Sections 444.743 and 444.6894 (NAC, 2002a).

Control the Source(s) of the Release

An objective of a corrective action remedy is to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup. Therefore, each corrective action alternative must use an effective source control program to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

During implementation of any corrective action alternative, all waste management activities must be conducted in accordance with applicable state and federal regulations (e.g., *Nevada Revised Statutes* [NRS] 459.400-459.600, "Disposal of Hazardous Waste" [NRS, 2001]; the hazardous waste management regulations found in 40 *Code of Federal Regulations* (CFR) 260-282 [CFR, 2002a]; 40 CFR 761, "Polychlorinated Biphenyls (PCB) Manufacturing, Processing, Distribution in Commerce, and Use Restrictions" [CFR, 2002b]; NAC 444, "Sanitation" [NAC, 2002a]; and NAC 459.9974, "Disposal and Evaluation of Contaminated Soil" [NAC, 2002b]). The requirements for management of the waste, if any, derived from the corrective action will be determined based on applicable state and federal regulations, field observations, process knowledge, characterization data, and data collected and analyzed during corrective action implementation. Administrative controls (e.g., decontamination procedures and corrective action strategies) will minimize waste generated during site corrective action activities. Decontamination activities will be performed in accordance with approved procedures and will be designated according to the COCs present at the site.

3.2.2 Remedy Selection Decision Factors

The following text describes the remedy selection decision factors used to evaluate the corrective action alternatives.

Short-Term Reliability and Effectiveness

Each corrective action alternative must be evaluated with respect to its effects on human health and the environment during implementation of the corrective action. The following factors will be addressed for each alternative:

- Protection of the community from potential risks associated with implementation, such as fugitive dusts, transportation of hazardous materials, and explosion
- Protection of workers during implementation
- Environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

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

Long-Term Reliability and Effectiveness

Each corrective action alternative must be evaluated in terms of risk remaining at CAU 5 after the corrective action alternative has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the control that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

Feasibility

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

- Construction and Operation. Refers to the feasibility of implementing a corrective action alternative given the existing set of waste and site-specific conditions.
- Administrative Feasibility. Refers to the administrative activities needed to implement the corrective action alternative (e.g., permits, public acceptance, rights of way, off-site approval).
- Availability of Services and Materials. Refers to the availability of adequate off-site and on-site treatment, storage capacity, disposal services, necessary technical services and materials, and prospective technologies for each corrective action alternative.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each corrective action alternative includes both capital and operation and maintenance costs, as applicable. The following is a brief description of each component:

- Capital Costs. These costs include both direct and indirect costs. Direct costs may consist of materials, labor, mobilization, demobilization, site preparation, construction materials, equipment purchase and rental, sampling and analysis, waste disposal, and health and safety measures. Indirect costs include such items as engineering design, permits and/or fees, start-up costs, and any contingency allowances.
- Operation and Maintenance. These costs include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures.

Cost estimates for the corrective action alternatives are provided in Appendix C.

3.3 Development of Corrective Action Alternatives

This section identifies and briefly describes the viable corrective action technologies and the corrective action alternatives considered for the affected media. Based on the review of existing data, future use, and current operations at the NTS, the following alternatives have been developed for consideration at CAU 5:

- Alternative 1 - No Further Action
- Alternative 2 - Close in Place with Administrative Controls
- Alternative 3 - Close in Place with Administrative Controls and Construction of Covers

Other technologies were not considered because they are not applicable to the large volumes of subsurface waste present at CAU 5.

3.3.1 Alternative 1 - No Further Action

Under the No Further Action Alternative, no corrective action activities will be implemented. This alternative is a baseline case with which to compare and assess the other corrective action alternatives and their ability to meet the corrective action standards. Alternative 1 does not meet corrective action objectives for any of the CAU 5 CASs because no actions are taken to prevent exposure to COCs or potentially contaminated waste.

3.3.2 Alternative 2 - Close in Place with Administrative Controls

Alternative 2 will use administrative controls to prevent inadvertent contact with COCs and potentially contaminated media. These controls would consist of use restrictions (e.g., fencing, signage) to minimize access and prevent unauthorized intrusive activities. The future use would be restricted from any activity that would alter or modify the containment control unless appropriate concurrence was obtained from the NDEP. The combination of these measures will effectively prevent inadvertent intrusive activities and mobilization of COCs. In addition to administrative controls, minimal earthwork will be conducted as required to backfill any depressions or low points to eliminate potential ponding and prevent run-on during precipitation events.

Post-closure monitoring requirements will consist of an annual visual inspection for years one through five. After the fifth year, inspections will be conducted every five years for 30 years. The purpose of the inspections is to verify the integrity of postings and/or fences, as appropriate.

Alternative 2 has been evaluated for all the CASs in CAU 5 and is discussed in the following subsections.

3.3.2.1 CAS 05-15-01, Sanitary Landfill

The landfill boundary will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area.

The small soil mound containing some concrete (20 yd^3), located at the southwest edge of site, will be removed and disposed of at an appropriate facility. Waste characterization samples will be collected, as appropriate. Removal of the debris will be visually confirmed. The two existing soil mounds near T1 will be spread out and leveled to grade, if waste characterization sampling confirms they are not contaminated. Otherwise, the soil mounds will be removed and disposed of at an appropriate facility. Soil berms or ditches will be constructed to prevent run-on during precipitation events.

3.3.2.2 CAS 05-16-01, Landfill

The landfill boundary will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area. The use restrictions will be structured to not interfere with operations at the Area 5 RWMS. In addition to posting, the SMT will be fenced. The CAP will discuss the potential impacts on the flood dike located adjacent to the CAS and present the mitigation strategy to prevent any adverse impacts to the dike from the closure activities. The potential adverse impacts to the local habitat of the desert tortoise will also be discussed in the CAP and mitigation methods identified. However, because this is currently an active area used for the disposal and storage of low-level radioactive waste, the area where CAS 05-16-01 is located is not within the immediate area of tortoise habitat.

The sinkhole at the west end of T1 will be backfilled with clean fill material and mounded to eliminate ponding and account for subsidence. The wire rope coming out of the sinkhole will be disposed of at an appropriate facility or otherwise appropriately managed.

The ball of chicken wire located west of the flood dike (estimated at 20 yd^3) will be removed and disposed of at an appropriate facility. Waste characterization will be conducted as appropriate. Removal of the debris will be visually confirmed.

3.3.2.3 CAS 06-08-01, Landfill

The landfill boundary and the utility corridor along Road 6-01 will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area. The landfill boundary north of Road 6-01 will also be fenced. The use restrictions will be structured to not interfere with operations at the Area 6 Equipment Yard including those utilities within the utility corridor and those within the Area 6 Equipment Yard that will be within the use-restricted area.

3.3.2.4 CAS 06-15-02, Sanitary Landfill

The landfill boundary will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area. Any small depressions identified within the CAS boundary will be filled and leveled to prevent ponding on the surface. The position of this CAS along the edges of Yucca Lake and the elevation will limit the volume and time that water could stand on the surface during a significant precipitation event. There is limited risk for the site to become inundated and remain under standing water for more than a short period of time, less than two or three days. The permeability of the cover material is less than or equal to natural subsoil and will not create a bathtub effect in the waste material. The surface is sloped at 4 percent to limit surface water run-on and run-off. The use restrictions will be structured to not interfere with operations at the Area 6 Hydrocarbon Landfill.

3.3.2.5 CAS 06-15-03, Sanitary Landfill; Burn Pit

The landfill boundary will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area. Any small depressions identified within the CAS boundary will be filled and leveled to prevent ponding on the surface. The position of this CAS along the edges of Yucca Lake and the elevation will limit the volume and time that water could stand on the surface during a significant precipitation event. There is limited risk for the site to become inundated and remain under standing water for more than a short period of time, less than two or three days. The surface is also sloped at 5 percent to limit surface water run-on and run-off. The permeability of the cover is less than or equal to natural subsoil or less than $1X10^{-5}$ cm/sec so infiltration will not create a bathtub effect in the waste material. The use restrictions will be structured to not interfere with operations at the Area 6 Hydrocarbon Landfill.

3.3.2.6 CAS 12-15-01, Sanitary Landfill

The landfill boundary will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area. The use restrictions will be structured to not interfere with operations of the existing septic system and monitoring station.

Surface debris, consisting of several steel and wooden signs around T1, several pieces of broken transite pipe at the east end of CWA1, and scattered pieces of vitrified clay pipe just west of the existing leachfield will be removed and disposed of at an appropriate facility. Waste characterization samples will be collected, as appropriate. Removal of the debris will be visually confirmed.

The following evaluation in accordance with NAC 445A.227 (2) (a-k) (NAC, 2003) supports the protection of groundwater from COCs at this CAS:

a. Depth to groundwater at the nearest monitoring well (Well ER-12-1) is approximately 1,540 ft bgs. The well is located 2.3 mi from the site (DRI, 1996). Groundwater discharge is to the Amargosa groundwater system located south-southwest of the NTS (Winograd and Thordarson, 1975).

b. The distance to the nearest active water-supply well (Water Well UE-2ce) is approximately 4 mi south of this CAS. The well is used to provide potable water to NTS activities in the area. Groundwater flow is generally to the southwest (Laczniak et al., 1996).

c. Soil type at this site is generally poorly graded, moderately consolidated, alluvial silty sands with gravel and some cobble-sized volcanic detritus.

d. Average annual precipitation for valleys in the South-Central Great Basin ranges from 3 to 6 in. Annual evaporation is roughly 5 to 25 times the annual precipitation (Wingograd and Thordarson, 1975). The high potential evaporation and low precipitation rates create a negative water balance for the area; therefore, no driving force associated with precipitation is available to mobilize COCs vertically.

e. TPH and VOCs are present in the soil underneath CWA1. Downward migration is slowed by the following parameters:

    - <u>Volume of release</u> - it is assumed small volumes of these COCs were released over a long period of time rather than a large volume over a short duration.

    - <u>Soil saturation</u> - the soil is dry, especially near the surface and shallow subsurface where the COCs are located. The surface is sloped at approximately 4.3 percent, which will limit the run-on and run-off of surface water and reduce the potential for standing water to infiltrate into or through the waste.

- Soil particle adsorption/desorption - petroleum hydrocarbons tend to adsorb to the soil particles with little desorption as suggested by the limited vertical migration of COCs.

f. The lateral extent of contamination is defined by analytical data showing the lack of COCs found in nearby sample locations, thereby demonstrating minimal lateral mobility (i.e., <25 ft). Contaminant concentrations below the upper sampling horizon were significantly lower, demonstrating minimal vertical migration. The vertical extent of contamination is confined between 9 and 30 ft bgs.

g. Presently, CAS 12-15-01 is located on a government-controlled facility. The NTS is a restricted area that is guarded on a 24-hour, 365 days per year basis; unauthorized personnel are not admitted to the facility. Corrective Action Site 12-15-01 is contained within a nonresidential restricted use zone classified as "Nuclear and High Explosive Test Land-Use Zone" (DOE/NV, 1998).

h. Preferred routes of vertical and lateral migration are nonexistent since the sources have been eliminated and driving forces are not viable.

i. Section 2.3.6 discusses site-specific considerations.

j. The potential for a hazard related to fire, vapor, or explosion is nonexistent for the COCs at the site.

k. No other site-specific factors are known at this site.

Based on this evaluation, impacts to groundwater are not expected. Therefore, groundwater monitoring is not proposed for this site and is not considered an element of the alternative.

3.3.2.7 CAS 20-15-01, Landfill

The landfill boundary will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area. Approximately 175 ft of utility cable at the west end of the CAS will be removed and disposed of at an appropriate facility.

3.3.2.8 CAS 23-15-03, Disposal Site

The landfill boundary will be posted with T-posts and metal signs every 100 ft, and the boundary will be established on land-use maps as a use-restricted area.

The exposed debris west of T1 will be covered and the miscellaneous piles of construction waste (15 yd^3) in the wash west of T1 will be removed and disposed of at an appropriate facility. The final grade will be maintained to be not less than 3 percent to control run-on and run-off so standing water will not be allowed to infiltrate into the waste. Waste characterization samples will be collected as appropriate. Removal of the debris will be visually confirmed.

3.3.3 Alternative 3 - Close in Place with Administrative Controls and Construction of Covers

Alternative 3 includes administrative controls to prevent inadvertent contact with COCs and potentially contaminated media, as described in Section 3.3.2. In addition, Alternative 3 will include construction or improvement of covers over single disposal features or combinations of disposal features to minimize infiltration, eliminate potential ponding, and redirect or control run-on and run-off. Covers will be constructed as needed to bring the final cover thickness to a minimum of 2 ft and will be graded to a minimum 2 percent slope. Covers will be wheel compacted.

Post-closure monitoring requirements will consist of an annual visual inspection for years one through five. After the fifth year, inspections will be conducted every five years for 20 years. The purpose of the inspections is to verify the integrity of postings and/or damage to the covers through erosion or human activity.

Alternative 3 has been evaluated for all the CAU 5 CASs and is discussed in the following subsections.

3.3.3.1 CAS 05-15-01, Sanitary Landfill

All the administrative controls described in Section 3.3.2.1 will be implemented. In addition, a continuous 2-ft thick cover will be constructed over the combined area of the disposal features, an area of approximately 87,500 ft^2. The cover will be designed in accordance with NAC 444.6891 (NAC, 2002a).

3.3.3.2 CAS 05-16-01, Landfill

All the administrative controls described in Section 3.3.2.2 will be implemented. In addition, a 1-ft thick cover will be constructed over T1 (35,000 ft^2) and the SMT (2,500 ft^2) as individual features. A 1-ft tall engineered berm will be built around T1 to redirect surface flow.

3.3.3.3 CAS 06-08-01, Landfill

All the administrative controls described in Section 3.3.2.3 will be implemented. In addition, a continuous 2-ft thick cover will be constructed over the combined area of the disposal features, an area of approximately 720,000 ft^2.

3.3.3.4 CAS 06-15-02, Sanitary Landfill

All the administrative controls described in Section 3.3.2.4 will be implemented. In addition, a continuous 1-ft thick cover will be constructed over the combined area of the disposal features, an area of approximately 500,000 ft^2.

3.3.3.5 CAS 06-15-03, Sanitary Landfill; Burn Pit

All the administrative controls described in Section 3.3.2.5 will be implemented. In addition, a 2-ft thick cover will be constructed over TL2 and a 1-ft thick cover will be installed over the combined area of CWA1, CWA2, and CWA3. The areas to be covered are approximately 325,000 ft^2. The existing cover is at least 2-ft thick at TL1/CWA5 and CWA4.

3.3.3.6 CAS 12-15-01, Sanitary Landfill

All the administrative controls described in Section 3.3.2.6 will be implemented. In addition, a 2-ft thick cover will be installed over T3. The existing cover is at least 2-ft thick over the other disposal features.

The following evaluation in accordance with NAC 445A.227 (2) (a-k) (NAC, 2003) supports the protection of groundwater from COCs at this CAS:

a. Depth to groundwater at the nearest monitoring well (Well ER-12-1) is approximately 1,540 ft bgs. The well is located 2.3 mi from the site (DRI, 1996). Groundwater discharge is to the Amargosa groundwater system located south-southwest of the NTS (Winograd and Thordarson, 1975).

b. The distance to the nearest active water-supply well (Water Well UE-2ce) is approximately 4 mi south of this CAS. The well is used to provide potable water to NTS activities in the area. Groundwater flow is generally to the southwest (Laczniak et al., 1996).

c. Soil type at this site is generally poorly graded, moderately consolidated, alluvial silty sands with gravel and some cobble-sized volcanic detritus.

d. Average annual precipitation for valleys in the South-Central Great Basin ranges from 3 to 6 in. Annual evaporation is roughly 5 to 25 times the annual precipitation (Wingograd and Thordarson, 1975). The high potential evaporation and low precipitation rates create a negative water balance for the area; therefore, no driving force associated with precipitation is available to mobilize COCs vertically.

e. TPH and VOCs are present in the soil underneath CWA1. Downward migration is slowed by the following parameters:

- Volume of release - it is assumed small volumes of these COCs were released over a long period of time rather than a large volume over a short duration.

- Soil saturation - the soil is dry, especially near the surface and shallow subsurface where the COCs are located.

- Soil particle adsorption/desorption - petroleum hydrocarbons tend to adsorb to the soil particles with little desorption as suggested by the limited vertical migration of COCs.

f. The lateral extent of contamination is defined by analytical data showing the lack of COCs found in nearby sample locations, thereby demonstrating minimal lateral mobility (i.e., <25 ft). Contaminant concentrations below the upper sampling horizon were significantly lower, demonstrating minimal vertical migration. The vertical extent of contamination is confined between 9 and 30 ft bgs.

g. Presently, CAS 12-15-01 is located on a government-controlled facility. The NTS is a restricted area that is guarded on a 24-hour, 365 days per year basis; unauthorized personnel are not admitted to the facility. Corrective Action Site 12-15-01 is contained within a nonresidential restricted use zone classified as "Nuclear and High Explosive Test Land-Use Zone" (DOE/NV, 1998).

h. Preferred routes of vertical and lateral migration are nonexistent since the sources have been eliminated and driving forces are not viable.

i. Section 2.3.6 discusses site-specific considerations.

j. The potential for a hazard related to fire, vapor, or explosion is nonexistent for the COCs at the site.

k. No other site-specific factors are known at this site.

Based on this evaluation, impacts to groundwater are not expected. Therefore, groundwater monitoring is not proposed for this site and is not considered an element of the alternative.

3.3.3.7 CAS 20-15-01, Landfill

All the administrative controls described in Section 3.3.2.7 will be implemented. The existing cover at T1 is at least 2-ft thick. Appropriate material will be added and graded to bring the final grade to a minimum 2 percent slope.

3.3.3.8 CAS 23-15-03, Disposal Site

All the administrative controls described in Section 3.3.2.8 will be implemented. In addition, a 2-ft thick cover will be installed over the combined area of the disposal features, an area of approximately 435,000 ft^2.

3.4 Evaluation and Comparison of Alternatives

The general corrective action standards and remedy selection decision factors described in Section 3.2 were used to conduct detailed and comparative analyses of each corrective action alternative. The advantages and disadvantages of each alternative were assessed to select preferred alternatives for CAU 5. Table 3-1 and Table 3-2 present the detailed and comparative evaluation of the alternatives evaluated for the CAU 5 CASs. Detailed cost summaries for these evaluated alternatives are provided in Appendix C.

Table 3-1
Detailed Evaluation of Alternatives for Corrective Action Unit 5
(Page 1 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Close in Place with Administrative Controls	Alternative 3 Close in Place with Administrative Controls and Construction of Covers
Closure Standards			
Protection of Human Health and the Environment	• Does not prevent inadvertent intrusion into landfills and subsequent potential for human exposure or spread of COCs. • No worker exposure associated with implementation. • Low risk to environment because COCs are not migrating. • NAC 445.227 (2) (a-k) analysis shows COCs are not expected to impact groundwater.	• Prevents inadvertent intrusion into landfills. • Low risk to workers because of minimal use of heavy equipment to implement alternative. • Low risk to public because of remote location and controlled access to the NTS. • Low risk to environment because COCs are not migrating. • NAC 445.227 (2) (a-k) analysis shows COCs are not expected to impact groundwater.	• Moderate risk to workers using heavy equipment to construct landfill covers. • Low risk to public because of remote location and controlled access to the NTS. • Very low risk to environment because of additional protection against migration of COCs into surrounding media. • NAC 445.227 (2) (a-k) analysis shows COCs are not expected to impact groundwater.
Compliance with Media Cleanup Standards	• Complies with media cleanup standards because COCs are not migrating. • NAC 445.227 (2) (a-k) analysis shows COCs are not expected to impact groundwater.	• Complies with media cleanup standards because COCs are not migrating. • Controls exposure pathways. • NAC 445.227 (2) (a-k) analysis shows COCs are not expected to impact groundwater.	• Complies with media cleanup standards because COCs are not migrating. • Controls exposure pathways. • NAC 445.227 (2) (a-k) analysis shows COCs are not expected to impact groundwater.
Controls the Source(s) of Release	• Landfills are inactive and will not receive future waste.	• Landfills are inactive and will not receive future waste.	• Landfills are inactive and will not receive future waste.
Compliance with Applicable Federal, State, and Local Standards for Waste Management	• No waste generated.	• Minimal waste will be generated. • Waste will be handled and disposed of per applicable standards.	• Waste will be generated. • Waste will be handled and disposed of per applicable standards.

Table 3-1
Detailed Evaluation of Alternatives for Corrective Action Unit 5
(Page 2 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Close in Place with Administrative Controls	Alternative 3 Close in Place with Administrative Controls and Construction of Covers
Remedy Selection Decision Factors			
Short-Term Reliability and Effectiveness	• Not evaluated	• Public protected by remote location and NTS site-access controls. • Low risk to workers using heavy equipment during implementation. • Environmental impacts are not anticipated due to implementation. Appropriate measures will be taken at the site to protect desert tortoises. • Implementation should not require an extended period of time.	• Public protected by remote location and NTS site-access controls. • Moderate risk to workers using heavy equipment during implementation. • Some environmental impacts (disruption of existing flow patterns, nuisance dust) may be encountered during implementation. • Desert tortoise habitat may be impacted. • Implementation will require an extended period of time.
Reduction of Toxicity, Mobility, and/or Volume	• Not evaluated	• Does not reduce toxicity or volume of waste. • Mobility of potential contaminants is reduced by backfilling depressions.	• Does not reduce toxicity or volume of waste. • Greatly reduces mobility.
Long-Term Reliability and Effectiveness	• Not evaluated	• Controls prevent inadvertent intrusion into the landfill. • Administrative controls must be maintained.	• Controls prevent inadvertent intrusion into the landfill. • Administrative controls must be maintained.
Feasibility	• Not evaluated	• Easily implemented. • Coordination with multiple entities required to ensure compliance with administrative controls.	• Difficult to implement due to active status and presence of buried utilities at some sites. • Coordination with multiple entities required to ensure compliance with administrative controls.

Table 3-1
Detailed Evaluation of Alternatives for Corrective Action Unit 5
(Page 3 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Close in Place with Administrative Controls	Alternative 3 Close in Place with Administrative Controls and Construction of Covers
Cost	• CAS 05-15-01: $0 • CAS 05-16-01: $0 • CAS 06-08-01: $0 • CAS 06-15-02: $0 • CAS 06-15-03: $0 • CAS 12-15-01: $0 • CAS 20-15-01: $0 • CAS 23-15-03: $0	• CAS 05-15-01: $75,756 • CAS 05-16-01: $73,276 • CAS 06-08-01: $147,329 • CAS 06-15-02: $57,544 • CAS 06-15-03: $61,100 • CAS 12-15-01: $70,855 • CAS 20-15-01: $60,116 • CAS 23-15-03: $117,553 • Post-closure monitoring (all CASs): $117,132	• CAS 05-15-01: $357,467 • CAS 05-16-01: $226,536 • CAS 06-08-01: $1,047,737 • CAS 06-15-02: $742,110 • CAS 06-15-03: $732,437 • CAS 12-15-01: $1,473,526 • CAS 20-15-01: $186,648 • CAS 23-15-03: $3,115,343 • Post-closure monitoring (all CASs): $280,288

Table 3-2
Comparative Evaluation of Alternatives for Corrective Action Unit 5

Evaluation Criteria	Comparative Evaluation		
Closure Standards			
Protection of Human Health and the Environment	Alternatives 2 and 3 meet corrective action objectives; Alternative 1 does not. No worker exposure to risks are associated with Alternative 1. Low risk is associated with Alternative 2 and moderate risk is associated with Alternative 3. All alternatives provide low risk to the environment.		
Compliance with Media Cleanup Standards	All alternatives comply with media cleanup standards.		
Controls the Source(s) of Release	The sources at each CAS have been discontinued.		
Compliance with Applicable Federal, State, and Local Standards for Waste Management	Alternative 1 does not generate waste. Alternatives 2 and 3 will generate waste that will be handled in accordance with applicable standards. Alternative 3 generates more waste than Alternative 2.		
Remedy Selection Decision Factors			
Short-Term Reliability and Effectiveness	Alternative 1 not evaluated. Low risk is associated with Alternative 2 and moderate risk is associated with Alternative 3.		
Reduction of Toxicity, Mobility, and/or Volume	Alternative 1 not evaluated. Alternatives 2 and 3 reduce mobility but do not reduce toxicity or volume. Alternative 3 reduces mobility more than Alternative 2.		
Long-Term Reliability and Effectiveness	Alternative 1 not evaluated. Residual risk is low for Alternative 2 and lower for Alternative 3. Both alternatives will require administrative measures to control intrusive activities.		
Feasibility	Alternative 1 not evaluated. Alternatives 2 and 3 are feasible. Alternative 3 will be difficult to implement and will be very resource intensive.		
Cost	Alternative 1: CAS 05-15-01: $0 CAS 05-16-01: $0 CAS 06-08-01: $0 CAS 06-15-02: $0 CAS 06-15-03: $0 CAS 12-15-01: $0 CAS 20-15-01: $0 CAS 23-15-03: $0	Alternative 2: CAS 05-15-01: $75,756 CAS 05-16-01: $73,276 CAS 06-08-01: $147,329 CAS 06-15-02: $57,544 CAS 06-15-03: $61,100 CAS 12-15-01: $70,855 CAS 20-15-01: $60,116 CAS 23-15-03: $117,553 Post-closure monitoring (all CASs): $117,132	Alternative 3: CAS 05-15-01: $357,467 CAS 05-16-01: $226,536 CAS 06-08-01: $1,047,737 CAS 06-15-02: $742,110 CAS 06-15-03: $732,437 CAS 12-15-01: $1,473,526 CAS 20-15-01: $186,648 CAS 23-15-03: $3,115,343 Post-closure monitoring (all CASs): $280,288

4.0 Recommended Alternatives

The preferred corrective action alternatives were evaluated on their technical merits, focusing on performance, reliability, feasibility, and safety. The selected alternatives were judged to meet all requirements for the technical components evaluated. The selected alternatives meet all applicable state and federal regulations for closure of the sites and will minimize potential future exposure pathways to the contaminated media at CAU 5.

Alternative 2, Close in Place with Administrative Controls, is the preferred corrective action for all of the CASs in CAU 5. Alternative 2 was chosen for the following reasons:

- Current conditions (e.g., cover slope, thickness, and permeability; nature of buried waste, lack of contaminants) are not conducive to migration of contaminants.
- The investigation showed that contaminants are not migrating from disposal features, except at CAS 12-15-01 where the migration is limited to 15 ft below the base of the fill. Therefore, vertical migration is minimal and shows little likelihood of impacting groundwater.
- Administrative controls will prevent inadvertent public and worker intrusion into the landfills, effectively minimizing long-term health risks.
- The alternative has the least impact on ongoing activities at active sites (e.g., the Area 6 Equipment Yard, the Area 5 RWMS, the Area 23 Sanitary Landfill, WSI training activities, the CAU 112 use restrictions, and the septic system associated with the Area 12 Camp).
- The short-term risks and costs of cover construction are eliminated.
- Minimal waste will be generated and closure is easily implemented.
- The alternative is cost-effective, relative to other closure alternatives.

5.0 References

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Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix details corrective action investigation activities and analytical results for CAU 5. This CAU is located in Areas 5, 6, 12, 20, and 23 of the NTS as shown in Figure 1-1. The CAU is comprised of the following CASs:

- CAS 05-15-01, Sanitary Landfill
- CAS 05-16-01, Landfill
- CAS 06-08-01, Landfill
- CAS 06-15-02, Sanitary Landfill
- CAS 06-15-03, Sanitary Landfill; Burn Pit
- CAS 12-15-01, Sanitary Landfill
- CAS 20-15-01, Landfill
- CAS 23-15-03, Disposal Site

The CASs consist of unlined landfills where disposal operations occurred between 1952 and 1992. Large volumes of solid waste were produced from various research and development projects including nuclear weapons testing at the NTS. Instead of managing solid waste at one or two disposal sites, the practice on the NTS was to dispose of solid waste in the vicinity of the project.

Information regarding the history of each site, planning process, and the scope of the investigation is presented in the CAIP (NNSA/NV, 2002a). The investigation was conducted in accordance with the CAIP as developed under the FFACO (1996).

A.1.1 Objectives

The objectives of the investigation were to:

- Collect data to identify, evaluate, and defend appropriate corrective action alternatives.
- Determine if buried waste is present in the various disposal features.
- Determine the nature of disposal feature covers (i.e., thickness, permeability, and slope).
- Determine if COCs have migrated from disposal features.
- If migration has occurred, determine the vertical and lateral extent of contamination.

The selection of soil sample locations was based on site conditions and the strategy developed during the DQO process as outlined in the CAIP.

A.1.2 Content

This appendix contains information and data in sufficient detail to support the selection of a preferred corrective action alternative in the CADD. The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and content.
- Section A.2.0 provides an investigation overview.
- Section A.3.0 through Section A.10.0 provides CAS-specific information regarding field activities, sampling methods, and laboratory analytical results from investigation samples.
- Section A.11.0 summarizes waste management activities.
- Section A.12.0 discusses the quality assurance (QA) and QC procedures that were followed and the results of the QA/QC activities.
- Section A.13.0 is a summary of the investigation results.
- Section A.14.0 lists the cited references.

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

A.2.0 Investigation Overview

The investigation consisted of geophysical surveys to locate buried metallic (conductive) and nonmetallic waste, backhoe excavations to substantiate the results of the geophysical surveys and determine nature and presence of buried waste, rotary sonic drilling to observe subsurface features and collect soil samples for on-site field screening and off-site laboratory analysis (i.e., chemical, radiological, and geotechnical), and topographic surveys. The geophysical surveys were conducted from March 6 through May 8, 2002. Excavation, drilling, and sampling was conducted from October 7, 2002 through January 30, 2003. The topographic surveys were conducted from March 11 through April 29, 2003.

The investigation was managed according to requirements set forth in the CAIP. Field activities were conducted according to the site-specific health and safety plan (SSHASP) (IT, 2002), which is consistent with the DOE Integrated Safety Management System. Samples were collected and documented following approved protocols and procedures indicated in the CAIP. Quality control samples (e.g., field blanks, equipment rinsate blanks, trip blanks, and duplicate samples) were collected as required by the Industrial Sites QAPP (NNSA/NV, 2002b) and approved procedures. During the investigation, waste minimization practices were followed according to approved procedures, including segregation of waste by waste stream.

Weather conditions during the investigation varied from sunny to intermittent cloudiness, moderate temperatures, occasional snow, and light to strong winds. High winds delayed site operations on three separate occasions but weather conditions were generally favorable. The project experienced other minor routine delays such as training, rig repairs, and access issues.

The CASs were characterized by geophysical surveys, backhoe excavations to substantiate the results of the geophysical surveys, and sample collection via rotary sonic drilling. Selected drill core soil intervals were field screened for VOCs, TPH (DRO), and alpha and beta/gamma radiation. The results were compared to FSLs to guide the investigation. Samples were shipped to an off-site laboratory for analysis of appropriate chemical, radiological, and geotechnical parameters.

Except as noted in the CAS-specific sections (Section A.3.0 through Section A.10.0), CAU 5 sampling locations were accessible and sampling activities at planned locations were not restricted by buildings, storage areas, active operations, or aboveground and underground utilities. Sampling stepout locations were accessible and remained within anticipated spatial boundaries.

A.2.1 Conceptual Site Models

Investigation activities validated the CSMs provided in the CAIP.

A.2.2 Sample Locations

Investigation locations selected for sampling were based on interpretation of engineering drawings, aerial photos, interviews with former and current site employees, geophysical surveys, investigation trenching, and site conditions as provided in the CAIP. The planned biased sample locations are shown in the CAIP. Actual sample locations are shown in CAS-specific Section A.3.0 through Section A.10.0.

Most sample locations were biased adjacent to disposal feature boundaries due to the potentially dangerous nature of buried waste (i.e, compressed gas cylinders, medical waste, or asbestos). This approach assumed that any significant migration of contaminants will have both lateral and vertical components. Sites with multiple disposal features in close proximity to each other were treated as one area of concern. Therefore, sample locations were selected adjacent to the outer boundaries of the outer disposal features with limited locations between disposal features. The frequency of sample locations was based on biasing factors and was approximately between 75 and 150 ft with a minimum of one per lateral side of each CAS. Exceptions are discussed in the CAS-specific sections.

Sample locations were staked in the field, labeled appropriately, and surveyed with a GPS instrument. The actual locations have been plotted on the figures based on GPS coordinates, and what may appear as inaccuracies are due to the limited resolution of the technology and the small scale of the figures.

A.2.3 Investigation Activities

The investigation activities performed at CAU 5 were based on general field investigation activities discussed in the CAIP. The technical approach consisted of the following activities:

- Geophysical surveys
- Excavation
- Surface and subsurface soil sampling
- Field screening
- Off-site laboratory analysis of samples
- Topographic surveys

This investigation strategy fulfilled the DQOs established in the CAIP. The following sections describe the specific investigation activities that took place at CAU 5.

A.2.3.1 Geophysical Surveys

Geophysical surveys were conducted to determine the lateral extent of buried metallic (conductive) and nonmetallic waste, the landfill thickness, trench orientation, and any utilities within close proximity. Electromagnetic (EM) induction methodology using the Geonics EM31 and EM61 instruments determined the approximate lateral extent of disposed waste. Electrical imaging (EI) methodology using the Advanced Geosciences, Inc. Supersting® determined the approximate vertical extent of disposed waste. Seismic refraction methodology using the Geometrics R-24 Strataview was used coincident with an EI profile at CAS 06-15-02 to identify the optimal method to determine vertical limits to targets identified during the EM31 survey.

At each site, surveys grids were established parallel to the long axis and fairly perpendicular to the topographic slope to maximize traverse length and minimize the number or required traverses. The various surveys were conducted along the grid lines. Coordinates of grid lines, survey points, and points of interest (e.g., monuments and other cultural features) were collected with a GPS instrument. Survey data were downloaded using appropriate software, interpreted, plotted onto base maps, and compiled into the *Surface Geophysical Survey Final Report Industrial Sites Project - CAU 5 Nevada Test Site* (SAIC, 2002). Additional detail is provided in Section A.3.0 through Section A.10.0.

A.2.3.2 Excavations

A backhoe was used to confirm the lateral extent of disposal features, determine disposal feature cover thickness, identify the presence and nature of buried waste, and occasionally to determine the base of disposal features when this information was not identified by the geophysical surveys. Backhoe locations were preselected based on the results of the geophysical surveys. Excavations were generally oriented perpendicular to the interpreted disposal feature boundary. Trenching progressed from outside the boundary toward the boundary. Observations about cover thickness, nature and extent of debris, and other pertinent information was documented. As soon as debris or other indications of a boundary (e.g., changes in lithology and/or structure) were observed, the location was noted, staked for drilling, surveyed with GPS equipment, and the trench backfilled. In this manner, disposal features were minimally penetrated. Excavated soil and debris was temporarily staged next to the excavation and was returned as near to its original position as possible.

A.2.3.3 Drilling and Sample Collection

Samples were collected with a rotary sonic drill rig. This rig used a hollow core barrel fitted with a standard carbide button bit. The core barrel was advanced via pull-down and rotation, and when the barrel was full (or blocked, as was often the case), it was brought to the surface and the contents extruded by vibration into plastic bags. *In situ* lithology was not preserved due to this drilling method; however, gross lithologic breaks could be recognized.

Site characterization soil samples were collected for off-site laboratory analysis below the base of disposal features, as determined by geophysical surveys or excavation. Additional samples were collected for off-site analysis based on biasing factors, particularly field screening (e.g., FSRs greater than FSLs) and visual observation of core. Geotechnical samples were collected from cover material and from native soil beneath disposal features.

To collect samples, a decontaminated core barrel was used to drill through the desired interval, the interval was extruded, the depth of the interval was marked on the bag, and the bag was delivered to the sampling crew. The total VOCs and TPH (GRO) sample containers were filled directly from the bag, followed by collection of soil for VOC and TPH field screening. Additional soil was transferred into a decontaminated stainless-steel bowl, homogenized, and screened for alpha and beta/gamma radiation. After radiological field screening, remaining sample containers were filled from the stainless-steel bowl.

Geotechnical samples were collected with a split spoon loaded with decontaminated brass sleeves to preserve *in situ* conditions. The sleeves were immediately capped, taped, and labeled, and stored until shipment to the geotechnical laboratory.

Cuttings were returned to the borings as near to their original position as possible, and void spaces were filled with bentonite pellets. The borehole location was staked and surveyed with GPS equipment.

A.2.3.4 Field-Screening Methodology

On-site field screening was performed as specified in the CAIP. Selected core intervals were screened for VOCs, TPH (DRO), and alpha and beta/gamma radiation. Intervals selected for field screening were located both above and below the anticipated base(s) of the disposal feature(s). Field-screening intervals above disposal feature bases were approximately evenly spaced between the bottom of the cover and the anticipated bottom of the disposal feature. Field-screening intervals below the base of the disposal feature were spaced at approximate 5-ft intervals and a minimum of two intervals were field screened (i.e., 5 ft and 10 ft below the base). This strategy ensured that any COPCs migrating outside of disposal feature boundaries would be detected. Field-screening results were used to guide sampling decisions.

A Photovac flame ionization detector or photoionization detector were used to screen for VOCs. The FSL for VOC headspace was established at 20 parts per million (ppm) or 2.5 times background, whichever was greater. Two SRI 8610C gas chromatographs were used to screen for TPH (DRO). The TPH (DRO) FSL was established at 75 ppm. An Eberline E-600 was used to screen for alpha and beta/gamma radiation. Site-specific FSLs for alpha and beta/gamma radiation were defined as the mean background activity level plus two times the standard deviation of readings from 20 background locations.

A.2.3.5 Topographic Surveys

Upon conclusion of the main field investigation, topographic surveys were completed at each CAS to determine the surface slope. Control was achieved using existing points previously set by GPS and control sets for other nearby surveys. Points inside the survey area were shot with a "Total Station" type instrument which recorded the raw data (i.e., angle from known point to random point, the distance measured, and a difference in elevation between the instrument and the random point). Data were stored electronically, downloaded to a computer, and plotted on a map to show northing and easting coordinates, a description of the point (e.g., top, toe, flowline, edge of road) and the ground elevation. Breaklines, such as washes and roads, were followed and mapped. Incidental shots of the natural ground surface were taken at locations dictated by surface conditions. Adequate field data were collected to produce 2-ft contour intervals. This was accomplished in most cases by taking shots at around 50-ft intervals on the ground surface.

A.2.4 Geology

Regional geology of the investigation sites is provided in Section 2.1 of the CAIP. Local geology observed during excavation and drilling was documented in FADLs and borehole logs. Disturbed strata (i.e., cover material and fill) consisted of poorly graded, poor to moderately consolidated, silty sands with gravel and some cobble-sized fragments. Gravel clasts were country rock that included combinations of subangular welded and nonwelded volcanic tuffs, carbonates, marble, quartzite, and unidentified clasts. Often, the lithology of cover material was similar to native soil and the distinction was frequently based on structural discontinuities.

A caliche hardpan was often encountered several feet below the ground surface. Its presence was obvious by backhoe refusal, slower drilling penetration rates, and characteristic lithology. The presence of caliche hardpan and/or caliche stringers was often used to identify undisturbed strata.

A.2.5 Hydrology

Dry washes provide channels that concentrate surface run-off; however, there is no perennial streamflow in the region. Surface topography at all of the CASs ranged from nearly flat to sites where distribution planes slope gently in the down-flow direction.

Due to depth to groundwater and climatic conditions, groundwater at the NTS Areas 5, 6, 12, 20, and 23 is not expected to have been impacted by COPCs. In Area 5, the depth to groundwater is estimated at approximately 684 ft bgs (DOE/NV, 1996). In Areas 6 and 12, the depth to groundwater is estimated at about 1,540 ft bgs (DOE/NV, 1996; DRI, 1996). In Area 20, the depth to groundwater is estimated at approximately 1,956 ft bgs (REECo, 1993). In Area 23, two perched water layers are present at 500 ft bgs and 1,080 ft bgs, respectively (BN, 1997). The static water level depth in the area is at 690 ft bgs (DOE/NV, 1996).

A.2.6 Laboratory Analytical Information

Chemical and radiological analyses were performed by Paragon Analytics, Inc., in Fort Collins, Colorado. Geotechnical analysis was performed by D.B. Stephens and Associates in Albuquerque, New Mexico.

The analytical parameters, laboratory analytical methods, and MRLs used to analyze CAU 5 investigation samples are shown in Table 3-2 (organic and inorganic) and Table 3-3 (radionuclides) of the CAIP. Validated analytical data for CAU 5 investigation samples have been compiled and evaluated in Section A.3.0 through Section A.10.0 to determine the presence and/or extent of contamination. Geotechnical analytical parameters and methods are shown in Table 4-1 of the CAIP; geotechnical data were not validated. The analytical parameters were selected through the application of site process knowledge according to the EPA's *Guidance for the Data Quality Objectives Process* (EPA, 2000a). The complete laboratory data packages are available in the project central files.

A.2.7 Comparison to Preliminary Action Levels

Contaminants detected at concentrations greater than PALs are termed COCs. If COCs are present, corrective action must be considered. The PALs for chemical COPCs are EPA Region 9 risk-based PRGs (EPA, 2000b). Background concentrations for arsenic were used instead of the PRG because natural background exceeds the PRG. 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 (NBMG) throughout the Nevada Test and Training Range (NTTR) (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999). The PAL for TPH is 100 mg/kg, per NAC 445A.2272

(NAC, 2003). The PALs for radiological COPCs are isotope-specific and defined as the maximum background concentrations for that isotope from undisturbed locations in the vicinity of the NTS (US Ecology and Atlan-Tech, 1991). A more detailed discussion of the radiological PALs is presented in Appendix I.

Analytical results above MRLs are tabulated and discussed in Section A.3.0 through Section A.10.0. Results greater than PALs (a subset of those that exceed MRLs) are bolded in the corresponding tables; these values represent the presence of COCs.

A.3.0 CAS 05-15-01, Sanitary Landfill

This landfill is located northwest of the Area 5 Spill Center and was operational from 1965 to 1971. The landfill may have received solid, liquid, and sludge waste. Waste was burned before burial, as evident by burned debris protruding through the landfill surface. Additional detail is provided in the CAIP.

A.3.1 Corrective Action Investigation

Thirteen site characterization samples (including one field duplicate) and six geotechnical samples were collected by rotary sonic drilling, and are listed in Table A.3-1. One sample (005A008) was collected from soil contaminated by a drill rig hydraulic fluid leak; analytical results of this sample will be used for waste disposition of the impacted soil. Figure A.3-1 is a site sketch showing excavation and sampling locations at CAS 05-15-01. The activities conducted to meet the CAIP requirements at CAS 05-15-01 are discussed in the following sections.

Table A.3-1
Samples Collected at CAS 05-15-01, Sanitary Landfill
(Page 1 of 2)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
005A001	A03	T1	7 - 8	Soil	SC, WM, Lab QC	Set 1, GS
005A002	A02		7 - 8	Soil	SC	Set 1
005A003	A01		7 - 8	Soil	SC	Set 1
005A004	A04		7 - 8	Soil	SC	Set 1
005A005	A05	T2	7 - 8	Soil	SC, WM	Set 1, GS
005A006			7 - 8	Soil	Field Duplicate of 005A005	Set 1, GS
005A007	A06		7 - 8	Soil	SC	Set 1
005A008[a]	NA	NA	NA	Soil	WM	TPH (DRO)[c]
005A009	A07	T3	11 - 12	Soil	SC, WM	Set 1, GS
005A010	A08		11 - 12	Soil	SC	Set 1
005A011	A09		11 - 12	Soil	SC	Set 1

Table A.3-1
Samples Collected at CAS 05-15-01, Sanitary Landfill
(Page 2 of 2)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
005A012	A10	T4	11 - 12	Soil	SC	Set 1
005A013	A11		11 - 12	Soil	SC, WM	Set 1, GS
005A014	A12		11 - 12	Soil	SC	Set 1
Geotechnical Samples						
005A401	A04	T1	8 - 9	Soil	Geotechnical	Set 2
005A405	A15	T2	0 - 1	Soil	Geotechnical	Set 2
005A404	A14	T3	0 - 1	Soil	Geotechnical	Set 2
005A402	A08		12 - 13	Soil	Geotechnical	Set 2
005A406	A13	T4	0 - 1	Soil	Geotechnical	Set 2
005A403	A11		12 - 13	Soil	Geotechnical	Set 2
Quality Control Samples						
005A301	NA	NA	NA	Water	Trip Blank	Total VOCs
005A302	NA	NA	NA	Water	Trip Blank	Total VOCs
005A303	NA	NA	NA	Water	Source Blank	Set 1, GS, Dioxins
005A304	NA	NA	NA	Water	Field Blank	Set 1, GS, Dioxins
005A305	NA	NA	NA	Water	Trip Blank	Total VOCs

Set 1 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs
Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics

[a]This sample was collected from soil associated with a minor hydrocarbon spill from the drill rig.

SC = Site characterization
WM = Waste management
QC = Quality control
NA = Not applicable
GS = Gamma spectrometry
ft bgs = Feet below ground surface
T = Trench

A.3.1.1 CAIP Implementation

The following activities were conducted at CAS 05-15-01 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste

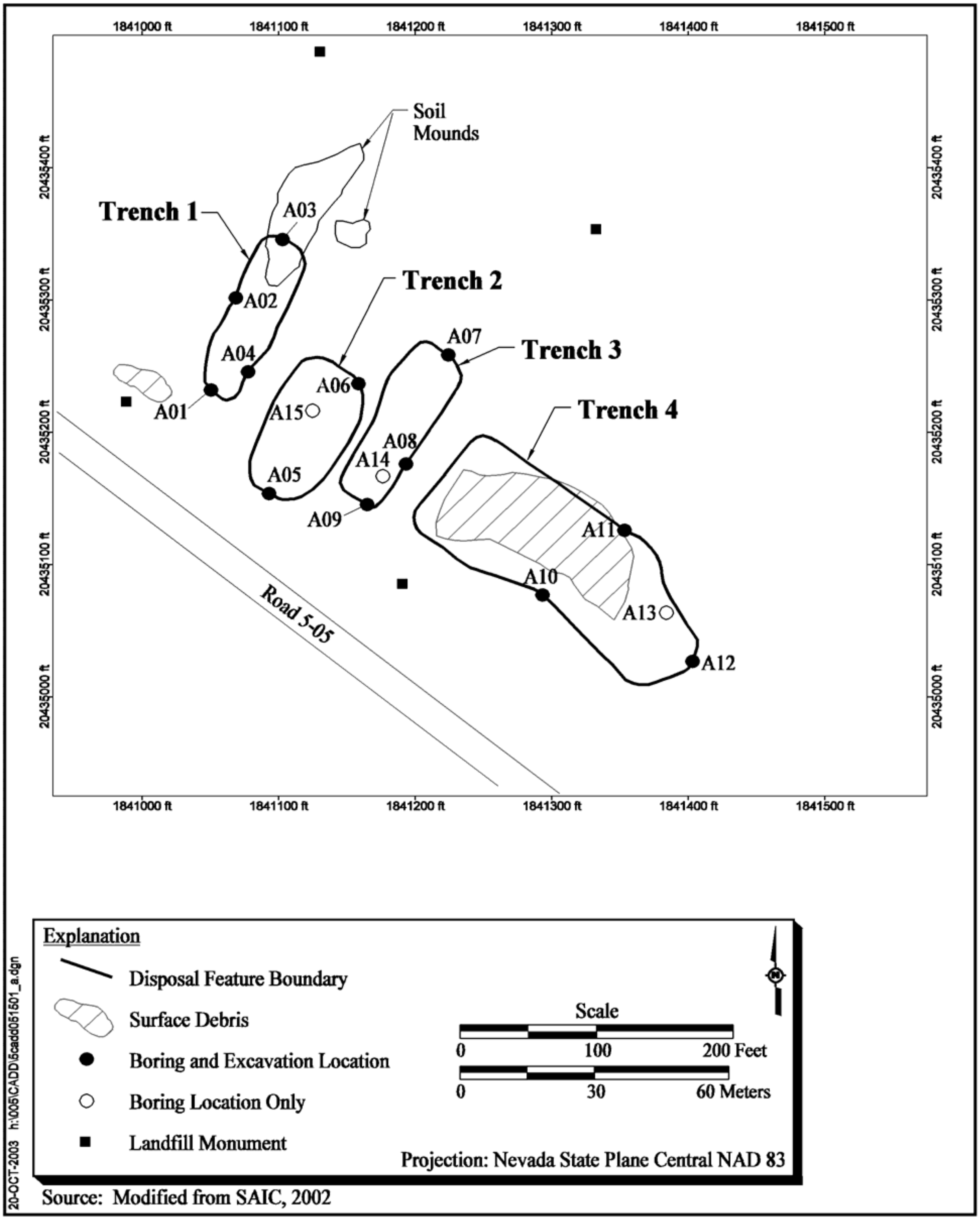

Figure A.3-1
Site Sketch and Sampling Locations at CAS 05-15-01, Sanitary Landfill

- Backhoe excavations at preselected locations to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, and verify the lateral boundaries of the disposal features
- Rotary sonic drilling at locations identified during excavation to collect samples at intervals corresponding to the base of disposal features
- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of disposal features
- Topographic survey to determine the slope of disposal feature covers
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

A.3.1.2 Deviations

There were no deviations to the CAIP investigation strategy; therefore, the CAIP requirements were met.

A.3.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.3.2.1 Geophysical Survey

An EM31 terrain conductivity survey was conducted along southeast to northwest traverses with a 10-ft traverse separation. The EM31 survey identified four potential disposal features containing subsurface metallic debris. Three of the features (T1, T2, and T3) trend northeast to southwest. Trench 4 is larger and trends northwest to southeast. No other linear features (e.g., buried utilities) were identified.

Following the EM31 survey, two EI survey traverses were conducted to determine the vertical limits of the buried waste material. EI Traverse 1 extended northwest to southeast across T1, T2, and T3. EI Traverse 2 extended southwest to northeast across T4. The EI survey indicated the bases of T1 and T2 are approximately 8 ft bgs, and the bases of T3 and T4 are approximately 10 to 12 ft bgs.

A.3.2.2 Excavation, Drilling, and Sampling

Twelve backhoe excavations were made to determine the thickness of cover material and to verify the lateral boundaries of the disposal features. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation. Site characterization samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from EI geophysical traverses. Excavation, drilling, and sampling details are discussed in the following subsections.

A.3.2.2.1 Trench 1

Four excavations (A01 through A04) were made perpendicular to the south, west, north, and east edges of T1 as shown in Figure A.3-1. The excavations bounded the T1 edges and showed the lateral extent of T1 to be smaller than indicated by the geophysical survey. A thin soil veneer was present at the south side of T1. A cover composed of gravelly sand with silt was 3.5-ft thick at the north side, 1-ft thick at the west side, and 1.5-ft thick on the east side. Debris encountered consisted mostly of burned and unburned wood and paper. Lesser amounts of cement, possible transite pipe, and metallic scrap were also encountered. There is a small debris pile southwest of T1 that contains mostly soil with some concrete. Debris was not observed in two soil mounds at the north end of T1 and the piles may be spoils from the initial excavation of T1. These features are shown on Figure A.3-1.

Four borings (A01 through A04) were drilled at locations determined from excavation. The geophysical survey indicated the base of T1 at approximately 8 ft bgs. The core intervals from 4 to 5 ft bgs, 7 to 8 ft bgs, 12 to 13 ft bgs, and 17 to 18 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Therefore, the core intervals from 7 to 8 ft bgs were selected for off-site analysis, the basal depth of T1. One geotechnical sample was collected in native soil below the T1 base from 8 to 9 ft bgs.

A.3.2.2.2 Trench 2

Two excavations (A05 and A06) were made perpendicular to the south and north edges of T2, as shown in Figure A.3-1. The excavations bounded the T2 edges and were generally consistent with the geophysical survey. The cover was 2-ft thick at the north side, 3-ft thick at the south side, and consisted of gravelly sand with silt. Debris encountered consisted of burned wood and metallic scrap.

Two borings (A05 and A06) were drilled at locations determined from excavation. The geophysical survey indicated the base of T2 at approximately 8 ft bgs. The core intervals from 4 to 5 ft bgs, 7 to 8 ft bgs, 12 to 13 ft bgs, and 17 to 18 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Therefore, the core interval from 7 to 8 ft bgs (the basal depth of T2) was selected for off-site analysis. One geotechnical sample was collected in cover material from 0 to 1 ft bgs.

A.3.2.2.3 Trench 3

Three excavations (A07 through A09) were made perpendicular to the north, east, and south edges of T3, as shown in Figure A.3-1. The excavations established the T3 edges and showed the lateral extent of T3 to be slightly smaller than indicated by the geophysical survey. The cover ranged from 1- to 1.5-ft thick, and consisted of gravelly sand with silt. Debris encountered consisted of burned and unburned wood, wire, and metallic scrap.

Three borings (A07 through A09) were drilled at locations determined from excavation. The geophysical survey indicated the base of T3 at approximately 10 to 12 ft bgs. The core intervals from 4 to 5 ft bgs, 7 to 8 ft bgs, 11 to 12 ft bgs, 16 to 17 ft bgs, and 21 to 22 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Therefore, the core intervals from 11 to 12 ft bgs (the basal depth of T3) were sent for off-site analysis.

Two geotechnical samples were collected. A cover material sample was collected from 0 to 1 ft bgs and a native soil sample was collected below the T3 base from 12 to 13 ft bgs.

A.3.2.2.4 Trench 4

Three excavations (A10 through A12) were made perpendicular to the south, north, and east edges of T4, respectively, as shown in Figure A.3-1. The excavations bounded the T4 edges and showed the lateral extent of T4 to be smaller than indicated by the geophysical survey. The cover was 3-in. thick at the north side, 1.5-ft thick at the south side, and 1-ft thick at the east side. The cover was composed of gravelly sand with silt. Debris encountered consisted mostly of metallic scrap with lesser amounts of concrete, and possibly transite pipe. Surface debris consisting of steel scrap, concrete, some transite chips, and wood is irregularly scattered over most of T4, as shown in Figure A.3-1.

Three borings (A10 through A12) were drilled at locations determined from excavation. The geophysical survey indicated the base of T4 at approximately 10 to 12 ft bgs. The core intervals from 4 to 5 ft bgs, 7 to 8 ft bgs, 11 to 12 ft bgs, 16 to 17 ft bgs, and 21 to 22 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Therefore, the core intervals from 11 to 12 ft bgs (the basal depth of T4) were sent for off-site analysis.

Two geotechnical samples were collected. A cover material sample was collected from 0 to 1 ft, and a native soil sample was collected below the base of T4 from 12 to 13 ft bgs.

A.3.2.3 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. A topographic map of CAS 05-15-01 was prepared and is included in the engineering drawings in Appendix H.

The ground surface at CAS 05-15-01 slopes gently from the northwest to southeast at approximately 1.3 percent. Topographic highs at the site include two soil mounds in the northwest corner, adjacent to T1.

A.3.2.4 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs which include total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), and PCBs. In addition, 25 percent of the soil samples were analyzed for gamma spectrometry. The QC source blank and field blank were analyzed for the soil sample parameters listed above, gamma spectrometry, and dioxins. Trip blanks were analyzed only for total VOCs.

One waste management sample (005A008) was collected from soil contaminated by a small hydraulic fluid leak from the drill rig. This sample was analyzed only for TPH (DRO) for waste disposition purposes.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.3.2.5 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Total VOCs
- Total SVOCs
- Ethylene glycol
- TPH (GRO)
- PCBs

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total RCRA metals, nickel, and zinc
- TPH (DRO)
- Gamma-emitting radionuclides

A.3.2.5.1 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.3-2. Arsenic, barium, chromium, lead, nickel, selenium, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below PALs established in the CAIP.

A.3.2.5.2 Total Petroleum Hydrocarbon Analytical Results for Soil Samples

The TPH (DRO) detected in soil samples at concentrations exceeding MRLs are listed in Table A.3-3. An estimated concentration of 23,000 mg/kg was detected in sample 005A008, which was a sample from soil contaminated by a small hydraulic fluid leak in the drill rig. The sample was collected for waste management determinations and does not represent site conditions. Additional detail is provided in Section A.11.0. There was no TPH detected in any of the environmental soil samples collected at CAS 05-15-01.

Table A.3-2
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 05-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	10,000[b]	100,000[b]
005A001	A03	7 - 8	4.4	200	11.0	6.7	6.2	1.00	31
005A002	A02	7 - 8	4.6	160	12.0	6.4	6.1	0.74	29
005A003	A01	7 - 8	5.7	160	9.4	9.9	6.2	0.78	35
005A004	A04	7 - 8	4.6	190	11.0	7.2	6.3	--	32
005A005	A05	7 - 8	4.2	170	15.0	7.7	7.0	--	31
005A006		7 - 8	4.7	190	15.0	7.5	7.7	--	34
005A007	A06	7 - 8	4.6	170	13.0	7.7	6.4	--	31
005A009	A07	11 - 12	4.5	180	11.0	8.4	7.8	0.82	33
005A010	A08	11 - 12	4.3	170	11.0	7.3	5.8	0.84	29
005A011	A09	11 - 12	4.1	190	8.8	10.0	6.6	1.00	31
005A012	A10	11 - 12	7.7	160	11.0	6.7	6.0	0.82	29
005A013	A11	11 - 12	4.4	180	14.0	6.9	6.3	0.93	30
005A014	A12	11 - 12	5.3	140	9.3	9.4	5.8	1.00	29

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
-- = Not detected above minimum reporting limits

Table A.3-3
Soil Sample Results for TPH-DRO Detected Above Minimum Reporting Limits at CAS 05-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel-Range Organics
Preliminary Action Level[a]			100
005A008	NA	NA	23,000 (J)

[a]TPH PAL from *Nevada Administrative Code* (NAC, 2003)

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
J = Estimated value. Qualifier added to laboratory data; record accepted. Surrogates diluted out. Total extractable petroleum hydrocarbons result quantitated from diesel standard calibration.

A.3.2.5.3 Gamma Spectrometry Analytical Results for Soil Samples

Gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.3-4. The isotopes actinium (Ac)-228, bismuth (Bi)-214, lead (Pb)-212, Pb-214, potassium (K)-40, and thallium (Tl)-208 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results exceed background concentrations so PALs for these isotopes were not exceeded at CAS 05-15-01.

Table A.3-4
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 05-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			**3.64**	**3.47**	**3.64**	**3.47**	**31.1**	**3.38**
005A001	A03	7 - 8	--	--	1.34 ± 0.33	0.82 ± 0.26	23.8 ± 5.6	0.49 ± 0.18
005A005	A05	7 - 8	--	--	1.19 ± 0.32	0.82 ± 0.25	15.6 ± 4.3	0.44 ± 0.18
005A006		7 - 8	1.50 ± 0.42	0.83 ± 0.27	1.48 ± 0.31	1.00 ± 0.26	25.2 ± 4.9	0.36 ± 0.12
005A009	A07	11 - 12	1.64 ± 0.63	--	1.49 ± 0.39	0.73 ± 0.27	22.2 ± 5.8	0.49 ± 0.20
005A013	A11	11 - 12	1.53 ± 0.55	0.94 ± 0.38	1.21 ± 0.36	1.08 ± 0.34	26.2 ± 6.6	0.53 ± 0.20

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991)

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

A.3.2.5.4 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.3-5. Data summaries for all of the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

- Based on saturated hydraulic conductivity measurements, cover soil has lower permeabilities than subcell soil.

- Moisture content measurements show that the soil is well below saturation.

- Dry bulk densities ranged from 1.82 to 1.84 grams per cubic centimeter (g/cm^3) in cover soil and from 1.67 to 1.72 g/cm^3 in subcell native soil. Cover soil had higher densities than subsurface soils.

- Porosities in cover soil ranged from 30.6 to 31.4 percent while subcell soil porosities ranged from 35.2 to 37.1 percent. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

Table A.3-5
Soil Sample Results for Select Geotechnical Parameters at CAS 05-15-01

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat[a] (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005A405	T2	0 - 1	8.3E-05	2.3	4.1	1.82	1.86	31.4
005A401	T1	8 - 9	8.7E-04	3.6	6.2	1.72	1.78	35.2
005A404	T3	0 - 1	1.4E-04	2.4	4.4	1.84	1.88	30.6
005A402		12 - 13	3.6E-04	3.6	6.0	1.67	1.74	36.8
005A406	T4	0 - 1	5.1E-05	1.7	3.1	1.83	1.86	30.9
005A403		12 - 13	5.7E-05	6.8	11.4	1.67	1.78	37.1

[a]Constant head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

A.3.2.6 Contaminants of Concern

Based on the aforementioned analytical results, no COCs are migrating from CAS 05-15-01.

A.3.3 Nature and Extent of Contamination

Since COCs are not migrating, the extent of any contamination that may be present at CAS 05-15-01 is limited to within the boundaries of the subsurface disposal features.

A.3.4 Revised Conceptual Site Model

No variations in the CSM were identified.

A.4.0 CAS 05-16-01, Landfill

This landfill is located partially within the Area 5 RWMS site boundary and received construction debris from 1965 to 1971. Four concrete monuments delineate the corners of the landfill. The RWMS flood control dike runs north and south across the width of the landfill, separating the western one-third of the site. Additional detail is provided in the CAIP.

A.4.1 Corrective Action Investigation

Ten site characterization samples (including one field duplicate) and six geotechnical samples were collected by rotary sonic drilling, and are listed in Table A.4-1. Figure A.4-1 is a site sketch showing excavation and sampling locations at CAS 05-16-01. The activities conducted to meet the CAIP requirements at CAS 05-16-01 are discussed in the following sections.

A.4.1.1 CAIP Implementation

The following activities were conducted at CAS 05-16-01 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste
- Backhoe excavations at preselected locations to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, verify the lateral boundaries of the disposal features, and determine the base of the SMT
- Rotary sonic drilling at locations identified during excavation to collect samples at intervals corresponding to the base of the disposal feature and the SMT
- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of the disposal feature and subsurface metallic target
- Topographic survey to determine the slope of the cover
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

Table A.4-1
Samples Collected at CAS 05-16-01, Landfill

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
005B001	B09	SMT	7 - 8	Soil	SC	Set 1, Pesticides
005B002	B08	SMT	7 - 8	Soil	SC	Set 1, Pesticides
005B003	B07	SMT	7 - 8	Soil	SC	Set 1, Pesticides
005B004	B01	T1	11 - 12	Soil	SC, WM, Lab QC	Set 1, Pesticides, GS
005B005	B04	T1	11 - 12	Soil	SC	Set 1
005B006	B03	T1	11 - 12	Soil	SC	Set 1
005B007	B02	T1	11 - 12	Soil	SC	Set 1
005B008	B06	T1	11 - 12	Soil	SC, WM	Set 1, GS
005B009	B06	T1	11 - 12	Soil	Field Duplicate of 005B008	Set 1, GS
005B010	B05	T1	11 - 12	Soil	SC, WM	Set 1, GS
Geotechnical Samples						
005B401	B08	SMT	8 - 9	Soil	Geotechnical	Set 2
005B402	B11	SMT	0 - 1	Soil	Geotechnical	Set 2
005B403	B12	T1	0 - 1	Soil	Geotechnical	Set 2
005B404	B03	T1	12 - 13	Soil	Geotechnical	Set 2
005B405	B06	T1	12 - 13	Soil	Geotechnical	Set 2
005B406	B13	T1	0 - 1	Soil	Geotechnical	Set 2
Quality Control Samples						
005B301	NA	NA	NA	Water	Trip Blank	Total VOCs
005B302	NA	NA	NA	Water	Trip Blank	Total VOCs
005B303	NA	NA	NA	Water	Field Blank	Set 1, GS

Set 1 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs
Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics

SC = Site characterization
WM = Waste management
NA = Not applicable
QC = Quality control
GS = Gamma spectrometry
ft bgs = Feet below ground surface
SMT = Subsurface metallic target
T = Trench

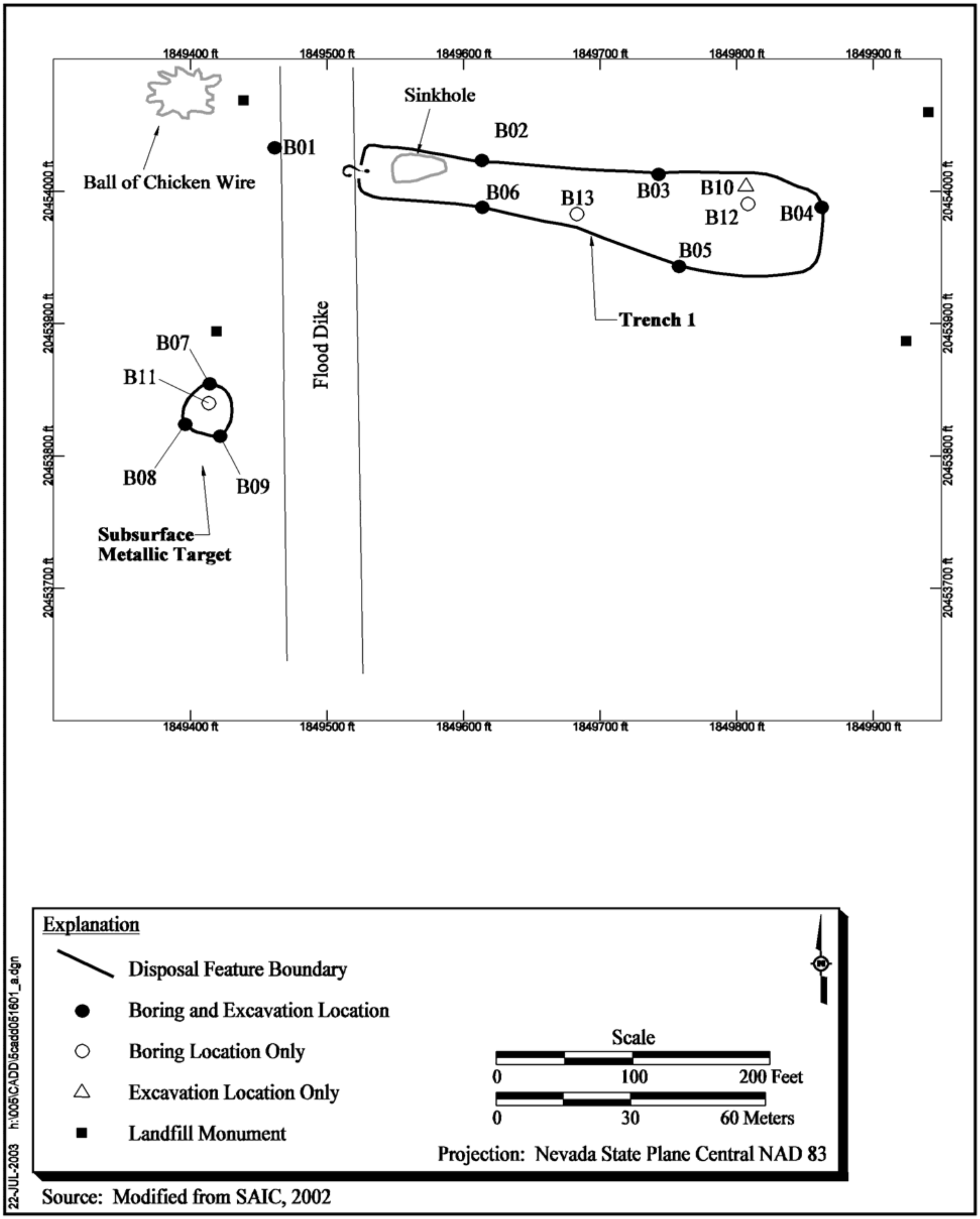

Figure A.4-1
Site Sketch and Sampling Locations at CAS 05-16-01, Landfill

A.4.1.2 Deviations

There were no deviations to the CAIP investigation strategy; therefore, the CAIP requirements were met.

A.4.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.4.2.1 Geophysical Survey

An EM31 terrain conductivity survey was conducted along southeast to northwest traverses east of the flood dike and along east to west traverses west of the flood dike. The traverses had a 10-ft separation. The EM31 survey confirmed the existence of buried waste material within one disposal feature (T1) east of the flood dike, trending nearly west to east. Two smaller metallic targets were identified from the EM31 survey, but were not considered part of the disposal feature. Both of the targets were found west of the flood dike and included the SMT toward the south, and a ball of chicken wire on the surface, toward the north. No other linear features (e.g., buried utilities) were identified.

Two EI traverses were completed to define the vertical extent of T1. The EI traverses showed the vertical extent of T1 at approximately 10 to 12 ft bgs.

A.4.2.2 Excavation, Drilling, and Sampling

Ten backhoe excavations were made to determine the thickness of cover material, to verify the lateral boundaries of T1, and to determine the basal depth of the SMT. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation. Site characterization samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from EI geophysical traverses at T1 and excavation at the SMT. Excavation, drilling, and sampling details are discussed in the following subsections.

A.4.2.2.1 Trench 1

Seven excavations (B01 through B06, and B10) were made to investigate T1, as shown in Figure A.4-1. Excavations B02, B03, and B10 established the north edge; the cover at these locations was 2.5-, 4.5-, and 1.5-ft thick, respectively. Excavation B04 established the east edge and the cover was 1.5-ft thick. Excavations B05 and B06 established the south edge and the cover at these locations was 1.5-ft and 3-ft thick, respectively. The excavations showed the lateral boundaries of T1 to be smaller than indicated by the geophysical survey.

The cover consisted of a gravelly sand with silt matrix, and appeared to be reworked native material. Debris encountered consisted mostly of metallic scrap, with lesser amounts of burned and unburned paper and wood, glass, and plastic.

Excavation B01 was made to see if T1 extended west of the flood dike. No debris was noted here, confirming the geophysical conclusion that the eastern edge of T1 lies beneath or just east of the dike. A 1.5-ft deep sinkhole is located at the west end of T1 near the flood dike, as shown in Figure A.4-1.

Six borings (B01 through B06) were drilled at locations determined from excavation. The geophysical survey indicated the base of T1 at approximately 10 to 12 ft bgs. The core intervals from 4 to 5 ft bgs, 7 to 8 ft bgs, 11 to 12 ft bgs, 16 to 17 ft bgs, and 21 to 22 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Therefore, the core intervals from 11 to 12 ft bgs, the basal depth of T1, were selected for off-site analysis.

Four geotechnical samples were collected at T1; two in cover material from 0 to 1 ft bgs and two in subcell native soil from 12 to 13 ft bgs.

A.4.2.2.2 Subsurface Metallic Target

Three excavations (B07 through B09) were made to investigate the SMT in the southwest corner of the CAS, as shown in Figure A.4-1. The cover ranged from 1- to 2-ft thick and was composed of reworked native sandy gravel with silt. The base of the SMT ranged from 6.5 to 7 ft bgs. Excavations established the SMT boundaries and showed the lateral extent of the SMT to be less than indicated by the geophysical survey. Debris encountered was mostly metallic scrap, with minor amounts of wood. There was no evidence of burning at the SMT.

Three borings (B07 through B09) were drilled at locations determined from excavation. Excavation indicated the base of the SMT at approximately 6.5 to 7 ft bgs. The core intervals from 2 to 3 ft bgs, 7 to 8 ft bgs, 12 to 13 ft bgs, and 17 to 18 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Therefore, the core interval from 7 to 8 ft bgs, the basal depth of the SMT, was selected for off-site analysis.

Two geotechnical samples were collected at the SMT; one in cover material from 0 to 1 ft bgs and one in subcell native soil from 8 to 9 ft bgs.

A.4.2.3 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. A topographic map of CAS 05-16-01 was prepared and is included in the engineering drawings in Appendix H.

The ground surface at CAS 05-16-01 slopes gently from the northeast to southwest at approximately 1.8 percent. The flood dike transecting the eastern third of the site rises approximately 8 ft above the surrounding surface and the sinkhole east of the flood dike is approximately 1.5-ft deep.

A.4.2.4 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs including total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), and PCBs. Pesticide analysis was inadvertently requested for samples 005B001 through 005B004. In addition, 25 percent of the soil samples were analyzed for gamma spectrometry. The QC field blank was analyzed for the soil sample parameters and gamma spectrometry. Trip blanks were analyzed only for total VOCs.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.4.2.5 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Total VOCs
- Total SVOCs
- Ethylene glycol
- TPH (DRO and GRO)
- PCBs
- Pesticides

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total RCRA metals, nickel, and zinc
- Gamma-emitting radionuclides

A.4.2.5.1 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.4-2. Arsenic, barium, chromium, lead, nickel, selenium, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below PALs established in the CAIP.

A.4.2.5.2 Gamma Spectrometry Analytical Results for Soil Samples

Gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.4-3. The isotopes Ac-228, Bi-214, Pb-212, Pb-214, K-40, and Tl-208 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results exceed background concentrations, so PALs for these isotopes were not exceeded at CAS 05-16-01.

A.4.2.5.3 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.4-4. Data summaries for all of

Table A.4-2
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 05-16-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	10,000[b]	100,000[b]
005B001	B09	7 - 8	3.8	140	3.9	7.5	4.5	--	20
005B002	B08	7 - 8	3.6	150	5.1	7.3	5.0	--	24
005B003	B07	7 - 8	3.6	140	4.3	5.9	--	--	17
005B004	B01	11 - 12	3.4	140	4.6	5.8	--	--	16
005B005	B04	11 - 12	2.5	150	3.8	5.4 (J)	--	0.59	23
005B006	B03	11 - 12	3.0	130	3.3	7.7 (J)	--	--	20
005B007	B02	11 - 12	2.5	130	3.2	4.1 (J)	--	--	19
005B008	B06	11 - 12	3.6	170	3.0	6.7 (J)	--	--	19
005B009		11 - 12	3.7	130	2.6	5.2 (J)	--	--	17
005B010	B05	11 - 12	2.5	130	4.9	6.6 (J)	--	--	24

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
-- = Not detected above minimum reporting limits
J = Estimated value. Qualifier added to laboratory data; record accepted. Duplicate precision analysis (relative percent difference) outside control limits.

the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

- Based on saturated hydraulic conductivity, the T1 cover has a lower permeability than subcell native soil, and the SMT cover has a higher permeability than subcell native soil.
- Moisture content measurements show that the soil is well below saturation.
- Dry bulk densities ranged from 1.50 to 1.60 g/cm^3 in covers and from 1.62 to 1.68 g/cm^3 in subcell native soil. Cover soil had lower densities than subcell soil.
- Porosities in cover soil ranged from 39.4 to 43.3 percent while subcell native soil porosities ranged form 36.7 to 39.1 percent. Subcell porosities were slightly less than cover porosities.

Table A.4-3
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 05-16-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			3.64	3.47	3.64	3.47	31.1	3.38
005B004	B01	11 - 12	1.66 ± 0.45	--	1.54 ± 0.32	0.81 ± 0.23	26.2 ± 5.2	0.40 ± 0.13
005B008	B06	11 - 12	1.35 ± 0.44	0.69 ± 0.30	1.37 ± 0.35	0.78 ± 0.27	21.2 ± 4.9	0.40 ± 0.16
005B009		11 - 12	1.66 ± 0.54	0.88 ± 0.37	1.34 ± 0.36	1.04 ± 0.29	23.5 ± 5.5	0.67 ± 0.22
005B010	B05	11 - 12	1.81 ± 0.60	1.02 ± 0.35	1.64 ± 0.39	0.86 ± 0.26	18.2 ± 4.5	0.42 ± 0.18

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991).

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

A.4.2.6 Contaminants of Concern

Based on the aforementioned analytical results, no COCs are migrating from CAS 05-16-01.

A.4.3 Nature and Extent of Contamination

Since COCs are not migrating, the extent of any contamination that may be present at CAS 05-16-01 is limited to within the boundaries of the subsurface disposal features.

A.4.4 Revised Conceptual Site Model

No variations in the CSM were identified.

Table A.4-4
Soil Sample Results for Select Geotechnical Parameters at CAS 05-16-01

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat[a] (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005B402	SMT	0 - 1	7.6E-05	4.2	6.3	1.50	1.57	43.3
005B401		8 - 9	1.2E-05	3.2	5.4	1.68	1.73	36.7
005B403	T1	0 - 1	5.7E-05	6.1	9.8	1.60	1.70	39.4
005B406		0 - 1	9.3E-06	3.2	5.2	1.60	1.65	39.6
005B404		12 - 13	7.7E-04	5.9	9.5	1.62	1.71	39.1
005B405		12 - 13	7.1E-05	4.3	7.1	1.64	1.71	38.2

[a]Constant head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

A.5.0 CAS 06-08-01, Landfill

This landfill is located in the Area 6 Equipment Yard, east of Control Point Hill. The landfill is alleged to have been operational from 1969 through 1974, but aerial photographs show open disposal trenches in the southwest corner in 1967. The landfill is believed to have accepted construction debris, garbage, rubbish and refuse, and possibly waste from the Area 6 cafeterias and support facilities. Currently, the equipment yard is covered with pea gravel and compacted soil. Additional detail is provided in the CAIP.

A.5.1 Corrective Action Investigation

Twenty-seven site characterization samples (including two field duplicates) and six geotechnical samples were collected by rotary sonic drilling and are listed in Table A.5-1. Figure A.5-1 is a site sketch showing excavation and sampling locations at CAS 06-08-01. The activities conducted to meet the CAIP requirements at CAS 06-08-01 are discussed in the following sections.

A.5.1.1 CAIP Implementation

The following activities were conducted at CAS 06-08-01 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste
- Backhoe excavations at preselected locations to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, verify the lateral boundaries of the disposal features, and determine disposal feature bases
- Rotary sonic drilling at locations identified during excavation to collect samples at intervals corresponding to the base of disposal features
- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of disposal features
- Topographic survey to determine the slope of the cover
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

Table A.5-1
Samples Collected at CAS 06-08-01, Landfill
(Page 1 of 2)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
005C001	C22	T1	4 - 5	Soil	SC, WM	Set 1, GS
005C002	C21		4 - 5	Soil	SC	Set 1
005C003			4 - 5	Soil	Field Duplicate of 005C002	Set 1
005C004	CMA21		2 - 3	Soil	SC, Lab QC	Set 1
005C005	C12		3 - 4	Soil	SC, WM	Set 1, GS
005C006	C13		3 - 4	Soil	SC	Set 1
005C007	C14		4 - 5	Soil	SC	Set 1
005C008	C15		7.5 - 8.5	Soil	SC	Set 1
005C009	C16		6.5 - 7.5	Soil	SC, WM	Set 1, GS
005C026	C11		4 - 5	Soil	SC	Set 1
005C010	C24	T2	8 - 9	Soil	SC	Set 1
005C011	C07		8 - 9	Soil	SC	Set 1
005C012	C04		4 - 5	Soil	SC	Set 1
005C013	C08		4 - 5	Soil	SC, WM	Set 1, GS
005C014	C03		4.5 - 5.5	Soil	SC	Set 1
005C015	C02		3.5 - 4.5	Soil	SC	Set 1
005C016	C09		7.5 - 8.5	Soil	SC	Set 1
005C027	C10		3.5 - 4.5	Soil	SC	Set 1
005C017	C27	AA	5.5 - 6.5	Soil	SC, WM	Set 1, GS
005C018	C01		7.5 - 8.5	Soil	SC	Set 1
005C019	C25		3.5 - 4.5	Soil	SC	Set 1
005C020	C26		3.5 - 4.5	Soil	SC	Set 1
005C021	C18	PT3	4 - 5	Soil	SC, WM, Lab QC	Set 1, GS
005C022	C17		7.5 - 8.5	Soil	SC	Set 1
005C023	C19	PT4	6.5 - 7.5	Soil	SC	Set 1
005C024	C20		6.5 - 7.5	Soil	SC, WM	Set 1, GS
005C025			6.5 - 7.5	Soil	Field Duplicate of 005C024	Set 1, GS
Geotechnical Samples						
005C404	C28	T1	0 - 1	Soil	Geotechnical	Set 2
005C401	C15		8.5 - 9.5	Soil	Geotechnical	Set 2

Table A.5-1
Samples Collected at CAS 06-08-01, Landfill
(Page 2 of 2)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Geotechnical Samples						
005C405	C29	T2	0 - 1	Soil	Geotechnical	Set 2
005C402	C07		9 - 10	Soil	Geotechnical	Set 2
005C406	C30	AA	0 - 1	Soil	Geotechnical	Set 2
005C403	C01		8.5 - 9.5	Soil	Geotechnical	Set 2
Quality Control Samples						
005C301	NA	NA	NA	Water	Trip Blank	Total VOCs
005C302	NA	NA	NA	Water	Trip Blank	Total VOCs
005C303	NA	NA	NA	Water	Field Blank	Set 1, GS, Dioxins
005C304	NA	NA	NA	Water	Trip Blank	Total VOCs
005C305	NA	NA	NA	Water	Trip Blank	Total VOCs
005C306	NA	NA	NA	Water	Trip Blank	Total VOCs
005C307	NA	NA	NA	Water	Trip Blank	Total VOCs
005C308	NA	NA	NA	Water	Field Blank	Set 1, GS, Dioxins
005C309	NA	NA	NA	Water	Source Blank	Set 3

Set 1 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs
Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics
Set 3 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs, Pesticides, Gamma Spectrometry, Isotopic Plutonium, Strontium-90, and Dioxins

SC = Site characterization
WM = Waste management
NA = Not applicable
QC = Quality control
GS = Gamma spectrometry
ft bgs = Feet below ground surface
T = Trench
PT = Potential Trench
AA = Anomaly A

A.5.1.2 Deviations

There were two minor deviations to the CAIP investigation strategy. Some excavations and borings were relocated beyond the CAIP-mandated 150-ft maximum separation due to the presence of extensive underground utilities and concrete pads on the surface. The investigation locations were adjusted along the trench boundary to a point where intrusive activities could safely be conducted. This data gap was acceptable because field screening and other biasing factors supported limited

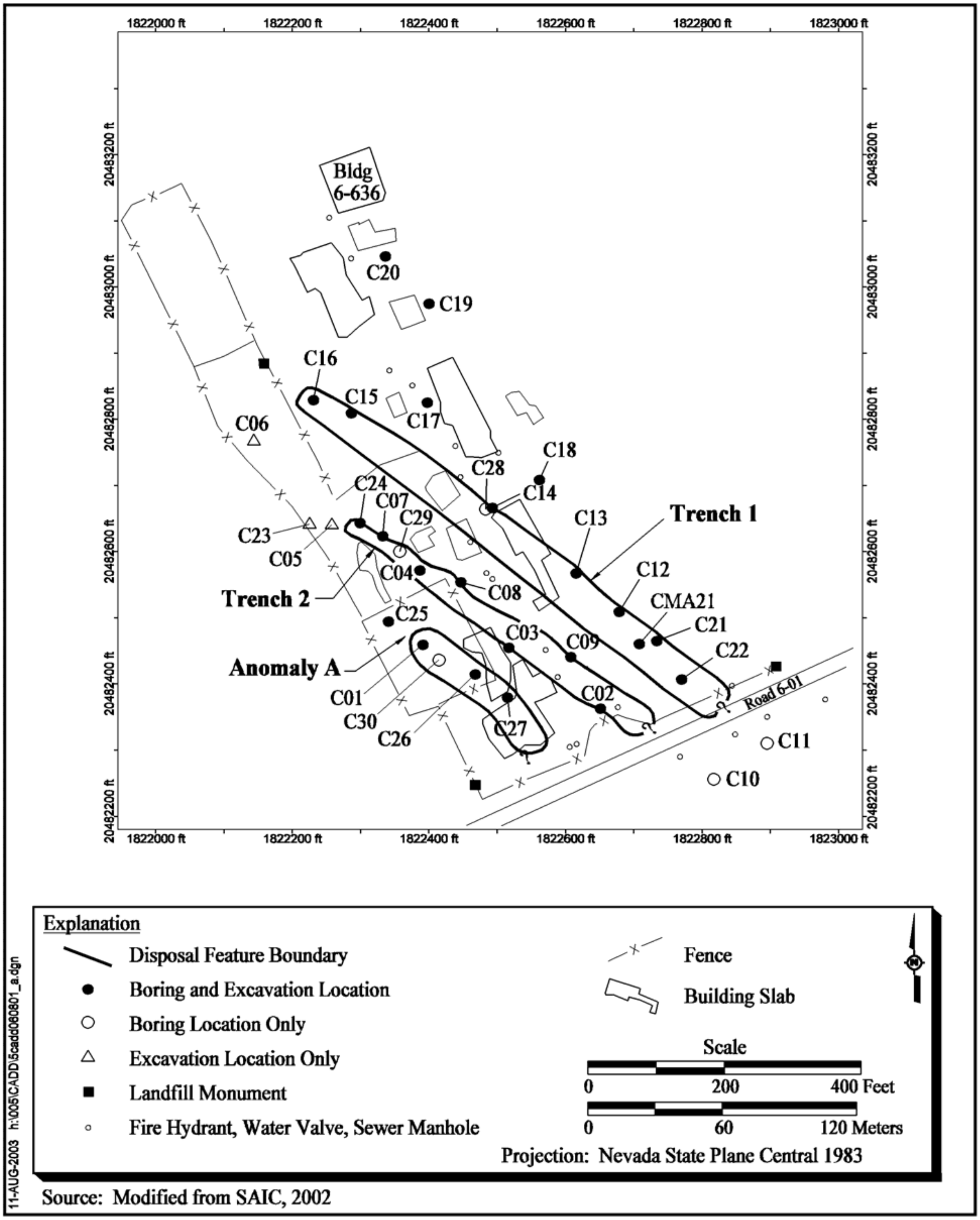

Figure A.5-1
Site Sketch and Sampling Locations at CAS 06-08-01, Landfill

potential for the presence or migration of COCs. One of the potential disposal features was not fully investigated because some buried, disconnected utilities were encountered during excavation. Enough data were gathered though to make conclusions about this feature and are discussed in Section A.5.2.2.3.

A.5.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.5.2.1 Geophysical Survey

An EM61 High Sensitivity Metal Detector survey was conducted across the site along traverses with a 10-ft separation. Despite interference from numerous surface metallic features, the data confirm the existence of buried waste within two disposal features (T1 and T2), trending northwest to southeast. The survey did not positively identify the presence of two shorter potential disposal features (PT3 and PT4), which were identified from aerial photographs. This is likely due to site obstructions (buildings, etc.), metallic surface debris, and the possibility that these potential disposal features do not contain metallic debris (the EM61 is only able to detect subsurface metals). A roughly circular anomaly (AA) was identified within the fenced tire storage area and could not be correlated with a surface feature.

Due to abundant concrete building slabs and other cultural features, an EI or seismic survey was not attempted. As a result, the geophysical survey did not identify disposal feature bases.

A.5.2.2 Excavation, Drilling, and Sampling

Twenty-six backhoe excavations were made to determine the thickness of cover material, verify the lateral boundaries of the disposal features, and determine the basal depths of the disposal features. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation. Site characterization samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from excavation. Excavation, drilling, and sampling details are discussed in the following subsections.

A.5.2.2.1 Trench 1

Eight excavations (C12 through C16, C21, CMA21, and C22) were made to investigate T1, as shown in Figure A.5-1. Five of these excavations (C12 through C16) were located along the northeastern edge of T1. Excavations C21 and CMA21 were located within the expected boundary of T1 to explore an anomalous target from the geophysical survey. Excavation C22 was also located inside the expected boundary of T1 near the southern fence line of the equipment yard to determine if T1 continued across the fence line and Road 6-01. The excavations established the lateral extent of T1 and showed it to be generally consistent with the geophysical survey, except as noted in the following discussion. The base of T1, where encountered, ranged from 2 to 7.5 ft bgs.

Excavations C13, C14, and C21 did not expose any debris, and observed lithology did not conclusively indicate the presence of a disposal feature. A caliche hardpan was encountered at approximately 3 to 4 ft bgs in each of these excavations. Excavation C12, located near the southeastern end of T1, did not encounter any metallic debris, but a soft white material, possibly lime, was noted from 1 to 3 ft bgs. This material is not native and represents some type of buried construction debris. Excavations C15 and C16, located near the northwestern end of T1, showed a 1- to 1.5-ft thick gravel cover. Burned and unburned wood and general refuse (glass, brick, and some metallic debris) was present from the base of the cover to 7.5 ft bgs and was mixed with fill material. Excavation C16 was determined to be at the northwestern end of T1, based on the absence of caliche, sloughing between disturbed and native material, lithologic changes, and truncated caliche stringers. Excavation CMA21 exposed a 1-ft thick gravel cover overlying metallic scrap and burned wood to a depth of 2 ft bgs. Excavation C22 exposed a 1-ft thick gravel cover based on subtle lithologic changes. However, minor burned wood and tar was noted at 2.5 ft bgs, indicating T1 extends to the southeast at least to this point.

The buried utility corridor paralleling Road 6-01 prevented excavation between C22 and the parking lot of the Area 6 support facilities. To determine if T1 extended beneath this area, borehole C11 was drilled in the parking lot in line with the strike of T1. Debris was not encountered in this boring and lithology did not indicate the presence of a disposal feature. Thus, it was concluded that the southeastern extent of T1 lies somewhere between excavation C22 and boring C11, probably near the equipment yard fence line or under Road 6-01.

Nine borings (C11 through C16, CMA21, C21, and C22) were drilled at locations determined from excavation. Excavation indicated the base of T1 varies from 2 to 7.5 ft bgs. Core was field screened at intervals both above and below the T1 base at a particular location, as described in Section A.2.3.4. The FSRs were less than FSLs and no biasing factors were noted. Therefore, core intervals from 2 to 3 ft bgs (CMA21), 3 to 4 ft bgs (C12 and C13), 4 to 5 ft bgs (C11, C14, C21, and C22), 6.5 to 7.5 ft bgs (C16), and 7.5 to 8.5 ft bgs (C15) were selected for off-site analysis. These are the basal depths of T1 at the various locations.

Two geotechnical samples were collected at T1. One sample was collected in cover material from 0 to 1 ft bgs and one sample was collected in subcell native soil from 8.5 to 9.5 ft bgs.

A.5.2.2.2 Trench 2

Ten excavations (C02 through C09, C23, and C24) were made to investigate T2, as shown in Figure A.5-1. Four of these excavations (C07, C08, C09, and C24) were made along the northeastern edge of T2. Excavations C05, C06, and C23 were made at the inferred northwest end of T2 on an elevated gravel bench. Excavations C02, C03, and C04 were made along the southwestern edge of T2. Excavations established the lateral extent of T2 and showed it to be generally consistent with the geophysical survey, except as noted in the following discussion. The base of T2 varied from 2.5 to 8 ft bgs.

Several excavations were made around the inferred northwestern end of T2 to determine the extent of T2 in this direction. Excavations C05, C06, and C23 were located on a gravel bench that rose 2.5 to 3.5 ft above the surface of the rest of the equipment yard. The excavations did not encounter debris and observed lithology did not conclusively indicate the presence of a disposal feature. A hardpan caliche was encountered at 2.5 to 3.5 ft bgs, corresponding to the surface elevation of the rest of the yard. Based on lack of debris and the presence of hardpan, it was concluded that T2 does not extend beneath the gravel bench. Excavations C07 and C24, located near the toe of the gravel bench, encountered very scarce debris mixed in with reworked fill material, which extended to a caliche hardpan at 8 ft bgs. Excavations C02, C04, and C09 encountered a 1-ft thick gravel cover overlying generally abundant metallic debris to depths of 3.5 ft to 8 ft bgs. Obvious disposal feature edges were also noted at these locations. These observations support a conclusion that the northwestern edge of T2 is between C05 and C24.

Excavation C03 did not encounter debris, and observed lithology did not conclusively indicate the presence of a disposal feature at this location. Excavation C08 encountered a thin zone of discolored soil at 1 ft bgs, possibly from burning.

Due to the buried utility corridor paralleling Road 6-01, it was not possible to excavate between C02 and the parking lot of the Area 6 support facilities. To determine if T2 extended beneath this area, borehole C10 was drilled in the parking lot in line with the strike of T2. Debris was not encountered in this boring and lithology did not indicate the presence of a disposal feature. Thus, it was concluded that the southernmost extent of T2 lies somewhere between excavation C02 and boring C10, probably near the equipment yard fence line or under Road 6-01.

Eight borings (C02 through C04, C07 through C10, and C24) were drilled at locations determined from excavation. Excavation indicated the base of T2 varies from 3.5 to 8 ft bgs. Core was field screened at intervals both above and below the T2 base at a particular location, as described in Section A.2.3.4. The FSRs were less than FSLs and no biasing factors were noted. Therefore, the core intervals from 3.5 to 4.5 ft bgs (C02 and C10), 4 to 5 ft bgs (C04 and C08), 4.5 to 5.5 ft bgs (C03), 7.5 to 8.5 ft bgs (C09), and 8 to 9 ft bgs (C07 and C24) were sent for off-site analysis. These are the T2 basal depths at a particular location.

Two geotechnical samples were collected at T2. One sample was collected in cover material from 0 to 1 ft bgs and one sample was collected in native soil from 9 to 10 ft bgs.

A.5.2.2.3 Potential Trench 3

Two excavations (C17 and C18) were made to explore PT3, as shown in Figure A.5-1. Excavation C17 was oriented southeast to northwest, was 10-ft long and extended to 1.5 ft bgs where disconnected underground phone wires were encountered. Debris, disturbed material, or trench sidewalls were not encountered. Excavation C18 was oriented southwest to northeast, was 20-ft long and 3-ft deep. The excavation did not encounter debris and or expose disturbed material or trench sidewalls. Based on these observations, it was concluded that PT3 does not contain buried waste.

Two borings (C17 and C18) were drilled at locations determined by the geophysical survey. Since excavation did not indicate the presence of a disposal feature at PT3, sample depths were selected based on the depth of debris at nearby T1. At boring C17, core intervals from 4 to 5 ft bgs, 7.5 to 8.5 ft bgs, 12 to 13 ft bgs, and 17 to 18 ft bgs were field screened. The FSRs were less than FSLs so the core from 7.5 to 8.5 ft bgs was sent for off-site analysis. At boring C18, core intervals from 4 to 5 ft bgs, 9 to 10 ft bgs, and 14 to 15 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were observed, so the core from 4 to 5 ft bgs was sent for off-site analysis. No geotechnical samples were collected at PT3.

A.5.2.2.4 Potential Trench 4

Two excavations (C19 and C20) were made to explore PT4, as shown in Figure A.5-1. Excavation C19 was oriented northeast to southwest and was 20-ft long and 3-ft deep. Excavation C20 was oriented southwest to northeast, and was 15-ft long and 3.5-ft deep. Neither excavation encountered debris or exposed disturbed material or trench sidewalls. Based on these observations, it was concluded that PT4 does not contain buried waste.

Two borings (C19 and C20) were drilled at locations determined by the geophysical survey. Since the excavation did not indicate the presence of a disposal feature at PT4, a sample depth was selected based on the depth of debris at nearby T1. Two borings were drilled and core intervals from 2 to 3 ft bgs, 6.5 to 7.5 ft bgs, 12 to 13 ft bgs, and 17 to 18 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted, so the core from 6.5 to 7.5 ft bgs was sent for off-site analysis. No geotechnical samples were collected at PT4.

A.5.2.2.5 Anomaly A

Four excavations (C01, C25, C26, and C27) were made to explore AA, located inside the fenced tire storage yard, as shown in Figure A.5-1.

Excavation C01 was sited at the anomaly and uncovered a 3.5-ft thick gravel cover overlying metallic debris to a depth of 6.5 ft bgs. To determine if the anomaly was a linear disposal feature, C25 was sited in the far northwestern corner of the tire yard. No debris was found, indicating this location was outside AA. Excavation C26 was sited in the far southeastern corner of the tire yard and encountered a 3-ft thick gravel cover overlaying metallic scrap and burned debris to a depth of 3.5 ft bgs. Excavation C27 was located outside the tire yard and north of a steel Quonset hut (since removed) in line with the strike of AA. Here, occasional glass was encountered from 3 to 5.5 ft bgs, indicating the presence of a disposal feature. It was not possible to excavate any further south due to concrete building slabs and the utility corridor along Road 6-01.

Four borings (C01, C25, C26, and C27) were drilled at locations determined from excavation. Excavation indicated the base of AA to vary from 3.5 to 7.5 ft bgs. Core was field screened at intervals above and below the AA base, as described in Section A.2.3.4. The FSRs were less than FSLs and no biasing factors were noted. Therefore, core intervals from 3.5 to 4.5 ft bgs (C25 and C26), 5.5 to 6.5 ft bgs (C27), and 7.5 to 8.5 ft bgs (C01) were sent for off-site analysis. These are AA basal depth at a particular location.

Two geotechnical samples were collected at AA. One sample was collected in cover material from 0 to 1 ft bgs and one sample was collected in native soil from 8.5 to 9.5 ft bgs.

A.5.2.3 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. A topographic map of CAS 06-08-01 was prepared and is included in the engineering drawings in Appendix H.

The ground surface at CAS 06-08-01 slopes gently from the southwest to northeast at approximately 2.3 percent. The gravelled bench in the northwest corner of the site rises approximately 4 ft above the surrounding ground surface. There are numerous flat concrete pads at the site.

A.5.2.4 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs which include total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), and PCBs. In addition, 25 percent of the soil samples were analyzed for gamma spectrometry. The QC field blanks were analyzed for the soil sample parameters, dioxins, and gamma spectrometry. The QC source blank was analyzed for the soil sample parameters, pesticides, gamma spectrometry, isotopic Pu, Sr-90, and dioxins. Trip blanks were analyzed only for total VOCs.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.5.2.5 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Ethylene glycol
- TPH (DRO and GRO)
- PCBs

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total VOCs
- Total SVOCs
- Total RCRA metals, nickel, and zinc
- Gamma-emitting radionuclides

A.5.2.5.1 Total Volatile Organic Compound Analytical Results for Soil Samples

The total VOCs detected in soil samples at concentrations exceeding MRLs are listed in Table A.5-2. Acetone was detected in a single sample at an estimated concentration of 260 micrograms per kilogram (µg/kg). Methylene chloride was detected in four samples at concentrations ranging from 11 to 24 µg/kg. These concentrations exceed the MRLs but are well below the corresponding PALs established in the CAIP.

A.5.2.5.2 Total Semivolatile Organic Compound Analytical Results for Soil Samples

The total SVOCs detected in soil samples at concentrations exceeding MRLs are listed in Table A.5-3. Bis(2-ethylhexyl)phthalate was detected in a single sample at a concentration of 790 µg/kg. This concentration exceeds the MRL but is well below the PAL established in the CAIP.

Table A.5-2
Soil Sample Results for Total VOCs
Detected Above Minimum Reporting Limits at CAS 06-08-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (μg/kg)	
			Acetone	Methylene Chloride
Preliminary Action Levels[a]			6,200,000	21,000
005C001	C22	4 - 5	260 (J)[b]	11
005C003	C21	4 - 5	--	17 (J)[c]
005C004	CMA21	2 - 3	--	15
005C005	C12	3 - 4	--	24 (J)[d]

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[b]Qualifier added to laboratory data; record accepted. Value was 10x the contamination in the calibration/method blank. Average relative response factor <0.05. Relative response factor <0.05. Calibration verification did not meet criteria or was not performed.
[c]Qualifier added to laboratory data; record accepted. Surrogate recovery exceeded upper limits.
[d]Qualifier added to laboratory data; record accepted. Internal standard area count outside control limits. Matrix effects may exist. Surrogate recovery exceeded the upper limits.

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

Table A.5-3
Soil Sample Results for Total SVOCs
Detected Above Minimum Reporting Limits at CAS 06-08-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (μg/kg)
			Bis(2-Ethylhexyl)Phthalate
Preliminary Action Levels[a]			180,000
005C026	C11	4 - 5	790

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

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

A.5.2.5.3 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.5-4. Arsenic, barium, chromium, lead, mercury, nickel, silver, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below the PALs established in the CAIP.

Table A.5-4
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 06-08-01
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	**Barium**	**Chromium**	**Lead**	**Mercury**	**Nickel**	**Silver**	**Zinc**
Preliminary Action Levels			**23[a]**	**100,000[b]**	**450[b]**	**750[b]**	**610[b]**	**41,000[b]**	**10,000[b]**	**100,000[b]**
005C001	C22	4 - 5	6.3	71	10.0 (J)[c]	20.0	0.41	9.9 (J)[c]	4.7	230 (J)[c]
005C002	C21	4 - 5	4.8	68	4.8 (J)[c]	5.1	--	--	--	16 (J)[c]
005C003	C21	4 - 5	4.6	69	4.9 (J)[c]	6.0	--	--	--	19 (J)[c]
005C004	CMA21	2 - 3	4.9	74	4.4 (J)[c]	9.2	--	4.3 (J)[c]	--	23 (J)[c]
005C005	C12	3 - 4	4.7	84	6.0 (J)[c]	7.6	0.12	5.0 (J)[c]	--	22 (J)[c]
005C006	C13	3 - 4	6.7	77	4.4 (J)[c]	6.5	--	4.3 (J)[c]	--	27 (J)[c]
005C007	C14	4 - 5	5.7	92	6.3 (J)[c]	7.6	--	6.1 (J)[c]	--	22 (J)[c]
005C008	C15	7.5 - 8.5	3.7	72	4.2	4.9	0.21 (J)[d]	--	--	14
005C009	C16	6.5 - 7.5	4.5	76	3.6	6.1	--	4.7	--	21
005C010	C24	8 - 9	5.2	170	9.1	11.0	--	11.0	--	39
005C011	C07	8 - 9	5.2	81	3.8	7.5	--	5.3	--	21
005C012	C04	4 - 5	4.7	66	2.8	6.7	--	--	--	15
005C013	C08	4 - 5	4.6	76	3.6	5.1	0.29 (J)[d]	--	--	15
005C014	C03	4.5 - 5.5	4.8	110	5.9	11.0	--	6.7	--	30
005C015	C02	3.5 - 4.5	5.5	69	3.1	5.3	--	--	--	15
005C016	C09	7.5 - 8.5	4.3	75	3.5	8.4	0.24 (J)[d]	4.3	--	19
005C017	C27	5.5 - 6.5	3.9	76	7.4	7.0	--	4.6	--	19
005C018	C01	7.5 - 8.5	6.1	100	5.5	8.1	0.55	5.4 (J)[c]	--	28 (J)[c]
005C019	C25	3.5 - 4.5	4.3	76	3.4	8.9	--	--	--	20 (J)[c]
005C020	C26	3.5 - 4.5	5.1	69	4.7	6.1	0.13	--	--	16 (J)[c]
005C021	C18	4 - 5	4.1	56	2.8	4.2	--	--	--	15 (J)[c]
005C022	C17	7.5 - 8.5	4.6	100	5.4	32.0	6.50	6.1 (J)[c]	2.1	130 (J)[c]
005C023	C19	6.5 - 7.5	4.4	79	3.8	6.5	--	4.1 (J)[c]	--	20 (J)[c]
005C024	C20	6.5 - 7.5	4.0	79	4.7	6.9	--	4.9 (J)[c]	--	21 (J)[c]
005C025	C20	6.5 - 7.5	4.7	76	4.6	6.1	--	4.8 (J)[c]	--	19 (J)[c]
005C026	C11	4 - 5	4.6	73	3.4	5.3	--	--	--	17 (J)[c]

Table A.5-4
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc
Detected Above Minimum Reporting Limits at CAS 06-08-01
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Chromium	Lead	Mercury	Nickel	Silver	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	610[b]	41,000[b]	10,000[b]	100,000[b]
005C027	C10	3.5 - 4.5	4.2	56	3.8	5.9	--	--	--	18 (J)[c]

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[c]Qualifier added to laboratory data; record accepted. Serial dilution %D outside control limits. Matrix effects may exist.
[d]Qualifier added to laboratory data; record accepted. Matrix spike recovery outside control limits.

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

A.5.2.5.4 Gamma Spectrometry Analytical Results for Soil Samples

The gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.5-5. The isotopes Ac-228, Bi-214, Pb-212, Pb-214, K-40, and Tl-208 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results exceed background concentrations; therefore, PALs for these isotopes were not exceeded at CAS 06-08-01.

A.5.2.5.5 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.5-6. Data summaries for all of the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

- Based on saturated hydraulic conductivity measurements, cover soil at T1 and T2 has higher permeabilities than subcell soil, and cover soil at AA has lower permeabilities than subcell soil.
- Moisture content measurements show that the soil is well below saturation.

Table A.5-5
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 06-08-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			3.64	3.47	3.64	3.47	31.1	3.38
005C001	C22	4 - 5	1.09 ± 0.36	--	1.30 ± 0.28	0.68 ± 0.19	17.7 ± 3.7	0.31 ± 0.11
005C005	C12	3 - 4	1.22 ± 0.42	0.60 ± 0.27	1.20 ± 0.29	0.45 ± 0.18	11.8 ± 3.2	--
005C009	C16	6. 5 - 7.5	1.08 ± 0.34	0.68 ± 0.27	1.18 ± 0.27	0.65 ± 0.19	17.4 ± 3.6	0.41 ± 0.13
005C013	C08	4 - 5	--	--	0.77 ± 0.24	--	12.1 ± 3.4	--
005C017	C27	5.5 - 6.5	1.81 ± 0.61	0.85 ± 0.35	1.13 ± 0.32	0.74 ± 0.27	19.4 ± 5.2	0.52 ± 0.22
005C021	C18	4 - 5	1.23 ± 0.37	0.55 ± 0.21	1.00 ± 0.23	0.57 ± 0.16	14.5 ± 3.1	0.33 ± 0.11
005C024	C20	6.5 - 7.5	0.86 ± 0.31	--	0.97 ± 0.22	0.65 ± 0.17	16.1 ± 3.3	0.30 ± 0.10
005C025		6.5 - 7.5	--	--	1.02 ± 0.27	0.52 ± 0.22	11.4 ± 3.6	--

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991)

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

- Dry bulk densities ranged from 1.59 to 1.91 g/cm^3 in cover soil and from 1.45 to 1.53 g/cm^3 in subcell native soil. Cover soil had higher densities than subcell soil.

- Porosities in cover soil ranged from 27.8 to 40.1 percent, while subcell soil porosities ranged from 42.4 to 45.2 percent. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

A.5.2.6 Contaminants of Concern

Based on the aforementioned analytical results, no COCs are migrating from CAS 06-08-01.

A.5.3 Nature and Extent of Contamination

Since COCs are not migrating, the extent of any contamination that may be present at CAS 06-08-01 is limited to within the boundaries of the subsurface disposal features.

Table A.5-6
Soil Sample Results for Select Geotechnical Parameters at CAS 06-08-01

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat[a] (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005C404	T1	0 - 1	1.3E-04	4.7	8.1	1.71	1.79	35.6
005C401		8.5 - 9.5	9.6E-05	8.6	13.2	1.53	1.66	42.4
005C405	T2	0 - 1	3.1E-04	4.2	6.6	1.59	1.65	40.1
005C402		9 - 10	1.0E-04	13.5	19.7	1.47	1.66	44.7
005C406	AA	0 - 1	1.3E-04	3.0	5.7	1.91	1.97	27.8
005C403		8.5 - 9.5	3.5E-04	11.4	16.5	1.45	1.62	45.2

[a]Constant head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

A.5.4 Revised Conceptual Site Model

No variations in the CSM were identified.

A.6.0 CAS 06-15-02, Sanitary Landfill

This landfill is located along the southwestern edge of Yucca Lake positioned between CAS 06-15-03 to the north and the Area 6 Hydrocarbon Landfill to the south. The landfill was in use in 1974 but it is uncertain when it was discontinued, with possible dates ranging from 1976 to 1989. The types of waste disposed of in the landfill are believed to consist of sanitary trash, construction debris, concrete, asphalt, refuse, empty barrels, and oil. Additional detail is provided in the CAIP.

A.6.1 Corrective Action Investigation

Sixteen site characterization samples (including one field duplicate) and seven geotechnical samples were collected by rotary sonic drilling, and are listed in Table A.6-1. Two site characterization samples (005D011 and 005D014) were not analyzed because other samples were collected at more representative intervals. Geotechnical sample 005D406 was not analyzed because field screening showed it to have slightly elevated TPH concentrations; additional detail is provided in Section A.6.2.4. Figure A.6-1 is a site sketch showing excavation and sampling locations at CAS 06-15-02. The activities conducted to meet the CAIP requirements at CAS 06-15-02 are discussed in the following sections.

Table A.6-1
Samples Collected at CAS 06-15-02, Sanitary Landfill
(Page 1 of 2)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
005D001	D09	TL4 / CWA9	23 - 24	Soil	SC	Set 4
005D002	D08		23 - 24	Soil	SC	Set 4
005D003	D07		23 - 24	Soil	SC	Set 4
005D004	D06	CWA8	3.5 - 4.5	Soil	SC	Set 4
005D005			3.5 - 4.5	Soil	Field Duplicate of 005D004	Set 4

Table A.6-1
Samples Collected at CAS 06-15-02, Sanitary Landfill
(Page 2 of 2)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
005D006	D04	TL3 / CWA7	9 - 10	Soil	SC	Set 4
005D007			19 - 20	Soil	SC, Lab QC	Set 4
005D008	D05		16 - 17	Soil	SC	Set 4
005D009			22 - 23	Soil	SC	Set 4
005D010			27 - 28	Soil	SC	Set 4
005D011			32 - 33	Soil	SC	Not Analyzed
005D012	D01	CWA6	3.5 - 4.5	Soil	SC	Set 4
005D013			8.5 - 9.5	Soil	SC	Set 4
005D014			13.5 - 14.5	Soil	SC	Not Analyzed
005D015	D02		3.5 - 4.5	Soil	SC	Set 4
005D016	D03		3.5 - 4.5	Soil	SC	Set 4
Geotechnical Samples						
005D406	D10	TL4 / CWA9	0 - 1	Soil	Geotechnical	Not Analyzed
005D407	D13		0 - 1	Soil	Geotechnical	Set 2
005D401	D09		24 - 25	Soil	Geotechnical	Set 2
005D402	D02	CWA6	4.5 - 5.5	Soil	Geotechnical	Set 2
005D403	D03		4.5 - 5.5	Soil	Geotechnical	Set 2
005D404	D12		0.0 - 1.0	Soil	Geotechnical	Set 2
005D405	D11	TL3 / CWA7	0 - 1	Soil	Geotechnical	Set 2
Quality Control Samples						
005D301	NA	NA	NA	Water	Trip Blank	Total VOCs
005D302	NA	NA	NA	Water	Trip Blank	Total VOCs
005D303	NA	NA	NA	Water	Field Blank	Set 4, Dioxins, Sr-90
005D304	NA	NA	NA	Water	Trip Blank	Total VOCs
005D305	NA	NA	NA	Water	Trip Blank	Total VOCs
005D306	NA	NA	NA	Water	Trip Blank	Total VOCs
005D307	NA	NA	NA	Water	Trip Blank	Total VOCs

Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics
Set 4 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs, Gamma Spectrometry, and Isotopic Plutonium

SC = Site characterization
NA = Not applicable
QC = Quality control
ft bgs = Feet below ground surface
TL = Trench/Landfill
CWA = Conductive waste area

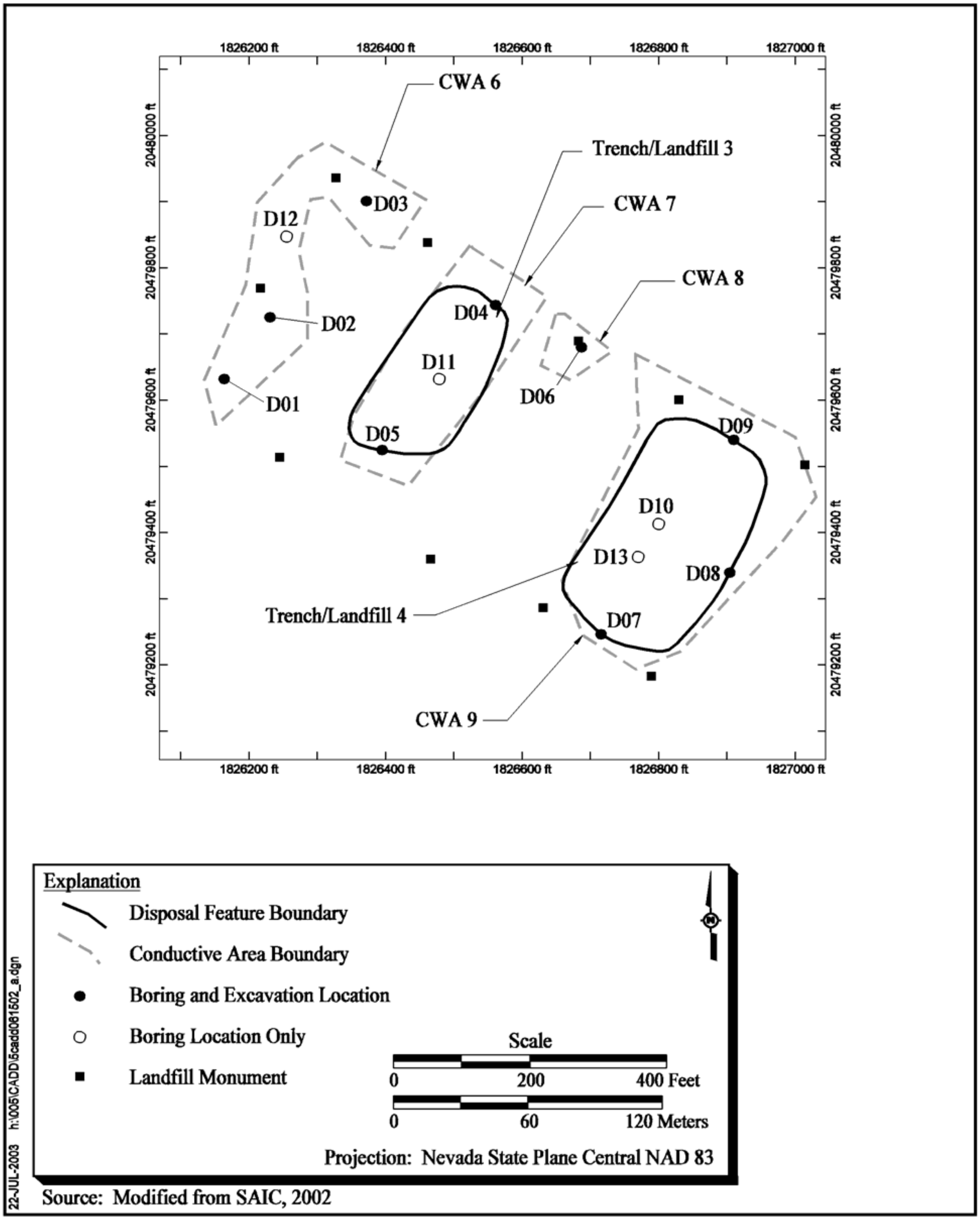

Figure A.6-1
Site Sketch and Sampling Locations at CAS 06-15-02, Sanitary Landfill

A.6.1.1 CAIP Implementation

The following activities were conducted at CAS 06-15-02 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste
- Backhoe excavations at preselected locations to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, verify the lateral boundaries of the disposal features, and determine the base of a CWA
- Rotary sonic drilling at locations identified during excavation to collect samples at intervals corresponding to the base of disposal features and from other intervals determined by biasing factors (e.g., field screening and visual observation of core)
- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of disposal features
- Topographic survey to determine the slope of the cover
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

A.6.1.2 Deviations

There were no deviations to the CAIP investigation strategy; therefore, the CAIP requirements were met.

A.6.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.6.2.1 Geophysical Survey

A geophysical survey was completed across CAS 06-15-02 and adjoining CAS 06-15-03 as a single field effort. An EM31 terrain conductivity survey was conducted along traverses with a 10-ft separation. Several small extensions to the survey grid were added to further delineate the edges of particular anomalies. The survey identified two kinds of subsurface anomalies, metallic and conductive (nonmetallic) trending northeast to southwest. Four CWAs were identified and include CWA6, CWA7, CWA8, and CWA9. Two TLs were identified (TL3 and TL4). TL3 was found within the boundaries of CWA7, and TL4 was found within the boundaries of CWA9. In the following discussion, these features will be referred to as TL3/CWA7 and TL4/CWA9, respectively.

Five EI traverses were conducted across CAS 06-15-02 and defined the vertical limits of the disposal features ranging from approximately 18 to 24 ft bgs, depending on location. An EI traverse was not conducted across CWA8 so the base of this feature was determined by excavation.

A.6.2.2 Excavation, Drilling, and Sampling

Nine backhoe excavations were made to determine the thickness of cover material, verify the lateral boundaries of the disposal features, and determine the basal depth of CWA8. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation. Site characterization samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from EI geophysical traverses and excavation. Excavation, drilling, and sampling details are discussed in the following subsections.

A.6.2.2.1 Conductive Waste Area 6

Three excavations (D01 through D03) were made inside the geophysical boundaries of CWA6, as shown in Figure A.6-1. Excavation D01 encountered nonmetallic debris (e.g., paper and wood) from 1 to 2 ft bgs. A 1-ft thick gravel cover was observed. Excavations D02 and D03 did not encounter debris, but a lithologic break at 1 ft bgs was present that corresponds to a cover thickness observed elsewhere at this CAS. The lateral extent of CWA6 is shown in Figure A.6-1.

Three borings (D01 through D03) were drilled at locations determined from excavation. The geophysical survey indicated the base of CWA6 at approximately 20 to 22 ft bgs. At boring D01, a VOC FSR of 81 ppm from 3.5 to 4.5 ft bgs suggested contamination; therefore, deeper samples from 8.5 to 9.5 ft bgs and 13.5 to 14.5 ft bgs were collected and field screened. The FSRs of these deeper samples were less than FSLs so the two shallow samples were submitted for off-site analysis. Based on the elevated FSR, nonmetallic debris at 1 to 2 ft bgs and caliche hardpan at 4 ft bgs, these samples were judged to best satisfy the CAIP objective of sampling at the base of the disposal feature.

At borings D02 and D03, core intervals from 3.5 to 4.5 ft bgs, 9 to 10 ft bgs, 14 to 15 ft bgs, 21 to 22 ft bgs, 26 to 27 ft bgs, and 31 to 32 ft bgs were field screened. The FSRs were less than FSLs and observations from earlier excavation and drilling supported a conclusion that the base of CWA6 is at 3.5 ft bgs. Thus, samples from 3.5 to 4.5 ft bgs were sent for off-site analysis since they were judged to best satisfy the CAIP objective of sampling at the base of the disposal feature.

Three geotechnical samples were collected at CWA6; one in cover material from 0 to 1 ft bgs, and two in native soil from 4.5 to 5.5 ft bgs.

A.6.2.2.2 Conductive Waste Area 8

A single excavation, D06, was made to investigate CWA8, as shown in Figure A.6-1. The excavation was 25-ft long, 4.5-ft deep, oriented northeast to southwest, and was made entirely within the boundary of the feature identified by the geophysical survey. No debris was observed but a caliche hardpan was encountered at 4.5 ft bgs, which may have accounted for the geophysical signature. A lithologic break (gravel to poorly sorted gravel with sandy silt) was noted at 1 ft bgs, which corresponds to a cover thickness observed at other disposal features at this CAS.

One boring, D06, was drilled at a location determined from excavation. Excavation indicated the base of CWA8 at 4.5 ft bgs, based on the presence of a caliche hardpan. The hardpan was the most likely place to encounter contamination, if present. Core intervals from 3.5 to 4.5 ft bgs, 8 to 9 ft bgs, and 13.5 to 14.5 ft bgs were field screened. Based on FSRs less than FSLs, increased drilling resistance below 3.5 ft bgs and drilling refusal at 14.5 ft bgs, the interval from 3.5 to 4.5 ft bgs was submitted for off-site analysis. There were no geotechnical samples collected at CWA8.

A.6.2.2.3 Trench/Landfill 3, Conductive Waste Area 7

Two excavations (D04 and D05) were made to investigate TL3/CWA7, as shown in Figure A.6-1. Scarce plastic scrap was observed at D04 from 1 to 2 ft bgs and scarce metallic debris was encountered in fill material from 1 to 4 ft bgs at D05. A 1-ft thick gravel cover was present at both excavations. Excavations established the lateral extent of TL3/CWA7 and showed it to be slightly smaller than indicated by the geophysical survey.

Two borings (D04 and D05) were drilled at locations determined from excavation. The geophysical survey indicated the base of TL3/CWA7 at 18 to 20 ft bgs. At boring D04, core intervals from 4 to 5.5 ft bgs, 5.5 to 6.5 ft bgs, 9 to 10 ft bgs, 14 to 15 ft bgs, 19 to 20 ft bgs, 24 to 27 ft bgs, and 29 to 30 ft bgs were field screened. Based on FSRs less than FSLs, and the biasing factors of increased drilling resistance and a lithologic break at 9 ft bgs, the core from 9 to 10 ft bgs was sent for off-site analysis. In addition, the interval from 19 to 20 ft bgs (the basal depth as determined from the geophysical survey) was sent for off-site analysis.

At boring D05, core intervals from 3 to 5.5 ft bgs, 8 to 10.5 ft bgs, 13 to 15.5 ft bgs, 16 to 17 ft bgs, 22 to 23 ft bgs, 27 to 28 ft bgs, and 32 to 33 ft bgs were field screened. The core from 16 to 17 ft bgs had a VOC FSR of 51.4 ppm, exceeding the FSL of 20 ppm. Based on this FSR and the deepest extent of minor debris in the drill core at 23 ft bgs, core from 16 to 17 ft bgs, 22 to 23 ft bgs, and 27 to 28 ft bgs was sent for off-site analysis. These intervals were selected to fulfill the CAIP objective of sampling at biased locations and at the base of the disposal feature. One geotechnical sample was collected in cover material from 0 to 1 ft bgs.

A.6.2.2.4 Trench/Landfill 4, Conductive Waste Area 9

Three excavations (D07 through D09) were made to investigate TL4/CWA9, as shown in Figure A.6-1. At all excavations, nonmetallic debris (mostly plastic with minor amounts of wood) was encountered first laterally, followed by metallic scrap. These observations support the geophysical survey, which indicated an outer zone of conductive material (CWA9) with an inner zone of metallic debris (TL4). A 1-ft thick gravel cover was present at all excavations.

Three borings (D07 through D09) were drilled at locations determined from excavation. The geophysical survey indicated the base of TL4/CWA9 at 22 to 24 ft bgs. The core intervals from 4 to 5 ft bgs, 9 to 10 ft bgs, 14 to 15 ft bgs, 19 to 20 ft bgs, 23 to 24 ft bgs, 28 to 29 ft bgs, and 33 to 34 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted, so the cores from 23 to 24 ft bgs were selected for off-site analysis. This is the TL4/CWA9 basal depth identified by the geophysical survey.

Three geotechnical samples were collected at TL4/CWA9. The TPH (DRO) FSR for geotechnical sample 005D406 was reported at 181.8 ppm (first run) and 308.9 ppm (second run), which exceeded the FSL of 75 ppm. The sample had no other biasing factors suggesting contamination (e.g., odor or staining). The sample was returned to the boring and sample 005D407 was collected as a replacement. This sample also had no biasing factors but a TPH (DRO) FSR of 92.9 ppm was reported. The FSR exceeded the FSL but was below the analytical PAL of 100 ppm, so the decision was made to submit this sample for geotechnical analysis. The third geotechnical sample was collected in native soil from 24 to 25 ft bgs.

A.6.2.3 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. A topographic map of CAS 06-15-02 was prepared and is included in the engineering drawings in Appendix H.

The ground surface at CAS 06-15-02 slopes from the southwest to the northeast at approximately 4.1 percent. The Area 6 Hydrocarbon Landfill, located at the east end of the site, rises approximately 8 ft above the surrounding surface.

A.6.2.4 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs which include total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, gamma spectrometry, and isotopic plutonium. The QC field blank was analyzed for the soil sample parameters, dioxins, and Sr-90. Trip blanks were analyzed only for total VOCs.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.6.2.5 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Total SVOCs
- Ethylene glycol
- TPH (DRO)

- PCBs
- Isotopic plutonium

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total VOCs
- Total RCRA metals, nickel, and zinc
- TPH (GRO)
- Gamma-emitting radionuclides

A.6.2.5.1 Total Volatile Organic Compound Analytical Results for Soil Samples

The total VOCs detected in soil samples at concentrations exceeding MRLs are listed in Table A.6-2. Methylene chloride was detected in a single sample at an estimated concentration of 17 μg/kg. 2-Butanone, acetone, and naphthalene were detected in a single sample at respective estimated concentrations of 68, 290, and 250 μg/kg. These concentrations exceed MRLs but are well below corresponding PALs established in the CAIP.

Table A.6-2
Soil Sample Results for Total VOCs
Detected Above Minimum Reporting Limits at CAS 06-15-02

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (μg/kg)			
			2-Butanone	Acetone	Methylene Chloride	Naphthalene
Preliminary Action Levels[a]			28,000,000	6,200,000	21,000	190,000
005D001	D09	23 - 24	--	--	17 (J)[b]	--
005D008	D05	16 - 17	68 (J)[c]	290 (B)	--	250 (J)[d]

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[b]Qualifier added to laboratory data; record accepted. Calibration verification did not meet criteria or was not performed.
[c]Qualifier added to laboratory data; record accepted. Percent relative standard deviation exceeded 30 percent.
[d]Qualifier added to laboratory data; record accepted. Value exceeded linear/calibration range of instrument.

ft bgs = Feet below ground surface
μg/kg = Micrograms per kilogram
B = Analyte found in both sample and associated blank
J = Estimated value

A.6.2.5.2 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.6-3. Arsenic, barium, chromium, lead, nickel, selenium, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below PALs established in the CAIP.

Table A.6-3
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 06-15-02

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000	10,000[b]	100,000[b]
005D001	D09	23 - 24	7.4	140	12.0 (J)	12.0	15.0	--	64
005D002	D08	23 - 24	5.5	120	7.0 (J)	9.9	9.5	--	57
005D003	D07	23 - 24	6.0	140	8.4 (J)	11.0	12.0	--	60
005D004	D06	3.5 - 4.5	5.8	150	8.0 (J)	10.0	12.0	--	48
005D005		3.5 - 4.5	5.6	140	8.5 (J)	10.0	12.0	--	49
005D006	D04	9 - 10	6.3	150	9.7 (J)	13.0	14.0	--	52
005D007		19 - 20	8.2	150	9.6 (J)	12.0	14.0	--	53
005D008	D05	16 - 17	6.3	130	8.6 (J)	11.0	12.0	--	49
005D009		22 - 23	5.4	99	7.1 (J)	9.5	9.6	--	39
005D010		27 - 28	5.2	110	7.7 (J)	10.0	8.9	--	41
005D012	D01	3.5 - 4.5	5.6	130	8.5	9.3	11.0	--	45
005D013		8.5 - 9.5	7.8	160	12.0	14.0	17.0	--	58
005D015	D02	3.5 - 4.5	6.8	160	10.0	12.0	15.0	--	59
005D016	D03	3.5 - 4.5	7.9	170	12.0	14.0	18.0	0.61	66

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
-- = Not detected above minimum reporting limits
J = Estimated value. Qualifier added to laboratory data; record accepted. Serial dilution %D outside of control limits. Matrix effects may exist.

A.6.2.5.3 Total Petroleum Hydrocarbon Analytical Results for Soil Samples

The TPH detected in soil samples at concentrations exceeding MRLs are listed in Table A.6-4. The TPH (GRO) was detected in a single sample at an estimated concentration of 0.69 mg/kg. This concentration exceeds the MRL, but is well below the PAL of 100 mg/kg established in the CAIP.

Table A.6-4
Soil Sample Results for TPH (DRO and GRO)
Detected Above Minimum Reporting Limits at CAS 06-15-02

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)	
			Diesel-Range Organics	Gasoline-Range Organics
Preliminary Action Level[a]			100	
005D008	D05	16 - 17	--	0.69 (J)[b]

[a]TPH PAL from *Nevada Administrative Code* (NAC, 2003)
[b]Qualifier added to laboratory data; record accepted. Total extractable petroleum hydrocarbons result quantitated from diesel standard calibration.

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

A.6.2.5.4 Gamma Spectrometry Analytical Results for Soil Samples

The gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.6-5. The isotopes Ac-228, Bi-214, Pb-212, Pb-214, K-40, and Tl-208 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results exceed background concentrations so PALs for these isotopes were not exceeded at CAS 06-15-02.

A.6.2.5.5 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.6-6. Data summaries for all of the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

Table A.6-5
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 06-15-02

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			3.64	3.47	3.64	3.47	31.1	3.38
005D001	D09	23 - 24	1.96 ± 0.50	1.18 ± 0.33	2.35 ± 0.47	1.25 ± 0.30	28.2 ± 5.5	0.75 ± 0.19
005D002	D08	23 - 24	2.62 ± 0.66	1.14 ± 0.37	2.58 ± 0.53	1.29 ± 0.32	30.3 ± 6.4	0.87 ± 0.24
005D003	D07	23 - 24	1.78 ± 0.61	1.15 ± 0.41	2.70 ± 0.56	1.15 ± 0.33	30.9 ± 6.8	0.70 ± 0.24
005D004	D06	3.5 - 4.5	2.34 ± 0.71	1.15 ± 0.43	1.93 ± 0.48	0.99 ± 0.32	18.4 ± 5.4	0.61 ± 0.23
005D005		3.5 - 4.5	1.98 ± 0.48	0.98 ± 0.31	2.13 ± 0.42	0.99 ± 0.25	23.2 ± 4.7	0.57 ± 0.16
005D006	D04	9 - 10	2.51 ± 0.62	1.11 ± 0.37	2.15 ± 0.47	1.20 ± 0.32	29.4 ± 6.3	0.80 ± 0.22
005D007		19 - 20	--	1.38 ± 0.46	2.01 ± 0.48	1.34 ± 0.37	21.1 ± 5.2	0.51 ± 0.19
005D008	D05	16 - 17	2.13 ± 0.69	1.03 ± 0.40	2.61 ± 0.59	1.06 ± 0.34	26.5 ± 6.6	0.65 ± 0.28
005D009		22 - 23	2.00 ± 0.52	1.08 ± 0.32	2.43 ± 0.47	1.38 ± 0.31	27.9 ± 5.5	0.65 ± 0.17
005D010		27 - 28	2.11 ± 0.61	0.87 ± 0.34	2.18 ± 0.46	1.50 ± 0.37	27.3 ± 5.9	0.74 ± 0.21
005D012	D01	3.5 - 4.5	1.99 ± 0.65	1.00 ± 0.40	2.26 ± 0.52	1.15 ± 0.34	24.7 ± 5.9	0.79 ± 0.26
005D013		8.5 - 9.5	2.86 ± 0.87	--	2.54 ± 0.60	1.03 ± 0.34	27.3 ± 6.9	0.69 ± 0.25
005D015	D02	3.5 - 4.5	--	0.97 ± 0.43	1.87 ± 0.49	1.12 ± 0.38	21.1 ± 6.1	0.62 ± 0.25
005D016	D03	3.5 - 4.5	2.14 ± 0.55	0.97 ± 0.33	2.47 ± 0.48	1.06 ± 0.28	26.6 ± 5.3	0.62 ± 0.18

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991)

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

- Based on saturated hydraulic conductivity measurements, cover soil has lower permeabilities than subcell soil.
- Moisture content measurements show that the soil is well below saturation.
- Dry bulk densities ranged from 1.47 to 1.90 g/cm^3 in cover soil and from 1.34 to 1.47 g/cm^3 in subcell native soil. Cover soil had higher densities than subcell soil.
- Porosities in cover soil ranged from 28.4 to 44.4 percent, while subcell soil porosities ranged from 44.6 to 49.4 percent. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

Table A.6-6
Soil Sample Results for Select Geotechnical Parameters at CAS 06-15-02

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005D407	TL4/CWA9	0 - 1	1.2E-05[a]	3.3	6.3	1.90	1.96	28.4
005D401		24 - 25	3.1E-04[a]	10.1	14.1	1.39	1.54	47.4
005D404	CWA6	0 - 1	1.8E-07[b]	15.1	23.3	1.54	1.78	41.8
005D402		4.5 - 5.5	7.4E-04[a]	15.4	20.6	1.34	1.55	49.4
005D405	TL3/CWA7	0 - 1	3.2E-05[a]	7.5	11.0	1.47	1.58	44.4
005D403	CWA6	4.5 - 5.5	5.0E-04[a]	9.2	13.5	1.47	1.60	44.6

[a]Constant head method
[b]Falling head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

A.6.2.6 Contaminants of Concern

Based on the aforementioned analytical results, no COCs are migrating from CAS 06-15-02.

A.6.3 Nature and Extent of Contamination

Since COCs are not migrating, the extent of any contamination that may be present at CAS 06-15-02 is limited to within the boundaries of the subsurface disposal features.

A.6.4 Revised Conceptual Site Model

No variations in the CSM were identified.

A.7.0 CAS 06-15-03, Sanitary Landfill; Burn Pit

This sanitary landfill and burn pit is located along the southwestern edge of Yucca Lake in Area 6, adjacent to CAS 06-15-02. The operational history of the landfill is uncertain. It is unknown when the landfill began receiving waste. It was reported to have become inactive in 1974, but a 1982 aerial photograph shows trenches that appear to be open and an interviewee remembered using the trenches around 1986. Other documentation suggests dates of inactivity to include 1975 through 1980 or 1989. The landfill is believed to have accepted diesel fuel, dead animals, aerosol cans, sewage waste, trash, and possibly other types of waste. Additional detail is provided in the CAIP.

A.7.1 Corrective Action Investigation

Thirty-six site characterization samples (including two field duplicates) and six geotechnical samples were collected by rotary sonic drilling, and are listed in Table A.7-1. Figure A.7-1 is a site sketch showing excavation and sampling locations at CAS 06-15-03. The activities conducted to meet the CAIP requirements at CAS 06-15-03 are discussed in the following sections.

Table A.7-1
Samples Collected at CAS 06-15-03, Sanitary Landfill; Burn Pit
(Page 1 of 3)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
005E008	E03	CWA1	2.5 - 3.5	Soil	SC	Set 4
005E009			2.5 - 3.5	Soil	Field Duplicate of 005E008	Set 4
005E010			19 - 20	Soil	SC	Set 4
005E011	E02		1 - 2	Soil	SC	Set 4
005E012			19 - 20	Soil	SC	Set 4
005E013	E01		1.5 - 2.5	Soil	SC, Lab QC	Set 4
005E014			19 - 21	Soil	SC	Set 4
005E004	E04	CWA2	3 - 4	Soil	SC	Set 4
005E005			19 - 20	Soil	SC	Set 4
005E006	E05		3 - 4	Soil	SC	Set 4
005E007			19 - 20	Soil	SC	Set 4

Table A.7-1
Samples Collected at CAS 06-15-03, Sanitary Landfill; Burn Pit
(Page 2 of 3)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
005E015	E21	CWA3	2 - 3	Soil	SC	Set 4
005E016			19 - 20	Soil	SC	Set 4
005E017	E20		19 - 20	Soil	SC	Set 4
005E018	E19		3 - 4	Soil	SC	Set 4
005E019			19 - 20	Soil	SC	Set 4
005E001	E06	CWA4	3 - 4	Soil	SC	Set 4
005E002	E07		4.5 - 5.5	Soil	SC	Set 4
005E003			19 - 20	Soil	SC	Set 4
005E020	E18		19 - 20	Soil	SC	Set 4
005E021	E16		3.5 - 4.5	Soil	SC	Set 4
005E022			19 - 20	Soil	SC	Set 4
005E023	E15		4 - 5	Soil	SC	Set 4
005E024			19 - 20	Soil	SC	Set 4
005E025	E17		4.5 - 5.5	Soil	SC	Set 4
005E026			19 - 20	Soil	SC	Set 4
005E027	E11		4.5 - 5.5	Soil	SC	Set 4
005E028			19 - 20	Soil	SC	Set 4, Sr-90
005E029			30 - 31	Soil	SC	Set 4
005E033	E10	TL1 / CWA5	8 - 9	Soil	SC	Set 4
005E034			8 - 9	Soil	Field Duplicate of 005E033	Set 4
005E035	E09		8 - 9	Soil	SC, Lab QC	Set 4
005E036	E08		8 - 9	Soil	SC	Set 4
005E030	E12	TL2	23 - 24	Soil	SC	Set 4
005E031	E13		23 - 24	Soil	SC	Set 4
005E032	E14		23 - 24	Soil	SC	Set 4
Geotechnical Samples						
005E402	E22	TL1 / CWA5	0.5 - 1.5	Soil	Geotechnical	Set 2
005E401	E08		9 - 10	Soil	Geotechnical	Set 2
005E404	E24	CWA3	0 - 1	Soil	Geotechnical	Set 2
005E405	E19		20 - 21	Soil	Geotechnical	Set 2
005E403	E23	CWA4	0.5 - 1.5	Soil	Geotechnical	Set 2
005E406	E17		20 - 21	Soil	Geotechnical	Set 2

Table A.7-1
Samples Collected at CAS 06-15-03, Sanitary Landfill; Burn Pit
(Page 3 of 3)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Quality Control Samples						
005E301	NA	NA	NA	Water	Trip Blank	Total VOCs
005E302	NA	NA	NA	Water	Equipment Rinsate Blank	Set 4, Sr-90
005E303	NA	NA	NA	Water	Trip Blank	Total VOCs
005E304	NA	NA	NA	Water	Trip Blank	Total VOCs
005E305	NA	NA	NA	Water	Trip Blank	Total VOCs
005E306	NA	NA	NA	Water	Field Blank	Set 4, Sr-90
005E307	NA	NA	NA	Water	Trip Blank	Total VOCs
005E308	NA	NA	NA	Water	Trip Blank	Total VOCs
005E309	NA	NA	NA	Water	Trip Blank	Total VOCs
005E310	NA	NA	NA	Water	Field Blank	Set 4, Dioxins, Sr-90
005E311	NA	NA	NA	Water	Source Blank	Set 4, Dioxins, Sr-90
005E312	NA	NA	NA	Water	Trip Blank	Total VOCs
005E313	NA	NA	NA	Water	Trip Blank	Not Analyzed
005E314	NA	NA	NA	Water	Trip Blank	Total VOCs

Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics
Set 4 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs, Gamma Spectrometry, and Isotopic Plutonium

SC = Site characterization
NA = Not applicable
QC = Quality control
ft bgs = Feet below ground surface
TL = Trench/Landfill
CWA = Conductive waste area
Sr-90 = Strontium-90

A.7.1.1 CAIP Implementation

The following activities were conducted at CAS 06-15-03 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste
- Backhoe excavations at preselected locations to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, and verify the lateral boundaries of the disposal features

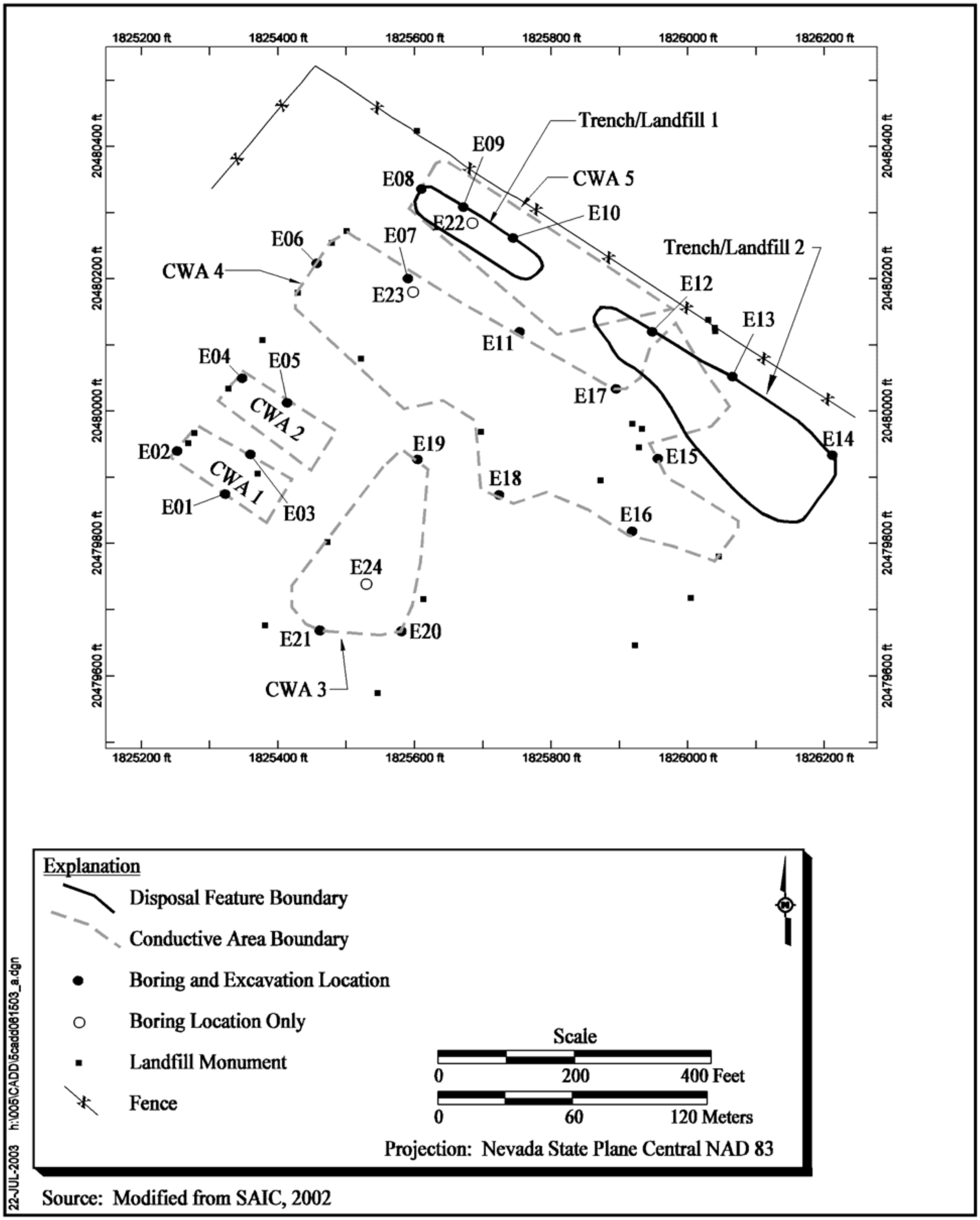

Figure A.7-1
Site Sketch and Sampling Locations at CAS 06-15-03, Sanitary Landfill; Burn Pit

- Rotary sonic drilling at locations identified during excavation to collect samples at intervals corresponding to the base of disposal features and from other intervals determined by biasing factors (e.g., presence of a caliche hardpan)
- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of disposal features
- Topographic survey to determine the slope of the cover
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

A.7.1.2 Deviations

There was one minor deviation to the CAIP investigation strategy. As discussed in Section A.7.2.2.4, a sample was not collected from one of the borings at CWA4 at the basal depth identified by the geophysical survey. The sample could not be collected because of drilling refusal at 4 ft bgs on a caliche hardpan. The caliche hardpan strongly suggests the absence of a disposal feature at this location. A replacement sample was collected from 3 to 4 ft bgs at the caliche hardpan where COCs, if present, would likely accumulate. Target sampling depths were achieved in the remaining borings at CAS 06-15-03.

A.7.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.7.2.1 Geophysical Survey

A geophysical survey was completed across CAS 06-15-03 and adjoining CAS 06-15-02 as a single field effort. An EM31 terrain conductivity survey was conducted along traverses with a 10-ft separation. Several small extensions to the survey grid were added to further delineate the edges of particular anomalies. The survey identified two kinds of subsurface anomalies, metallic and conductive (nonmetallic), trending mostly northwest to southeast. A single anomaly trending northeast to southwest was also identified. Five CWAs (CWA1 through CWA5) and two TLs

(TL1 and TL2) were identified. TL1 was found within the boundaries of CWA5 and will be referred to as TL1/CWA5 in the following discussion.

Three EI traverses were conducted across CAS 06-15-03 and defined the vertical limits of the disposal features ranging from approximately 18 to 24 ft bgs, depending on location. The exception is TL1/CWA5 where the base was determined to be about 8 ft bgs.

A.7.2.2 Excavation, Drilling, and Sampling

Twenty-one backhoe excavations were made to determine the thickness of cover material and verify the lateral boundaries of the disposal features. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation. Site characterization samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from EI geophysical traverses or excavation. Excavation, drilling, and sampling details are discussed in the following subsections.

A.7.2.2.1 Conductive Waste Area 1

Three excavations (E01 through E03) were made to investigate CWA1, as shown in Figure A.7-1. No debris was encountered but subtle lithologic changes suggest a gravel cover several inches to 0.5-ft thick may be present over CWA1. A caliche hardpan was consistently encountered from 2 to 3.5 ft bgs.

Three borings (E01 through E03) were drilled at locations determined from excavation. The geophysical survey indicated the base of CWA1 at 18 to 20 ft bgs. The core intervals from 1 to 3 ft bgs, 4 to 5 ft bgs, 9 to 10 ft bgs, 14 to 15 ft bgs, 19 to 20 ft bgs, 24 to 25 ft bgs, and 29 to 30 ft bgs were field screened. The FSRs were less than FSLs, so the cores from 19 to 20 ft bgs (the basal depth of CWA1 from the geophysical survey) were sent for off-site analysis. At boring E01, the sample depth was extended to 21 ft bgs to collect adequate sample volume.

As discussed above, a caliche hardpan was noted at varying depths at each boring. This hardpan was determined to be a biasing factor where COCs, if present, would tend to accumulate. Thus, samples from 1.5 to 2.5 ft bgs (boring E01), 1 to 2 ft bgs (boring E02), and 2.5 to 3.5 ft bgs (boring E03) were also sent for off-site analysis. No geotechnical samples were collected at CWA1.

A.7.2.2.2 Conductive Waste Area 2

Two excavations (E04 and E05) were made to investigate CWA2, as shown in Figure A.7-1. No debris was encountered but subtle lithologic changes suggest a gravel cover or reworked surface material 2- to 3-ft thick may be present over CWA2. A caliche hardpan was consistently encountered at 4 ft bgs.

Two borings (E04 and E05) were drilled at locations determined from excavation. The geophysical survey indicated the base of CWA2 at 18 to 20 ft bgs. The core intervals from 3 to 4 ft bgs, 9 to 10 ft bgs, 14 to 15 ft bgs, 19 to 20 ft bgs, 24 to 25 ft bgs, and 29 to 30 ft bgs were field screened, except VOC field screening was not completed at boring E05 from 0 to 20 ft bgs due to an instrument malfunction. This data gap is acceptable because analytical results of samples from this interval show COCs are not present. The FSRs for the remaining core intervals were less than FSLs.

A caliche hardpan was noted at 4 ft bgs at each boring. This hardpan was determined to be a biasing factor where COCs, if present, would likely accumulate. Thus, the cores from 3 to 4 ft bgs at the caliche hardpan, and from 19 to 20 ft bgs at the basal depth of CWA2 identified by the geophysical survey, were sent for off-site analysis. No geotechnical samples were collected at CWA2.

A.7.2.2.3 Conductive Waste Area 3

Three excavations (E19 through E21) were made to investigate CWA3, as shown in Figure A.7-1. Asphalt debris was encountered at excavation E20 from 1 in. to 1 ft bgs. Five exploratory holes trenched to 0.5 ft bgs showed this asphalt is discontinuously present in a 500 ft^2 area within the geophysical boundary of CWA3.

Debris was not encountered at excavations E19 and E21. Subtle lithologic changes suggest a gravel cover or reworked surface material is present, and was observed to be 1-ft thick at E19 and 2-in. thick at E21. Excavations did not definitively confirm the edges of CWA3. However, the lateral extent of the asphalt was determined, as discussed above. A caliche hardpan was encountered from 3.5 to 5 ft bgs below the geophysical boundaries of CWA3.

Three borings (E19 through E21) were drilled at locations determined from excavation. The geophysical survey indicated the base of CWA3 at 18 to 20 ft bgs. The core intervals from 2 to 4 ft bgs (borings E19 and E21), 4 to 5 ft bgs, 9 to 10 ft bgs, 14 to 15 ft bgs, 19 to 20 ft bgs, 24 to 25 ft bgs, and 29 to 30 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted, so the cores from 19 to 20 ft bgs (the basal depth of CWA1 from the geophysical survey) were sent for off-site analysis.

As discussed above, a caliche hardpan was noted at varying depths at borings E19 and E21. This hardpan was determined to be a biasing factor where COCs, if present, may tend to accumulate. Thus, samples from 3 to 4 ft bgs (boring E19) and 2 to 3 ft bgs (boring E21) were also sent for off-site analysis.

Two geotechnical samples were collected at CWA3; one in cover material from 0 to 1 ft bgs, and one in subcell native soil from 20 to 21 ft bgs.

A.7.2.2.4 Conductive Waste Area 4

Seven excavations (E06, E07, E11, and E15 through E18) were made to investigate CWA4, as shown in Figure A.7-1. No debris was encountered but subtle lithologic changes suggest a 2-ft thick gravel cover or reworked surface material is present over CWA4. A caliche hardpan was consistently encountered at varying depths from 3.5 to 5.5 ft bgs except at E18, where caliche was not observed.

Seven borings (E06, E07, E11, and E15 through E18) were drilled at locations determined from excavation. The geophysical survey indicated the base of CWA4 at 18 to 20 ft bgs. The core intervals from 4 to 5 ft bgs, 9 to 10 ft bgs, 14 to 15 ft bgs, 19 to 20 ft bgs, 24 to 25 ft bgs, and 29 to 30 ft bgs were field screened, with the following exceptions. At boring E06, drilling refusal occurred at 4 ft bgs so deeper intervals could not be collected for field screening. At boring E11, VOC field screening was not completed for sample 005E029, collected from 30 to 31 ft bgs, due to instrument malfunction. This data gap is acceptable because laboratory analytical results for the sample show COCs are not present.

The FSRs were less than FSLs with the following exceptions. Sample 005E028, collected from 19 to 20 ft bgs in boring E11, had a beta/gamma reading of 2,760 disintegrations (dpm) per 100 square centimeters (cm^2). This result exceeded the FSL of 2,666 dpm/100 cm^2 and the sample was analyzed for Sr-90 per the CAIP. However, the on-site radiological control technician suspected that high wind may have affected the reading. Subsequent samples were shielded from the wind and the beta/gamma results were below FSLs.

Cores from 19 to 20 ft bgs (the basal depth of CWA4 from the geophysical survey) were sent for off-site analysis. As discussed above, a caliche hardpan was noted at each location except E18. This hardpan was determined to be a biasing factor where COCs, if present, may tend to accumulate. Thus, samples from 3 to 4 ft bgs (boring E06), 4.5 to 4.5 ft bgs (E07, E011, and E17), 4 to 5 ft bgs (E15), and 3.5 to 4.5 ft bgs (E16) were also sent for off-site analysis.

Two geotechnical samples were collected at CWA4; one in cover material from 0.5 to 1.5 ft bgs, and one in native soil from 20 to 21 ft bgs.

A.7.2.2.5 Trench/Landfill 1, Conductive Waste Area 5

Three excavations (E08 through E10) were made to investigate TL1/CWA5, as shown in Figure A.7-1. Sparse metallic and plastic debris were encountered underlying a 2-ft thick gravel cover. The excavations established the lateral extent of TL1/CWA5 and showed it to be generally consistent with the geophysical survey.

Three borings (E08 through E10) were drilled at locations determined from excavation. The geophysical survey indicated the base of TL1/CWA5 at 8 ft bgs. The core intervals from 4 to 5 ft bgs, 8 to 9 ft bgs, 13 to 14 ft bgs, and 18 to 19 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Thus, the cores from 8 to 9 ft bgs (the basal depth of TL1/CWA5 from the geophysical survey) were sent for off-site analysis.

Two geotechnical samples were collected at TL1/CWA5; one in cover material from 0.5 to 1.5 ft bgs, and one in subcell native soil from 9 to 10 ft bgs.

A.7.2.2.6 Trench/Landfill 2

Three excavations (E12 through E14) were made to investigate TL2, as shown in Figure A.7-1. Metallic and plastic debris were encountered underlying a 1-ft thick gravel cover. These excavations established the lateral extent of TL2 and showed it to be generally consistent with the geophysical survey.

Three borings (E12 through E14) were drilled at locations determined from excavation. The geophysical survey indicated the base of TL2 at 22 to 24 ft bgs. The core intervals from 4 to 5 ft bgs, 8 to 9 ft bgs, 13 to 14 ft bgs, 18 to 19 ft bgs, 23 to 24 ft bgs, 28 to 29 ft bgs, and 33 to 34 ft bgs were field screened except VOC field screening was not completed at boring E12 due to an instrument malfunction. This data gap is acceptable because TPH and radiological field screening was performed and laboratory results show COCs are not present.

The FSRs of the remaining intervals were less than FSLs and no biasing factors were noted. Thus, the cores from 23 to 24 ft bgs (the basal depth of TL2 from the geophysical survey) were sent for off-site analysis. No geotechnical samples were collected at TL2.

A.7.2.3 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. A topographic map of CAS 06-15-03 was prepared and is included in the engineering drawings in Appendix H.

The ground surface at CAS 06-15-03 slopes from the southwest to the northeast at approximately 5 percent. There is a low, linear mound (less than 1 ft in height) over most of CWA4. The ground surface at most of CWA3 is generally flat.

A.7.2.4 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs which include total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, gamma spectrometry, and isotopic plutonium. As discussed above, sample 005E028 was also analyzed for Sr-90 due to an elevated beta/gamma FSR. The QC field blanks and the equipment rinsate blank were analyzed for the soil sample parameters and Sr-90; dioxins was an additional analysis for one of the field blanks (005E310). The QC source blank was analyzed for the soil sample parameters, dioxins, and Sr-90. Trip blanks were analyzed only for total VOCs.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.7.2.5 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Total SVOCs
- Ethylene glycol
- TPH (DRO and GRO)
- PCBs
- Isotopic Pu
- Sr-90

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total VOCs
- Total RCRA metals, nickel, and zinc
- Gamma-emitting radionuclides

A.7.2.5.1 Total Volatile Organic Compound Analytical Results for Soil Samples

The total VOCs detected in soil samples at concentrations exceeding MRLs are listed in Table A.7-2. Tetrachloroethene was detected in a single sample at a concentration of 51 µg/kg. Acetone was detected in two samples at concentrations of 50 and 360 (estimated) µg/kg. These concentrations exceed MRLs but are well below corresponding PALs established in the CAIP.

A.7.2.5.2 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.7-3. Arsenic, barium, chromium, lead, nickel, selenium, silver, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below PALs established in the CAIP.

A.7.2.5.3 Gamma Spectrometry Analytical Results for Soil Samples

The gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.7-4. The isotopes Ac-228, Bi-214, Pb-212, Pb-214, K-40, and Tl-208 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results

Table A.7-2
Soil Sample Results for Total VOCs
Detected Above Minimum Reporting Limits at CAS 06-15-03

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (µg/kg)	
			Acetone	Tetrachloroethene
Preliminary Action Levels[a]			6,200,000	19,000
005E005	E04	19 - 20	--	51
005E018	E19	3 - 4	50	--
005E025	E17	4.5 - 5.5	360 (J)	--

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

ft bgs = Feet below ground surface
µg/kg = Micrograms per kilogram
J = Estimated value. Qualifier added to laboratory data; record accepted. Calibration verification did not meet criteria or was not performed.
-- = Not detected above minimum reporting limits

Table A.7-3
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc
Detected Above Minimum Reporting Limits at CAS 06-15-03
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Silver	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	10,000[b]	10,000[b]	100,000[b]
005E001	E06	3 - 4	4.9	140	9.1	12.0	12.0 (J)[c]	--	13 (J)[d]	50
005E002	E07	4.5 - 5.5	4.7	150	12.0	12.0	12.0 (J)[c]	--	--	45
005E003		19 - 20	5.1	100	7.2	9.3	9.4 (J)[c]	--	--	43
005E004	E04	3 - 4	5.4	130	11.0	12.0	11.0 (J)[c]	--	--	48
005E005		19 - 20	5.8	120	11.0	9.2	10.0	--	--	38
005E006	E05	3 - 4	7.3	200	13.0	14.0	17.0	--	2.9	68
005E007		19 - 20	6.7	150	12.0	13.0	15.0	--	--	56
005E008	E03	2.5 - 3.5	5.8	140	13.0	11.0	12.0	0.82	--	70
005E009		2.5 - 3.5	6.5	130	15.0	12.0	14.0	0.80	--	77
005E010		19 - 20	5.9	110	8.8	8.0	9.8	--	--	45
005E011	E02	1 - 2	3.3	78	4.4	6.5	4.9	--	--	25
005E012		19 - 20	3.7	76	11.0	5.6	6.1	--	--	26
005E013	E01	1.5 - 2.5	4.3	120	8.1	9.1	9.0	--	--	36
005E014		19 - 21	4.4	98	13.0	7.3	8.7	--	--	56

Table A.7-3
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 06-15-03
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Silver	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	10,000[b]	10,000[b]	100,000[b]
005E015	E21	2 - 3	7.7	190	13.0	15.0	16.0	--	2.9	65
005E016		19 - 20	7.1	150	11.0	12.0	15.0	--	--	59
005E017	E20	19 - 20	4.1	93	9.1	7.6	7.1	--	--	48
005E018	E19	3 - 4	5.9	130	7.9	10.0	12.0	--	--	72
005E019		19 - 20	5.9	140	9.8	10.0	11.0	--	--	54
005E020	E18	19 - 20	5.6	120	10.0	11.0	12.0	--	--	67
005E021	E16	3.5 - 4.5	8.6	200	10.0	11.0	13.0	--	--	56
005E022		19 - 20	7.0	130	9.6	11.0	14.0	--	--	77
005E023	E15	4 - 5	6.6	180	13.0	15.0	17.0	--	--	75
005E024		19 - 20	6.1	120	8.9	11.0	11.0	0.59	--	81
005E025	E17	4.5 - 5.5	7.1	170	11.0	13.0	16.0	--	--	61
005E026		19 - 20	4.9	110	6.3	8.8	8.6	--	--	41
005E027	E11	4.5 - 5.5	7.1	160	12.0	13.0	15.0	0.58	--	60
005E028		19 - 20	5.5	120	7.9	10.0	10.0	0.57	--	79
005E029		30 - 31	5.6	120	13.0	9.0	10.0	--	--	74
005E030	E12	23 - 24	8.5	150	11.0	13.0	16.0	--	--	64
005E031	E13	23 - 24	8.0	160	11.0 (J)[c]	12.0	15.0	--	--	110
005E032	E14	23 - 24	6.7	110	14.0 (J)[c]	10.0	13.0	--	--	69
005E033	E10	8 - 9	8.5	190	15.0 (J)[c]	16.0	21.0	--	--	73
005E034		8 - 9	9.0	200	16.0 (J)[c]	17.0	22.0	0.71	--	78
005E035	E09	8 - 9	8.1	170	11.0 (J)[c]	14.0	17.0	--	--	62
005E036	E08	8 - 9	9.7	170	11.0 (J)[c]	13.0	17.0	--	--	63

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[c]Qualifier added to laboratory data; record accepted. Serial dilution %D outside of control limits. Matrix effects may exist.
[d]Qualifier added to laboratory data; record accepted. Matrix spike recovery grossly outside control limits. Duplicate precision analysis (relative percent difference) outside control limits.

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

exceed background concentrations; therefore, PALs for these isotopes were not exceeded at CAS 06-15-03.

Table A.7-4
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 06-15-03
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			3.64	3.47	3.64	3.47	31.1	3.38
005E001	E06	3 - 4	2.01 ± 0.50	0.74 ± 0.28	2.46 ± 0.48	1.14 ± 0.28	29.3 ± 5.6	0.47 ± 0.14
005E002	E07	4.5 - 5.5	2.52 ± 0.69	1.22 ± 0.45	2.28 ± 0.52	1.43 ± 0.39	32.5 ± 7.3	0.70 ± 0.25
005E003		19 - 20	--	--	2.16 ± 0.53	1.24 ± 0.39	28.4 ± 6.9	0.76 ± 0.26
005E004	E04	3 - 4	2.45 ± 0.78	1.15 ± 0.43	2.68 ± 0.58	1.22 ± 0.34	32.3 ± 7.7	0.69 ± 0.25
005E005		19 - 20	2.13 ± 0.78	1.19 ± 0.47	1.72 ± 0.45	1.07 ± 0.33	23.3 ± 6.1	0.54 ± 0.20
005E006	E05	3 - 4	2.03 ± 0.51	1.24 ± 0.34	2.39 ± 0.47	1.48 ± 0.33	29.5 ± 5.7	0.71 ± 0.18
005E007		19 - 20	2.56 ± 0.67	1.10 ± 0.36	2.19 ± 0.49	1.08 ± 0.32	25.6 ± 5.8	0.76 ± 0.23
005E008	E03	2.5 - 3.5	2.64 ± 0.71	1.27 ± 0.44	2.91 ± 0.60	1.53 ± 0.40	28.7 ± 6.6	0.78 ± 0.27
005E009		2.5 - 3.5	--	1.42 ± 0.50	2.32 ± 0.53	1.37 ± 0.40	28.0 ± 6.6	0.70 ± 0.25
005E010		19 - 20	2.02 ± 0.74	0.97 ± 0.41	2.09 ± 0.49	1.08 ± 0.35	23.1 ± 6.3	0.62 ± 0.23
005E011	E02	1 - 2	2.09 ± 0.65	1.03 ± 0.40	2.15 ± 0.48	1.02 ± 0.32	26.9 ± 6.5	0.49 ± 0.20
005E012		19 - 20	2.10 ± 0.50	1.08 ± 0.32	2.31 ± 0.45	1.39 ± 0.30	30.2 ± 5.7	0.59 ± 0.16
005E013	E01	1.5 - 2.5	1.87 ± 0.55	0.94 ± 0.37	2.45 ± 0.52	0.95 ± 0.30	27.1 ± 6.0	0.69 ± 0.21
005E014		19 - 21	2.24 ± 0.68	--	2.37 ± 0.51	1.26 ± 0.35	26.2 ± 6.2	0.65 ± 0.21
005E015	E21	2 - 3	2.16 ± 0.54	0.81 ± 0.29	2.35 ± 0.46	1.30 ± 0.30	27.9 ± 5.4	0.47 ± 0.15
005E016		19 - 20	--	--	1.98 ± 0.50	0.89 ± 0.32	23.5 ± 6.2	0.79 ± 0.29
005E017	E20	19 - 20	2.32 ± 0.56	1.01 ± 0.31	2.71 ± 0.52	1.26 ± 0.30	29.8 ± 5.7	0.74 ± 0.19
005E018	E19	3 - 4	2.16 ± 0.72	1.08 ± 0.43	1.88 ± 0.45	1.01 ± 0.31	23.0 ± 5.8	0.65 ± 0.22
005E019		19 - 20	--	--	2.07 ± 0.51	1.00 ± 0.36	28.9 ± 6.9	0.58 ± 0.25
005E020	E18	19 - 20	1.85 ± 0.50	1.21 ± 0.35	2.46 ± 0.49	1.40 ± 0.32	30.6 ± 5.9	0.72 ± 0.19
005E021	E16	3.5 - 4.5	--	1.02 ± 0.45	1.99 ± 0.47	1.06 ± 0.34	21.4 ± 5.7	0.55 ± 0.21
005E022		19 - 20	--	1.12 ± 0.47	2.30 ± 0.51	1.26 ± 0.36	21.7 ± 6.0	--
005E023	E15	4 - 5	2.37 ± 0.56	1.01 ± 0.30	2.46 ± 0.48	1.12 ± 0.28	29.5 ± 5.8	0.68 ± 0.18
005E024		19 - 20	1.94 ± 0.61	1.11 ± 0.43	2.14 ± 0.47	1.4 ± 0.36	27.0 ± 6.6	0.71 ± 0.23

Table A.7-4
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 06-15-03
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			3.64	3.47	3.64	3.47	31.1	3.38
005E025	E17	4.5 - 5.5	--	1.14 ± 0.44	1.55 ± 0.43	1.04 ± 0.33	25.8 ± 6.9	0.66 ± 0.25
005E026		19 - 20	2.03 ± 0.52	0.89 ± 0.28	2.33 ± 0.45	1.15 ± 0.27	28.0 ± 5.4	0.69 ± 0.18
005E027	E11	4.5 - 5.5	1.97 ± 0.73	--	2.32 ± 0.53	1.08 ± 0.34	21.0 ± 5.8	0.64 ± 0.23
005E028		19 - 20	2.24 ± 0.57	1.21 ± 0.35	2.29 ± 0.45	1.64 ± 0.34	26.4 ± 5.2	0.65 ± 0.17
005E029		30 - 31	2.06 ± 0.69	0.93 ± 0.40	2.42 ± 0.52	1.28 ± 0.35	25.4 ± 6.3	0.74 ± 0.25
005E030	E12	23 - 24	1.97 ± 0.71	1.12 ± 0.46	2.25 ± 0.52	1.13 ± 0.32	26.6 ± 6.8	0.96 ± 0.29
005E031	E13	23 - 24	1.97 ± 0.53	1.29 ± 0.39	2.36 ± 0.49	1.13 ± 0.30	23.6 ± 5.3	0.60 ± 0.19
005E032	E14	23 - 24	2.13 ± 0.75	1.19 ± 0.44	2.16 ± 0.50	1.38 ± 0.37	25.8 ± 6.2	0.69 ± 0.25
005E033	E10	8 - 9	1.79 ± 0.63	--	2.46 ± 0.55	1.40 ± 0.39	27.3 ± 6.8	0.57 ± 0.24
005E034		8 - 9	--	1.15 ± 0.47	2.23 ± 0.54	1.13 ± 0.36	22.6 ± 6.1	0.52 ± 0.21
005E035	E09	8 - 9	2.05 ± 0.50	0.99 ± 0.29	2.49 ± 0.48	1.16 ± 0.28	28.7 ± 5.5	0.65 ± 0.17
005E036	E08	8 - 9	2.20 ± 0.72	1.12 ± 0.47	2.38 ± 0.52	1.31 ± 0.36	20.1 ± 5.5	0.68 ± 0.24

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991)

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

A.7.2.5.4 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.7-5. Data summaries for all of the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

- Based on saturated hydraulic conductivity measurements, cover soil has lower permeabilities than subcell soil at TL1/CWA5 and at CWA4. At CWA3, cover soil has a higher permeability than subcell soil.

- Moisture content measurements show that the soil is well below saturation.

- Dry bulk densities ranged from 1.51 to 2.21 g/cm^3 in cover soil and from 1.33 to 1.54 g/cm^3 in subcell native soil. Cover soil had higher densities than subcell soil.

- Porosities in cover soil ranged from 16.6 to 43.1 percent, while subcell soil porosities ranged from 41.9 to 50.0 percent. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

Table A.7-5
Soil Sample Results for Select Geotechnical Parameters at CAS 06-15-03

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat[a] (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005E402	TL1/CWA5	0.5 - 1.5	3.9E-06	4.5	6.8	1.51	1.57	43.1
005E401		9 -10	5.2E-04	11.4	16.2	1.42	1.59	46.3
005E404	CWA3	0 - 1	2.5E-04	1.0	2.3	2.21	2.23	16.6
005E405		20 - 21	1.4E-04	9.2	14.1	1.54	1.68	41.9
005E403	CWA4	0.5 - 1.5	3.0E-06	4.6	7.3	1.59	1.66	40.0
005E406		20 - 21	4.0E-04	14.0	18.5	1.33	1.51	50.0

[a]Constant head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

A.7.2.6 Contaminants of Concern

Based on the aforementioned analytical results, no COCs are migrating from CAS 06-15-03.

A.7.3 Nature and Extent of Contamination

Since COCs are not migrating, the extent of any contamination that may be present at CAS 06-15-03 is limited to within the boundaries of the subsurface disposal features.

A.7.4 Revised Conceptual Site Model

No variations in the CSM were identified.

A.8.0 CAS 12-15-01, Sanitary Landfill

This landfill is located near the Area 12 Camp and is described as an inactive landfill that possibly contains hazardous waste. According to historical documentation, the landfill was operational from 1961 through 1987. The landfill is believed to have accepted solid waste, kitchen grease, sewage, aerosol cans, and possibly other kinds of waste. There are numerous concrete monuments at the site, delineating up to nine disposal features. Additional detail is provided in the CAIP.

A.8.1 Corrective Action Investigation

Thirty-seven site characterization samples (including two field duplicates) and seven geotechnical samples were collected by rotary sonic drilling, and are listed in Table A.8-1. One of the geotechnical samples was unnecessary and discarded. Figure A.8-1 is a site sketch showing excavation and sampling locations at CAS 12-15-01. The activities conducted to meet the CAIP requirements at CAS 12-15-01 are discussed in the following sections.

Table A.8-1
Samples Collected at CAS 12-15-01, Sanitary Landfill
(Page 1 of 3)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
005F027	F09	T1	13 - 14	Soil	SC	Set 1
005F028	F10		13 - 14	Soil	SC, WM, Lab QC	Set 1, GS
005F029	F08		13 - 14	Soil	SC	Set 1
005F030	F11		13 - 14	Soil	SC	Set 1
005F022	F14	T2	10 - 11	Soil	SC	Set 1
005F023			16 - 17	Soil	SC	Set 1
005F024	F15		16 - 17	Soil	SC, WM	Set 1, GS
005F025	F13		16 - 17	Soil	SC	Set 1
005F026	F12		16 - 17	Soil	SC	Set 1
005F036	F20		16 - 17	Soil	SC, WM	Set 1, GS
005F037	F31		16 - 17	Soil	SC	Set 1
005F031	F17	T3	11 - 12	Soil	SC	Set 1
005F035	F18		11 - 12	Soil	SC	Set 1

Table A.8-1
Samples Collected at CAS 12-15-01, Sanitary Landfill
(Page 2 of 3)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
005F001	F03	CWA1	11 - 12	Soil	SC	Set 1
005F002	F07		11 - 12	Soil	SC	Set 1
005F003	F04		7.5 - 8.5	Soil	SC	Set 1
005F004	F06		7.5 - 8.5	Soil	SC, WM	Set 1, GS
005F005	F02		7.5 - 8.5	Soil	SC	Set 1
005F006	F05		14 - 15	Soil	SC	Set 1
005F007			25 - 26	Soil	SC	Set 1
005F008			30 - 31	Soil	SC, WM	Set 1, GS
005F009			35 - 36	Soil	SC	Set 1
005F010	F01		11 - 12	Soil	SC	Set 1
005F011	F23 North step-out to F05		25 - 26	Soil	SC, WM	Set 1, GS
005F012			25 - 26	Soil	Field Duplicate of 005F011	Set 1, GS
005F013			30 - 31	Soil	SC	Set 1
005F014	F22 West step-out to F05		25 - 26	Soil	SC	Set 1
005F015			30 - 31	Soil	SC	Set 1
005F016	F21 South step-out to F05		25 - 26	Soil	SC, WM, Lab QC	Set 1, GS
005F017			30 - 31	Soil	SC	Set 1
005F018	F24 East step-out to F05		25 - 26	Soil	SC	Set 1
005F019			30 - 31	Soil	SC	Set 1
005F020	F25 East end of CWA1		20 - 21	Soil	SC, WM	Set 1, GS
005F021	F26 East end of CWA1		11 - 12	Soil	SC	Set 1
005F032	F16	CWA5	12.5 - 13.5	Soil	SC, WM	Set 1, GS
005F033			12.5 - 13.5	Soil	Field Duplicate of 005F032	Set 1, GS
005F034	F19		12.5 - 13.5	Soil	SC	Set 1
Geotechnical Samples						
005F404	F29	T1	0 - 1	Soil	Geotechnical	Set 2
005F405	F28		0 - 1	Soil	Geotechnical	Not Analyzed
005F403	F10		14 - 15	Soil	Geotechnical	Set 2

Table A.8-1
Samples Collected at CAS 12-15-01, Sanitary Landfill
(Page 3 of 3)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Geotechnical Samples						
005F406	F30	T2	0 - 1	Soil	Geotechnical	Set 2
005F407	F31		17 - 18	Soil	Geotechnical	Set 2
005F401	F02	CWA1	8.5 - 9.5	Soil	Geotechnical	Set 2
005F402	F27		0 - 1	Soil	Geotechnical	Set 2
Quality Control Samples						
005F301	NA	NA	NA	Water	Trip Blank	Total VOCs
005F302	NA	NA	NA	Water	Trip Blank	Total VOCs
005F303	NA	NA	NA	Water	Trip Blank	Total VOCs
005F304	NA	NA	NA	Water	Trip Blank	Total VOCs
005F305	NA	NA	NA	Water	Field Blank	Set 1, GS, Dioxins
005F306	NA	NA	NA	Water	Trip Blank	Total VOCs
005F307	NA	NA	NA	Water	Trip Blank	Total VOCs
005F308	NA	NA	NA	Water	Trip Blank	Total VOCs
005F309	NA	NA	NA	Water	Trip Blank	Total VOCs
005F310	NA	NA	NA	Water	Trip Blank	Total VOCs
005F311	NA	NA	NA	Water	Field Blank	Set 1, GS, Dioxins

Set 1 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs
Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics

SC = Site characterization
WM = Waste management
QC = Quality control
NA = Not applicable
ft bgs = Feet below ground surface
GS = Gamma spectrometry
CWA = Conductive waste area
T = Trench

A.8.1.1 CAIP Implementation

The following activities were conducted at CAS 12-15-01 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste

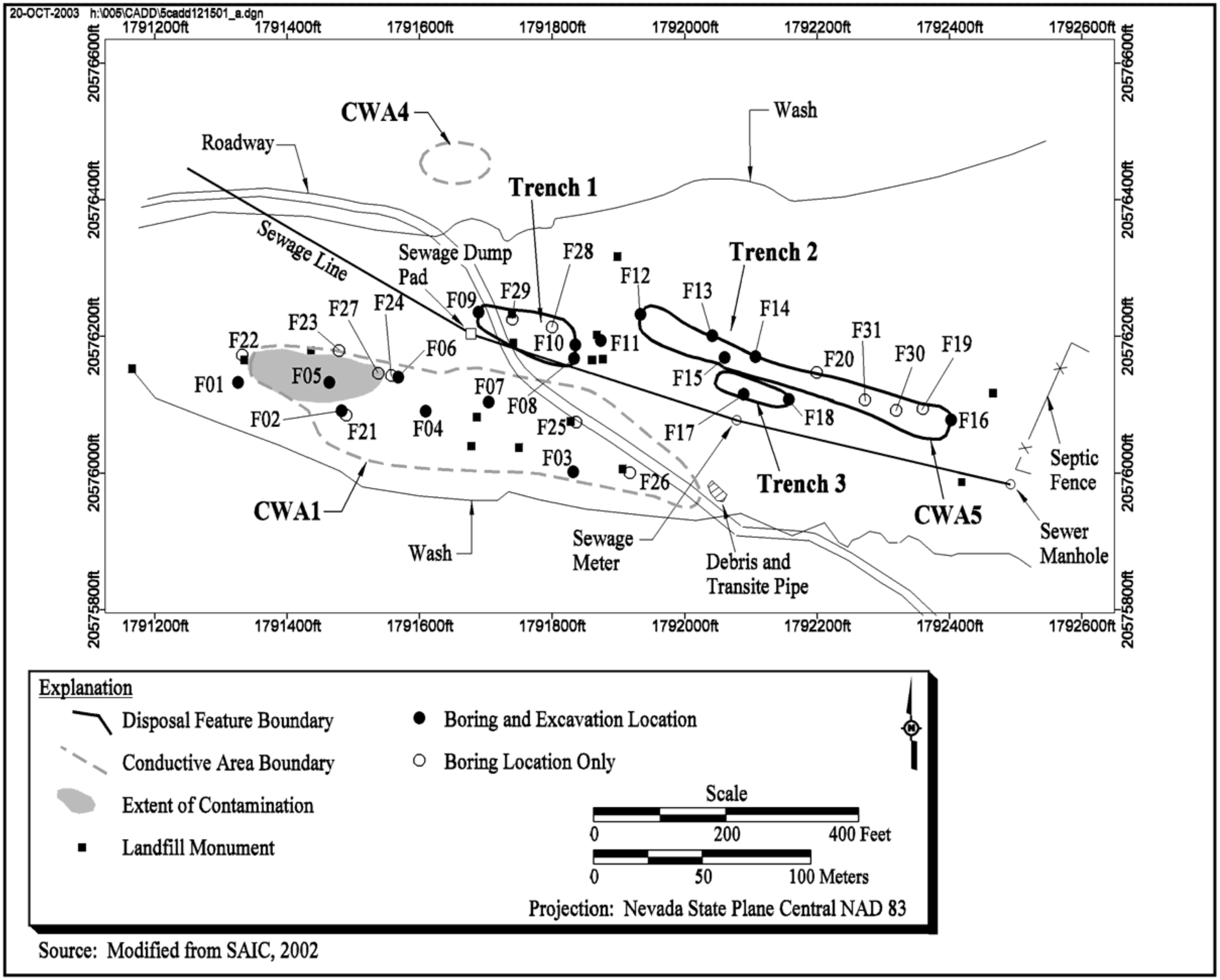

Figure A.8-1
Site Sketch and Sampling Locations at CAS 12-15-01, Sanitary Landfill

- Backhoe excavations at preselected locations to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, verify the lateral boundaries of the disposal features, and determine the bases of some of the disposal features
- Rotary sonic drilling at locations identified during excavation to collect samples at intervals corresponding to the base of disposal features and from other intervals determined by biasing factors (e.g., field screening and visual observation of drill core)
- Rotary sonic drilling at step-out locations to collect samples to bound the horizontal and vertical extent of possible contamination
- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of disposal features
- Topographic survey to determine the slope of the cover
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

A.8.1.2 Deviations

There was one minor deviation to the CAIP investigation strategy. Most of the samples collected from T2 were collected from 16 to 17 ft bgs, instead of 10 to 11 ft bgs (the predetermined depth based on geophysical survey results). This was done because a 2-in. thick zone containing minor debris was encountered at 16 ft bgs in boring F14 (one of the first T2 borings), and harder drilling was encountered below 16 ft bgs. These observations indicated the base of T2 was more likely present at 16 ft bgs instead of 10 ft bgs, as suggested by the geophysical survey. Thus, the CAIP requirement for sampling at the base of disposal features was met.

A.8.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.8.2.1 Geophysical Survey

An EM31 terrain conductivity survey was conducted along traverses with a 10-ft separation. The survey identified metallic and conductive (nonmetallic) subsurface waste. Three CWAs (CWA1, CWA4, and CWA5) and three disposal features (T1 through T3) were identified. In addition, two linear metallic features were identified, which are probably underground utilities. One of these features is interpreted to be part of the existing sanitary sewer system.

Three EI traverses were conducted to define the vertical limits of the disposal features. The traverses show the base of T1 at about 12 to 14 ft bgs and the base of T2 at about 10 ft bgs. The traverses did not identify bases of the remaining features so these were determined by excavation.

A.8.2.2 Excavation, Drilling, and Sampling

Eighteen backhoe excavations were made to determine the thickness of cover material, verify the lateral boundaries of the disposal features, and determine the basal depths of all the disposal features except T1. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation. Site characterization samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from EI geophysical traverses and excavation.

The CWA4 was not investigated because this area consists of soil and metallic debris that will be removed as a best management practice. Excavation, drilling, and sampling details are discussed in the following subsections.

A.8.2.2.1 Trench 1

Four excavations (F08 through F11) were made to investigate T1, as shown in Figure A.8-1. Plastic debris, soda cans, burned wood and paper, bones, and grease were encountered, underlying a consistent 2-ft thick cover of gravelly sand with silt. The edges of T1 were verified and showed the lateral extent to be generally consistent with the geophysical survey.

Four borings (F08 through F11) were drilled at locations determined from excavation. The geophysical survey indicated the base of T1 at 12 to 14 ft bgs. The core intervals from 4 to 5 ft bgs, 8 to 9 ft bgs, 13 to 14 ft bgs, 18 to 19 ft bgs, and 23 to 24 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Thus, cores from 13 to 14 ft bgs (the basal depth of T1 from the geophysical survey) were sent for off-site analysis.

Three geotechnical samples were collected at T1; two in cover material from 0 to 1 ft bgs and one in native soil from 14 to 15 ft bgs. One of the cover samples was later discarded as unnecessary.

A.8.2.2.2 Trench 2

Four excavations (F12 through F15) were made to investigate T2, as shown in Figure A.8-1. Burned debris, concrete, and metallic scrap was encountered underlying a fairly consistent 5- to 6-ft thick cover of gravelly sand with silt that thins to 2.5-ft thick at the western edge. Excavation showed the lateral extent of T2 is greater than indicated by the geophysical survey and it extends to CWA5 as a single disposal feature. Aerial photographs support this conclusion.

Six borings (F12 through F15, F20, and F31) were drilled at locations determined from excavation. The geophysical survey indicated the base of T2 was at 10 ft bgs. The core intervals from 5 to 6 ft bgs, 10 to 11 ft bgs, 16 to 17 ft bgs, 21 to 22 ft bgs, and 26 to 27 ft bgs were field screened. The FSRs were less than FSLs. At boring F14, a 2-in. thick zone of minor burned debris was encountered at 16 ft bgs and hard drilling was encountered below 16 ft bgs. These observations indicated the base of T2 is more likely present at 16 ft bgs instead of 10 ft bgs, as suggested by the geophysical survey. Thus, cores from 16 to 17 ft bgs were submitted for off-site analysis to satisfy the CAIP objective of sampling at the base of the disposal feature. In addition, the core at 10 to 11 ft bgs (the basal depth of T2 from the geophysical survey) from boring F14 was also submitted for analysis.

Two geotechnical samples were collected at T2. One sample was collected in cover material from 0 to 1 ft bgs and one sample was collected in subcell native soil from 17 to 18 ft bgs.

A.8.2.2.3 Conductive Waste Area 5

One excavation, F16, was made to explore CWA5 and is shown in Figure A.8-1. The excavation, pothole trenching to the northwest, and aerial photographs show that CWA5 extends to T2 as a single disposal feature. The excavation exposed abundant metallic scrap (i.e., aerosol cans, cable, and fence T-posts) in fill material, overlain by a 2.5-ft thick cover of gravelly sand. Where excavated, the debris extended to a depth of 13.5 ft bgs.

Two borings (F16 and F19) were drilled at locations determined from excavation. Excavation indicated the base of CWA5 was at 13.5 ft bgs, which was the bottom of debris-laden fill material.

The core intervals from 4 to 5 ft bgs, 9 to 10 ft bgs, 12.5 to 13.5 ft bgs, 18 to 19 ft bgs, and 23 to 24 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Thus, the cores from 12.5 to 13.5 ft bgs (the basal depth of CWA5 from excavation) were sent for off-site analysis. No geotechnical samples were collected from CWA5.

A.8.2.2.4 Trench 3

Two excavations (F17 and F18) were made to explore T3, as shown in Figure A.8-1. Abundant metallic scrap and burned plastic, wood, paper, and glass was found in fill material. This fill material was overlain by a 1-ft thick cover of gravelly sand and extended to varying depths of 6 to 11 ft bgs. The excavations suggest T3 may extend further to the east than indicated by the geophysical survey.

Two borings (F17 and F18) were drilled at locations determined from excavation. Excavation indicated the base of T3 at 11 ft bgs. The core intervals from 2 to 3 ft bgs, 7 to 8 ft bgs, 11 to 12 ft bgs, 16 to 17 ft bgs, and 21 to 22 ft bgs were field screened. The FSRs were less than FSLs and no biasing factors were noted. Cores from 11 to 12 ft bgs (intervals at the basal depth of T3) were submitted for off-site analysis. No geotechnical samples were collected from T3.

A.8.2.2.5 Conductive Waste Area 1

Seven excavations (F01 through F07) were made to investigate CWA1, as shown in Figure A.8-1. Debris was not encountered at F01, F02, F04, and F07. At these locations, fill material was present from the surface to a caliche hardpan found at depths varying from 2 to 2.5 ft bgs. Excavation F03 at the east end of CWA1 encountered plastic, metallic scrap, cans, and grease from 9 to 11 ft bgs. Atop the debris is fill material from 4 to 9 ft bgs and a cover of gravelly sand from 0 to 4 ft bgs. Excavation F06 at the north-central end of CWA1 encountered minor metallic debris at 4 ft bgs within fill material. This fill material was overlain by a 3-ft thick cover of gravelly sand. Excavation F05 toward the west end of CWA1 did not encounter any debris but fill material was observed from 3 to 7.5 ft bgs indicating the presence of a disposal feature. These excavations and aerial photographs suggest there are at least four disposal features trending northwest to southeast within the boundaries of CWA1.

Initially, seven borings (F01 through F07) were drilled at locations determined from excavation. Excavation indicated the base of CWA1 at depths varying from 7.5 to 11 ft bgs. Core was field screened at intervals both above and below the CWA1 base at a particular location, as described in Section A.2.3.4. The FSRs were less than FSLs, except at boring F05 as discussed below. The core interval from 7.5 to 8.5 ft bgs from borings F02, F04, and F06 was sent for off-site analysis. These intervals were selected based on the deepest extent of debris noted during excavation at nearby F05. The core interval from 11 to 12 ft bgs at borings F01, F03, and F07 were sent for off-site analysis. These intervals were selected based on the bottom of debris at excavation F03.

At boring F05, the core interval from 8.5 to 25.0 ft was noted to have a hydrocarbon odor and a greenish tinge (believed to be sewage sludge). Sample 005F006 was collected from 14 to 15 ft bgs for analysis. This sample interval was selected based on odor and color, a TPH (DRO) FSR of 226 ppm, and a VOC FSR of 98 ppm. Sample 005F007 was collected from 25 to 26 ft bgs for analysis. The lack of greenish discoloration suggested the base of the sludge had been reached. However, field screening showed this sample had an elevated TPH (DRO) FSR of 139.7 ppm. Two more samples (005F008 and 005F009) were collected at 30 to 31 ft bgs and 35 to 36 ft bgs, respectively, to vertically bound the extent of any contamination. The TPH (DRO) FSRs for these samples were 30.1 and 18.8 ppm, respectively, suggesting vertical extent of any contamination had been bounded.

Based on these FSRs, the decision was made to laterally bound the extent of contamination during this phase of the investigation. Four step-out drilling locations (F21 through F24) were selected to the north, south, east, and west of F05, as shown in Figure A.8-1. At each location, samples were collected and field screened at 25 to 26 ft bgs (the deepest occurrence at F05 where FSRs were greater than FSLs) and at 30 to 31 ft bgs (intervals believed to be uncontaminated, as verified by laboratory analysis). These samples had FSRs less than FSLs.

The decision was also made to drill and sample at the far east end of CWA1 (borings F25 and F26) to bound possible contamination in this area. A sample was collected at boring F25 from 20 to 21 ft bgs, and at boring F26 from 11 to 12 ft bgs. These intervals were selected based on debris noted in earlier excavation. Core above and below these intervals were field screened as described in Section A.2.3.4, and FSRs were less than FSLs.

Two geotechnical samples were collected from CWA1; one in cover material from 0 to 1 ft bgs and one in native soil from 8.5 to 9.5 ft bgs.

A.8.2.3 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. A topographic map of CAS 12-15-01 was prepared and is included in the engineering drawings in Appendix H.

The ground surface at CAS 12-15-01 is gently undulating, although it generally slopes from the west to the east at approximately 4.9 percent. Washes parallel the site to the north and south; each wash is about 8- to 10-ft deep. The topography at the northern end of the site where the access road crosses the north wash is irregular.

A.8.2.4 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs including total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), and PCBs. Twenty-five percent of the soil samples were also analyzed for gamma spectrometry for waste management purposes. The QC equipment field blanks were analyzed for the soil sample parameters, gamma spectrometry, and dioxins. Trip blanks were analyzed for only total VOCs.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.8.2.5 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Ethylene glycol
- PCBs

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total VOCs
- Total SVOCs
- Total RCRA metals, nickel, and zinc
- TPH (DRO and GRO)
- Gamma-emitting radionuclides

A.8.2.5.1 Total Volatile Organic Compound Analytical Results for Soil Samples

The total VOCs detected in soil samples at concentrations exceeding MRLs are listed in Table A.8-2. Trichlorobenzenes (1,2,3- and 1,2,4-), trimethylbenzenes (1,2,4- and 1,3,5-); dichlorobenzenes (1,2-, 1,3-, and 1,4-), chlorobenzene, naphthalene, n-butylbenzene, n-propylbenzene, o-xylene, p-isopropyltoluene, and trichloroethene were detected, primarily in sample 005F006. The dichlorobenzenes and 1,2,4-trichlorobenzene were also detected in sample 005F007 at significantly lower concentrations. The PALs were exceeded for 1,2-dichlorobenzene and 1,4-dichlorobenzene at concentrations of 390 (estimated) mg/kg and 160 mg/kg, respectively. The remaining results exceed MRLs but are well below corresponding PALs established in the CAIP.

1,4-dichlorobenzene is a target compound in both VOC and SVOC analysis and was detected in sample 168F006 above the PAL of 8.1 mg/kg in both VOC analysis (discussed above) and SVOC analysis (discussed below in Section A.8.2.5.2). The VOC result is considered more accurate; thus 1,4-dichlorobenzene will be considered only to be a VOC COC in subsequent discussion.

A.8.2.5.2 Total Semivolatile Organic Compound Analytical Results for Soil Samples

The total SVOCs detected in soil samples at concentrations exceeding MRLs are listed in Table A.8-3. Dichlorobenzenes (1,2-, 1,3-, and 1,4-) and 1,2,4-trichlorobenzene were detected in sample 005F006. Of the above listed SVOCs, only 1,4-dichlorobenzene was detected above the PAL (8.1 mg/kg) at an estimated concentration of 130 mg/kg. As discussed above in Section A.8.2.5.1, this compound will be considered a VOC COC. The remaining results exceed MRLs but are well below corresponding PALs established in the CAIP.

Table A.8-2
Soil Sample Results for Total VOCs
Detected Above Minimum Reporting Limits at CAS 12-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)													
			1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Chlorobenzene	Naphthalene	n-Butylbenzene	n-Propylbenzene	o-Xylene	p-Isopropyltoluene	Trichloroethene
Preliminary Action Levels[a]			**NI[b]**	**3,000**	**170**	**70**	**370**	**52**	**8.1**	**540**	**190**	**240**	**240**	**210**	**NI[b]**	**6.1**
005F006	F05	14 - 15	23	90	12	4 (J)	**390 (J)**	19	**160**	3.3 (J)	4.2 (J)	1.4 (J)	1.4 (J)	0.68 (J)	1.9 (J)	1.2 (J)
005F007		25 - 26	--	0.02	--	--	0.038	0.011	0.13	--	--	--	--	--	--	--

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[b]Not indicated: No EPA Region 9 PRG and compound is not listed in Integrated Risk Information System.

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
-- = Not detected above minimum reporting limits
J = Estimated value. Qualifier added to laboratory data; record accepted. Value exceeded the linear/calibration range of instrument. The reported value is from the dilution run.

Table A.8-3
Soil Sample Results for Total SVOCs
Detected Above Minimum Reporting Limits at CAS 12-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)			
			1,2,4-Trichlorobenzene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene
Preliminary Action Levels[a]			3,000	370	52	8.1
005F006	F05	14 - 15	90 (J)	300 (J)	15 (J)	**130 (J)**

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
J = Estimated value. Qualifier added to laboratory data; record accepted. Surrogates diluted out.

A.8.2.5.3 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.8-4. Arsenic, barium, chromium, lead, nickel, selenium, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below PALs established in the CAIP.

Table A.8-4
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc
Detected Above Minimum Reporting Limits at CAS 12-15-01
(Page 1 of 3)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	10,000[b]	100,000[b]
005F001	F03	11 - 12	3.7	83	4.7	13.0	5.3	--	27
005F002	F07	11 - 12	2.4	86	2.3	8.6	--	--	27
005F003	F04	7.5 - 8.5	3.8	68	1.5	9.7	--	--	21
005F004	F06	7.5 - 8.5	2.3	94	1.6	20.0	--	--	24

Table A.8-4
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 12-15-01
(Page 2 of 3)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	10,000[b]	100,000[b]
005F005	F02	7.5 - 8.5	4.1	130	1.7	48.0	--	--	23
005F006	F05	14 - 15	2.1	110	1.9	24.0	--	--	83
005F007		25 - 26	5.8	69	5.2	8.7	7.1	--	27
005F008		30 - 31	2.8	52	2.2	6.6	--	--	27
005F009		35 - 36	4.0	100	3.1	15.0	--	--	34
005F010	F01	11 - 12	2.4	75	4.0	11.0	--	--	27
005F011	F23	25 - 26	2.8	70	2.2 (J)[c]	8.9 (J)[d]	--	--	26
005F012		25 - 26	2.4	73	2.5 (J)[c]	11.0 (J)[d]	--	--	25
005F013		30 - 31	16.0	69	12.0 (J)[c]	14.0 (J)[d]	23.0	0.56	34
005F014	F22	25 - 26	2.6	63	2.4 (J)[c]	8.2 (J)[d]	--	--	21
005F015		30 - 31	2.4	100	8.8 (J)[c]	37.0 (J)[d]	--	--	18
005F016	F21	25 - 26	4.0	68	1.7 (J)[c]	8.7 (J)[d]	--	--	22
005F017		30 - 31	2.6	110	4.9 (J)[c]	32.0 (J)[d]	--	--	25
005F018	F24	25 - 26	3.1	81 (J)[e]	3.2	8.3 (J)[f]	--	--	20
005F019		30 - 31	5.1	61 (J)[e]	3.8	7.7 (J)[f]	4.5	--	26
005F020	F25	20 - 21	2.9	61 (J)[e]	1.8	7.5 (J)[f]	--	--	20
005F021	F26	11 - 12	3.3	72 (J)[e]	3.5	7.6 (J)[f]	--	--	21
005F022	F14	10 - 11	3.7	90 (J)[e]	2.9	10.0 (J)[f]	--	--	24
005F023		16 - 17	3.0	80 (J)[e]	2.3	7.9 (J)[f]	--	--	26
005F024	F15	16 - 17	2.6	79 (J)[e]	8.9	9.1 (J)[f]	--	--	22
005F025	F13	16 - 17	2.3	160 (J)[e]	1.7	9.5 (J)[f]	--	--	18
005F026	F12	16 - 17	2.5	87 (J)[e]	2.3	7.6 (J)[f]	--	--	18
005F027	F09	13 - 14	2.6	72 (J)[e]	2.6	8.7 (J)[f]	--	--	18
005F028	F10	13 - 14	2.0	71 (J)[e]	1.1	7.7 (J)[f]	--	--	19
005F029	F08	13 - 14	4.0	130 (J)[e]	5.0	28.0 (J)[f]	--	--	27
005F030	F11	13 - 14	2.9	85 (J)[e]	3.8	8.8 (J)[f]	--	--	19
005F031	F17	11 - 12	3.7	170	4.1 (J)[c]	77.0	5.7	--	33
005F032	F16	12.5 - 13.5	2.5	78	2.7 (J)[c]	8.8	--	--	16
005F033		12.5 - 13.5	2.6	59	1.7 (J)[c]	7.6	--	--	13
005F034	F19	12.5 - 13.5	3.3	110	1.6 (J)[c]	23.0	--	--	20
005F035	F18	11 - 12	3.3	110	2.2 (J)[c]	20.0	--	--	13

Table A.8-4
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 12-15-01
(Page 3 of 3)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)						
			Arsenic	Barium	Chromium	Lead	Nickel	Selenium	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	10,000[b]	100,000[b]
005F036	F20	16 - 17	2.7	110	2.1 (J)[c]	7.9	--	--	16
005F037	F31	16 - 17	3.3	66	1.7 (J)[c]	7.6	--	--	16

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[c]Qualifier added to laboratory data; record accepted. Serial dilution %D outside control limits. Matrix effects may exist.
[d]Qualifier added to laboratory data; record accepted. Duplicate precision analysis (relative percent difference) outside of control limits.
[e]Qualifier added to laboratory data; record accepted. Matrix spike recovery outside of control limits.
[f]Qualifier added to laboratory data; record accepted. Matrix spike recovery outside of control limits. Duplicate precision analysis (relative percent difference) outside of control limits.

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

A.8.2.5.4 Total Petroleum Hydrocarbon Analytical Results for Soil Samples

The TPH detected in soil samples at concentrations exceeding MRLs are listed in Table A.8-5. The TPH (DRO) was detected above the PAL of 100 mg/kg in samples 005F006 and 005F007 from boring F05 at CWA1. The estimated concentrations are 7,600 and 180 mg/kg, respectively. The TPH (GRO) was detected only in sample 005F006 at an estimated concentration of 740 mg/kg.

A.8.2.5.5 Gamma Spectrometry Analytical Results for Soil Samples

The gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.8-6. The isotopes Ac-228, Bi-214, Pb-212, Pb-214, K-40, and Tl-208 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results exceed background concentrations; therefore, PALs for these isotopes were not exceeded at CAS 12-15-01.

Table A.8-5
Soil Sample Results for TPH (DRO and GRO)
Detected Above Minimum Reporting Limits at CAS 12-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)	
			Diesel-Range Organics	Gasoline-Range Organics
Preliminary Action Level[a]			**100**	
005F006	F05	14 - 15	**7,600.0 (J)**[b]	**740 (J)**[c]
005F007		25 - 26	**180.0 (J)**[d]	--

[a]TPH PAL from *Nevada Administrative Code* (NAC, 2003)
[b]Qualifier added to laboratory data; record accepted. Surrogates diluted out. Total extractable petroleum hydrocarbons result quantitated from diesel standard calibration.
[c]Qualifier added to laboratory data; record accepted. Peak pattern for gasoline does not match.
[d]Qualifier added to laboratory data; record accepted. Total extractable petroleum hydrocarbons result quantitated from diesel standard calibration.

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

A.8.2.5.6 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.8-7. Data summaries for all of the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

- Based on saturated hydraulic conductivity measurements, cover soil has a lower permeability than subcell soil at CWA1; a higher permeability than subcell soil at T2; and a similar permeability to subcell soil at T1.
- Moisture content measurements show that the soil is well below saturation.
- Dry bulk densities ranged from 1.36 to 1.65 g/cm^3 in cover soil and from 1.49 to 1.67 g/cm^3 in subcell native soil. Generally, cover soil had lower densities than subcell soil.
- Porosities in cover soil ranged from 37.7 to 48.7 percent while subcell soil porosities ranged from 37.0 to 43.6 percent. Generally, cover porosities were greater than subcell porosities.

Table A.8-6
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 12-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			3.64	3.47	3.64	3.47	31.1	3.38
005F004	F06	7.5 - 8.5	1.84 ± 0.67	0.91 ± 0.38	1.39 ± 0.36	0.97 ± 0.31	24.5 ± 6.0	0.48 ± 0.20
005F008	F05	30 - 31	1.80 ± 0.56	--	2.00 ± 0.42	--	26.8 ± 5.6	0.52 ± 0.17
005F011	F23	25 - 26	1.75 ± 0.49	--	1.95 ± 0.40	1.07 ± 0.28	27.0 ± 5.4	0.53 ± 0.16
005F012		25 - 26	1.64 ± 0.57	0.85 ± 0.36	2.08 ± 0.46	1.30 ± 0.35	30.4 ± 6.8	0.43 ± 0.19
005F016	F21	25 - 26	1.80 ± 0.60	--	1.69 ± 0.41	0.75 ± 0.27	27.3 ± 6.2	0.58 ± 0.22
005F020	F25	20 - 21	1.92 ± 0.50	0.87 ± 0.32	1.98 ± 0.40	1.15 ± 0.30	29.7 ± 5.8	0.79 ± 0.21
005F024	F15	16 - 17	1.61 ± 0.60	--	1.72 ± 0.42	0.88 ± 0.30	24.8 ± 6.3	0.47 ± 0.20
005F028	F10	13 - 14	1.62 ± 0.46	--	2.05 ± 0.41	1.12 ± 0.27	28.3 ± 5.5	0.62 ± 0.17
005F032	F16	12.5 - 13.5	1.87 ± 0.61	1.08 ± 0.42	1.66 ± 0.43	1.01 ± 0.33	29.5 ± 6.8	0.88 ± 0.27
005F033		12.5 - 13.5	2.36 ± 0.75	1.13 ± 0.44	1.90 ± 0.46	0.86 ± 0.30	26.7 ± 6.6	0.56 ± 0.23
005F036	F20	16 - 17	1.73 ± 0.59	0.80 ± 0.34	1.78 ± 0.42	0.87 ± 0.30	22.0 ± 5.6	0.51 ± 0.20

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991)

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

A.8.2.6 Contaminants of Concern

Based on the aforementioned analytical results, TPH (DRO and GRO) and dichlorobenzenes (1,2- and 1,4-) are COCs at CAS 12-15-01.

A.8.3 Nature and Extent of Contamination

Contaminants of concern were detected only in boring F05 at CWA1. The COCs 1,2-dichlorobenzene, 1,4-dichlorobenzene, TPH (DRO), and TPH (GRO) were detected in sample 005F006 collected from 14 to 15 ft bgs. The TPH (GRO) was detected only in sample 005F007 that was collected from 25 to 26 ft bgs.

Table A.8-7
Soil Sample Results for Select Geotechnical Parameters at CAS 12-15-01

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat[a] (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005F402	CWA1	0 - 1	4.1E-06	5.9	9.7	1.65	1.75	37.7
005F401		8.5 - 9.5	5.4E-05	7.4	11.0	1.49	1.60	43.6
005F404	T1	0 - 1	1.1E-04	10.4	14.2	1.37	1.51	48.5
005F403		14 - 15	1.1E-04	6.7	11.3	1.67	1.78	37.0
005F406	T2	0 - 1	3.1E-04	9.3	12.6	1.36	1.49	48.7
005F407		17 - 18	6.7E-06	7.0	11.6	1.66	1.78	37.4

[a]Constant head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

The core interval from 8.5 to 26.0 ft bgs was described as medium, green, gravelly sand and the above samples were described as having a strong hydrocarbon odor. Field-screening results for TPH (DRO) from 9 to 26 ft bgs ranged from 116 to 302 ppm; readings from above and below this interval were less than the FSL of 75 ppm. Deeper samples collected from 30 to 31 ft bgs and 35 to 36 ft bgs were free of contamination, as shown by laboratory analysis. These observations, FSRs, and analytical data suggest sewage sludge, possibly containing some types of solvents or hydrocarbon waste, was disposed of at this location and that the vertical extent of contamination is confined to an interval from 9 to 30 ft bgs. This interval extends below the base of CWA1 and varies from 7.5 to 11 ft bgs as determined by excavation.

Samples from four step-out borings were also free of contamination, as shown by field screening and analytical results. Thus, the lateral extent of contamination is confined to an area of about 220 by 160 ft around the immediate vicinity of boring F05, as shown in Figure A.8-1.

A.8.4 Revised Conceptual Site Model

No variations in the CSM were identified.

A.9.0 CAS 20-15-01, Landfill

This landfill is located on Pahute Mesa in Area 20 and is historically described as a “clean” landfill that was operational from 1982 through 1991. The landfill accepted wood, miscellaneous construction debris, and possibly sanitary sewage. Aerial photographs and investigation excavations confirm this landfill is a single excavation or open dump with no disposal trenches. Four monuments denote the landfill boundaries and identify the site as a construction landfill. Additional detail is provided in the CAIP.

A.9.1 Corrective Action Investigation

Five site characterization samples (including a field duplicate) and six geotechnical samples were collected by rotary sonic drilling and are listed in Table A.9-1. Figure A.9-1 is a site sketch showing excavation and sampling locations at CAS 20-15-01. The activities conducted to meet the CAIP requirements at CAS 20-15-01 are discussed in the following sections.

A.9.1.1 CAIP Implementation

The following activities were conducted at CAS 20-15-01 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste
- Backhoe excavations at preselected locations to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, and verify the lateral boundaries of the disposal features
- Rotary sonic drilling at locations identified during excavation to collect samples at intervals corresponding to the base of disposal features
- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of disposal features
- Topographic survey to determine the slope of the cover
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

Table A.9-1
Samples Collected at CAS 20-15-01, Landfill

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
005G001	G03	T1	16 - 17	Soil	SC, WM	Set 1, GS
005G002			16 - 17	Soil	Field Duplicate of 005G001	Set 1, GS
005G003	G02		15 - 16	Soil	SC	Set 1
005G004	G01		15 - 16	Soil	SC, WM, Lab QC	Set 1, GS
005G005	G04		15 - 16	Soil	SC	Set 1
Geotechnical Samples						
005G401	G03	T1	16.5 - 17.5	Soil	Geotechnical	Set 2
005G402	G02		17.5 - 18.5	Soil	Geotechnical	Set 2
005G403	G01		17.5 - 18.5	Soil	Geotechnical	Set 2
005G404	G05		0 - 1	Soil	Geotechnical	Set 2
005G405	G06		0 - 1	Soil	Geotechnical	Set 2
005G406	G07		0 - 1	Soil	Geotechnical	Set 2
Quality Control Samples						
005G301	NA	NA	NA	Water	Trip Blank	Total VOCs

Set 1 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs
Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics

SC = Site characterization
WM = Waste management
QC = Quality control
NA = Not applicable
ft bgs = Feet below ground surface
GS = Gamma spectrometry
T = Trench

A.9.1.2 Deviations

There was one minor deviation to the CAIP investigation strategy. Site characterization samples were collected deeper than the preselected disposal feature basal depth determined by the geophysical survey. The deeper sampling intervals were selected at a caliche hardpan, determined by increased drilling resistance and lithology. It was decided a hardpan would be where contaminants would accumulate (if present) and the deeper depths were judged to better satisfy the CAIP objective of sampling at the base of the disposal feature.

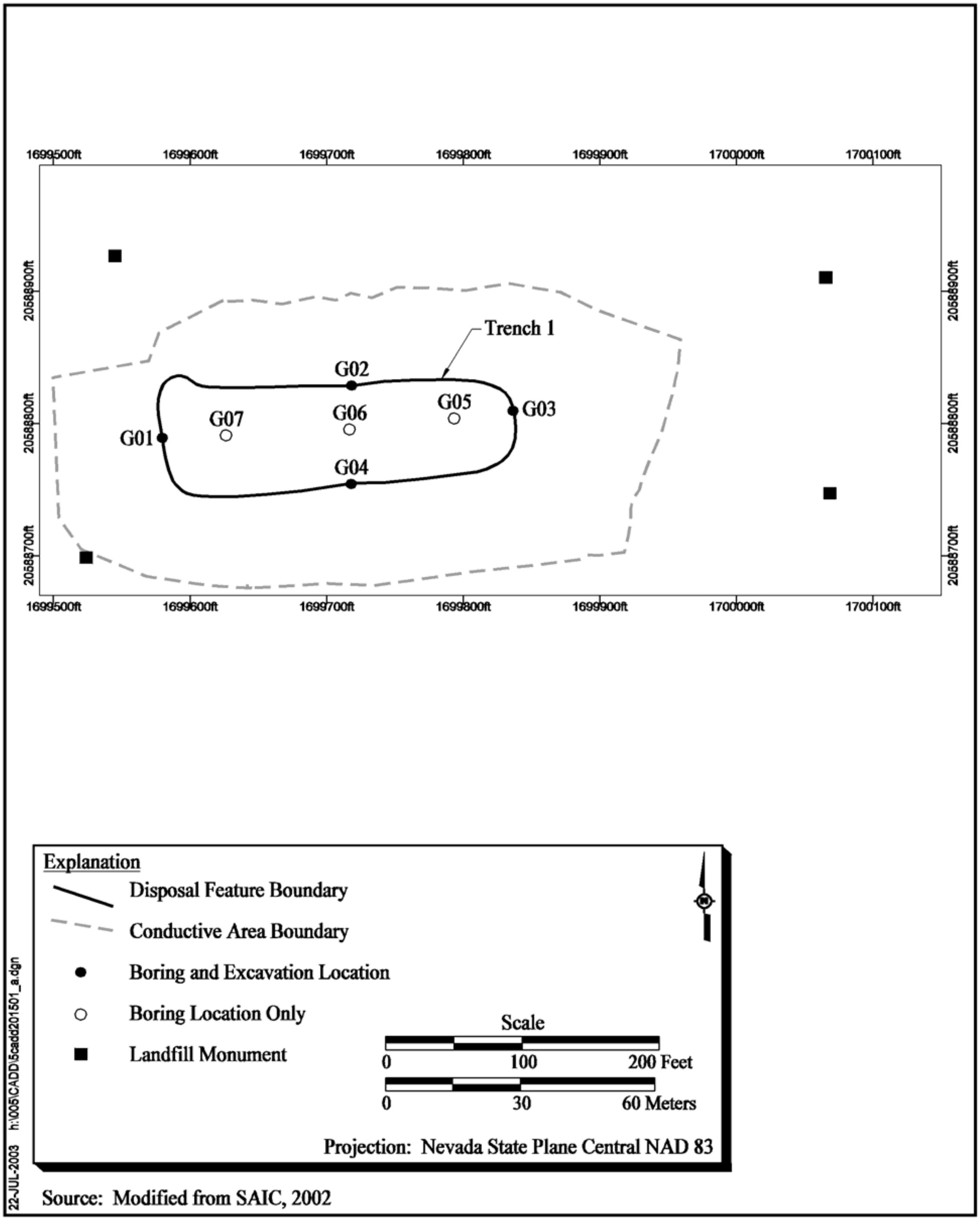

Figure A.9-1
Site Sketch and Sampling Locations at CAS 20-15-01, Sanitary Landfill

A.9.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.9.2.1 Geophysical Survey

An EM31 terrain conductivity survey was conducted along traverses with a 10-ft separation. The survey identified a single trench-like feature (T1) and possible conductive material. A utility cable visible on the ground surface was also identified by the EM31 survey.

Two EI traverses were conducted to define the vertical limits of the disposal feature. The traverses trended north to south and showed the base of the T1 at approximately 12 to 14 ft bgs.

A.9.2.2 Excavation, Drilling, and Sampling

Four backhoe excavations were made to determine the thickness of cover material and verify the lateral boundaries of T1. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal feature, as determined by excavation. Site characterization samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from EI geophysical traverses and excavation. Excavation, drilling, and sampling details are discussed in the following subsections.

A.9.2.2.1 Trench 1

Four excavations (G01 through G04) were made to investigate T1, as shown in Figure A.9-1. Fill material containing plastic debris was found at all the excavations, underlying a consistent 2-ft thick gravel cover. In addition, minor amounts of wood and metal scrap was found in excavation G03. The east, north, west, and south edges were established by excavations G01, G02, G03, and G04, respectively. The lateral extent of T1 as established by excavation is generally consistent with the geophysical survey.

Four borings (G01 through G04) were drilled at locations determined from excavation. The geophysical survey indicated the base of T1 at 12 to 14 ft bgs. However, harder drilling, lithology, and the presence of a caliche hardpan at 15 to 17 ft bgs suggest the base of T1 is deeper than indicated by the geophysical survey. Thus, the core intervals from 5 to 6 ft bgs, 10 to 11 ft bgs, 15 to 16 ft bgs, 17.5 to 18.5 ft bgs, 20 to 21 ft bgs, and 25 to 26 ft bgs were field screened. Based on FSRs less than FSLs and the observations discussed above, core intervals from 15 to 16 ft bgs and from 16 to 17 ft bgs were sent for off-site analysis.

Six geotechnical samples were collected at T1; three in cover material from 0 to 1 ft bgs and three in native soil (one from 16.5 to 17.5 ft bgs and two from 17.5 to 18.5 ft bgs).

A.9.2.3 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. A topographic map of CAS 20-15-01 was prepared and is included in the engineering drawings in Appendix H.

The ground surface at CAS 20-15-01 is relatively flat, sloping from the northeast to southwest at approximately 1.6 percent. There are no noticeable topographic highs or lows at the site.

A.9.2.4 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs including total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), and PCBs. Twenty-five percent of the soil samples were also analyzed for gamma spectrometry for waste management purposes. The trip blank was analyzed only for total VOCs.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.9.2.5 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Total VOCs
- Total SVOCs
- Ethylene glycol

- TPH (DRO and GRO)
- PCBs

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total RCRA metals, nickel, and zinc
- Gamma-emitting radionuclides

A.9.2.5.1 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.9-2. Arsenic, barium, chromium, lead, nickel, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below PALs established in the CAIP.

Table A.9-2
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 20-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)					
			Arsenic	Barium	Chromium	Lead	Nickel	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	41,000[b]	100,000[b]
005G001	G03	16 - 17	8.7	87	3.0 (J)	3.7	5.4	15
005G002		16 - 17	8.4	89	3.1 (J)	3.8	5.4	15
005G003	G02	15 - 16	3.5	46	1.6 (J)	2.8	--	12
005G004	G01	15 - 16	8.0	81	4.1 (J)	4.8	5.7 (J)	18 (J)
005G005	G04	15 - 16	2.2	36	1.5 (J)	2.1	--	10 (J)

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
J = Estimated value. Qualifier added to laboratory data; record accepted. Serial dilution %D outside of control limits. Matrix effects may exist.

A.9.2.5.2 Gamma Spectrometry Analytical Results for Soil Samples

The gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.9-3. The isotopes Ac-228, Bi-214, Pb-212, Pb-214, K-40, and Tl-208 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results exceed background concentrations; therefore, PALs for these isotopes were not exceeded at CAS 20-15-01.

Table A.9-3
Soil Sample Results for Gamma-Emitting Radionuclides Detected Above Minimum Reporting Limits at CAS 20-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)					
			Actinium-228	Bismuth-214	Lead-212	Lead-214	Potassium-40	Thallium-208
Preliminary Action Levels[a]			3.64	3.47	3.64	3.47	31.1	3.38
005G001	G03	16 - 17	--	--	--	0.83 ± 0.25	6.3 ± 2.6	--
005G002		16 - 17	--	--	--	0.98 ± 0.31	7.3 ± 3.2	--
005G004	G01	15 - 16	1.32 ± 0.46	0.79 ± 0.32	1.67 ± 0.36	1.13 ± 0.29	15.0 ± 3.7	0.44 ± 0.16

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991)

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

A.9.2.5.3 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.9-4. Data summaries for all of the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

- Based on saturated hydraulic conductivity measurements, cover soil has lower permeabilities than subcell soil.
- Moisture content measurements show that the soil is well below saturation.
- Dry bulk densities ranged from 1.38 to 1.51 g/cm^3 in cover soil and from 1.17 to 1.70 g/cm^3 in subcell native soil. These results show densities of cover soil and subcell soil are generally equivalent.

- Porosities in cover soil ranged from 42.9 to 48.0 percent while subcell soil porosities ranged from 35.8 to 56.0 percent. Cover porosities were generally less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

Table A.9-4
Soil Sample Results for Select Geotechnical Parameters at CAS 20-15-01

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat[a] (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005G404	T1	0 - 1	4.4E-04	9.3	12.8	1.38	1.50	48.0
005G405		0 - 1	7.0E-04	8.3	11.9	1.43	1.54	46.2
005G406		0 - 1	4.9E-05	16.1	24.4	1.51	1.76	42.9
005G401		16.5 - 17.5	7.5E-04	13.0	16.9	1.30	1.47	50.8
005G402		17.5 - 18.5	1.9E-04	10.7	18.2	1.70	1.88	35.8
005G403		17.5 - 18.5	1.4E-03	23.3	27.2	1.17	1.44	56.0

[a]Constant head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

A.9.2.6 Contaminants of Concern

Based on the aforementioned analytical results, no COCs are migrating from CAS 20-15-01.

A.9.3 Nature and Extent of Contamination

Since COCs are not migrating, the extent of any contamination that may be present at CAS 20-15-01 is limited to within the boundaries of the subsurface disposal features.

A.9.4 Revised Conceptual Site Model

No variations in the CSM were identified.

A.10.0 CAS 23-15-03, Disposal Site

There are two discrete areas of interest at this CAS: a surface disposal area (Disposal Area) and a landfill (Landfill). The Disposal Area is located within the WSI Protective Forces Training Complex and was active from 1970 to 1973. Burning in the disposal area ceased in 1971; however, the area continued to be used for surface dumping until 1973. Burned tires, asphalt, and other material (e.g., tire soap, miscellaneous surface debris) is present on the ground surface.

The Landfill is located within and adjacent to the active Area 23 Sanitary Landfill. A burn pit, located in the western portion of the Landfill, was used from 1952 through 1971. In 1971, burning operations ceased but disposal activities in the area continued until 1976. During the mid- to late-1980s, the solid waste trenches were completely filled in and became the foundation for the Area 23 Sanitary Landfill. Additional detail is provided in the CAIP.

A.10.1 Corrective Action Investigation

Forty-six site characterization samples (including three field duplicates) and six geotechnical samples were collected by rotary sonic drilling, and are listed in Table A.10-1. Site sketches showing excavations and sampling locations at the Disposal Area and Landfill are shown in Figure A.10-1 and Figure A.10-2, respectively. Figure A.10-3 shows travel corridors at the Landfill. The activities conducted to meet the CAIP requirements at CAS 23-15-03 are discussed in the following sections.

Table A.10-1
Samples Collected at CAS 23-15-03, Disposal Site
(Page 1 of 4)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
Site Characterization Samples						
Disposal Area						
005H003	H03	CWA1	1 - 2	Soil	SC	Set 5
005H001	H04	CWA2	0.5 - 1.5	Soil	SC	Set 5
005H002	H05		3 - 4	Soil	SC	Set 5
005H004	H02	MWA2	2.5 - 3.5	Soil	SC, WM, Lab QC	Set 5, GS
005H006	H06	MWA3	1.5 - 2.5	Soil	SC	Set 5
005H005	H01	MWA4	1 - 2	Soil	SC	Set 5

Table A.10-1
Samples Collected at CAS 23-15-03, Disposal Site
(Page 2 of 4)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
005H037	H41	Disposal Area Step-outs	1.5 - 2.5	Soil	SC	Set 5
005H038	H42		1.5 - 2.5	Soil	SC	Set 5
005H039	H43		1.5 - 2.5	Soil	SC, WM	Set 5, GS
005H040			1.5 - 2.5	Soil	Field Duplicate of 005H039	Set 5, GS
005H041	H44		2 - 3	Soil	SC, WM, Lab QC	Set 5, GS
Landfill						
005H012	H11	T1	5.5 - 6.5	Soil	SC, WM	Set 5, GS
005H013	H13		4.5 - 5.5	Soil	SC	Set 5, Dioxins
005H014	H10		2 - 3	Soil	SC	Set 5
005H015	H09		4 - 5	Soil	SC	Set 5, Dioxins
005H016	H12		6 - 7	Soil	SC, WM	Set 5, GS
005H034	H14		5.5 - 6.5	Soil	SC	Set 5
005H035	H08		5.5 - 6.5	Soil	SC	Set 5
005H036	H07		5.5 - 6.5	Soil	SC, WM	Set 5, GS
005H042	H45	Step-out at T1	3.5 - 4.5	Soil	SC	Set 5
005H043	H46		2.5 - 3.5	Soil	SC	Set 5
005H044	H47		3.5 - 4.5	Soil	SC	Set 5
005H045	H48		5 - 6	Soil	SC	Set 5
005H046	H49		10 - 11	Soil	SC, WM	Set 5, GS
005H011	H18	T2	11 - 12	Soil	SC	Set 5
005H019	H16		13 - 14	Soil	SC	Set 5
005H021	H17		13 - 14	Soil	SC	Set 5
005H022	H15		13 - 14	Soil	SC	Set 5
005H032	H19		13 - 14	Soil	SC	Set 5
005H033	H36		13 - 14	Soil	SC, WM	Set 5, GS
005H010	H24	T3	5 - 6	Soil	SC	Set 5
005H018	H25		5 - 6	Soil	SC	Set 5
005H030	H23		5 - 6	Soil	SC	Set 5
005H031	H37		5 - 6	Soil	SC	Set 5

Table A.10-1
Samples Collected at CAS 23-15-03, Disposal Site
(Page 3 of 4)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
005H017	H26	T4	6 - 7	Soil	SC	Set 5
005H020	H27		6 - 7	Soil	SC, WM	Set 5, GS
005H024	H28		6 - 7	Soil	SC, WM, Lab QC	Set 5, GS
005H028	H29		8.5 - 9.5	Soil	SC, WM	Set 5, GS
005H029			8.5 - 9.5	Soil	Field Duplicate of 005028	Set 5, GS
005H007	H31	T5	8 - 9	Soil	SC	Set 5
005H027	H30		8 - 9	Soil	SC	Set 5
005H008	H32	T6	8 - 9	Soil	SC, WM	Set 5, GS
005H009			8 - 9	Soil	Field Duplicate of 005H008	Set 5, GS
005H025	H34		8 - 9	Soil	SC	Set 5
005H026	H33		8 - 9	Soil	SC	Set 5
005H023	H35	HCA5	3 - 4	Soil	SC	Set 5
Geotechnical Samples						
005H404	H38	T1	0 - 1	Soil	Geotechnical	Set 2
005H403	H11		7 - 8	Soil	Geotechnical	Set 2
005H405	H39	T2	0 - 1	Soil	Geotechnical	Set 2
005H402	H18		13 - 14	Soil	Geotechnical	Set 2
005H406	H40	T3	0 - 1	Soil	Geotechnical	Set 2
005H401	H24		6 - 7	Soil	Geotechnical	Set 2
Quality Control Samples						
005H301	NA	NA	NA	Water	Trip Blank	Total VOCs
005H302	NA	NA	NA	Water	Trip Blank	Total VOCs
005H303	NA	NA	NA	Water	Trip Blank	Total VOCs
005H304	NA	NA	NA	Water	Trip Blank	Total VOCs
005H305	NA	NA	NA	Water	Trip Blank	Total VOCs
005H306	NA	NA	NA	Water	Field Blank	Set 5, GS, Dioxins
005H307	NA	NA	NA	Water	Equipment Rinsate Blank	Set 5, GS, Isotopic Pu, Sr-90, Dioxins
005H308	NA	NA	NA	Water	Trip Blank	Total VOCs
005H309	NA	NA	NA	Water	Equipment Rinsate Blank	Set 5, GS, Isotopic Pu, Sr-90, Dioxins

Table A.10-1
Samples Collected at CAS 23-15-03, Disposal Site
(Page 4 of 4)

Sample Number	Sample Location	Disposal Feature	Depth (ft bgs)	Sample Matrix	Sample Type	Analyses
005H310	NA	NA	NA	Water	Trip Blank	Total VOCs
005H311	NA	NA	NA	Water	Field Blank	Set 5, GS
005H313	NA	NA	NA	Water	Trip Blank	Total VOCs
005H314	NA	NA	NA	Water	Trip Blank	Total VOCs
005H315	NA	NA	NA	Water	Trip Blank	Total VOCs

Set 2 = Moisture content, bulk density, calculated total porosity, saturated hydraulic conductivity, calculated unsaturated hydraulic conductivity, particle-size analysis/soil classification, and moisture characteristics
Set 5 = Total VOCs, Total SVOCs, Ethylene Glycol, Total RCRA Metals, Nickel, Zinc, TPH (DRO and GRO), PCBs, Pesticides

SC = Site characterization
WM = Waste management
NA = Not applicable
QC = Quality control
ft bgs = Feet below ground surface
GS = Gamma spectrometry
CWA = Conductive waste area
HCA = High conductive area
MWA = Metallic waste area
T = Trench
Sr-90 = Strontium-90
Pu = Plutonium

A.10.1.1 CAIP Implementation

The following activities were conducted at CAS 23-15-03 to meet CAIP requirements:

- Geophysical survey to identify subsurface waste
- Backhoe excavations at locations identified from the geophysical survey to confirm the presence of disposal features, determine the cover thickness, determine the nature of buried waste, verify the lateral boundaries of the disposal features, and determine bases of certain disposal features
- Rotary sonic drilling at locations identified during excavation to collect samples beneath surface debris, at intervals corresponding to the base of disposal features, and at other intervals determined by biasing factors (e.g., visual observation of drill core)
- Rotary sonic drilling at step-out locations to collect samples to delineate the lateral extent of possible debris or contamination

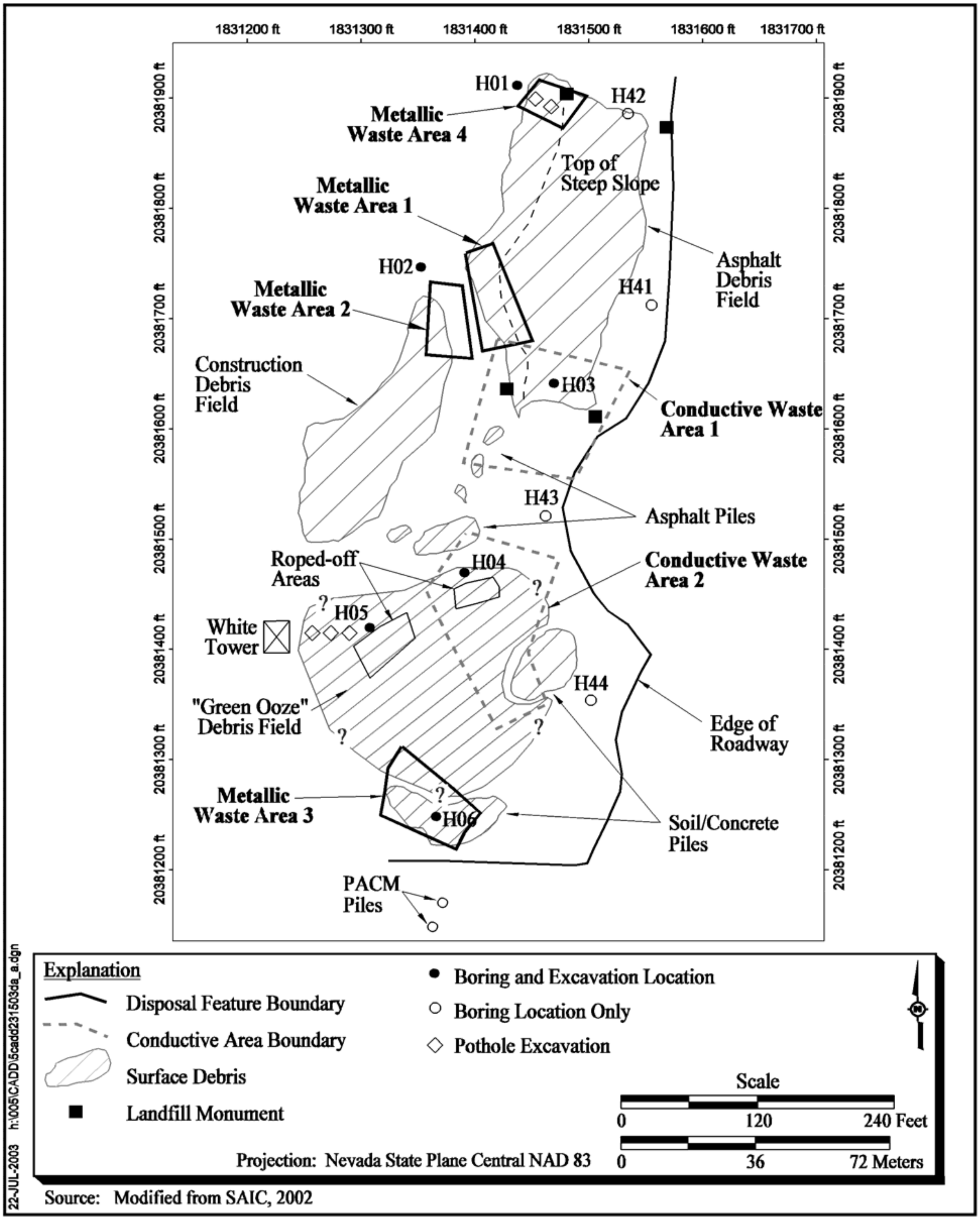

Figure A.10-1
Site Sketch and Sampling Locations at CAS 23-15-03, Disposal Site (Disposal Area)

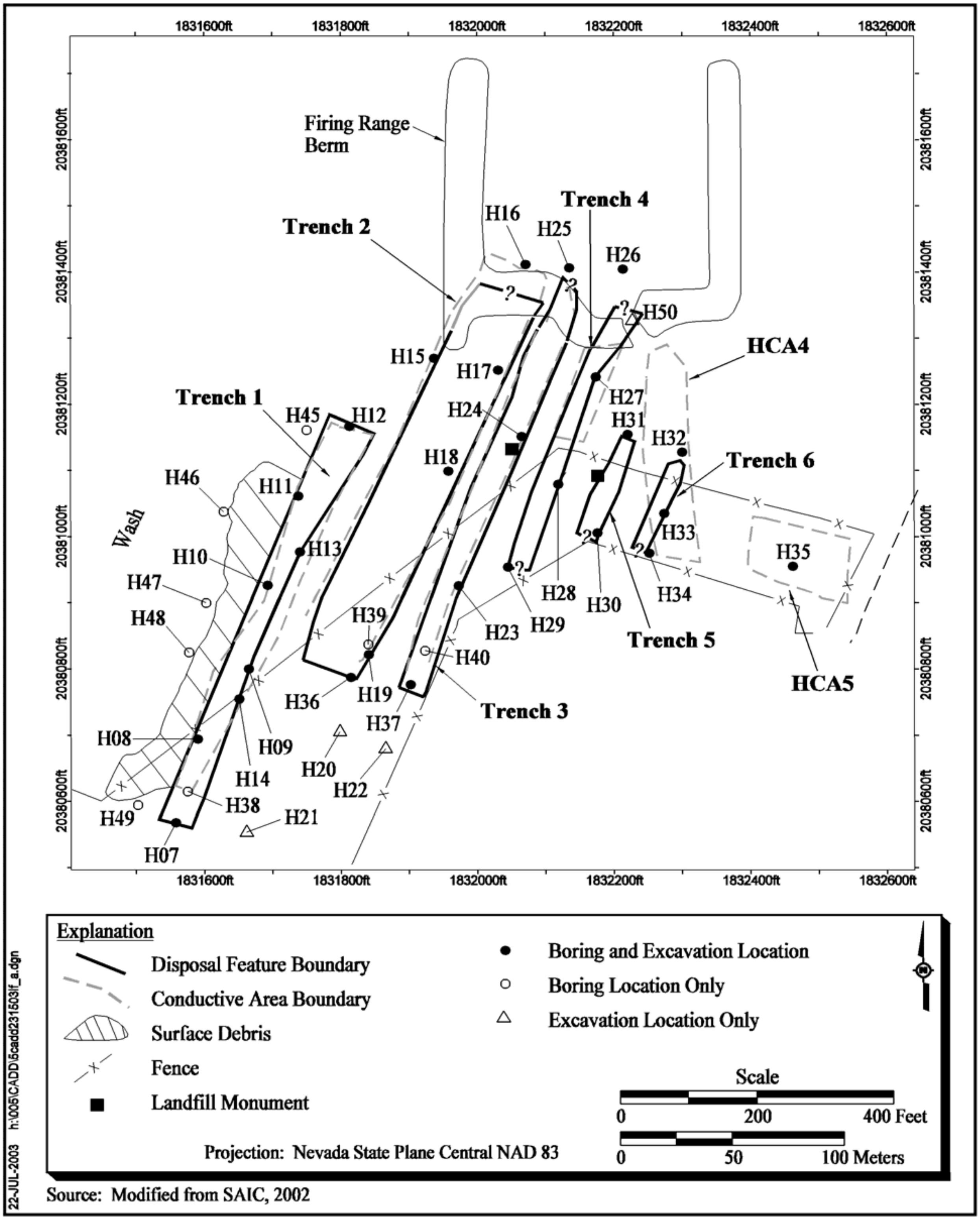

Figure A.10-2
Site Sketch and Sampling Locations at CAS 23-15-03, Disposal Site (Landfill)

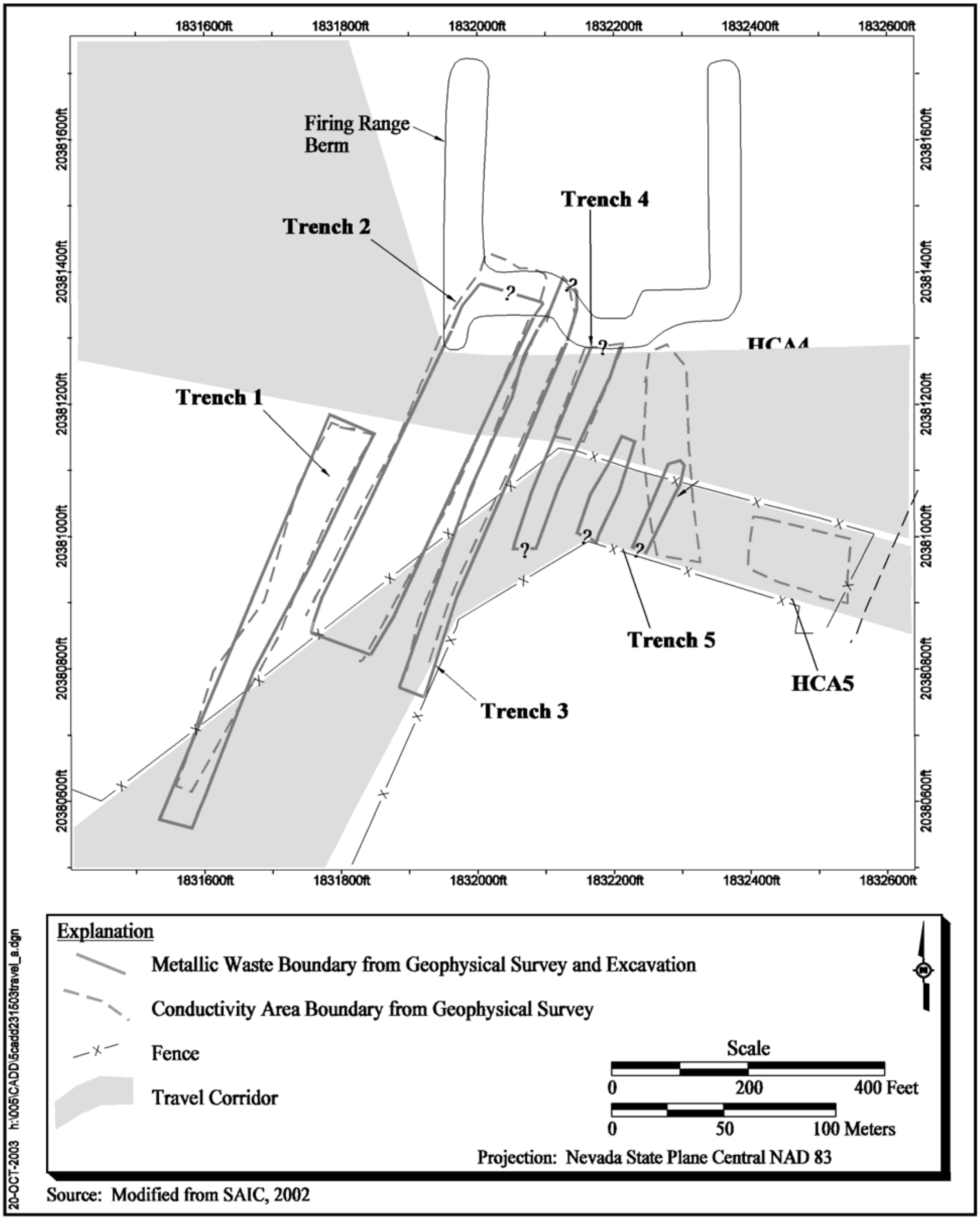

Figure A.10-3
Travel Corridors at CAS 23-15-03, Disposal Site (Landfill)

- Rotary sonic drilling to collect geotechnical samples from cover material and from native soil at intervals beneath the base of disposal features
- Topographic survey to determine the slope of the cover
- Field screened selected drill core intervals for VOCs, radionuclides, and TPH (DRO)
- Submitted samples for off-site laboratory analysis of chemical, radiological, and geotechnical parameters

A.10.1.2 Deviations

There were no deviations to the CAIP investigation strategy; therefore, the CAIP requirements were met.

A.10.2 Investigation Results

The following subsections provide CAS-specific details of the geophysical survey, excavations, drilling, sampling, topographic survey, sample analysis, and analytes detected above MRLs.

A.10.2.1 Geophysical Survey

An EM31 terrain conductivity survey was conducted along traverses with a 10-ft separation over the Disposal Area and Landfill. At the Disposal Area, the survey confirmed the existence of waste material and identified four MWAs (MWA1 through MWA4) that are associated with surface metallic debris. Two CWAs (CWA1 and CWA2) were also identified that may indicate other subsurface changes or waste material. An EI survey was not conducted due to the small size of the anomalies.

At the Landfill, the survey confirmed the existence of buried material and identified six disposal features (T1 through T6) that may contain both metallic and conductive material. The boundaries of T1, T2, and T3 coincide with areas of high conductivity, and T6 lies partially within another HCA (HCA4). An anomalous HCA (HCA5) was identified that does not appear to coincide with a disposal feature.

Two EI traverses were conducted to define the vertical limits of the landfill disposal features. The traverses trended northwest to southeast across all the disposal features, except T1. The EI traverses showed the base of T2 at approximately 12 to 14 ft bgs, T3 at 5 ft bgs, T4 at 6 ft bgs, and T5 and T6 at 8 ft bgs.

A.10.2.2 Excavation, Drilling, and Sampling at Disposal Area

Six backhoe excavations and five potholes were made at the various Disposal Area targets to determine the thickness of cover material, verify the lateral boundaries, and determine the base of the disposal features. Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation or site observations of surface debris. Eleven site characterization samples (including one field duplicate) were collected. Six of the samples were collected in native soil at depths corresponding to the base of the surface debris and/or at a caliche hardpan, as determined from excavation. Five of the samples were collected from step-out borings along the east side of the Disposal Area. Section A.10.2.2.6 provides additional detail about the Disposal Area step-out borings and samples.

A.10.2.2.1 Conductive Waste Area 1

One excavation (H03) was made to investigate CWA1, as shown in Figure A.10-1. Surface debris consisting mostly of asphalt with some small-arms shell casings was found from the surface to 1 ft bgs. A caliche hardpan was encountered at 2.5 ft bgs. Surface debris is visible and widely scattered around the northern portion of CWA1. Excavation did not identify a subsurface disposal feature at CWA1; debris apparently was disposed of on the surface and was not placed into a trench. Additional detail about the debris is provided in Section A.10.2.2.7.

One boring (H03) was drilled at a location determined from excavation. Excavation showed surface debris extending to 1 ft bgs. Core intervals from 1 to 2 ft bgs, 6 to 7 ft bgs, and 11 to 12 ft bgs were field screened. Based on FSRs less than FSLs and debris extending to 1 ft bgs, the core from 1 to 2 ft bgs was submitted for off-site analysis. There were no geotechnical samples collected at CWA1 because a disposal feature was not present.

A.10.2.2.2 Conductive Waste Area 2

Two excavations (H04 and H05) and three potholes were made to investigate CWA2, as shown in Figure A.10-1. Excavation H04, located inside a fenced enclosure around the reported “green ooze” (tire soap), encountered minor concrete and dried "green ooze" from 1 in. to 0.5 ft bgs. A caliche hardpan was encountered at 5 ft bgs. Excavation H05, also located within a fenced enclosure, encountered gravelly soil with minor amounts of plastic, rubber, concrete, and transite pipe from 1 in. to 3 ft bgs. At this interval, a layer of damp "green ooze" was found from 1 to 3 ft bgs. Three pothole excavations (spaced 20, 40, and 60 ft northwest of H05) encountered similar debris (except the "green ooze") from the surface to 1.5 ft bgs. Excavation did not identify a subsurface disposal feature at CWA2; debris apparently was disposed of on the surface and was not placed into a trench. Additional detail about the debris is provided in Section A.10.2.2.7.

Two borings (H04 and H05) were drilled at locations determined from excavation. Excavation showed debris extending to depths varying from 0.5 to 3 ft bgs, as discussed above. At H04, core intervals from 0.5 to 1.5 ft bgs and 4 to 5 ft bgs were field screened. Core refusal was encountered at 5 ft bgs so it was not possible to collect a deeper interval for field screening. Based on FSRs less than FSLs and debris extending to 0.5 ft bgs, the core from 0.5 to 1.5 ft bgs was selected for off-site analysis. At H05, core intervals from 2 to 3 ft bgs, 3 to 4 ft bgs, 8 to 9 ft bgs, and 12 to 13 ft bgs were field screened. The core from 3 to 4 ft bgs was selected for off-site analysis since FSRs were less than FSLs and debris extended to 3 ft bgs. There were no geotechnical samples collected at CWA2 because a disposal feature was not present.

A.10.2.2.3 Metallic Waste Area 1 and Metallic Waste Area 2

The MWA1 and MWA2 are contiguous to each other and were investigated as a single unit. One excavation (H02) was made to investigate the area, as shown in Figure A.10-1. Metallic debris was encountered from the surface to 2.5 ft bgs. Surface debris is visible and widely scattered over most of the area. Excavation did not identify a subsurface disposal feature at MWA1/MWA2; debris was disposed of on the surface and was not placed into a trench. Additional detail about the debris is provided in Section A.10.2.2.7.

One boring (H02) was drilled at a location determined from excavation. Excavation showed surface debris extending to 2.5 ft bgs, as discussed above. Core intervals from 2.5 to 3.5 ft bgs and 4 to 5 ft bgs were field screened. Core refusal was encountered at 6 ft bgs so it was not possible to collect a deeper interval for field screening. The core from 2.5 to 3.5 ft bgs was selected for off-site analysis since FSRs were less than FSLs and debris extended to 2.5 ft bgs. There were no geotechnical samples collected at MWA2 because a disposal feature was not present.

A.10.2.2.4 Metallic Waste Area 3

One excavation (H06) was made to investigate MWA3, as shown in Figure A.10-1. At the northeast end of the excavation on the hill slope, soil containing asphalt and concrete was found from the surface to 2 ft bgs. At the bottom of the hill, soil containing lesser amounts of asphalt and concrete was found from the surface to 1 ft bgs. A caliche hardpan was encountered at 4.5 ft bgs. Surface debris is scattered on the surface over most of MWA3. Excavation did not identify a subsurface disposal feature at MWA3; debris was disposed of on the surface and was not placed into a trench. Additional detail about the debris is provided in Section A.10.2.2.7.

One boring (H06) was drilled at a location determined from excavation. Excavation showed surface debris extending to 2 ft bgs, as discussed above. Core intervals from 1.5 to 2.5 ft bgs, 6 to 7 ft bgs, and 11 to 12 ft bgs were field screened. The core from 1.5 to 2.5 ft bgs was selected for off-site analysis since FSRs were less than FSLs and debris extended to 2 ft bgs. There were no geotechnical samples collected at MWA3 because a disposal feature was not present.

A.10.2.2.5 Metallic Waste Area 4

One excavation (H01) and two potholes were made to investigate MWA4, as shown in Figure A.10-1. The excavation was made in the bottom of the north/south-trending wash in the area. One pothole was located at the toe of the hill slope at the edge of the wash and the other pothole was located about halfway up the hill slope. At all locations, 1 to 3 in. of burned surface debris was found, overlying undisturbed caliche sediments. On the hilltop, surface debris consisting of small-arms shell casings and asphalt was observed to a depth of 1 to 2 ft bgs. Excavation did not identify a subsurface disposal feature at MWA4; debris was disposed of on the surface and was not placed into a trench. Additional detail about the debris is provided in Section A.10.2.2.7.

One boring (H01) was drilled at a location determined from excavation. Excavation showed surface debris extending to 2 ft bgs, as discussed above. Core intervals from 1 to 2 ft bgs, 6 to 7 ft bgs, and 11 to 12 ft bgs were field screened. The core from 1 to 2 ft bgs was selected for off-site analysis since

FSRs were less than FSLs and debris extended to 2 ft bgs. There were no geotechnical samples collected at MWA4 because a disposal feature was not present.

A.10.2.2.6 Disposal Area Step-out Borings

Four step-out boring locations (H41 through H44) were located east of the Disposal Area along the north/south-trending access road, as shown in Figure A.10-1. The purpose of these borings was to delineate the lateral extent of possible debris/contamination to the east since excavation did not definitively identify the eastward extent of debris. At each boring except H44, the core interval from 1.5 to 2.5 ft bgs was field screened. At boring H44, the interval from 2 to 3 ft bgs was field screened. Refusal was encountered at 2.5 to 3 ft bgs, so it was not possible to collect deeper samples for field screening. Based on FSRs less than FSLs, drilling refusal, lack of debris in core, and no other biasing factors, the cores from 1.5 to 2.5 ft bgs (borings H41 through H44) 2 to 3 ft bgs (boring H44) were sent for off-site analysis.

A.10.2.2.7 Disposal Area Surface Debris

Surface debris is scattered over much of the Disposal Area portion of CAS 23-15-03, as shown in Figure A.10-1. Most of the material is found in three debris fields; there are also several debris piles throughout the site. The following subsections describe each area of surface debris.

Asphalt Debris Field

Material here consists mostly of asphalt, with some areas of burned material and many coiled rolls of thin wire. The field, extending over approximately 31,375 ft^2, is located at the north end of the CAS and is bordered by the north/south-trending access road to the east and the bottom of the steep wash to the west. Most of the debris field is on a flat area between the road and the wash and is visible as a layer of waste at the top of the hill. In some places the wastes drapes over the side of the hill toward and into the adjacent wash. Lesser amounts of waste are visible as scattered occurrences along the slope of the hill and in the bottom of the wash. Thin stringers and layers of caliche are present in the hill sidewall, showing that the hill is natural material and not waste.

Asphalt was found only on the surface to an average thickness of about 1 ft (1,160 yd^3), based on excavation, borings, and a sidewall view of the debris from the wash. Figure A.10-4 shows the surface asphalt debris and burned wire.

Asphalt Debris on Surface, View to South
(Photograph Taken 05/06/2003)

Asphalt and Wire on Surface, View to Southwest
(Photograph Taken 05/06/2003)

Figure A.10-4
Asphalt Debris Field at CAS 23-15-03, Disposal Site (Disposal Area)

Construction Debris Field

The construction debris field is located in the central portion of the site between the white observation tower and MWA2. The debris is scattered over approximately 13,930 ft^2 and is found in piles and areas of disturbed soil containing concrete, rebar, and miscellaneous metallic scrap. Assuming a maximum thickness of 0.5 ft, the volume of waste is estimated at 260 yd^3. Figure A.10-5 shows the surface debris at this location.

"Green Ooze" Debris Field

This field consists of surface debris containing the "green ooze" around CWA2. In places, the debris is covered with about 1 in. of dirt and reaches a maximum thickness of 3 ft. The surface area of the field is estimated at approximately 18,900 ft^2, based on excavation, borings, and visual examination. The volume of waste in this field is estimated at 2,100 yd^3, based on the above dimensions. This debris field is the source of the material excavated during the investigation, as described below.

Concrete Debris on Surface, View to Northwest (Photograph Taken 05/06/2003)

Irregular Piles of Surface Debris, View to Northwest (Photograph Taken 05/06/2003)

Figure A.10-5
Construction Debris Field at CAS 23-15-03, Disposal Site (Disposal Area)

Soil/Asphalt/Concrete Piles

During the investigation, surface debris was removed from the southern end of the Disposal Area. The activity was suspended when it was determined that the removal activity had removed soil that was not intended for removal. Seven truckloads (approximately 190,200 pounds) of debris and soil had already been disposed of at the Area 9 U10C Landfill. The activity also generated two piles of soil containing abundant asphalt and concrete.

The soil piles and the waste at the Area 9 U10C Landfill were sampled for waste characterization purposes. Analytical results showed elevated concentrations of TPH, consistent with the presence of abundant asphalt in the samples. As such, the TPH concentrations do not indicate contamination. Additional information is provided in Section 2.1.8.

The piles consist mostly of soil containing asphalt and debris. One of the piles is around MWA3 and is estimated to be 375 yd^3 of material. The other pile is around CWA2 and is estimated to contain 485 yd^3 of material. These volumes were estimated based on a GPS perimeter survey, a visual estimate of height (7-ft tall), and a "cone volume" calculation. Figure A.10-6 shows the two debris piles.

Debris Pile Around MWA3, View to Southeast (Photograph Taken 05/06/2003)

Debris Pile Around CWA2, View to Northeast (Photograph Taken 05/06/2003)

Figure A.10-6
Soil/Concrete Piles at CAS 23-15-03, Disposal Site (Disposal Area)

Asphalt Piles

There are several circular and linear debris piles around the southern portion of CWA1 and north of CWA2. The piles contain mostly asphalt with lesser amounts of concrete, metallic scrap, and soil. The combined volume of this material is estimated to be about 65 yd^3. Figure A.10-7 is a photograph of one of the asphalt debris piles at this area.

Close-up of Asphalt Debris Pile
(Photograph Taken 05/06/2003)

Figure A.10-7
Asphalt Debris Pile at CAS 23-15-03, Disposal Site (Disposal Area)

Potentially Asbestos-Containing Material

South of the east/west access road are two small piles of PACM. The PACM is white, brittle, fibrous tile or roofing material and each pile is estimated to be 1.5 yd^3. Figure A.10-8 shows the PACM piles.

A.10.2.3 Excavation, Drilling, and Sampling at Landfill

Thirty-two backhoe excavations were made to determine the thickness of cover material, verify the lateral boundaries of disposal features, and determine the base of T1 and HCA5. Excavation details are discussed in the following subsections.

Drilling and sampling locations were staked outside and adjacent to the boundaries of the disposal features, as determined by excavation or site observations. Thirty-five site characterization samples (including two field duplicates) were collected. Thirty of the samples were collected in native soil at depths corresponding to the base of the disposal features, as determined from the geophysical survey and excavation. Five of the samples were collected from step-out borings west of T1. Section A.10.2.3.8 provides additional detail about the landfill step-out borings and samples. Six

PACM Pile, View to South
(Photograph Taken 05/06/2003)

Close-up of PACM Pile
(Photograph Taken 05/06/2003)

Figure A.10-8
PACM at CAS 23-15-03, Disposal Site (Disposal Area)

geotechnical samples were collected; three from cover material and three from native soil beneath the base of selected disposal features.

A.10.2.3.1 Trench 1

Eight excavations (H07 through H14) were made to investigate T1, as shown in Figure A.10-2. The excavations revealed a widely varying gravel cover thickness, from several inches at some locations to 3 ft in other areas. Below the cover, gravel fill containing debris was found in all the excavations except H08. Debris encountered included burned wood, ash, metallic scrap, asphalt, concrete, and glass. The base of T1 was not definitively established at all locations. However, the presence of debris, fill material, and/or caliche hardpan, suggest the T1 base ranges from 2 to 10 ft bgs.

The northern and southern extent of T1 was established by excavations H12 and H07, respectively. The eastern edge was established by excavations H09, H13, and H14 and the western edge was established by excavation H11. The lateral extent of T1 as established by excavation is generally consistent with the geophysical survey.

Approximately 50 ft west of T1, there is a north/south-trending linear pile of surface debris, consisting mostly of soil with concrete and miscellaneous metallic scrap, as shown in Figure A.10-2. The material is estimated to cover approximately 3,900 ft^2. This debris pile is adjacent to a natural wash, which meanders through a generally undisturbed area to the west. Based on observations made in excavation H09 that was extended to the west as well as scattered debris on the surface, it appears debris was dumped in the wash and on the surface between T1 and the wash. This debris is currently covered with a few inches of soil, except the linear debris pile described above. There are also several piles of miscellaneous construction waste in the wash, with a combined estimated volume of 15 yd^3. Figure A.10-9 shows the debris pile and its relation to the wash.

Concrete Surface Debris, View to Northeast (Photograph Taken 01/26/2003)

Surface Debris and Landfill Monument, View to South (Photograph Taken 05/06/2003)

Figure A.10-9
Surface Debris West of Trench 1 at CAS 23-15-03, Disposal Site (Landfill)

Eight borings (H07 through H14) were drilled at locations determined from excavation. Excavation showed the base of T1 varying from 2 to 10 ft bgs, depending on location. Core intervals above and below the T1 basal depth were field screened, as described in Section A.2.3.4.

Based on FSRs less than FSLs and the observed T1 base from excavation, the core intervals from 2 to 3 ft bgs (boring H10), 4 to 5 ft bgs (boring H09), 5.5 to 6.5 ft bgs (borings H07, H08, H11, and H14), and 6 to 7 ft bgs (boring H12) were selected for off-site analysis. These depths correspond to the identified or presumed basal depth of T1 and satisfy the CAIP objective of sampling at the base of disposal features.

At boring H13, scarce metallic debris and glass was observed in a discolored zone from 3 to 4.5 ft bgs. Drill core from 2 to 3 ft bgs had a TPH (DRO) FSR of 177 ppm and a reanalysis showed 116 ppm. The next screened interval was sample 005H013 (4.5 to 5.5 ft bgs) and the result was below the FSL of 75 ppm. Based on these FSRs and the observations described above, the core interval from 4.5 to 5.5 ft bgs (the T1 basal depth at this location) was selected for off-site analysis.

Two geotechnical samples were collected; one from 0 to 1 ft bgs in cover material and one from 7 to 8 ft bgs in native soil below the T1 base.

A.10.2.3.2 Trench 2

Eight excavations (H15 through H21, H36) were made to investigate T2, as shown in Figure A.10-2. The excavations revealed a widely varying gravel cover thickness, from 3-in. thick at several locations up to 2-ft thick at H19. Where encountered, debris consisted of asphalt, burned wood, ash, plastic, metallic scrap, and some glass.

Debris or obvious fill material was found at all locations, except H20 and H21 to the south and H16 to the north. The east edge of T1 is defined by excavations H17 and H18, the west edge is defined by excavation H15, and the south edge is defined by excavation H36. The north edge lies north of H17 and south of H16 and probably terminates beneath or near the firing range berm. The lateral extent of T2 established by excavation is generally consistent with the geophysical survey.

Six borings (H15 through H19 and H36) were drilled at locations determined from excavation. The geophysical survey showed the base of T2 at 12 to 14 ft bgs. Core intervals from 4 to 5 ft bgs, 9 to 10 ft bgs, 13 to 14 ft bgs, 18 to 19 ft bgs, and 23 to 24 ft bgs were field screened, with the following exceptions. Refusal occurred at boring H17 at 21.5 ft bgs so the deepest screened interval was 20 to

21 ft bgs. At boring H18, minor glass debris was noted to 10 ft bgs, representing the base of T2. Thus, field-screening intervals below this depth were adjusted accordingly.

The FSRs were less than FSLs and no biasing factors were observed other than as described above. Core intervals from 11 to 12 ft bgs were selected for off-site analysis at all borings except H18. At this boring, the core interval from 11 to 12 ft bgs was selected for analysis based on minor glass debris in the core at 10 ft bgs. The selected intervals represent the basal depth of T2 as determined from the geophysical survey and drilling.

Two geotechnical samples were collected; one from 0 to 1 ft bgs in cover material and one from 13 to 14 ft bgs in native soil below the T2 base.

A.10.2.3.3 Trench 3

Five excavations (H22 through H25, H37) were made to investigate T3, as shown in Figure A.10-2. A gravel cover from 1- to 1.5-ft thick was consistently encountered with the exception of excavations H22 and H25. Fill material beneath the cover contained burned wood and ash as well as lesser amounts of concrete, asphalt, and glass.

Debris and/or fill material was found at all locations except H22 and H25. The south edge of T3 was established by excavation H37 and the east edge is defined by excavations H23 and H24. The north edge is south of excavation H25, and probably terminates beneath or near the firing range berm. The lateral extent of T3 as established by excavation is generally consistent with the geophysical survey.

Four borings (H23 through H25 and H37) were drilled at locations determined from excavation. The geophysical survey showed the base of T3 at 5 ft bgs. Core intervals from 2 to 3 ft bgs, 5 to 6 ft bgs, 10 to 11 ft bgs, and 15 to 16 ft bgs were field screened at all borings except H25. At H25 refusal occurred at 13 ft so the deepest screened interval was 12 to 13 ft bgs. The FSRs were less than FSLs and no other biasing factors were noted, so the core intervals from 5 to 6 ft bgs were selected for off-site analysis. This interval represents the basal depth of T3, as determined by the geophysical survey.

Two geotechnical samples were collected; one from 0 to 1 ft bgs in cover material and one from 6 to 7 ft bgs in native soil below the T3 base.

A.10.2.3.4 Trench 4

Five excavations (H26 through H29, H50) were made to investigate T4, as shown in Figure A.10-2. The thickness of the gravel cover varied from 3-in. thick at the south end to 2-ft thick at the north end. Fill material beneath the cover contained burned wood and ash as well as lesser amounts of concrete, asphalt, and glass. The fill material/debris was encountered at all excavations except H26.

The east edge of T4 was established by excavations H27 and H28. The south end of T4 was not confirmed. Excavation H29 encountered fill gravel containing asphalt and concrete from 0.25 to 0.5 ft bgs, showing the presence of a disposal feature. However, the excavation did not extend beyond the fence for the CAU 112 use restriction.

The north end of T4 was explored by excavations H26 and H50. Debris or fill material was not present at H26, which was located north of the firing range berm. Excavation H50 was located in a narrow access road through the berm. Here, a 2-ft thick gravel cover was observed, overlying fill material containing burned debris from 2 to 3.5 ft bgs. These observations support the conclusion that the northern edge of T4 is underneath or very near the north side of the berm between excavations H26 and H50.

Four borings (H26 through H29) were drilled at locations determined from excavation. The geophysical survey showed the base of T4 at 6 ft bgs. Core intervals from 3 to 4 ft bgs, 6 to 7 ft bgs, 11 to 12 ft bgs, and 16 to 17 ft bgs were field screened with the following exceptions. At boring H27, the hole sloughed around the casing with subsequent core loss from 0 to 3.5 ft bgs so the first screened interval was 4 to 5 ft bgs. At boring H29, lithology and the presence of scarce burned debris and metallic scrap suggested a T4 basal depth of 7.5 ft bgs. Field-screening intervals were adjusted accordingly to 3 to 4 ft bgs, 8.5 to 9.5 ft bgs, 14 to 15 ft bgs, and 19 to 20 ft bgs.

The FSRs were less than FSLs and there were no biasing factors other than those discussed above. Thus, the core intervals from 6 to 7 ft bgs were selected for off-site analysis except at boring H29. The interval from 8.5 to 9.5 ft bgs was submitted for analysis. These depths represent the base of T4, as determined from the geophysical survey and drilling observations. There were no geotechnical samples collected at T4.

A.10.2.3.5 Trench 5

Two excavations (H30 and H31) were made to investigate T5, as shown in Figure A.10-2. A gravel cover with a thickness varying from 0.5 to 2 ft was encountered, overlying gravel fill-material contained burned wood, ash, glass, and metallic debris. The southern boundary of T5 was not confirmed and is believed to extend into the CAU 112 use-restriction fenced area. The northern end of T5 was established at excavation H31.

Two borings (H30 and H31) were drilled at locations determined from excavation. The geophysical survey showed the base of T4 at 8 ft bgs. Core intervals from 4 to 5 ft bgs, 8 to 9 ft bgs, 13 to 14 ft bgs, and 18 to 19 ft bgs were field screened. The FSRs were less than FSLs and no other biasing factors were noted; therefore, the core intervals from 8 to 9 ft bgs were sent for off-site analysis. This depth represents the basal depth of T5, as determined from the geophysical survey. There were no geotechnical samples collected at T5.

A.10.2.3.6 Trench 6 / High Conductive Area 4

Three excavations (H32 through H34) were made to investigate T6/HCA4, as shown in Figure A.10-2. A gravel cover was found to generally thicken from north to south. The cover was found to be 4-ft thick at the south end of the trench (H34), 2-ft thick at the middle of the trench (H33), and 0.5-ft thick at the north end of the trench (H32). Beneath the cover, fill material containing metallic debris, burned wood, ash, and glass was encountered.

The north and east edges were confirmed by excavations H32 and H33, respectively. The southern boundary was not confirmed and is believed to extend into the CAU 112 use-restriction fenced area.

Three borings (H32 through H34) were drilled at locations determined from excavation. The geophysical survey showed the base of T6/HCA4 at 8 ft bgs. Core intervals from 4 to 5 ft bgs, 8 to 9 ft bgs, 13 to 14 ft bgs, and 18 to 19 ft bgs were field screened. The FSRs were less than FSLs and no other biasing factors were noted, so the core intervals from 8 to 9 ft bgs were sent for off-site analysis. This depth represents the basal depth of T5, as determined from the geophysical survey. There were no geotechnical samples collected at T6/HCA4.

A.10.2.3.7 High Conductive Area 5

One excavation (H35) was made to investigate HCA5, as shown in Figure A.10-2. The excavation was located inside the boundaries established by the geophysical survey and was made to determine the base of HCA5. The excavation was made from the southwest to the northeast, was 15-ft long, and was dug to a depth of 6.5 ft bgs. Gravel fill-material devoid of debris was noted from the surface to 3 ft bgs overlying native soil. The base of HCA5 was identified at 3 ft bgs, based on a lithologic transition from fill material to native soil.

One boring (H35) was drilled at a location determined from excavation. Excavation showed the base of HCA5 at 3 ft bgs. Core intervals from 3 to 4 ft bgs, 8 to 9 ft bgs, and 13 to 14 ft bgs were field screened. The FSRs were less than FSLs and no other biasing factors were noted, so the core interval from 3 to 4 ft bgs was sent for off-site analysis. This depth represents the basal depth of HCA5, as determined from excavation. There were no geotechnical samples collected at HCA5.

A.10.2.3.8 Landfill Step-out Borings

Five borings (H45 through H49) were selected west of T1 to determine the lateral extent of debris and any contamination in this direction. At boring H45, the core interval from 3.5 to 4.5 ft bgs was field screened. Drill refusal at 4.5 ft bgs precluded the collection of deeper cores. At borings H46 and H47, the core interval from 2.5 to 3.5 ft bgs was field screened. Drill refusal at 3.5 ft bgs precluded the collection of deeper cores at these borings. At boring H48, the core interval from 5 to 6 ft bgs was field screened. Drill refusal at 6 ft bgs precluded the collection of deeper cores. At boring H49, the core intervals from 5 to 6 ft bgs, 10 to 11 ft bgs, and 15 to 16 ft bgs were field screened. Drill refusal at 17 ft bgs precluded the collection of deeper cores.

The FSRs were less than FSLs and no other biasing factors than those noted above were identified. Thus, the core intervals from 2.5 to 3.5 ft bgs (boring H46), 3.5 to 4.5 ft bgs (borings H45 and H47), 5 to 6 ft bgs (boring H48), and 10 to 11 ft bgs (boring H49) were selected for off-site analysis. These depths were selected based on lithologic changes and drill refusal. These factors indicate undisturbed material, probably caliche hardpan, which represent the most likely locations for contamination, if present. The CAIP objective of sampling at the base of disposal features was met by sampling from these intervals.

A.10.2.4 Topographic Survey

A topographic survey was conducted as discussed in Section A.2.3.5. Topographic maps of the Disposal Area and Landfill portions of CAS 23-15-03 were prepared and are included in the engineering drawings in Appendix H.

A north/south-trending wash through the center of the area is the primary topographic feature at the Disposal Area portion of CAS 23-15-03. The wash is about 8-ft deep toward the north with a steep hillslope on its eastern flank and a less steep hillslope to the west. As the wash descends to the south, the surrounding hillslopes flatten out and the wash loses any discernible drainage channel around the center of the area. There is another wash that bounds the southern end of the area. This feature is first discernible about 55-ft southeast of the white tower and trends to the southeast. It reaches its deepest point just south of excavation H06.

Exclusive of these washes, the ground surface of the CAS 23-15-03 Disposal Site slopes from the north to the south at approximately 6.4 percent. Topographic highs include two, 7-ft tall, soil mounds at the south end of the area.

The ground surface at the Landfill portion of CAS 23-15-03 slopes from the northeast to southwest at approximately 4.3 percent. The primary topographic high at this area is the WSI firing range berm to the north. There is a shallow wash trending northeast to southwest that parallels the western edge of the area.

A.10.2.5 Sample Analysis

Site characterization soil samples were analyzed for the CAIP-specified COPCs including total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, and pesticides. The CAIP stipulated that samples containing PCBs at concentrations greater than MRLs will be analyzed for dioxins. Thus, the two samples containing PCBs (005H013 and 005H015) were analyzed for dioxins and furans. Twenty-five percent of the soil samples were also analyzed for gamma spectrometry for waste management purposes. The QC field blanks was analyzed for the soil sample parameters and gamma spectrometry; one of the field blanks (005H306) had dioxins as an additional analysis. The QC equipment rinsate blanks were analyzed for the soil sample parameters, gamma spectrometry, isotopic Pu, Sr-90, and dioxins. Trip blanks were analyzed only for total VOCs.

The PCBs Aroclor-1016 and Aroclor-1260 were detected in samples 005H013 and 005H015, respectively. In accordance with the CAIP, these samples were also analyzed for dioxins/furans.

Geotechnical soil samples were analyzed for moisture content, bulk density (dry and wet), calculated total porosity, hydraulic conductivity (saturated and unsaturated), particle-size distribution/soil classification, and moisture characteristics.

A.10.2.6 Analytes Detected Above Minimum Reporting Limits

The following analytes were not detected in soil samples at concentrations exceeding MRLs as presented in the CAIP:

- Total SVOCs
- Ethylene glycol
- TPH (GRO)

The following analytes were detected in soil samples at concentrations exceeding MRLs as presented in the CAIP, and are summarized below:

- Total VOCs
- Total RCRA metals, nickel, and zinc
- TPH (DRO)
- PCBs
- Pesticides
- Dioxins/furans
- Gamma-emitting radionuclides

A.10.2.6.1 Total Volatile Organic Compound Analytical Results for Soil Samples

The total VOCs detected in soil samples at concentrations exceeding MRLs are listed in Table A.10-2. Methylene chloride was detected in five samples at concentrations ranging from 5.5 to 8.7 µg/kg. M+P-xylene was detected in a single sample at a concentration of 5.3 µg/kg. These concentrations exceed MRLs but are well below corresponding PALs established in the CAIP.

Table A.10-2
Soil Sample Results for Total VOCs
Detected Above Minimum Reporting Limits at CAS 23-15-03

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (µg/kg)	
			Methylene Chloride	M+P-Xylene
Preliminary Action Levels[a]			21,000	210,000
005H012	H11	5.5 - 6.5	7.6	--
005H013	H13	4.5 - 5.5	5.5	--
005H016	H12	6 - 7	5.9	--
005H022	H15	13 - 14	8.7	--
005H024	H28	6 - 7	6.5	--
005H030	H23	5 - 6	--	5.3

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

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

A.10.2.6.2 Total RCRA Metals, Nickel, and Zinc Analytical Results for Soil Samples

The total RCRA metals, nickel, and zinc detected in soil samples at concentrations exceeding MRLs are listed in Table A.10-3. Arsenic, barium, chromium, lead, mercury, nickel, silver, and zinc exceeded MRLs in some or all of the samples. However, the concentrations were well below PALs established in the CAIP.

A.10.2.6.3 Total Petroleum Hydrocarbon Analytical Results for Soil Samples

The TPH (DRO) detected in soil samples at concentrations exceeding MRLs is listed in Table A.10-4. The TPH (DRO) was detected in one sample at an estimated concentration of 37.0 mg/kg. This concentration exceeds the MRL but is below the PAL of 100 mg/kg established in the CAIP.

A.10.2.6.4 Polychlorinated Biphenyl Analytical Results for Soil Samples

The PCBs detected in soil samples at concentrations exceeding MRLs are listed in Table A.10-5. The PCB Aroclor-1016 was detected in a single sample at a concentration of 110 µg/kg. The PCB Aroclor-1260 was detected in another sample at a concentration of 210 µg/kg. These concentrations exceed MRLs but are well below corresponding PALs established in the CAIP.

Table A.10-3
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 23-15-03
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Chromium	Lead	Mercury	Nickel	Silver	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	610[b]	41,000[b]	10,000[b]	100,000[b]
005H001	H04	0.5 - 1.5	8.3	65	5.1	3.3	--	4.5	--	12.0
005H002	H05	3 - 4	7.9	61	8.1	5.0	--	5.2	--	17.0
005H003	H03	1 - 2	7.6	46	3.3	2.6	--	4.3	--	8.7
005H004	H02	2.5 - 3.5	7.5	37	3.8 (J)[c]	--	--	--	--	12.0 (J)[c]
005H005	H01	1 - 2	8.4	38	2.8 (J)[c]	--	--	--	--	5.2 (J)[c]
005H006	H06	1.5 - 2.5	6.5	49	2.5 (J)[c]	--	--	--	--	5.7 (J)[c]
005H007	H31	8 - 9	9.1	51	4.0 (J)[c]	--	--	--	--	7.8 (J)[c]
005H008	H32	8 - 9	14.0	58	3.0 (J)[c]	--	--	--	--	5.5 (J)[b]
005H009		8 - 9	13.0	55	2.8 (J)[c]	--	--	--	--	5.6 (J)[c]
005H010	H24	5 - 6	6.9	50	13.0 (J)[c]	--	--	4.2 (J)[c]	--	11.0 (J)[c]
005H011	H18	11 - 12	7.9	60	3.4 (J)[c]	--	--	--	--	9.7 (J)[c]
005H012	H11	5.5 - 6.5	9.6	41	5.8 (J)[c]	3.7	--	--	15.0 (J)[d]	9.5 (J)[c]
005H013	H13	4.5 - 5.5	10.0	58	4.8 (J)[c]	6.1	--	5.5	--	17.0 (J)[c]
005H014	H10	2 - 3	10.0	80	5.0 (J)[c]	5.2	--	4.7	--	14.0 (J)[c]
005H015	H09	4 - 5	9.3	71	4.1 (J)[c]	6.9	0.16	4.2	--	24.0 (J)[c]
005H016	H12	6 - 7	9.0	34	3.5 (J)[c]	2.6	--	--	--	7.9 (J)[c]
005H017	H26	6 - 7	7.6	60	8.0 (J)[c]	3.6	--	--	--	11.0 (J)[c]
005H018	H25	5 - 6	9.2	48	2.0 (J)[c]	3.0	--	--	1.0 (J)[d]	7.8 (J)[c]
005H019	H16	13 - 14	6.8	55	3.0 (J)[c]	4.2	--	--	1.2 (J)[d]	12.0 (J)[c]
005H020	H27	6 - 7	9.1	46	4.6 (J)[c]	13.0	5.9	7.9	1.9 (J)[d]	70.0 (J)[c]
005H021	H17	13 - 14	7.6	73	3.6 (J)[c]	4.4	--	--	--	12.0 (J)[c]
005H022	H15	13 - 14	9.2	54	2.6 (J)[c]	4.1	--	--	--	10.0 (J)[c]
005H023	H35	3 - 4	8.6	55	2.8 (J)[c]	3.4	--	--	--	10.0 (J)[c]
005H024	H28	6 - 7	6.5	41	3.1 (J)[c]	2.7	--	--	--	10.0 (J)[c]
005H025	H34	8 - 9	6.4	56	3.0 (J)[c]	4.4	--	--	--	11.0 (J)[c]
005H026	H33	8 - 9	8.0	35	2.9	2.2	--	--	--	7.1
005H027	H30	8 - 9	9.0	61	2.5	4.0	--	--	--	9.5
005H028	H29	8.5 - 9.5	7.7	44	2.4	1.9	--	--	--	7.0
005H029		8.5 - 9.5	8.1	42	2.5	--	--	--	--	7.5
005H030	H23	5 - 6	8.2	72	5.7	7.6	0.14	4.6	--	19.0
005H031	H37	5 - 6	8.6	51	3.0	3.0	--	--	--	9.8

Table A.10-3
Soil Sample Results for Total RCRA Metals, Nickel, and Zinc Detected Above Minimum Reporting Limits at CAS 23-15-03
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)							
			Arsenic	Barium	Chromium	Lead	Mercury	Nickel	Silver	Zinc
Preliminary Action Levels			23[a]	100,000[b]	450[b]	750[b]	610[b]	41,000[b]	10,000[b]	100,000[b]
005H032	H19	13 - 14	8.6	39	2.6	2.8	--	--	--	7.3
005H033	H36	13 - 14	9.0	57	3.2	3.5	--	--	--	11.0
005H034	H14	5.5 - 6.5	7.8	60	2.9	3.2	--	--	--	9.6
005H035	H08	5.5 - 6.5	13.0	57	2.7	3.4	--	--	--	8.9
005H036	H07	5.5 - 6.5	8.2	43	6.3	8.3	--	--	--	12.0
005H037	H41	1.5 - 2.5	13.0	60	3.5 (J)[c]	3.7	--	4.3 (J)[c]	--	9.4 (J)[c]
005H038	H42	1.5 - 2.5	10.0	68	5.0 (J)[c]	5.5	--	5.4 (J)[c]	--	14.0 (J)[c]
005H039	H43	1.5 - 2.5	9.1	58	2.8 (J)[c]	2.8	--	--	--	6.7 (J)[c]
005H040		1.5 - 2.5	11.0	56	2.8 (J)[c]	1.9	--	--	--	6.5 (J)[c]
005H041	H44	2 - 3	9.1	41	3.6 (J)[c]	2.8	--	--	--	6.5 (J)[c]
005H042	H45	3.5 - 4.5	12.0	54	3.5 (J)[c]	3.1	--	--	--	9.4 (J)[c]
005H043	H46	2.5 - 3.5	8.3	38	2.7 (J)[c]	2.0	--	--	--	7.7 (J)[c]
005H044	H47	3.5 - 4.5	10.0	51	3.1 (J)[c]	3.3	--	--	--	10.0 (J)[c]
005H045	H48	5 - 6	11.0	65	3.3 (J)[c]	3.7	--	--	--	11.0 (J)[c]
005H046	H49	10 - 11	11.0	44	2.9 (J)[c]	3.1	--	--	--	8.2 (J)[c]

[a]Mean plus two times the standard deviation of the mean for sediment samples collected by the NBMG throughout the NTTR (NBMG, 1998; Moore, 1999)
[b]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[c]Qualifier added to laboratory data; record accepted. Serial dilution %D outside of control limits. Matrix effects may exist.
[d]Qualifier added to laboratory data; record accepted. Matrix spike recovery outside of control limits.

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

Table A.10-4
Soil Sample Results for TPH-DRO
Detected Above Minimum Reporting Limits at CAS 23-15-01

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)
			Diesel-Range Organics
Preliminary Action Level[a]			100
005H002	H05	3 - 4	37.0 (J)

[a]TPH PAL from *Nevada Administrative Code* (NAC, 2003)

ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
J = Estimated value. Qualifier added to laboratory data; record accepted. Total extractable petroleum hydrocarbons result quantitated from diesel standard calibration.

Table A.10-5
Soil Sample Results for PCBs
Detected Above Minimum Reporting Limits at CAS 23-15-03

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (μg/kg)	
			Aroclor-1016	Aroclor-1260
Preliminary Action Levels[a]			29,000	1,000
005H013	H13	4.5 - 5.5	110	--
005H015	H09	4 - 5	--	210

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)

ft bgs = Feet below ground surface
μg/kg = Milligrams per kilogram
-- = Not detected above minimum reporting limits

A.10.2.6.5 Dioxin/Furan Analytical Results for Soil Samples

As specified in the CAIP the samples containing concentrations of PCBs above the MRL were analyzed for dioxins and furans. The dioxins and furans detected in two soil samples (005H013 and 005H015) at concentration exceeding the MRLs are listed in Table A.10-6. However, there is no comparison to the current PALs presented in the table because there are only two PRGs available for the dioxin congers.

The accepted approach for evaluating the overall toxicity of dioxins and furans is to add the toxicity of individual dioxins and furans together in order to evaluate the complex environmental mixtures that receptors may potentially be exposed (EPA, 2001). However, the toxicities of the dioxin and furan congers are different. To account for this difference, Toxicity Equivalency Factors (TEFs) that compare the toxicity of different dioxins and furans have been established. Using the TEFs the toxicity of a mixture of dioxins or furans can be expressed in terms of Toxicity Equivalents (TEQ), which is the amount of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) it would take to equal the combined toxic effect of all the dioxins or furans found in the soil samples (EPA 2001). The congener TCDD is used for the calculation of the TED because it is the most toxic conger. This approach has been established to account for the varying toxicity of each congener in the mixture.

The TEQ approach has been used to determine if the dioxin or furan concentrations detected in the two CAS 23-15-03 samples exceed the corresponding PALs established in the CAIP and require further evaluation. The determination of the TEQ and subsequent comparison to the PALs is presented in Table A.10-7 and shows the TEQs do not exceed the PAL in either sample.

A.10.2.6.6 Pesticide Analytical Results for Soil Samples

The pesticides detected in soil samples at concentrations exceeding MRLs are listed in Table A.10-8. The pesticide 4,4'-DDT was detected in two samples at concentrations of 4.3 and 6.0 (estimated) µg/kg. Alpha-chlordane and gamma-chlordane (primary constituents of technical chlordane) were detected in four samples at concentrations ranging from 4.7 to 59.0 µg/kg and 3.6 to 59.0 µg/kg, respectively. These concentrations exceed MRLs but are well below corresponding PALs established in the CAIP.

A.10.2.6.7 Gamma Spectrometry Analytical Results for Soil Samples

The gamma-emitting radionuclides detected in soil samples at concentrations exceeding MRLs are listed in Table A.10-8. The isotopes Pb-212, Pb-214, and K-40 were detected above MRLs in some or all of the samples analyzed for gamma spectrometry. None of the results exceed background concentrations, so PALs for these isotopes were not exceeded at CAS 23-15-03.

Table A.10-6
Soil Sample Results for Dioxins and Furans
Detected Above Minimum Reporting Limits at CAS 23-15-03, Disposal Site

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pg/g)																	
			Total TCDD	1,2,3,4,7,8-HxCDD	Total HxCDD	1,2,3,4,6,7,8-HpCDD	Total HpCDD	OCDD	Total TCDF	1,2,3,7,8-PeCDF	2,3,4,7,8-PeCDF	Total PeCDF	1,2,3,4,7,8-HxCDF	1,2,3,6,7,8-HxCDF	2,3,4,6,7,8-HXCDF	Total HxCDF	1,2,3,4,6,7,8-HpCDF	Total HpCDF	OCDF	2,3,7,8-TCDF
005H013	H13	4.5-5.5	0.6	--	--	--	--	--	0.37	--	--	--	--	--	--	--	--	--	--	--
005H015	H09	4-5	4.2	0.45	5.5	4.5	8.0	18	29	0.93	2.5	19	4.4	1.4	2.2	28	17	23	11	2

Dioxins
TCDD =Tetrachlorodibenzo-p-dioxin
PeCDD = Pentachlorodibenzo-p-dioxin
HxCDD = Hexachlorodibenzo-p-dioxin
HpCDD = Heptachlorodibenzo-p-dioxin
OCDD = Octachlorodibenzo-p-dioxin

Furans
TCDF = Tetrachlorodibenzofuran
PeCDF = Pentachlorodienzofuran
HxCDF = Hexachlorodibenzofuran
HpCDF = Heptachlorodibenzofuran
OCDF = Octachlorodibenzofuran

Pg/g = Picogram per gram
-- = Not detected above minimum reporting limits

Table A.10-7
TEQ Calculations and Comparison to PALs for Dioxins and Furans Detected at CAS 23-15-03
(Page 1 of 2)

Compounds	Toxic Equivalency Factors (TEF)	Sample Numbers							
		005H013				005H015			
		% Solid	1.9			% Solid	1.5		
		Reported Wet Weight (pg/g)	Calculated Dry Weight (pg/g)	Calculated Dry Weight (mg/kg)	TEQ relative to 2,3,7,8,-TCDD (mg/kg)	Reported Wet Weight (pg/g)	Calculated Dry Weight (pg/g)	Calculated Dry Weight (mg/kg)	TEQ relative to 2,3,7,8,-TCDD (mg/kg)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1.00	0.6	0.6	6.00E-07	6.00E-07	4.1	4.2	1.00E-06	1.00E-06
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1.00	--	--			--	--		
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.10					0.44	0.45	4.50E-07	4.50E-08
Total HxCDD		--	--			5.4	5.5		
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.10	--	--			4.4	4.5	4.50E-06	4.50E-07
Total HpCDD		--	--			7.9	8.0		
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	0.0001	--	--			18	18	1.80E-05	1.80E-09
TEQ for all Dioxins Detected					6.00E-07				1.50E-06
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	1.00	0.37	0.37	3.70E-07	3.70E-07	29	29	2.90E-05	2.90E-05
1,2,3,7,8-Pentachlordibenzofuran (PeCDF)	0.05					0.92	0.93	9.30E-07	4.65E-08
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.50	--	--			2.5	2.5	2.50E-06	1.25E-06
Total PeCDF						19	19	1.90E-05	
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.10	--	--			1.4	1.4	1.40E-06	1.40E-07
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.10	--	--			4.3	4.4	4.40E-06	4.40E-07
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.10	--	--			2.2	2.2	2.20E-06	2.20E-07

Table A.10-7
TEQ Calculations and Comparison to PALs for Dioxins and Furans Detected at CAS 23-15-03
(Page 2 of 2)

Compounds	Toxic Equivalency Factors (TEF)	Sample Numbers							
		005H013				005H015			
		% Solid	1.9	Calculated Dry Weight (mg/kg)	TEQ relative to 2,3,7,8,-TCDD (mg/kg)	% Solid	1.5	Calculated Dry Weight (mg/kg)	TEQ relative to 2,3,7,8,-TCDD (mg/kg)
		Reported Wet Weight (pg/g)	Calculated Dry Weight (pg/g)			Reported Wet Weight (pg/g)	Calculated Dry Weight (pg/g)		
Total HxCDF						28	28	2.80E-05	
1,2,3,4,6,7,8-Heptachlordibenzofuran (HpCDF)	0.01	--	--			17	17	1.70E-05	1.70E-07
1,2,3,4,7,8,9-Heptachlordibenzofuran (HpCDF)	0.01	--	--			--	--		
Total HpCDF		--	--			23	23	2.30E-05	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	0.0001	--	--			11	11	1.10E-05	1.10E-09
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.10	--	--			2	2	2.00E-06	2.00E-07
TEQ for all Furans Detected					3.70E-07				2.47E-06

-- Compound not detected
PALs:
2,3,7,8-TCDD 2.70E-05 mg/kg
Hexachlorodibenzo-p-dioxin mixture (HxCDD) 4.00E-04 mg/kg
Dibenzofuran 5.10E+03 mg/kg
pg/g = Picograms per gram
mg/kg = Milligrams per kilogram

Table A.10-8
Soil Sample Results for Pesticides
Detected Above Minimum Reporting Limits at CAS 23-15-03

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (μg/kg)		
			4,4'-DDT	Alpha-Chlordane	Gamma-Chlordane
Preliminary Action Levels[a]			12,000	11,000[b]	
005H002	H05	3 - 4	4.3	6.3 (J)	4.6
005H015	H09	4 - 5	6.0 (J)	7.0	7.2
005H030	H23	5 - 6	--	59.0	59.0
005H036	H07	5.5 - 6.5	--	4.7 (J)	3.6 (J)

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000b)
[b]PAL is for technical chlordane which contains alpha-chlordane, gamma-chlordane, and other constituents

ft bgs = Feet below ground surface
μg/kg = Micrograms per kilogram
-- = Not detected above minimum reporting limits
J = Estimated value. Qualifier added to laboratory data; record accepted. %D between columns > 25.

Table A.10-9
Soil Sample Results for Gamma-Emitting Radionuclides
Detected Above Minimum Reporting Limits at CAS 23-15-03

Sample Number	Sample Location	Depth (ft bgs)	Contaminants of Potential Concern (pCi/g)		
			Lead-212	Lead-214	Potassium-40
Preliminary Action Levels[a]			3.64	3.47	31.1
005H004	H02	2.5 - 3.5	--	--	4.6 ± 1.9
005H008	H32	8 - 9	--	--	4.8 ± 2.1
005H012	H11	11 - 12	--	--	6.5 ± 2.8
005H020	H27	6 - 7	0.51 ± 0.16	--	9.1 ± 2.3
005H024	H28	6 - 7	0.43 ± 0.15	0.39 ± 0.15	7.9 ± 2.2
005H029	H29	8.5 - 9.5	--	--	5.9 ± 2.6
005H033	H36	13 - 14	--	0.55 ± 0.21	--
005H039	H43	1.5 - 2.5	--	--	5.3 ± 1.8

[a]Based on background concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley, California, Low-Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1991).

ft bgs = Feet below ground surface
pCi/g = Picocuries per gram
-- = Not detected above minimum reporting limits

A.10.2.6.8 Geotechnical Analytical Results for Soil Samples

Results for saturated hydraulic conductivity, gravimetric and volumetric initial moisture content, dry and wet bulk density, and calculated porosity are shown in Table A.10-10. Data summaries for all of the analyzed geotechnical parameters are included in Appendix F. In summary, the data indicate the following:

- Based on saturated hydraulic conductivity measurements, cover soil at T3 has lower permeabilities than subcell soil, while cover soil at T1 and T2 have higher permeabilities than subcell soil.
- Moisture content measurements show that the soil is well below saturation.
- Dry bulk densities ranged from 1.71 to 1.93 g/cm^3 in cover soil and from 1.80 to 1.97 g/cm^3 in subcell native soil. Cover soil had about the same density as subcell soil.
- Porosities in cover soil ranged from 27.2 to 35.3 percent, while subcell soil porosities ranged from 25.5 to 32.1 percent. Cover porosities were generally greater than subcell porosities, although the differences were minor.

Table A.10-10
Soil Sample Results for Select Geotechnical Parameters at CAS 23-15-03

Sample Number	Disposal Feature	Depth (ft bgs)	Ksat[a] (cm/s)	Initial Moisture Content		Bulk Density (g/cm^3)		Calculated Porosity (%)
				Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry	Wet	
005H404	T1	0 - 1	7.5E-05	4.1	7.0	1.71	1.78	35.3
005H403		7 - 8	2.2E-05	3.0	5.8	1.97	2.03	25.5
005H405	T2	0 - 1	9.9E-04	3.9	6.9	1.79	1.86	32.4
005H402		13 - 14	2.0E-04	3.2	5.7	1.80	1.86	32.1
005H406	T3	0 - 1	3.9E-05	2.6	5.1	1.93	1.98	27.2
005H401		6 - 7	1.9E-04	2.4	4.6	1.93	1.98	27.0

[a]Constant head method

ft bgs = Feet below ground surface
Ksat = Saturated hydraulic conductivity
cm/s = Centimeters per second
g/cm^3 = Grams per cubic centimeter
% = Percent
g/g = Grams per gram
cm^3/cm^3 = Cubic centimeters per cubic centimeter

A.10.2.7 Contaminants of Concern

Based on the aforementioned analytical results, no COCs are migrating from CAS 23-15-03.

A.10.3 Nature and Extent of Contamination

Since COCs are not migrating, the extent of any contamination that may be present at CAS 23-15-03 is limited to within the boundaries of the subsurface disposal features.

A.10.4 Revised Conceptual Site Model

No variations in the CSM were identified.

A.11.0 Waste Management

A.11.1 Waste Minimization

Waste minimization was integrated into all aspects of the CAU 5 investigation. The IDW was segregated to the greatest extent possible. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste. Decontamination activities were planned and executed to minimize the volume of rinsate generated.

Potentially hazardous IDW generated during the investigation was placed in 55-gallon steel drums and labeled as "Hazardous Waste - Pending Analysis." Eight, 90-day Hazardous Waste Accumulation Areas (HWAAs) were established to manage the waste at the investigation areas. The amount, type, and source of waste placed into each drum were recorded in waste management logbooks at each location.

A.11.2 Characterization

Analytical results of associated samples and process knowledge for each drum was reviewed to ensure compliance with federal regulations, state regulations, DOE directives/policies, waste disposal criteria, and applicable procedures. Analytical data was reviewed through Tier I, II, and III validation.

A.11.3 Waste Streams

The IDW was segregated into the following waste streams:

- Personal protective equipment (PPE) and disposable sampling equipment
- Decontamination rinsate
- Hydrocarbon waste including impacted soil and absorbent material
- Industrial waste including, but not limited to: plastic sheeting, glass/plastic sample jars, PPE, soil, sampling scoops, and aluminum foil
- Sanitary waste including, but not limited to: paper and lunch trash

A.11.3.1 Investigation-derived Waste Generated

A total of 32 drums of IDW were generated during the investigation. Additional waste (e.g., decontamination pad liners) may be generated during completion of waste management activities and CAS closures. The drums of IDW include:

- 4 drums of IDW were characterized as hydrocarbon waste exceeding the regulatory threshold established by State of Nevada regulations (NDEP, 1997). Hydrocarbon waste was generated at CASs 05-15-01, 12-15-01, and 23-15-03. This includes waste from a small hydraulic fluid spill that occurred at CAS 05-15-01. The waste from the spill was removed, drummed, and sampled for waste characterization purposes. The recommended disposal of the four drums is at the permitted NTS Hydrocarbon Landfill.

- 18 drums of rinsate and 10 drums of solid waste that are sanitary waste are recommended for disposal at the NTS-permitted sanitary facilities (NDEP, 1997).

A.11.4 Waste Management Samples

One sample (005A008) was collected from soil contaminated by a small hydraulic fluid leak at CAS 05-15-01 for characterization purposes. The impacted soil and absorbents used during rig repair and cleanup were drummed separately. No other waste management samples were collected from drummed waste.

A.11.5 Polychlorinated Biphenyls Waste

No PCBs were detected in soil at concentrations exceeding action levels established in Title 40 CFR Part 761, which regulates PCBs (CFR, 2002).

A.12.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling, analysis, and investigation activities conducted during the CAU 5 investigation. The following sections discuss the data validation process, QC samples, and nonconformances. The evaluation of the DQIs is presented in Appendix B.

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

A.12.1 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002b) and approved procedures. All chemical laboratory data from samples collected and analyzed for CAU 5 were evaluated for data quality according the EPA's Contract Laboratory Program National Functional Guidelines (EPA, 1994 and 1999). These guidelines are implemented in a tiered process and are presented in Section A.12.1.1 through Section A.12.1.3. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results passed data validation criteria. Documentation of the data qualifications resulting from these reviews is retained in project files as a hard copy and electronic media.

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

A.12.1.1 Tier I Evaluation

Tier I evaluation for both chemical and radiological analysis examines, but is not limited to:

- Sample count/type consistent with chain of custody
- Analysis count/type consistent with chain of custody
- Correct sample matrix

- Significant problems stated in the cover letter or case narrative
- Completeness of certificates of analysis
- Completeness of contract laboratory program (CLP) or CLP-like packages
- Completeness of signatures, dates, and times on chain of custody
- Condition-upon-receipt variance form included
- Requested analyses performed on all samples
- Date received/analyzed given for each sample
- Correct concentration units indicated
- Electronic data transfer supplied
- Results reported for field and laboratory QC samples
- Whether or not the deliverable met the overall objectives of the project
- Proper field documentation accompanies project packages

A.12.1.2 Tier II Evaluation

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

Chemical:

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

- Surrogate %R evaluated and applied to laboratory results/qualifiers
- Laboratory control sample %R evaluated and applied to laboratory results/qualifiers
- Initial and continuing calibration evaluated and applied to laboratory results/qualifiers
- Internal standard evaluated and applied to laboratory results/qualifiers
- Mass spectrometer tuning criteria
- Organic compound quantitation
- Inductively coupled plasma (ICP) interference check sample evaluation
- Graphite furnace atomic absorption quality control
- ICP serial dilution effects
- Recalculation of 10 percent of laboratory results from raw data

Radioanalytical:

- Correct detection limits achieved
- Blank contamination evaluated and applied to sample results/qualifiers
- Certificate of Analysis consistent with data package documentation
- QC sample results (duplicates, laboratory control samples, laboratory blanks) evaluated and applied to laboratory result qualifiers
- Sample results, error, and minimum detectable activity evaluated and applied to laboratory result qualifiers
- Detector system calibrated to National Institute for Standards and Technology (NIST)-traceable sources
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations
- Detector system response to daily, weekly, and monthly background and calibration checks, which may include peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system

- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements
- Documentation of all QC sample preparation complete and properly performed
- QC sample results (e.g., calibration source concentration, %R, and RPD) verified
- Spectra lines, emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration
- Recalculation of 10 percent of laboratory results from raw data

A.12.1.3 Tier III

The Tier III evaluation looks at all the items evaluated in the Tier II evaluation, but for only a limited number of samples (typically 5 percent). It serves as a check on the Tier II process. The Tier III review includes the following additional evaluations.

Chemical:

- Recalculation of laboratory results from raw data

Radioanalytical:

- Radionuclides and their concentration appropriate considering their decay schemes and half-lives
- Each identified line in spectra verified against emission libraries and calibration results
- Independent identification of spectra lines, area under the peaks, and quantification of radionuclide concentration in a random number of sample results
- Recalculation of laboratory results from raw data

A Tier III review of at least five percent of the sample analytical data was performed by TechLaw, Inc., of Lakewood, Colorado. The data was not changed based on the Tier III review.

A.12.2 Field Quality Control Samples

A total of 46 trip blanks, 3 equipment rinsate blanks, 11 field blanks, 3 source blanks, 13 MS/MSDs, and 13 field duplicates were collected and submitted for laboratory analysis as listed in the sample tables of Section A.3.0 through Section A.10.0. The blanks and duplicates were assigned individual sample numbers and sent to the laboratory "blind." Additional samples were selected by the laboratory to be analyzed as laboratory duplicates. Documentation related to the collection and analyses of these samples is retained in project files. The minimum requirements set forth in the Industrial Sites QAPP (NNSA/NV, 2002b) and the CAIP (NNSA/NV, 2002a) for collecting field QC samples were met.

Field blanks, source blanks, and equipment rinsate blanks were analyzed for the parameters listed in the sample tables in Section A.3.0 through Section A.10.0. Trip blanks were only analyzed for VOCs. Review of the field-blank analytical data for the CAU 5 sampling indicates that cross-contamination did not occur during sample collection. There were no environmental samples rejected or deemed unusable based on the results of field-collected blank analytical data.

Field duplicate samples were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in the sample tables in Section A.3.0 through Section A.10.0. The review and discussion of field duplicates and MS/MSD results as they apply to precision and/or accuracy is presented in Appendix B.

A.12.2.1 Laboratory Quality Control Samples

Analysis of surrogate spikes (for organic analyses), method blanks, preparation blanks (for chemical analyses), initial and continuing calibration blanks (for total metals), and laboratory control samples (LCSs) were performed for each sample delivery group (SDG) by Paragon Analytics, Inc. (Ft. Collins, Colorado). The results of these analyses were used to qualify associated environmental sample results according to EPA Contract Laboratory Program National Functional Guidelines (EPA, 1994 and 1999). Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

One laboratory duplicate analysis for metals was performed for each SDG that reported total metals. The duplicate results are compared to the original sample results to provide a measure of analytical laboratory precision. A more detailed discussion of the laboratory QC samples as they relate to precision and accuracy is presented in Appendix B.

A.12.3 Field Nonconformances

There was one field nonconformance generated for the project. The analytical laboratory sent unpreserved ethylene glycol trip blanks. On several occasions, the field crew used these unpreserved trip blanks for VOCs instead of blanks preserved with hydrochloric acid, as required by the CAIP and the Industrial Sites QAPP. The nonconformance resulted in estimated results for the VOC trip blanks but did not affect validation or usability of characterization soil samples.

Four field surveillances (Numbers 00136, 00337, 00434, and 00578) were conducted for this investigation by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), Environmental Restoration Division (ERD). There were no findings from any of the surveillances.

One QA assessment (Assessment Report #QA-03-003) was conducted by Shaw Environmental, Inc. (Shaw) personnel to verify that field activities were performed in accordance with applicable requirements. The assessment resulted in one finding and one discrepancy noted as an opportunity for improvement. The finding noted that, contrary to applicable procedures, there were numerous examples of cross-outs and overwrites on the gas chromatograph (GC) data sheets. Preventative action included enhanced training for GC operators including specific instruction on proper documentation methods. The discrepancy noted that the controlled copy of the approved procedures present at the site had not been updated with the latest revision. The assessment report suggested field crews should work with Document Control personnel to ensure current revisions to field documents are sent to the field in a timely and organized manner.

Two Shaw management assessments (Assessment Reports #IS-03-001 and #IS-03-008) were conducted during the investigation. Each assessment identified strengths and weaknesses as well as suggested areas of improvements. The recommendations were incorporated into routine field practices.

Seven project safety inspection reports were completed during the investigation. Several safety issues were identified and were immediately addressed, primarily through improved daily safety briefings.

The requirements of the plans and procedures governing the activities at the CAU 5 sites were met.

A.12.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to inconsistencies in analytical instrumentation operation, sample preparations, extractions, missed holding times, and fluctuations in internal standard and/or calibration results. Twelve laboratory nonconformances were documented for this project and have been accounted for in the data qualification process.

A.13.0 Summary

Analytes detected in soil samples collected during the investigation were evaluated against PALs to determine the nature and extent of COCs for CAU 5, and particularly to determine if COCs had migrated from disposal features. Assessment of the data indicates the PALs were exceeded in soil samples only at CAS 12-15-01. Drilling and sampling bounded the lateral and vertical extent of contamination. The data show that COCs have not migrated laterally beyond the disposal feature boundaries but that COCs have migrated vertically beyond the base of the disposal feature. Additional detail is provided in Section A.13.6.

Excavation, field observations, geotechnical sampling, and topographic surveys characterized existing disposal feature covers. Cover thickness, slope, and geotechncial/hydrological characteristics were assessed. The following sections summarize soil sample analytical results and characteristics of disposal feature covers at each CAS.

A.13.1 CAS 05-15-01, Sanitary Landfill

No COCs were found migrating from this CAS. Analytical results for total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, and gamma spectrometry were all below PALs established in the CAIP.

The cover at T2 ranged from 2- to 3-ft thick. The covers at the remaining disposal features were less than 2-ft thick and ranged from nonexistent over a portion of T1 to 1.5-ft thick over portions of T3 and T4. Debris encountered included metal, burned and unburned wood, and lesser amounts of concrete and transite pipe.

Based on interpretation of geotechnical data, cover soil has lower permeabilities than subcell soil and the soil is well below saturation. Cover soil had higher densities than subsurface soils. Cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

The ground surface at CAS 05-15-01 slopes gently from the northwest to southeast at approximately 1.3 percent. Topographic highs at the site include two soil mounds in the northwest corner adjacent to T1.

A.13.2 CAS 05-16-01, Landfill

No COCs were found migrating from this CAS. Analytical results for total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, pesticides, and gamma spectrometry were all below PALs established in the CAIP.

The covers at T1 and the SMT ranged from 1.5- to 4.5-ft thick and 1- to 2-ft thick, respectively. Metallic waste was consistently found in both disposal features, with lesser amounts of paper and glass.

Based on interpretation of geotechnical data, the T1 cover has a lower permeability than subcell native soil, and the SMT cover has a higher permeability than subcell native soil. The soil is well below saturation. Cover soil had lower densities than subcell soil and subcell porosities were slightly less than cover porosities.

The ground surface at CAS 05-16-01 slopes gently from the northeast to southwest at approximately 1.8 percent. The flood dike transecting the eastern third of the site rises approximately 8 ft above the surrounding surface and the sinkhole east of the flood dike is approximately 1.5-ft deep.

A.13.3 CAS 06-08-01, Landfill

No COCs were found migrating from this CAS. Analytical results for total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, and gamma spectrometry were all below PALs established in the CAIP.

The cover at AA was more than 2-ft thick. The covers at T1 and T2 generally did not exceed more than 1-ft thick. The extent of AA, T1, and T2 were established, except the southern ends. The southern ends of T1 and T2 do not extend into the Area 6 support facility parking lot and probably terminate under Road 6-01 or the utility corridor that parallels Road 6-01. The southern extent of AA could not be established due to the presence of utilities and numerous concrete pads and other structures.

Buried waste was sporadically encountered and conclusions about disposal features were often based on subtle lithological and/or structural changes. The investigation determined that no debris is present at PT3 and PT4.

Based on interpretation of geotechnical data, cover soil at T1 and T2 has higher permeabilities than subcell soil and cover soil at AA has lower permeabilities than subcell soil. Moisture content measurements show that the soil is well below saturation. Cover soil had higher densities than subcell soil and cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

The ground surface at CAS 06-08-01 slopes gently from the northeast to southwest at approximately 2.3 percent. The gravelled bench in the northwest corner of the site rises approximately 4 ft above the surrounding ground surface. There are numerous flat concrete pads at the site.

A.13.4 CAS 06-15-02, Sanitary Landfill

No COCs were found migrating from this CAS. Analytical results for total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, gamma spectrometry, and isotopic plutonium were all below PALs established in the CAIP.

The covers at all the disposal features in this CAS were consistently found to be 1-ft thick. Debris was encountered at all the disposal features except CWA8, where cover thickness was determined by lithologic changes. Debris encountered included metallic waste and lesser amounts of plastic and wood.

Based on interpretation of geotechnical data, cover soil has lower permeabilities than subcell soil. Moisture content measurements show that the soil is well below saturation. Cover soil had higher densities than subcell soil and cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

The ground surface at CAS 06-15-02 slopes from the southwest to the northeast at approximately 4.1 percent. The Area 6 Hydrocarbon Landfill, located at the east end of the site, rises approximately 8 ft above the surrounding surface.

A.13.5 CAS 06-15-03, Sanitary Landfill; Burn Pit

No COCs were found migrating from this CAS. Analytical results for total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, gamma spectrometry, isotopic plutonium, and Sr-90 were all below PALs established in the CAIP.

The covers at CWA2, CWA4, and TL1/CWA5 were at least 2-ft thick. The cover at TL2 was consistently 1-ft thick. The covers at CWA1 and CWA3 were only a few inches thick. At CWA3, asphalt debris was noted from just below the surface to about 1 ft bgs over about half of the feature.

There was no debris observed at CWA1, CWA2, or CWA4. Covers at these disposal features were based on variations in structure and lithology. Debris at TL1/CWA5 and TL2 included minor amounts of metal and plastic.

Based on interpretation of geotechnical data, cover soil has lower permeabilities than subcell soil at TL1/CWA5 and at CWA4. At CWA3, cover soil has a higher permeability than subcell soil. Moisture content measurements show that the soil is well below saturation. Cover soil had higher densities than subcell soil and cover porosities were less than subcell porosities, suggesting relatively more compaction on the surface than subsurface.

The ground surface at CAS 06-15-03 slopes from the southwest to the northeast at approximately 5 percent. There is a low, linear mound (less than 1-ft high) over most of CWA4. The ground surface at most of CWA3 is generally flat.

A.13.6 CAS 12-15-01, Sanitary Landfill

Analytical results for total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, PCBs, and gamma spectrometry were all below PALs established in the CAIP.

The COCs at this CAS are the VOCs 1,2-dichlorobenzene and 1,4-dichlorobenzene, and TPH (DRO and GRO). The COCs were detected in samples collected from boring F05 located toward the western edge of CWA1. The VOCs were detected at 14 to 15 ft bgs and TPH was detected at 14 to 15 ft bgs and 25 to 26 ft bgs. The core at and between these intervals was described as medium, green, gravelly sand with a strong hydrocarbon odor. Field screening and analytical results from samples collected above and below this horizon show the contamination is vertically confined from 9 to 30 ft bgs at this location. This interval extends below the base of CWA1, determined by excavation to vary from 7.5 to 11 ft bgs. Samples from four step-out borings were free of contamination, indicating the lateral extent of contamination is confined to an area of about 160 by 220 ft around the immediate vicinity of boring F05.

Disposal feature covers were found to be at least 2-ft thick and reached up to 6-ft thick at T2/CWA5. The exception was T3 where the cover was 1-ft thick. Varying amounts and types of debris were encountered and included miscellaneous burned material, kitchen garbage, and metallic scrap.

Based on interpretation of geotechnical data, cover soil has permeabilities less than, equal to, or greater than subcell soil permeabilities, depending on location. Moisture content measurements show that the soil is well below saturation. Generally, cover soil had lower densities than subcell soil and cover porosities were greater than subcell porosities.

The ground surface at CAS 12-15-01 is gently undulating, although it generally slopes from the west to east at approximately 4.9 percent. Washes parallel the site to the north and south; each wash is about 8- to 10-ft deep. The topography at the northern end of the site where the access road crosses the north wash is irregular.

A.13.7 CAS 20-15-01, Landfill

No COCs were found migrating from this CAS. Analytical results for total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, and gamma spectrometry were all below PALs established in the CAIP.

The cover at T1 was found to be 2-ft thick at all excavation locations. Plastic waste was encountered at all excavations. Scarce metal and wood was also found at excavation G03.

Based on interpretation of geotechnical data, cover soil has lower permeabilities than subcell soil. Moisture content measurements show that the soil is well below saturation. Cover soil and subcell soil densities were generally equivalent. Cover porosities were generally less than subcell porosities, suggesting more compaction on the surface than subsurface.

The ground surface at CAS 20-15-01 is relatively flat, sloping from the northeast to southwest at approximately 1.6 percent. There are no noticeable topographic highs or lows at the site.

A.13.8 CAS 23-15-03, Disposal Site

No COCs were found migrating from this CAS. Analytical results for total VOCs, total SVOCs, ethylene glycol, total RCRA metals, nickel, zinc, TPH (DRO and GRO), PCBs, dioxins, pesticides, and gamma spectrometry were all below PALs established in the CAIP.

Debris in the Disposal Area portion of the site is on the surface with negligible to no covers. A caliche hardpan was typically encountered at 1.5 to 2.5 ft bgs. Three surface debris fields and several piles of miscellaneous construction debris were identified. There are also two tall piles of soil containing some concrete and asphalt that were excavated during the investigation.

At the Landfill portion of the CAS, covers were identified at each disposal feature, except HCA5. At T1, the cover ranged in thickness from 3 in. to 3 ft. The covers at T2 and T4 were generally about 0.5-ft thick, though were a little more at some locations. The cover at T3 ranged from 1- to 1.5-ft thick. The covers at T5 and T6 ranged from 0.5- to 2-ft thick and 0.5- to 4-ft thick, respectively. At HCA5, fill material was noted from the surface to 3 ft bgs.

In general, fill material containing varying amounts and types of debris were encountered at all the Landfill disposal features. Waste included burned material and ash, metal, concrete, glass, and miscellaneous metallic scrap. At several excavations, including the single excavation at HCA5, debris was not encountered and cover thicknesses were based on variations in lithology and structure.

There is waste covered with several inches of soil in an area extending to the west from T1 to the east edge of a north/south-trending wash. This is based on excavations in the described area as well as the presence of a linear pile of concrete debris along the east edge of the wash.

The northern edges of T2, T3, and T4 were not definitively established, although they are believed to be beneath the WSI firing range berm, or just to the south of the berm. The southern boundaries of T4, T5, and T6 were not established due to CAU 112 use-restrictions.

Based on interpretation of geotechnical data collected at the Landfill portion of the CAS, cover soil at T3 has a lower permeability than subcell soil, while cover soil at T1 and T2 has higher permeabilities than subcell soil. Moisture content measurements show that the soil is well below saturation. Cover soil had about the same density as subcell soil and cover porosities were generally greater than subcell porosities, though the differences were minor. No geotechnical samples were collected at the Disposal Area because disposal features and covers were not present.

The Disposal Area portion of CAS 23-15-03 contains two washes. One wash predominates the northern portion of this area and the other wash defines the southern portion. Exclusive of these washes, the ground surface in this area slopes from the north to the south at approximately 6.4 percent. Topographic highs include two, 7-ft tall, soil mounds at the south end of the area.

The ground surface at the Landfill portion of CAS 23-15-03 slopes from the northeast to southwest at approximately 4.3 percent. The primary topographic high at this area is the WSI firing range berm to the north. There is a shallow wash trending northeast to southwest that parallels the western edge of the area.

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Appendix B

Data Assessment

B.1.0 Data Assessment

This appendix provides an assessment of CAU 5 investigation results to determine whether the data collected met the DOQs and can support their intended use in the decision-making process. This assessment includes a reconciliation of the data with the CSM established for this project.

B.1.1 Statement of Usability

The data set collected at CAU 5 is of high quality and is appropriate for use in decision making. This section provides an evaluation of the DQIs in determining the degree of acceptability or usability of the reported data in the decision-making process.

B.1.1.1 Precision

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 RPD between duplicate measurements (EPA, 1996). The RPD is determined by dividing the difference between the replicate measurement values by the average measurement value and multiplying the result by 100.

Determinations of precision can be made for field sample duplicates, laboratory duplicates, or both. Field sample duplicates are collected simultaneously with a sample 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 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 portions of an existing sample. Typically, other laboratory duplicate QC samples include MSD and laboratory control sample duplicates (LCSDs).

The variability in the results from the analysis of field sample duplicates is generally greater than the variability in the results of laboratory duplicates. This higher variability for field sample duplicates results from the increased potential to introduce factors influencing the analytical results during sampling, sample preparation, containerization, handling, packaging, preservation, and environmental conditions before the samples reach the laboratory. Laboratory QC samples assess only the variability of results introduced by sample handling and preparation in the laboratory and by the analytical procedure, which also impacts field sample duplicates. In addition, the variability in duplicate results is expected to be greater for soil samples than water samples, primarily due to the inherent nonhomogeneous nature of soil samples, despite sample preparation methods that include mixing to improve sample homogeneity.

B.1.1.1.1 Precision for Chemical Analyses

The RPD criteria used for assessment of laboratory sample duplicate precision for analytical results of samples collected at CAU 5 were established. Inorganic analysis RPD criteria is obtained from the EPA's *A Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 1994). Organic analysis RPD criteria is established by the laboratory to evaluate precision for MSD and LCSD analyses. The control limits are evaluated at the laboratory on a quarterly basis by monitoring the historical data and performance for each method. No review criteria for organic field sample duplicate RPD comparability have been established; therefore, the laboratory MSD RPD criteria is applied for precision evaluation of field sample duplicates.

Precision values for organic and inorganic analysis that are within the established control criteria indicate that precision of analytical methods and laboratory performance is within control. Laboratory duplicate 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. Inorganic laboratory duplicate RPD values outside the established control criteria do result in the qualification of associated analytical results as estimated. Field sample duplicate RPD values that are outside the criteria for organic and inorganic analyses do not result in the qualification of analytical data. Out of control RPD values do not necessarily indicate that the data is not useful for the purpose intended; however, it is an indication data precision should be considered for the overall assessment of the data quality and potential impact on data application in meeting project site characterization objectives.

Method-specific precision as RPD is determined by taking the number of measurements within criteria, dividing that by the number of measurements analyzed, and multiplying by 100. For the purpose of determining data precision of sample analyses for CAU 5, all water and soil samples including field QC samples (i.e. trip blanks, equipment rinsates, field blanks, source blanks) were evaluated and incorporated into the precision calculation.

Precision for the measurement of target compounds or analytes collected at CAU 5 was determined for RCRA metals, nickel, zinc, VOCs, SVOCs, PCBs, TPH (DRO and GRO), pesticides, and ethylene glycol.

Table B.1-1 and Table B.1-2 provide the field and laboratory duplicate precision results.

Table B.1-1
Organic Chemical Precision Measurements for CAU 5

	VOCs	SVOCs	TPH (DRO)	TPH (GRO)	PCBs	Pesticides	Ethylene Glycol	Dioxins/ Furans
Matrix Spike Duplicate Precision								
Total Number of MSD Measurements	105	176	24	26	36	24	24	0
Total Number of RPDs Within Criteria	100	176	24	26	36	24	24	0
MSD Percent Precision	95.24	100	100	100	100	100	100	NA
Laboratory Control Sample Duplicate Precision								
Total Number of LCSD Measurements	165	319	27	38	56	60	24	17
Total Number of RPDs Within Criteria	165	317	26	37	56	60	24	17
LCSD Percent Precision	100	99.37	96.30	97.37	100	100	100	100
Field Duplicate Precision								
Total Number of FD Measurements	897	923	13	13	91	63	13	0
Total Number of RPDs Within Criteria	897	923	13	13	91	63	13	0
FD Percent Precision	100	100	100	100	100	100	100	NA

MSD = Matrix spike duplicate
IDL = Instrument detection limit
RPD = Relative percent difference
LCSD = Laboratory control sample duplicate
FD = Field duplicate

Table B.1-2
Inorganic Chemical Precision Measurements for CAU 5

	Metals[a]	Mercury
Matrix Spike Duplicate Precision		
Total Number of MSD Measurements	189	25
Total Number of RPDs Within Criteria	188	25
MSD Percent Precision	99.47	100
Laboratory Control Sample Duplicate Precision		
Total Number of LCSD Measurements	243	29
Total Number of RPDs Within Criteria	243	29
LCSD Percent Precision	100	100
Field Duplicate Precision		
Total Number of FD Measurements	117	13
Total Number of RPDs Within Criteria	110	13
FD Percent Precision	94.02	100
Laboratory Sample Duplicate Precision		
Total Number of Laboratory Duplicate Measurements	189	25
Total Number of RPDs Within Criteria	185	25
Laboratory Duplicate Percent Precision	97.88	100

[a]Arsenic, barium, cadmium, chromium, lead, selenium, silver, nickel, zinc

MSD = Matrix spike duplicate
IDL = Instrument detection limit
RPD = Relative percent difference
LCSD = Laboratory control sample duplicate
FD = Field duplicate

Inorganic laboratory duplicate RPD values outside the established control criteria result in estimation for that measurement of all associated samples in the SDG. For example, if a laboratory duplicate had an RPD value for lead outside the established control criteria, lead results for all of the samples in that SDG would be qualified as estimated.

Out of control RPD values do not necessarily indicate that the data is not useful for the purpose intended. It does indicate that precision should be considered for the overall assessment of the data quality and impact to the application of associated data to meeting the project's objectives.

B.1.1.1.2 Precision for Radiological Analysis

The precision of radiological measurements is evaluated by measuring two aliquots of a sample and comparing the results. A laboratory duplicate is measured with every batch of samples analyzed by the laboratory. Field duplicate data is available when two aliquots of a sample are submitted to the laboratory for analysis. The LCSDs are measured by the laboratory when there is an insufficient sample to measure a duplicate of a field sample. The MSDs, also used to evaluate precision, are performed by the laboratory upon request. The MSDs were not included in CAU 5.

The duplicate precision is evaluated using the RPD or normalized difference. The RPD is applicable when both the sample and its duplicate have concentrations of the target radionuclide exceeding five times their minimum detectable concentration. This excludes many measurements because the samples contain nondeductible or low levels of the target radionuclide. In situations where the RPD does not apply, duplicate results are evaluated using the normalized difference which is expressed by:

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

Where:
S = Sample result
D = Duplicate result
TPU (total propagated uncertainty)$_S$ = 2F TPU of the sample
TPU_D = 2F TPU of the duplicate
F = Standard deviation

The control limit for the normalized difference is -1.96 to 1.96, which represent a confidence level of 95 percent. Depending on the sample concentration, only one duplicate evaluation needs to be performed.

Samples are qualified based on laboratory prepared duplicates, but not field duplicates or MSDs.

A duplicate comparison that is outside control limits does not necessarily indicate that the data is not useful for the purpose intended; however, it is an indication data precision should be considered for the overall assessment of the data quality and potential impact on data application in meeting project site characterization objectives.

For the purpose of determining data precision of sample analyses for CAU 5, all water and soil duplicates were evaluated and incorporated into Table B.1-3 and Table B.1-4.

Table B.1-3
Laboratory Duplicate Precision for Radioanalytes

	Gamma Spectrometry	Strontium-90	Isotopic Plutonium
Relative Percent Difference			
Number Performed	24	4	5
Number Within Limits	24	4	5
Percent Within Limits	100	100	100
Normalized Difference			
Number Performed	460	1	16
Number Within Limits	460	1	16
Percent Within Limits	100	100	100

Table B.1-4
Field Duplicate Precision for Radioanalytes

	Gamma Spectrometry	Isotopic Plutonium
Relative Percent Difference		
Number Performed	8	0
Number Within Limits	7	0
Percent Within Limits	88	Not Applicable
Normalized Difference		
Number Performed	212	6
Number Within Limits	212	6
Percent Within Limits	100	100

The isotopic gamma analysis provides results for 22 radionuclides. Only two or three of these radionuclides are usually present in sufficient concentrations to allow for the determination of their RPDs. The duplicate data for the remaining radionuclides is compared using the normalized difference. The Sr-90 analysis provides only the one result while the isotopic Pu analysis gives results for Pu-238 and Pu-239/240.

The laboratory precision tests for all the measurements were within the control limits.

Field duplicates were analyzed by gamma spectrometry and isotopic plutonium. All of the field duplicate comparisons were within the control limits except for one gamma spectrometry RPD. No field samples were qualified based on the RPD being outside control limits.

B.1.1.1.3 Precision Summary

Overall, the precision for CAU 5 measurements were within DQI specifications. The results of the duplicate comparison of the field duplicates (FDs) and laboratory duplicates (LDs) for chemical analysis are provided in Table B.1-1 (organic) and Table B.1-2 (inorganic). Of the 2,143 precision tests performed on FDs, 2,136 or 99.7 percent were within control limits. Of the 1,804 precision tests of MSDs, LCSDs, and LDs, 1,790 or 99.2 percent were within control limits. The results of radioanalyte LD and FD precision are provided in Table B.1-3 and Table B.1-4, respectively. All of the LD and FD precision tests performed were within control limits. Therefore, the measurements for CAU 5 are considered valid in regard to precision.

B.1.1.2 Accuracy

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.

B.1.1.2.1 Accuracy for Chemical Analysis

Accuracy is determined by analyzing a reference material of known pollutant concentration or by reanalyzing a sample to which a material of known concentration or amount of pollutant has been added (spiked). Accuracy is expressed as % R for the purposes of evaluating the quality of data reported for CAU 5.

Matrix spike samples are prepared by adding a known concentration of a target analyte to a specified amount of matrix sample for which an independent estimate of the target analyte concentration is available. Spiked samples are used to determine the laboratory's overall efficiency by comparing the percent recovered to the known true value. For example, a sample that is spiked with 10 ppm of a known analyte should produce a reported result of 10 ppm greater than the concentration of the sample itself. Consequently, the accuracy for this analysis would be reported as 100 percent.

Consequently, the accuracy for this analysis would be reported as 100 percent. Matrix spike recoveries within the specified criteria for organic and inorganic analyses indicate the laboratory is operating within established controls and producing valid, quality results. Matrix spike results outside the control limits for organic analyses may not result in qualification of the data. An assessment of the entire analytical process is performed to determine the quality of the data and whether qualification is necessary.

Laboratory control samples are generated to provide accuracy of analytical methods and laboratory performance. They are prepared, extracted (as required by method), analyzed, and reported one per SDG per matrix. For organic analyses, laboratory control limits are used to evaluate the accuracy of all analyses. The control limits are evaluated at the laboratory quarterly by monitoring the historical data and performance for each method. The acceptable limits for inorganic analyses are established in the EPA *Contract Laboratory Program Functional Guidelines for Inorganic Data Review* (EPA, 1994). Sample results within established control ranges for organic and inorganic analyses show that the analytical method is accurate and the data provided are accurate.

Surrogates (system monitoring compounds) are used to assess the method performance and matrix influences for each sample analyzed for organic analyses. Control limits established by the laboratory are used to evaluate the accuracy of the surrogate recoveries. 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.

Table B.1-5 and Table B.1-6 identify the number of MS, LCS, and surrogate measurements performed for CAU 5. The tables present the total number of measurements analyzed, the number of measurements within the specified criteria, and the percent accuracy of each method. Method-specific accuracy is determined by taking the number of measurements within criteria, dividing that by the total number of measurements analyzed, and multiplying by 100. For organic analyses, each sample had surrogates analyzed. Therefore, the tables include the total number of sample measurements performed for each method and the total number of sample measurements not qualified for surrogate recoveries exceeding criteria. Surrogate method-specific accuracy is determined by taking the number of sample measurements not qualified for surrogate recoveries exceeding criteria, dividing that by the total number of sample measurements analyzed, and multiplying by 100.

Table B.1-5
Organic Laboratory Accuracy Measurements for CAU 5

	VOCs	SVOCs	TPH (DRO)	TPH (GRO)	PCBs	Pesticides	Ethylene Glycol	Dioxins/ Furans
Matrix Spike Accuracy								
Total Number of MS Measurements	210	352	48	52	72	48	48	0
Total Number of MS Measurements Within Criteria	200	352	48	38	72	43	44	0
MS Percent Accuracy	95.24	100	100	73.08	100	89.58	91.67	NA
Laboratory Control Sample Accuracy								
Total Number of LCS Measurements	330	638	55	76	112	120	48	34
Total Number of LCS Measurements Within Criteria	330	637	55	76	112	120	48	34
LCS Percent Accuracy	100	99.84	100	100	100	100	100	100
Surrogate Accuracy								
Total Number of Measurements Analyzed	17,319	14,626	207	206	1,442	1,176	206	100
Total Number of Measurements not Affected by Out-of-Control Surrogates	17,312	14,555	205	155	1,373	1,092	206	100
Surrogate Percent Accuracy	99.96	99.51	99.03	75.24	95.21	92.86	100	100

MS = Matrix spike
LCS = Laboratory control sample

For the purpose of determining data accuracy of sample analysis for CAU 5, all water and soil samples including field QC samples (i.e., trip blanks, equipment rinsates, field blanks, source blanks) were evaluated and incorporated into the accuracy calculation.

Accuracy for the measurement of target analytes collected at CAU 5 was determined for RCRA metals, nickel, zinc, VOCs, SVOCs, PCBs, TPH (DRO and GRO), pesticides, and ethylene glycol.

Table B.1-6
Inorganic Laboratory Accuracy Measurements for CAU 5

	Metals[a]	Mercury
Matrix Spike Accuracy		
Total Number of MS Measurements	378	50
Total Number of MS Measurements within Criteria	371	45
MS Percent Accuracy	98.15	90.00
Laboratory Control Sample Accuracy		
Total Number of LCS Measurements	486	59
Total Number of LCS Measurements Within Criteria	486	59
LCS Percent Accuracy	100	100

[a]Arsenic, barium, cadmium, chromium, lead, selenium, silver, nickel, and zinc

MS = Matrix spike
LCS = Laboratory control sample

B.1.1.2.2 Accuracy for Radiological Analysis

Laboratory control samples and MS samples are used to determine the accuracy of radioanalytical measurements. 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 the target radionuclide to a specified field sample with a measured concentration. No MS sample analyses were performed for CAU 5.

The accuracy of the LCS determination is expressed as a percent recovery by the following:

$$\text{Percent Recovery} = \frac{\text{Amount of Analyte Measured}}{\text{Amount of Analyte Added}} \times 100$$

If the LCS results are outside acceptable control limits, qualifiers will be added to the field samples analyzed with the LCS.

Table B.1-7 gives the number of laboratory control samples, including soil and water matrices, measured for each radiochemical measurement for CAU 5. The percent accuracy for the procedure is determined as the number of LCS measurements that are within the control limits divided by the total number LCS analyses, multiplied by 100.

Table B.1-7
Radioanalyte Laboratory Control Sample Accuracy

	Gamma Spectrometry	Strontium-90	Isotopic Plutonium
Total Number	92	5	9
Total Number Within Criteria	92	5	9
Laboratory Control Sample Percent Accuracy	100	100	100

Laboratory control samples within the specified criteria for radiological analyses indicate the laboratory is producing valid data. If the LCS criteria are not met, the laboratory performance and method accuracy are in question. Radiological LCS recoveries outside of established controls require data to be qualified for the individual radionuclide out of control.

B.1.1.2.3 Accuracy Summary

Overall, the accuracy for CAU 5 was within acceptable limits. Of the 35,182 chemical surrogate measurements, 34,898 or 99 percent were not affected by out of control surrogates. Of the 2,209 chemical MS and LCS measurements, 2,175 or 98.5 percent were within criteria. All of the radioanalyte LCSs were within criteria. Therefore, the measurements for CAU 5 are considered valid in regard to accuracy.

B.1.1.3 Completeness

Completeness is defined as the acquisition of sufficient data of the appropriate quality to satisfy DQO decision data requirements. A measure of completeness is the amount of data that are judged to be valid. Percent completeness for sample analyses was determined by dividing the total number of samples analyzed (per method) by the total number of samples sent to the laboratory and multiplying the result by 100. Percent completeness for measurement usability (not rejected) was determined by dividing the total number of nonrejected measurements by the total number of measurements (per method) and multiplying the result by 100. All measurement for completeness include reanalyses. Table B.1-8, Table B.1-9, and Table B.1-10 contain results of completeness per analytical method.

Table B.1-8
Organic Chemical Completeness for CAU 5

Completeness Parameters	VOCs	SVOCs	TPH (DRO)	TPH (GRO)	PCBs	Pesticides	Ethylene Glycol	Dioxins/ Furans
Sample Analysis Completeness								
Total Samples Sent to Laboratory	251	206	207	206	206	56	206	2
Total Samples Analyzed	251	206	207	206	206	56	206	2
Total Samples Not Analyzed by the Laboratory	0	0	0	0	0	0	0	0
Percent Completeness	100	100	100	100	100	100	100	100
Measurement Usability Completeness								
Total Measurements[a]	17,319	14,626	207	206	1,442	1,176	206	100
Total Measurements Rejected - Field	0	0	0	0	0	0	0	0
Total Measurements Rejected - Lab/Matrix	6	16	0	0	0	0	0	0
Percent Completeness	99.97	99.89	100	100	100	100	100	100

[a] Measurements include reanalyses

In accordance with Table 6-1 of the CAIP (NNSA/NV, 2002) and as shown in Table B.1-8, Table B.1-9, and Table B.1-10, 80 percent completeness of Phase I analytes has been met with one exception. Completeness for Sr-90 analysis (Method SR7500) was 78 percent because QC samples 005E302 and 005E306 were not analyzed for Sr-90 due to laboratory oversight. Strontium-90 was not detected above the MRL in the single soil sample analyzed for this analyte so it is not likely to be present in the QC samples. Thus, the characterization of the site was not impacted and the 78 percent Sr-90 completeness is acceptable.

Table B.1-9
Inorganic Chemical Completeness for CAU 5

Completeness Parameters	Metals[a]	Mercury
Sample Analysis Completeness		
Total Samples Sent to Laboratory	206	206
Total Samples Analyzed	206	206
Total Samples Not Analyzed by the Laboratory	0	0
Percent Completeness	100	100
Measurement Usability Completeness		
Total Measurements[b]	1,854	206
Total Measurements Rejected - Field	0	0
Total Measurements Rejected - Lab/Matrix	3	0
Percent Completeness	99.84	100

[a]Arsenic, barium, cadmium, chromium, lead, nickel, selenium, silver, and zinc
[b]Measurements include reanalyses

Table B.1-10
Radiological Completeness for CAU 5

Completeness Parameters	Gamma Spectrometry	Strontium-90	Isotopic Plutonium
Sample Analysis Completeness			
Total Samples Sent to Laboratory	114	9	58
Total Samples Analyzed	114	7	58
Total Samples Not Analyzed by the Laboratory	0	2	0
Percent Completeness	100	78	100
Measurement Usability Completeness			
Total Measurements[a]	2,508	7	116
Total Measurements Rejected - Field	0	0	0
Total Measurements Rejected - Lab/Matrix	1	0	0
Percent Completeness	100	100	100

[a]Measurements include reanalyses

B.1.1.3.1 Rejected Data

Acetone was rejected in 78 soil and sludge samples (including 6 reanalyses) based on the results having low relative response factors (RRFs) (i.e., less than 0.05). These sample results were reevaluated to determine data usability.

The data were validated according to EPA's *A Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999). Although CLP guidelines require that the Acetone RRF be greater than 0.01 (Note: All calibrations associated with the samples in question had RRFs greater than 0.01), functional guidelines require that all nondetected data be rejected when the initial or continuing calibration curves have RRFs less than 0.05. The samples were rejected for acetone because initial and continuing calibration RRFs were less than 0.05.

Since the samples were analyzed using SW846 Method 8260 B (EPA, 1996), linear regression is a viable approach for instrument calibration. The calibrations were reexamined using linear regression calibrations, and all technical criteria were met. Using linear regression, the acetone results would not have been rejected since the sample results would not have been calculated using an average RRF. Therefore, there is no indication that acetone is present in the samples that were rejected for acetone, and all rejected acetone results are considered usable as nondetects.

Certain analytical data were rejected from samples collected at CASs 06-08-01, 06-15-03, and 12-15-01. The following sections discuss rejected data, per CAS.

Rejected Data for CAS 06-08-01, Landfill

Table B.1-11 lists the rejected results for CAS 06-08-01. All other results are considered usable. Results for six SVOCs were rejected in one sample because the internal area response showed an extremely low count. The data gap is acceptable because no other SVOCs were detected above MRLs in this sample or any other samples collected from the surrounding boreholes. Thus, it is unlikely that SVOCs were present above MRLs in the rejected sample.

Table B.1-11
CAU 5 Rejected Data for CAS 06-08-01

Sample Number	Laboratory Method	Parameter	Sample Matrix
005C016	SW8270	Benzo(A)Pyrene	Soil
005C016	SW8270	Benzo(B)Fluoranthene	Soil
005C016	SW8270	Benzo(G,H,I)Perylene	Soil
005C016	SW8270	Benzo(K)Fluoranthene	Soil
005C016	SW8270	Dibenzo(A,H)Anthracene	Soil
005C016	SW8270	Indeno(1,2,3-CD)Pyrene	Soil

Rejected Data for CAS 06-15-03, Sanitary Landfill; Burn Pit

Table B.1-12 lists the rejected results for CAS 06-15-03. All other results are considered usable. Silver results were rejected in three samples because the MS recovery was less than 30 percent. The data gap is acceptable because silver was only detected above MRLs in three samples collected from CAS 06-15-03 and was at concentrations well below PALs. Thus, it is unlikely silver is present or at significant concentrations in the rejected samples.

Table B.1-12
CAU 5 Rejected Data for CAS 06-15-03

Sample Number	Laboratory Method	Parameter	Sample Matrix
005E002	SW6010	Silver	Soil
005E003	SW6010	Silver	Soil
005E004	SW6010	Silver	Soil
005E016	PAI713R7	Europium-152	Soil

Europium-152 results were rejected in one soil sample because spectral identification was tentative. The data gap is acceptable because the isotope was not detected above MRLs in any samples collected from CAS 06-15-03; therefore, it is unlikely that Europium-152 is present at a concentration above the MRL in the rejected sample.

Rejected Data for CAS 12-15-01, Sanitary Landfill

Table B.1-13 lists the rejected results for CAS 12-15-01. All other results are considered usable. The SVOC 2,3,4,6-Tetrachlorophenol was rejected in seven soil samples because the RRF was less than 0.05. The data gap is acceptable because this SVOC was not detected above the MRL in any of the other samples collected at CAS 12-15-01; therefore, it is unlikely that this SVOC is present at a concentration exceeding the MRL in the rejected samples.

Table B.1-13
CAU 5 Rejected Data for CAS 12-15-01

Sample Number	Laboratory Method	Parameter	Sample Matrix
005F031	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005F032	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005F033	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005F034	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005F035	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005F036	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005F037	SW8270	2,3,4,6-Tetrachlorophenol	Soil

Rejected Data for CAS 20-15-01, Landfill

Table B.1-14 lists rejected results for CAS 20-15-01. All other results are considered usable. The SVOC 2,3,4,6-Tetrachlorophenol was rejected in three soil samples because the RRF was less than 0.05. The data gap is acceptable because no SVOCs including SVOC 2,3,4,6-Tetrachlorophenol, were detected above MRLs in any of the samples collected at CAS 20-15-01. Thus, it is unlikely that SVOCs are present at concentrations exceeding the MRL in the rejected samples.

B.1.1.4 Representativeness

The DQO process, as identified in Appendix A of the CAIP, was used to address sampling and analytical requirements for CAU 5. During this process, appropriate biased locations were selected that enabled the samples collected to be representative of the area being evaluated. Biased sampling was performed to ensure sampling of potentially migrating COCs. In addition, analytical

Table B.1-14
CAU 5 Rejected Data for CAS 20-15-01

Sample Number	Laboratory Method	Parameter	Sample Matrix
005G001	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005G002	SW8270	2,3,4,6-Tetrachlorophenol	Soil
005G003	SW8270	2,3,4,6-Tetrachlorophenol	Soil

requirements were specified in order to ensure appropriate methods were selected for COPCs. This was performed to address the concerns of all stakeholders and project personnel. The DQO approach was based upon process knowledge gained during the preliminary assessment. Samples were collected and analyzed as planned with the completeness issues discussed in Section B.1.1.3. In addition, QC blanks were used as a way of measuring outside factors that could impact sample results. No data were qualified due to QC blanks. Therefore, the analytical data acquired during the CAU 5 corrective action investigation are considered representative of site characteristics and contamination.

B.1.1.5 Comparability

Field sampling, as described in the CAIP (NNSA/NV, 2002), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per DOE were used to analyze, report, and validate the data. These are comparable to other methods used in industry and government practices, but most importantly are comparable to other investigations conducted for the NTS. Therefore, datasets within this project are considered comparable to other datasets generated using the same standardized DOE procedures, thereby meeting DQO requirements. The employed methods and procedures also ensured that data were appropriate for comparison to action levels specified in the CAIP and this CADD.

Also, standard, approved field and analytical methods ensured that data were appropriate for comparison to the investigation action levels specified in the CAIP (NNSA/NV, 2002).

B.1.2 Reconciliation of Conceptual Site Model to the Data

This section provides a reconciliation of the data collected and analyzed during this investigation with the CSM established in the DQO process.

B.1.2.1 Conceptual Site Model

One CSM was developed for all of the CAU 5 CASs as presented in the CAIP (NNSA/NV, 2002). The CSM was based on historical information and process knowledge and assumes that surface and/or subsurface soils are the potentially affected media where leachable solid and/or liquid waste may have contributed to contamination.

Any contamination would be attributable to direct release to the surface and/or subsurface of solid waste, residual fluids in discarded containers, release of contaminants through burning, erosion of various contaminants off the surface of solid materials, and leaching of contaminants from materials.

The amount of generated leachate is unknown but assumed to be minimal based on low precipitation and high evapotranspiration rates. The location of contamination or releases is assumed to be at or close to the native soil interface adjacent to the disposed waste. Any migrating contaminants, regardless of physical or chemical characteristics, are expected to be in soil adjacent to disposal feature walls and bases. Contamination, if present, is expected to be contiguous to the site. Concentrations are expected to decrease with distance and depth from the sites.

B.1.2.2 Investigation Design and Contaminant Identification

The CSM was used to identify appropriate sampling strategies and data collection methods. Results of DQIs were successful in identifying the accuracy of the CSM as a predictor of nature and extent of potential contamination. Precision and accuracy results from field samples identified sample homogeneity and minimal matrix interference, thereby providing confidence in collected data.

To address the CSM, subsurface samples collected for analysis were designed to define the nature and extent of COPCs identified in the CAIP. Biased strategies were developed to focus the investigation on areas of potential contamination, outside the boundaries of identified disposal features.

The investigation design has shown that contamination has not significantly migrated beyond disposal feature boundaries. Therefore, the CSM accurately predicted the extent of COPCs at each CAS. The CSM was successful in predicting contaminant location and the DQIs provided a measure of the success of this design.

B.1.2.3 Contaminant Nature and Extent

The presence of contamination was identified by sample results showing COPC soil concentrations exceeding PALs, thereby defining COCs at one CAS (CAS 12-15-01). Soil sample results demonstrated that the vertical and lateral extent of COCs was limited to the physical boundaries of the CSM defined in the CAIP (NNSA/NV, 2002). Field screening was conducted and samples were collected at locations to bound contaminated areas with results below action levels. This confirmed the contamination extent was limited to regions anticipated by the CSM.

B.1.3 Conclusions

Except as noted in Appendix A, samples were collected and analyzed as planned and were within acceptable performance limits. In some instances, sample locations had to be moved due to the presence of concrete pads or underground utilities. These deviations are noted in applicable sections in Appendix A and did not compromise the overall site characterization sampling strategy.

The DQIs (i.e., precision, accuracy, completeness, representativeness, and comparability) were evaluated for quality and impact to the data. All of the data, except data qualified as rejected, can be used in project decisions. The rejected data have been discussed and determined to have little impact on closure decisions.

Thus, the DQOs for the investigation have been met, and the data can be used to develop corrective action alternatives and to support selection of a preferred corrective action alternative for each site.

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

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

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Corrective Action Investigation Plan for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada*, DOE/NV--818, Rev. 0. Las Vegas, NV.

U.S. Environmental Protection Agency. 1994. *A Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013. Washington, DC.

U.S. Environmental Protection Agency. 1996. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846 CD ROM PB97-501928GEI, which contains updates for 1986, 1992, 1994, and 1996. Washington, DC.

U.S. Environmental Protection Agency. 1999. *A Contract Laboratory Program National Functional Guidelines for Organic Data Review*, EPA 540/R-99/008. Washington, DC.

Appendix C

Cost Estimates

(18 Pages)

BECHTEL NEVADA

EST ID: CAU 5
CAS 05-15-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson REF #:

TYPE OF ESTIMATE:

X ORDER OF MAGNITUDE
PRELIMINARY / PLANNING / STUDY
CONCEPTUAL / BUDGET
TITLE I
TITLE II
WORK ORDER
COMPARATIVE
OTHER

TYPE OF WORK:

NON-MANUAL ONLY
MANUAL ONLY
X MANUAL & NON-MANUAL
OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM)
BN CONSTRUCTION X
BN MAINTENANCE
being protective controls.
SUBCONTRACT
GPP
OTHER

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 05-15-01, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 05-15-01 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO). CAS 05-15-01 is specifically described within the FFACO as a Sanitary Landfill. Three alternatives have been evaluated for closure of the CAS. No Further Action, Closure in Place with Administrative Controls, and Closure in Place with Construction of Covers. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, report preparation, project support, and/or other activities are not included herein.

SCOPE:

Provide site closure using one of the following alternatives:
I NO FURTHER ACTION
II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS
III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: No Further Action

Alternative II: Closure in Place with Administrative Controls, No Cover

- Backfill any depressions to eliminate potential ponding. Assumes a maximum of 500 cubic yards material to be added. This volume includes covering Trench 4 as a Best Management Practice. This is not a calculated value. Actual required volume may vary.
- Cost of moving material is based upon five trucks, each hauling seven loads per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than 1 hour round-trip distance. Assumes borrow pit in Area 5 is accessible and available for use at the time fieldwork begins. Screening of borrow material will not be required.
- Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and the boundary of waste trenches.
- Characterize and remove approximately 20 cubic yards of soil containing debris. Assumes that two samples will be collected from the waste pile prior to disposal. Assumes a full analytical suite with standard turn-around-times. Assumes that all waste will be classified as sanitary.
- Spread and level two existing soil mounds. Assumes two soil mounds contain no debris. Assumes that two samples will be collected from the waste pile prior to disposal. Assumes a full analytical suite with standard turn-around-times. Assumes that all waste will be classified as sanitary.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings.

BECHTEL NEVADA

EST ID: CAU 5
CAS 05-15-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

Alternative III: Closure in Place with Construction of Cover

- Construct a minimum two-foot cover over the waste trenches. Calculated volume of material (approximately 10,000 cubic yards). The area to be covered is approximately 87,500 square feet.
- Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
- Cover material does not require screening.
- Cost of moving material is based upon five trucks, each hauling four loads per day, for a total of 20 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than one hour round-trip distance. Assumes borrow pit in Area 5 is accessible and available for use at the time fieldwork begins. Screening of borrow material will not be required.
- Characterize and remove approximately 20 cubic yards of soil containing debris. Assumes that two samples will be collected from each waste pile prior to disposal. Assumes a full analytical suite with standard turn-around-times. Assumes that all waste will be classified as sanitary.
- Spread and level two existing soil mounds. Assumes two soil mounds contain no debris. Assumes that two samples will be collected from each waste pile prior to disposal. Assumes a full analytical suite with standard turn-around-times. Assumes that all waste will be classified as sanitary.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or damage to the cover by erosion. No maintenance is required to remove vegetation. Natural revegetation is acceptable.
- Wheel compaction will be adequate to place borrow material.

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
- This estimate does not include costs for developing required project plans, permits, reports, or project management or project support.
- Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
- Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- Access to the site will be available and unrestricted throughout field activities.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**No Further Action**	**$0**
Alternative II:	**Closure in Place with Administrative Controls, No Cover**	**$75,756**
Alternative III:	**Closure in Place with Administrative Controls, Construction of Cover**	**$357,467**

REVIEW / CONCURRENCE:

[signature] 6/24/03
Project Manager — Date

Charles W. Denson 06-24-03
Estimating — Date

Margaret E Cook 6/24/03
Project Controls — Date

BECHTEL NEVADA

EST ID: CAU 5
CAS 05-16-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson REF #:

TYPE OF ESTIMATE:		TYPE OF WORK:
X ORDER OF MAGNITUDE	TITLE II	NON-MANUAL ONLY
PRELIMINARY / PLANNING / STUDY	WORK ORDER	MANUAL ONLY
CONCEPTUAL / BUDGET	COMPARATIVE	X MANUAL & NON-MANUAL
TITLE I	OTHER	OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM)	SUBCONTRACT
BN CONSTRUCTION X	GPP
BN MAINTENANCE	OTHER

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 05-16-01, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 05-16-01 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO). CAS 05-16-01 is specifically described within the FFACO as a Landfill. Three alternatives have been evaluated for closure of the CAS: No Further Action, Closure in Place with Administrative Controls, and Closure in Place with Construction of Covers. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, report preparation, project support, and/or other activities are not included herein.

SCOPE:

Provide site closure using one of the following alternatives:
I NO FURTHER ACTION
II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS
III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: No Further Action

Alternative II: Closure in Place with Administrative Controls, No Cover

- Backfill sinkhole and any depressions to eliminate potential ponding. Assumes a maximum of 100 cubic yards material to be added. This is not a calculated value. Actual required volume may vary.
- Remove and dispose of surface debris. Assumes this task can be concurrently done with other tasks.
- Cost of moving material is based upon five trucks, each hauling seven loads per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and the boundary of waste trenches.
- Location of soil borrow pit is less than 1 hour round-trip distance. Assumes borrow pit in Area 5 is accessible and available for use at the time fieldwork begins. Screening of borrow material will not be required.
- Install appropriate administrative controls (i.e. postings, signs, fence, etc.). Assumes the subsurface metallic target area will be fenced and posted using T-Posts and sheetmetal signs. Assumes that Trench 1 will be posted only using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or fence, whenever applicable.

BECHTEL NEVADA

EST ID: CAU 5
CAS 05-16-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon **FROM:** Charles Denson

Alternative III: Closure in Place with Construction of Cover

- Construct berm or dike to redirect surface flow around Trench 1. Assumes a one-foot, non-engineered berm.
- Remove and dispose of surface debris. Assumes this task can be concurrently done with other tasks.
- Install a continuous one-foot cover over Trench 1 and the subsurface metallic target area. Approximately 5,000 cubic yards of material will be required. The area to be covered is approximately 35,000 square feet for Trench 1, and 2,500 square feet for the Subsurface Metallic Target Area. This estimate is based on surface area. Actual volume may differ.
- Backfill remaining depressions or low points to eliminate potential ponding. Assumes a volume of 100 cubic yards material.
- Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
- Cost of moving material is based upon five trucks, each hauling seven loads per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than one hour round-trip distance. Assumes borrow pit in Area 5 is accessible and available for use at the time fieldwork begins. Screening of borrow material will not be required.
- Install appropriate administrative controls (i.e. postings, signs, fence, etc.). Assumes the subsurface metallic target area will be fenced and posted using T-Posts and sheetmetal signs. Assumes that Trench 1 will be posted only using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or damage to the cover by erosion. No maintenance is required to remove vegetation. Natural revegetation is acceptable.
- Wheel compaction will be adequate to place borrow material.

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
- This estimate does not include costs for developing required project plans, permits, reports, or project management.
- Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
- Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- Access to the site will be available and unrestricted throughout field activities.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	No Further Action	$0
Alternative II:	Closure in Place with Administrative Controls, No Cover	$73,276
Alternative III:	Closure in Place with Administrative Controls, Construction of Cover	$226,536

REVIEW/CONCURRENCE:

[signature] 6/24/03
Project Manager — Date

Charles W Denson 06-24-03
Estimating — Date

Margaret Cook 6/24/03
Project Controls — Date

BECHTEL NEVADA

COST ESTIMATE PROPOSAL DATA SHEET

EST ID: CAU 5
CAS 06-08-01

Date: 24-Jun-03

TO: Allison Urbon | FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson | REF #:

TYPE OF ESTIMATE:

- X ORDER OF MAGNITUDE
- ___ PRELIMINARY / PLANNING / STUDY
- ___ CONCEPTUAL / BUDGET
- ___ TITLE I
- ___ TITLE II
- ___ WORK ORDER
- ___ COMPARATIVE
- ___ OTHER

TYPE OF WORK:

- ___ NON-MANUAL ONLY
- ___ MANUAL ONLY
- X MANUAL & NON-MANUAL
- ___ OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

- DOE PRIME (LUMP SUM) ___
- BN CONSTRUCTION X
- BN MAINTENANCE ___
- being protective controls.
- SUBCONTRACT ___
- GPP ___
- OTHER ___

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 06-08-01, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 06-08-01 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO). CAS 06-08-01 is specifically described within the FFACO as a Landfill. Three alternatives have been evaluated for closure of the CAS: No Further Action, Closure in Place with Administrative Controls, and Closure in Place with Construction of Covers. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, project support, report preparation, and/or other activities are not included herein.

SCOPE:

Provide site closure using one of the following alternatives:
I NO FURTHER ACTION
II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS
III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: No Further Action

Alternative II: Closure in Place with Administrative Controls, No Cover

- Backfill any depressions to eliminate potential ponding. Assumes a maximum of 500 cubic yards material to be added. This is not a calculated estimate. The actual volume may vary.
- Cost of moving material is based upon five trucks, each hauling seven loads per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than 1 hour round-trip distance. Assumes borrow pit in Area 6 is accessible and available for use at the time fieldwork begins. Screening of borrow material will not be required.
- The concrete pads present in the vicinity of the covers will not be removed. The cost of potentially relocating the subsurface utilities (e.g., fire hydrant, power to overhead lights) is not included. If another fire hydrant is not present within acceptable distance per fire codes, the hydrant will have to be relocated. The cost also assumes that a mechanism is available for maintaining the utilities.
- Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and the boundary of waste trenches.
- Install appropriate administrative controls (i.e. postings, signs, fence, etc.). Assumes that the utility corridor along Road 6-01 will be posted only using T-Posts and sheetmetal signs. Assumes that the landfill north of Road 6-01 will be fenced and posted using T-posts, wire strand fence, and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and fencing.

BECHTEL NEVADA

EST ID: CAU 5
CAS 06-08-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

Alternative III: Closure in Place with Construction of Cover

- Install a continuous two-foot cover over all waste trenches. Approximately 26,666 cubic yards of material is required. An additional 6,666 cubic yards of material is required for constructing a minimum two percent slope. This volume is an estimate only. The actual required volume may change. The area to be covered is approximately 720,000 square feet.
- The cost for constructing the cover is calculated based on five trucks each hauling seven loads per day, for a total of 35 loads per day. It is assumed that 17 cubic yards is the maximum capacity of the truck.
- Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
- Location of soil borrow pit is less than one hour round-trip distance. Assumes borrow pit in Area 6 is accessible and available for use at the time fieldwork begins. Screening of borrow material will not be required.
- The concrete pads present in the vicinity of the covers will not be removed. Cover material will be installed on top of the existing pads.

The cost of potentially relocating the subsurface utilities (e.g., fire hydrant, power to overhead lights) is not included. If another fire hydrant is not present within acceptable distance per fire codes, the hydrant will have to be relocated. The cost also assumes that a mechanism is available for maintaining the utilities.

- Install appropriate administrative controls (i.e. postings, signs, fence, etc.). Assumes that the utility corridor along Road 6-01 will be posted only using T-Posts and sheetmetal signs. Assumes that the landfill north of Road 6-01 will be fenced and posted using T-posts, wire strand, and sheet metal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or damage to the cover by erosion. No maintenance is required to remove vegetation. Natural revegetation is acceptable.
- Wheel compaction will be adequate to place borrow material.

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
- This estimate does not include costs for developing required project plans, permits, reports, or project management.
- Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
- Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- The subsurface utilities on the north side of Road 6-01 will remain accessible. This utility corridor will not be covered, and the road will remain operational.
- The cost assumes that no mobilization or demobilization costs will be incurred, as the Area-6 Equipment Yard is in the immediate vicinity.
- Access to the site will be available and unrestricted throughout field activities.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**No Further Action**	**$0**
Alternative II:	**Closure in Place with Administrative Controls, No Cover**	**$147,329**
Alternative III:	**Closure in Place with Administrative Controls, Construction of Cover**	**$1,047,737**

REVIEW / CONCURRENCE:

[signature] 6/24/03
Project Manager — Date

Charles N. Denson 06-24-03
Estimating — Date

Margaret C. Cook 6/24/03
Project Controls — Date

BECHTEL NEVADA

COST ESTIMATE PROPOSAL DATA SHEET

EST ID: CAU 5
CAS 06-15-02

Date: 24-Jun-03

TO: Allison Urbon FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson REF #:

TYPE OF ESTIMATE:				TYPE OF WORK:	
X	ORDER OF MAGNITUDE		TITLE II		NON-MANUAL ONLY
	PRELIMINARY / PLANNING / STUDY		WORK ORDER		MANUAL ONLY
	CONCEPTUAL / BUDGET		COMPARATIVE	X	MANUAL & NON-MANUAL
	TITLE I		OTHER		OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM)		SUBCONTRACT	
BN CONSTRUCTION	X	GPP	
BN MAINTENANCE		OTHER	

being protective controls.

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 06-15-02, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 06-15-02 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO) CAS 06-15-02 is specifically described within the FFACO as a Sanitary Landfill. Three alternatives have been evaluated for closure of the CAS No Further Action, Closure in Place with Administrative Controls, and Closure in Place with Construction of Covers. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, report preparation, project support, and/or other activities are not included herein.

SCOPE:

Provide site closure using one of the following alternatives:
I NO FURTHER ACTION
II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS
III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: No Further Action

Alternative II: Closure in Place with Administrative Controls
- Backfill any depressions to eliminate potential ponding. Assumes a maximum of 500 cubic yards material to be added. This is not a calculated volume, actual volume may vary.
- Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and boundary of waste trenches.
- No waste will be generated.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- Cost of moving material is based upon five trucks, each hauling seven loads per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of borrow pit is less than one hour round-trip distance. Assumes borrow pit in Area 6 is available for use at the time fieldwork begins.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings.

Alternative III: Closure in Place with Construction of Cover
- Construct a minimum one-foot cover from Trench 4 to CWA 6 with a minimum two percent slope across all of the waste units. Approximately 24,305 cubic yards of material will be required. This volume is an estimate, actual volume required may change. The areas to be covered are approximately 500,000 square feet.
- Cost of moving material is based upon five trucks, each hauling seven loads per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of borrow pit is less than one hour round-trip distance. Assumes borrow pit in Area 6 is available for use at the time fieldwork begins.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or damage to the cover by erosion. No maintenance is required to remove vegetation. Natural revegetation is acceptable.
- Wheel compaction will be adequate to place borrow material.
- Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
- Cover material does not require screening.

BECHTEL NEVADA

EST ID: CAU 5
CAS 06-15-02

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
- This estimate does not include costs for developing required project plans, permits, reports, or project management or project support.
- Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
- Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- Access to the site will be available and unrestricted throughout field activities.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**No Further Action**	$0
Alternative II:	**Closure in Place with Administrative Controls, No Cover**	$57,544
Alternative III:	**Closure in Place with Administrative Controls, Construction of Cover**	$742,110

REVIEW/CONCURRENCE:

[signature] 6/24/03
Project Manager — Date

Charles W Denson 06-24-03
Estimating — Date

Margaret E Cook 6/24/03
Project Controls — Date

BECHTEL NEVADA

EST ID: CAU 5
CAS 06-15-03

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson REF #:

TYPE OF ESTIMATE:				TYPE OF WORK:	
X	ORDER OF MAGNITUDE		TITLE II		NON-MANUAL ONLY
	PRELIMINARY / PLANNING / STUDY		WORK ORDER		MANUAL ONLY
	CONCEPTUAL / BUDGET		COMPARATIVE	X	MANUAL & NON-MANUAL
	TITLE I		OTHER		OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM)		SUBCONTRACT	
BN CONSTRUCTION	X	GPP	
BN MAINTENANCE		OTHER	

being protective controls.

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 06-15-03, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 06-15-03 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO). CAS 06-15-03 is specifically described within the FFACO as a Sanitary Landfill; Burn Pit. Three alternatives have been evaluated for closure of the CAS: No Further Action, Closure in Place with Administrative Controls, and Close in Place with Construction of Covers. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, report preparation, project support, and/or other activities are not included herein.

SCOPE:

Provide site closure using one of the following alternatives:
I NO FURTHER ACTION
II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS
III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: No Further Action

Alternative II: Close in Place with Administrative Controls

- Backfill any depressions to eliminate potential ponding. Assumes a maximum of 500 cubic yards material to be added. This is not a calculated value. Actual required volume may vary.
- Cost of moving material is based upon five trucks, each hauling four seven per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than one hour round-trip distance. Assumes borrow pit in Area 6 is accessible and available for use at the time fieldwork begins.
- Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and the boundary of waste trenches.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings.

BECHTEL NEVADA

EST ID: CAU 5
CAS 06-15-03

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

Alternative III: Close in Place with Construction of Cover

- Install a minimum of a two-foot cover over Trench/Landfill 2 and a one-foot cover over CWA-1, -2, and -3 with a minium of a 2% slope. Approximately 24,305 cubic yards of material will be required. The areas to be covered are approximately 325,000 square feet.
- Cost of moving material is based upon five trucks, each hauling seven loads per day, for a total of 35 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than one hour round-trip distance. Assumes borrow pit in Area 6 is accessible and available for use at the time fieldwork begins.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or damage to the cover by erosion. No maintenance is required to remove vegetation. Natural revegetation is acceptable.
- Wheel compaction will be adequate to place borrow material.
- Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
- Cover material does not require screening.

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
- This estimate does not include costs for developing required project plans, permits, reports, or project management.
- Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
- Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- Access to the site will be available and unrestricted throughout field activities.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**No Further Action**	**$0**
Alternative II:	**Closure in Place with Administrative Controls, No Cover**	**$61,100**
Alternative III:	**Close in Place with Administrative Controls, Construction of Cover**	**$732,437**

REVIEW/CONCURRENCE:

[signature] 6/24/03
Project Manager — Date

[signature] 06-24-03
Estimating — Date

Margaret E Cook 6/24/03
Project Controls — Date

BECHTEL NEVADA

EST ID: CAU 5
CAS 12-15-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson REF #:

TYPE OF ESTIMATE:

X ORDER OF MAGNITUDE
___ PRELIMINARY / PLANNING / STUDY
___ CONCEPTUAL / BUDGET
___ TITLE I
___ TITLE II
___ WORK ORDER
___ COMPARATIVE
___ OTHER

TYPE OF WORK:

___ NON-MANUAL ONLY
___ MANUAL ONLY
X MANUAL & NON-MANUAL
___ OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM) ___
BN CONSTRUCTION X
BN MAINTENANCE ___
being protective controls
SUBCONTRACT ___
GPP ___
OTHER ___

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 12-15-01, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 12-15-01 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO). CAS 12-15-01 is specifically described within the FFACO as a Sanitary Landfill. Three alternatives have been evaluated for closure of the CAS: No Further Action, Closure in Place with Administrative Controls, and Closure in Place with Construction of Covers. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, report preparation, project support, and/or other activities are not included herein.

SCOPE:

Provide site closure using one of the following alternatives:
I NO FURTHER ACTION
II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS
III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: No Further Action

Alternative II: Closure in Place with Administrative Controls

• Backfill any depressions to eliminate potential ponding. Assumes a maximum of 100 cubic yards material to be added. This is not a calculated value. Actual required volume may vary.
• Remove and dispose of surface debris. Assumes this task can be concurrently done with other tasks.
• Cost of moving material is based upon five trucks, each hauling two loads per day, for a total of 10 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
• Location of soil borrow pit is less than 2 hour round-trip distance. Assumes borrow pit at the Shaker Plant in Area 4 is available for use at the time fieldwork begins. Screening of borrow material will not be required.
• Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and the boundary of waste trenches.
• Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes that individual waste units will be posted only using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
• Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings.

BECHTEL NEVADA

EST ID: CAU 5
CAS 12-15-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon **FROM:** Charles Denson

Alternative III: Closure In Place with Construction of Cover
• Install a Two-foot cover over Trench 3 and grade to minimum two percent slope. Approximately 33,000 cubic yards of material will be required. The cost for covering Trench 3 is calculated based on five trucks each hauling two loads per day, for a total of ten loads per day. It is assumed that 17 cubic yards is the maximum capacity of the truck.
• Remove and dispose of surface debris. Assumes this task can be concurrently done with other tasks.
• Backfill remaining depressions or low points to eliminate potential ponding. Assumes a volume of 100 cubic yards material. This is not a calculated value. Actual required volume may vary.
• Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
• Location of soil borrow pit is less than two hour round-trip distance. Assumes borrow pit Shaker Plant in Area 4 is available for use at the time fieldwork begins. Screening of borrow material will not be required.
• Install appropriate administrative controls (i.e. postings, signs, fence, etc.). Assumes that individual waste units will be posted only using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
• Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or damage to the cover by erosion. No maintenance is required to remove vegetation. Natural revegetation is acceptable.
• Wheel compaction will be adequate to place borrow material.

ASSUMPTIONS:

• Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
• This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
• This estimate does not include costs for developing required project plans, permits, reports, or project management.
• Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
• Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
• Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
• The road that provides access to the Area-12 camp will remain accessible, as will the road on the landfill.
• Utilities will remain in place and not be relocated.
• Access to the site will be available and unrestricted throughout field activities.
• Use Restrictions will allow access to and servicing of existing utilities within the CAS boundary. Moving utilities is not included in this estimate.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**No Further Action**	**$0**
Alternative II:	**Closure in Place with Administrative Controls, No Cover**	**$70,855**
Alternative III:	**Closure in Place with Administrative Controls, Construction of Cover**	**$1,473,526**

REVIEW / CONCURRENCE:

[signature] 6/24/03
Project Manager Date

[signature] 06-24-03
Estimating Date

Margaret C Cook 6/24/03
Project Controls Date

BECHTEL NEVADA

EST ID: CAU 5
CAS 20-15-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon — FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson — REF #:

TYPE OF ESTIMATE:				TYPE OF WORK:	
X	ORDER OF MAGNITUDE		TITLE II		NON-MANUAL ONLY
	PRELIMINARY / PLANNING / STUDY		WORK ORDER		MANUAL ONLY
	CONCEPTUAL / BUDGET		COMPARATIVE	X	MANUAL & NON-MANUAL
	TITLE I		OTHER		OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM)		SUBCONTRACT	
BN CONSTRUCTION	X	GPP	
BN MAINTENANCE		OTHER	

being protective controls.

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 20-15-01, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 20-15-01 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO). CAS 20-15-01 is specifically described within the FFACO as a Landfill. Three alternatives have been evaluated for closure of the CAS: No Further Action, Closure in Place with Administrative Controls and Closure in Place with Construction of Covers. The Closure in Place alternative includes a Cover and No Cover option. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, report preparation, project support, and/or other activities are not included herein.

SCOPE:

Provide site closure using one of the following alternatives:
I NO FURTHER ACTION
II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS
III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative II: Closure in Place with Administrative Controls, No Cover

- Backfill any depressions to eliminate potential ponding. Assumes a maximum of 100 cubic yards material to be added. This is not a calculated value. Actual required volume may vary.
- Cost of moving material is based upon five trucks, each hauling two loads per day, for a total of 10 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than three hours round-trip distance. Assumes borrow pit in Area 12 is accessible and available for use at the time fieldwork begins.
- Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and the boundary of waste trenches.
- Remove minimal surface debris. Assumes this debris can be removed concurrently with transporting borrow material.
- Install appropriate administrative controls (i.e. postings, signs, fence, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings.

Alternative III: Closure in Place with Construction of Cover

- Depth of current cover is adequate. Approximately 2,200 cubic yards of material would be required to allow construction of a minimum two percent slope. This number is an estimate, actual volume required may vary. The area to be sloped is approximately 30,000 square feet.
- Cost of moving material is based upon five trucks, each hauling two loads per day, for a total of 10 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of soil borrow pit is less than three hours round-trip distance. Assumes borrow pit in Area 12 is accessible and available for use at the time fieldwork begins.
- Remove minimal surface debris. Assumes this debris can be removed concurrently with other tasks.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts and sheetmetal signs. One sign will be installed every 100 feet.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and/or damage to the cover by erosion.
No maintenance is required to remove vegetation. Natural revegetation is acceptable.
- Wheel compaction will be adequate to place borrow material.
- Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
- Cover material does not require screening.

BECHTEL NEVADA

EST ID: CAU 5
CAS 20-15-01

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
- This estimate does not include costs for developing required project plans, permits, reports, or project management.
- Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
- Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- Access to the site will be available and unrestricted throughout field activities.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 Final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**No Further Action**	**$0**
Alternative II:	**Closure in Place with Administrative Controls, No Cover**	**$60,116**
Alternative III:	**Closure in Place with Administrative Controls, Construction of Cover**	**$186,648**

REVIEW / CONCURRENCE:

[signature] 6/24/03
Project Manager — Date

Charles W. Denson 06-24-03
Estimating — Date

Margaret E Cook 6/24/03
Project Controls — Date

BECHTEL NEVADA

EST ID: CAU 5
CAS 23-15-03 - Landfill

COST ESTIMATE PROPOSAL DATA SHEET

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson

REF #:

TYPE OF ESTIMATE:				TYPE OF WORK:	
X	ORDER OF MAGNITUDE		TITLE II		NON-MANUAL ONLY
	PRELIMINARY / PLANNING / STUDY		WORK ORDER		MANUAL ONLY
	CONCEPTUAL / BUDGET		COMPARATIVE	X	MANUAL & NON-MANUAL
	TITLE I		OTHER		OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM)		SUBCONTRACT	
BN CONSTRUCTION	X	GPP	
BN MAINTENANCE		OTHER	

being protective controls.

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 23-15-03, which is included within Corrective Action Unit (CAU) 5. CAU 5 CAS 23-15-03 is an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO). CAS 23-15-03 is specifically described within the FFACO as a Disposal Site. Three alternatives have been evaluated for closure of the CAS: No Further Action, Closure in Place with Administrative Controls, and Closure In Place with Construction of Covers. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment. The total estimated costs are intended for comparative analysis of remedial fieldwork cost only. Cost for project management, plan preparation, report preparation, project support, and/or other activities are not included herein. This estimate only applies to CAS 23-15-03, Landfill Area. The remaining Scope of Work is addressed in the cost estimate for CAS 23-15-03, Disposal Area.

SCOPE:

Provide site closure using one of the following alternatives:

I NO FURTHER ACTION

II CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS

III CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

The characterization contractor recently completed delineation of the landfill. Area estimates were calculated from data generated during this task. Site closure estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database. There is no estimate required for evaluation of the No Further Action alternative since no cost is incurred.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: No Further Action

Alternative II: Close in Place with Administrative Controls

- Backfill any depressions to eliminate potential ponding. Assumes a maximum of 100 cubic yards material to be added. This is not a calculated volume, actual volume may vary.
- Cost of moving material is based upon five trucks, each hauling four loads per day, for a total of 20 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Cover exposed debris along the open trench on the northwest section of the site. Assumes same volume and cost of moving material as for backfilling depressions.
- Remove and dispose of several small piles of debris located in the same trench as above. Cost is based on provided volume of 15 cubic yards. Task can be done concurrently with other tasks.
- Dimensions, volumes, and measurements provided by the characterization contractor accurately represent site conditions and the boundary of waste trenches.
- All material to be removed will be characterized prior to removal. A minimum of two samples will be collected from the waste areas and analyzed for the full suite using standard turn-around times.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- Location of soil borrow pit is less than two hours round-trip distance. Assumes borrow pit in Area 6 is accessible and available for use at the time fieldwork begins.
- Install appropriate administrative controls (i.e. postings, signs, fence, etc.). Assumes that access to the landfill will restricted by installation of T-Posts, sheetmetal signs, and wire strand fence. One sign will be installed every 100 feet. Only that portion of the landfill south of the WSI range and access roads will be fenced to restrict access.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings and fence.

Alternative III: Close in Place with Construction of Cover

- Install a continuous two-foot cover over all six disposal trenches with a minimum of a two percent slope. Approximately 42,000 cubic yards of material will be required. This volume is an estimate. Actual required volume may change. The areas to be covered are approximately 435,000 square feet.
- Cover exposed debris along the open trench on the northwest section of the site. Assumes task can be completed using the material for constructing the cover.
- Remove and dispose of several small piles of debris located along the open trench on the northwest section of the site. Assumes task can be concurrently done with other tasks.
- All material to be removed will be characterized prior to removal. A minimum of two samples will be collected from the waste areas and analyzed for the full suite using standard turn-around times.
- Cost of moving material is based upon five trucks, each hauling four loads per day, for a total of 20 loads per day. Assumption is that the average load will be approximately 17 cubic yards.
- Location of borrow pit is less than two hours round-trip distance. Assumes borrow pit in Area 6 is available for use at the time fieldwork begins.
- Install appropriate administrative controls (i.e. postings, signs, etc.). Assumes the landfill will only be posted using T-Posts, sheetmetal signs, and wire strand fence. One sign will be installed every 100 feet. Only that portion of the landfill south of the WSI range and access roads will be fenced to restrict access.
- Post Closure Monitoring requirements will consist of annual visual inspection for years one through five. Afterwards, inspections through year 20 would be performed every five years. Inspections to verify integrity of postings, fence, and/or damage to the cover by erosion. No maintenance is required to remove vegetation. Natural revegetation is acceptable.
- Wheel compaction will be adequate to place borrow material.
- Cover to be constructed according to pre-1993 closure requirements. Cover will not be engineered. However, meeting two percent slope requirements will require a grading plan.
- Cover to include the WSI range parking and access road and the area in the active landfill; however, ability to drive on the cover with no special precautions will remain.
- Cover material does not require screening.

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- This estimate will not include efficiencies which may be realized if work for similar activities at similar sites can be completed concurrently, or from demobilizing from one site directly to another.
- This estimate does not include costs for developing required project plans, permits, reports, or project management.
- Dimensions, volumes, and measurements provided by the contractor accurately represent site conditions and the boundary of waste trenches.
- Only Sanitary Waste or Construction Debris will be generated. All waste generated during closure are accepted in the Area-9, U10c Landfill.
- Equipment and qualified personnel will be available at the time of project start-up and throughout the duration of field activities.
- The ability to drive on the landfill cover will be maintained for active landfill section and for the road and area north of the east-west road in the northern section of the CAS 23-15-03 landfill area. This includes all access and parking for the WSI range. Current access roads will not require capping.
- Access to the site will be available and unrestricted throughout field activities.
- Use Restrictions will allow access to and servicing of existing utilities within the CAS boundary. Utilities will remain in place and not be relocated. Moving utilities is not included in this estimate.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**No Further Action**	**$0**
Alternative II:	**Close in Place with Administrative Controls**	**$117,553**
Alternative III:	**Close in Place with Administrative Controls, Construction of Cover**	**$3,115,343**

REVIEW/CONCURRENCE:

[signature] 6/24/03
Project Manager / Date

Charles L. Benson 6-24-03
Estimating / Date

Margaret E. Cook 6/24/03
Project Controls / Date

BECHTEL NEVADA

EST ID: CAU 5 — COST ESTIMATE PROPOSAL DATA SHEET — Date: 24-Jun-03

Post-Closure Monitoring

TO: Allison Urbon — FROM: Charles Denson

SUBJECT: CADD Alternative Cost Estimates for CAU-5: Landfills

ESTIMATOR: Charles Denson — REF #:

TYPE OF ESTIMATE:				TYPE OF WORK:	
X	ORDER OF MAGNITUDE		TITLE II		NON-MANUAL ONLY
	PRELIMINARY / PLANNING / STUDY		WORK ORDER		MANUAL ONLY
	CONCEPTUAL / BUDGET		COMPARATIVE	X	MANUAL & NON-MANUAL
	TITLE I		OTHER		OTHER

PROJECT WORK SCOPE IS EXPECTED TO BE PERFORMED BY:

DOE PRIME (LUMP SUM)		SUBCONTRACT	
BN CONSTRUCTION	X	GPP	
BN MAINTENANCE		OTHER	

being protective controls.

STATEMENT OF WORK

This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Site (CAS) 05-15-01, which is included within Corrective Action Unit (CAU) 5. This estimate for post-closure monitoring applies to all of the CASs in CAU 5, an environmental restoration site listed in the Federal Facility Agreement and Consent Order (FFACO), that will not be clean-closed. CAU 5 includes 8 landfills, one site of which also includes a surface disposal site (CAS 23-15-03 disposal area). Two alternatives have been provided for post-closure monitoring of the sites: (1) Post-Closure Monitoring (PCM) for Closure in Place with No Cover and (2) PCM for Closure in Place with a Cover. This estimate will be used to identify the most cost effective alternative for closure of the site while remaining protective of human health and the environment.

SCOPE:

Provide post-closure monitoring at CAU 5 sites that have been closed in place under one of the following alternatives:
I PCM FOR CLOSURE IN PLACE WITH ADMINISTRATIVE CONTROLS,
II PCM FOR CLOSURE IN PLACE WITH CONSTRUCTION OF COVERS

BASIS:

Two closure scenarios are provided for each of eight CASs (one of which has two separate areas) will most likely require post-closure monitoring. This estimate assumes that one of the two closure scenarios will be selected for all of the CASs, and that all of the post-closure monitoring will be planned and performed together. Estimates for each alternative were priced using standard construction references such as RS Means, Richardson's, and the BN estimating database.

ALTERNATIVE SPECIFIC BASIS OF ESTIMATE/ASSUMPTIONS

Alternative I: Post-Closure Monitoring for Closure in Place with Administrative Controls, No Cover
- Assumes that all CASs will require drive-by inspections annually during post-closure years 1 through 5 and every 5 years thereafter until year 20 (i.e., inspections during post-closure years 1, 2, 3, 4, 5, 10, 15, and 20).
- Assumes that only signs, posts, and fencing will need to be maintained post-closure.
- Assumes that maintenance will be required at all sites during years 2 and 5, but that no maintenance will be required in other years.
- Assumes that the post-closure report will consist of a letter report that is required only during those years when inspections are required.
- Assumes that efficiencies will be obtained by performing all inspections and maintenance under joint plans.

Alternative II: Post-Closure Monitoring for Closure in Place with Administrative Controls with Construction of Covers
- Assumes that all CASs will require drive-by inspections annually during post-closure years 1 through 5 and every 5 years thereafter until year 20 (i.e., inspections during post-closure years 1, 2, 3, 4, 5, 10, 15, and 20).
- Assumes that post-closure maintenance activities will consist of replacing and repairing signs, posts, and fencing, with additional repair to covers, all of which will take 2 days per CAS. Assumes that an average of 50 cubic yards of additional soil will need to be transported to each of the sites.
- Assumes that maintenance will be required at all sites during years 2 and 5, but that no maintenance will be required in other years.
- Assumes that the post-closure report will consist of a letter report that is required only during those years when inspections are required.
- Assumes that efficiencies will be obtained by performing all inspections and maintenance under joint plans.

ASSUMPTIONS:

- Work to be performed by BN during a "normal" workday (no provision for overtime has been provided). Shifts are based on 10-hour days / 4-days per week.
- Post closure monitoring will be needed as indicated in the assumptions.
- The amount of time and resources necessary to complete post-closure monitoring of each site may vary, depending on individual site conditions post-closure.
- Access to the site will be available and unrestricted throughout field activities.

ESCALATION:

No escalation factors have been applied. All costs are in FY03 dollars.

CONTINGENCY:

Contingency costs are not included in this estimate.

BECHTEL NEVADA

COST ESTIMATE PROPOSAL DATA SHEET

EST ID: CAU 5
Post-Closure Monitoring

Date: 24-Jun-03

TO: Allison Urbon

FROM: Charles Denson

RATES:

Rates are based on FY03 final rates (Rev 1) effective 4/28/03 and were applied using the BN FY03 cost model.

COST ALTERNATIVES SUMMARY:

Alternative I:	**Post-Closure Monitoring with Administrative Controls, No Cover (all CASs)**	**$**	**$117,132**
Alternative II:	**Post-Closure Monitoring with Administrative Controls and Covers (all CASs)**	**$**	**$280,288**

REVIEW / CONCURRENCE:

[signature] 6/27/03
Project Manager — Date

Charles W Denson 06-24-03
Estimating — Date

Margaret E Cook 6/24/03
Project Controls — Date

Appendix D

Investigation Location Coordinates

D.1.0 Sample Location Coordinates

Sample location coordinates were collected with a Trimble GPS, Model TSCI. These coordinates identify excavation, drilling, and sampling locations at each CAS in CAU 5. For clarity, only the location name, latitude, longitude, northing, easting, and elevation are shown in the tables. Other collected GPS parameters (e.g., file name, satellite position, correction status) are retained in project files.

D.1.1 CAS 05-15-01, Sanitary Landfill

Locations at CAS 05-15-01 are shown on Figure A.3-1. Drilling and excavation coordinates are listed in Table D.1-1 and Table D.1-2, respectively. Monument coordinates are also shown in Table D.1-1.

Table D.1-1
CAS 05-15-01, Drilling Locations
(Page 1 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
A01	36.8090551	-115.9812992	20435231.85	1841050.57	928.65
A02	36.8092458	-115.9812358	20435301.42	1841068.64	929.01
A03	36.8093662	-115.9811176	20435345.5	1841102.9	929.45
A04	36.8090921	-115.9812069	20435245.51	1841077.48	928.72
A05	36.8088392	-115.9811564	20435153.54	1841092.94	928.34
A06	36.8090665	-115.9809309	20435236.78	1841158.34	928.57
A07	36.8091242	-115.9807048	20435258.28	1841224.39	928.15
A08	36.8088991	-115.9808133	20435176.1	1841193.21	928.25
A09	36.8088153	-115.9809107	20435145.38	1841164.92	928.9
A10	36.8086253	-115.9804746	20435077.11	1841293.07	928.14
A11	36.808758	-115.9802676	20435125.86	1841353.33	928.23
A12	36.8084853	-115.9801005	20435026.92	1841402.95	928.08
A13	36.8085861	-115.9801651	20435063.48	1841383.78	928.06
A14	36.8088734	-115.9808711	20435166.62	1841176.37	928.94

Table D.1-1
CAS 05-15-01, Drilling Locations
(Page 2 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
A15	36.8090106	-115.9810462	20435216.18	1841124.74	928.47
MNT01	36.8086517	-115.9808177	20435085.99	1841192.57	928.91
MNT02	36.8093847	-115.980326	20435353.88	1841334.61	928.99
MNT03	36.8605974	-115.9504225	20454062.66	1849948.74	956.67
MNT04	36.8097543	-115.9810128	20435487.01	1841132.57	929.84

[a]U.S. State Plane 1983; Nevada Central 2702; North American Datum (NAD) 1983 Continental United States (CONUS)

Table D.1-2
CAS 05-15-01, Excavation Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
A01	36.8090536	-115.9812923	20435231.32	1841052.59	928.8
A02	36.8092821	-115.9812312	20435314.65	1841069.87	928.8
A03	36.8093684	-115.98112	20435346.3	1841102.21	929
A04	36.8090986	-115.9812043	20435247.91	1841078.22	929.2
A05	36.8088349	-115.9811483	20435152	1841095.32	928.43
A06	36.8090677	-115.9809297	20435237.21	1841158.7	928.84
A07	36.8091223	-115.9807027	20435257.58	1841225.02	928.34
A08	36.8088973	-115.9808105	20435175.44	1841194.04	928.1
A09	36.8088146	-115.9809106	20435145.11	1841164.94	928.14
A10	36.8086266	-115.9804698	20435077.59	1841294.47	927.62
A11	36.8087588	-115.9802589	20435126.17	1841355.88	927.79
A12	36.8084846	-115.9800985	20435026.67	1841403.55	927.52

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

D.1.2 CAS 05-16-01, Landfill

Locations at CAS 05-16-01 are shown on Figure A.4-1. Drilling and excavation coordinates are listed in Table D.1-3 and Table D.1-4, respectively.

Table D.1-3
CAS 05-16-01, Drilling Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
B01	36.8605259	-115.9520873	20454032.97	1849461.89	955.01
B02	36.8604967	-115.9515695	20454023.49	1849613.45	955.43
B03	36.860465	-115.9511273	20454012.91	1849742.91	955.54
B04	36.8603945	-115.9507193	20453988.13	1849862.46	955.78
B05	36.8602737	-115.9510778	20453943.38	1849757.9	955.37
B06	36.8603995	-115.9515695	20453988.1	1849613.73	954.4
B07	36.8600369	-115.9522547	20453854.58	1849414.27	954.29
B08	36.859953	-115.9523165	20453823.92	1849396.42	953.99
B09	36.859928	-115.9522299	20453814.99	1849421.8	954.53
B11	36.8599959	-115.952257	20453839.67	1849413.68	954.29
B12	36.8604021	-115.950904	20453990.5	1849808.39	955.66
B13	36.8603839	-115.9513325	20453982.92	1849683.09	955.21
MNT01	36.8601485	-115.952214	20453895.31	1849425.88	954.69
MNT02	36.8606261	-115.9521428	20454069.33	1849445.39	955.43

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-4
CAS 05-16-01, Excavation Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
B01	36.8605255	-115.9520857	20454032.85	1849462.37	955.95
B02	36.8605005	-115.951574	20454024.85	1849612.13	956.18
B03	36.8604606	-115.9511318	20454011.32	1849741.61	956.69
B04	36.8603916	-115.9507258	20453987.06	1849860.57	956.61
B05	36.8602727	-115.9510764	20453943.03	1849758.33	956.24
B06	36.8603948	-115.9515679	20453986.4	1849614.21	955.87
B07	36.8600394	-115.9522602	20453855.51	1849412.63	954.95
B08	36.8599511	-115.9523186	20453823.21	1849395.79	955.22
B09	36.8599238	-115.9522305	20453813.49	1849421.64	955.28
B10	36.8604491	-115.9509142	20454007.58	1849805.31	956.44

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

D.1.3 CAS 06-08-01, Landfill

Locations at CAS 06-08-01-01 are shown on Figure A.5-1. Drilling and excavation coordinates are listed in Table D.1-5 and Table D.1-6, respectively. Monument coordinates are also shown in Table D.1-5.

Table D.1-5
CAS 06-08-01, Drilling Locations
(Page 1 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
C01	36.9391228	-116.0439837	20482459.03	1822391.63	1177.07
C02	36.938853	-116.0430966	20482362.49	1822651.53	1176.62
C03	36.9391081	-116.0435545	20482454.51	1822517.09	1176.63
C04	36.939431	-116.043997	20482571.22	1822387	1176.5
C07	36.9395743	-116.0441829	20482623.02	1822332.32	1176.25
C08	36.9393812	-116.0437916	20482553.47	1822447.15	1176.44
C09	36.9390683	-116.043245	20482440.59	1822607.64	1176.41
C10	36.9385564	-116.0425305	20482255.62	1822817.66	1176.22
C11	36.938705	-116.0422625	20482310.21	1822895.61	1175.52
C12	36.9392545	-116.0429988	20482508.85	1822679.14	1175.61
C13	36.9394157	-116.0432152	20482567.14	1822615.5	1175.53
C14	36.9396892	-116.0436319	20482665.91	1822493.08	1175.49
C15	36.9400863	-116.0443344	20482809.12	1822286.84	1175.7
C16	36.9401408	-116.0445259	20482828.62	1822230.76	1176.59
C17	36.9401281	-116.0439535	20482825.09	1822398.05	1174.74
C18	36.9398036	-116.043396	20482708	1822561.74	1174.9
C19	36.9405378	-116.043943	20482974.25	1822400.16	1173.52
C20	36.9407368	-116.0441586	20483046.3	1822336.66	1173.35
C21	36.9391317	-116.0428136	20482464.51	1822733.54	1175.69
C22	36.9389729	-116.0426891	20482406.94	1822770.31	1175.7
C24	36.9396304	-116.0442948	20482643.25	1822299.5	1176.16
C25	36.9392197	-116.0441571	20482493.98	1822340.71	1177.22
C26	36.9389979	-116.0437225	20482414.07	1822468.27	1177.06
C27	36.9389005	-116.0435627	20482378.9	1822515.18	1177.08
C28	36.939684	-116.0436656	20482663.95	1822483.26	1175.53

Table D.1-5
CAS 06-08-01, Drilling Locations
(Page 2 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
C29	36.9395104	-116.0440966	20482599.94	1822357.7	1176.32
CMA21	36.9391204	-116.0429012	20482460.23	1822707.98	1175.85
MNT01	36.9403334	-116.0447733	20482898.28	1822158	1176.83
MNT02	36.939019	-116.0422075	20482424.65	1822910.94	1175.42
MNT03	36.9385535	-116.0437316	20482252.26	1822466.64	1178.55

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-6
CAS 06-08-01, Excavation Locations
(Page 1 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
C01	36.9396221	-116.0444374	20482457.66	1822389.74	1177.53
C02	36.9396872	-116.043631	20482357.48	1822650.24	1176.73
C03	36.9397959	-116.0434018	20482452.5	1822515.11	1177.16
C04	36.9390665	-116.0432483	20482569.71	1822384.49	1176.61
C05	36.9388392	-116.0431011	20482639.94	1822257.85	1177.53
C06	36.938895	-116.0435689	20482766.76	1822143.8	1178.09
C07	36.9392084	-116.044164	20482620.95	1822329.17	1176.55
C08	36.9389865	-116.04373	20482550.94	1822444.86	1176.28
C09	36.9393743	-116.0437995	20482439.94	1822606.68	1176.58
C12	36.9396804	-116.0445484	20482505.75	1822678.45	1176.37
C13	36.9399725	-116.0448248	20482563.7	1822613.55	1176.17
C14	36.9396241	-116.0443015	20482665.19	1822493.36	1176.18
C15	36.9395686	-116.0441938	20482799.75	1822285.5	1175.6
C16	36.9400605	-116.0443392	20482825.59	1822232.61	1176.07
C17	36.9401325	-116.0445196	20482821.18	1822397.54	1175.27
C18	36.9405281	-116.0439471	20482705.18	1822560.09	1175.55
C19	36.9407286	-116.0441578	20482970.73	1822398.98	1174.26
C20	36.9394063	-116.043222	20483043.31	1822336.91	1173.99
C21	36.939246	-116.0430012	20482460.67	1822731.59	1176.13
C22	36.9391117	-116.0429072	20482403.17	1822768.63	1176.25
C23	36.9391212	-116.0428204	20482660.95	1822225.28	1177.86

Table D.1-6
CAS 06-08-01, Excavation Locations
(Page 2 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
C24	36.9389626	-116.0426949	20482640.93	1822297.56	1176.41
C25	36.9391026	-116.0435613	20482489.84	1822338.72	1177.09
C26	36.9391191	-116.0439902	20482409.9	1822466.09	1177.22
C27	36.9401174	-116.0439554	20482376.91	1822513.39	1177.59
CMA21	36.9394269	-116.0440056	20482457.05	1822706.24	1176.51

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

D.1.4 CAS 06-15-02, Sanitary Landfill

Locations at CAS 06-15-02 are shown on Figure A.6-1. Drilling and excavation coordinates are listed in Table D.1-7 and Table D.1-8, respectively. Monument coordinates are also shown in Table D.1-7.

Table D.1-7
CAS 06-15-02, Drilling Locations
(Page 1 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
D01	36.9312578	-116.0311886	20479620.33	1826149.96	1173.67
D01 TWIN	36.9312894	-116.0311416	20479631.91	1826163.63	1173.4
D02	36.9315449	-116.0309099	20479725.38	1826230.71	1171.1
D03	36.9320245	-116.030423	20479900.97	1826371.88	1169.04
D04	36.931589	-116.0297783	20479743.65	1826561.37	1169.71
D05	36.930991	-116.0303522	20479524.83	1826395.07	1172.64
D06	36.9314119	-116.02935	20479680.03	1826686.95	1169.57
D07	36.9302192	-116.0292608	20479245.96	1826715.93	1173.08
D08	36.9304727	-116.0286152	20479339.52	1826904	1171.63
D09	36.9310227	-116.0285911	20479539.81	1826909.73	1170.13
D10	36.9306768	-116.0289696	20479413.14	1826799.94	1171.53
D11	36.9312843	-116.0300642	20479632.18	1826478.52	1171.08
D12	36.9318793	-116.0308228	20479847.3	1826255.37	1169.65
D13	36.9305401	-116.0290728	20479363.17	1826770.1	1171.69
MNT01	36.9309658	-116.0308902	20479514.59	1826237.9	1173.42

Table D.1-7
CAS 06-15-02, Drilling Locations
(Page 2 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
MNT02	36.9305369	-116.0301035	20479359.97	1826468.86	1173.88
MNT03	36.9303262	-116.0295599	20479284.33	1826628.26	1173.25
MNT04	36.930055	-116.0290081	20479186.7	1826790.19	1173.67
MNT05	36.9309073	-116.0282287	20479498.52	1827015.9	1169.74
MNT06	36.9311869	-116.0288581	20479599.06	1826831.28	1169.65
MNT07	36.9314364	-116.0293475	20479688.93	1826687.64	1169.47
MNT08	36.9318672	-116.0301203	20479844.27	1826460.71	1169.33
MNT09	36.9321164	-116.0305791	20479934.09	1826326.01	1168.98
MNT10	36.9316632	-116.0309603	20479768.35	1826215.71	1170.73

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-8
CAS 06-15-02, Excavation Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
D01	36.9312624	-116.0311811	20479622	1826152.14	1173.52
D02	36.9315467	-116.0309048	20479726.05	1826232.22	1171.74
D03	36.9320321	-116.0304195	20479903.71	1826372.88	1169.75
D04	36.9315951	-116.0297805	20479745.89	1826560.69	1170.45
D05	36.9309902	-116.0303344	20479524.57	1826400.27	1173.6
D06	36.9314146	-116.0293458	20479681.01	1826688.19	1170.3
D07	36.9302199	-116.0292512	20479246.24	1826718.73	1173.99
D08	36.9304813	-116.0286081	20479342.66	1826906.05	1172.13
D09	36.9310261	-116.0285835	20479541.04	1826911.92	1170.57

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

D.1.5 CAS 06-15-03, Sanitary Landfill; Burn Pit

Locations at CAS 06-15-03 are shown on Figure A.7-1. Drilling and excavation coordinates are listed in Table D.1-9 and Table D.1-10, respectively. Monument coordinates are also shown in Table D.1-9.

Table D.1-9
CAS 06-15-03, Drilling Locations
(Page 1 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
E01	36.9319701	-116.034014	20479874.17	1825322.45	1176.63
E02	36.9321513	-116.0342518	20479939.66	1825252.53	1177.06
E03	36.9321348	-116.0338857	20479934.37	1825359.58	1175.94
E04	36.9324509	-116.0339228	20480049.37	1825347.94	1174.42
E05	36.9323479	-116.0337004	20480012.32	1825413.22	1173.98
E06	36.9329265	-116.0335468	20480223.27	1825456.69	1171.53
E07	36.9328602	-116.0330896	20480200	1825590.49	1171.16
E08	36.9332314	-116.033019	20480335.3	1825610.21	1168.95
E09	36.9331562	-116.0328101	20480308.32	1825671.45	1169.17
E10	36.9330264	-116.0325619	20480261.55	1825744.31	1169.27
E11	36.9326358	-116.0325332	20480119.4	1825753.64	1170.51
E12	36.9326322	-116.0318686	20480119.36	1825947.88	1169.23
E13	36.932444	-116.0314676	20480051.63	1826065.55	1169.07
E14	36.9321154	-116.0309702	20479932.99	1826211.73	1169.06
E15	36.9321068	-116.0318443	20479928.16	1825956.25	1170.67
E16	36.9318052	-116.0319753	20479818.09	1825918.71	1171.2
E17	36.9323977	-116.0320519	20480033.65	1825894.88	1170.71
E18	36.9319591	-116.0326415	20479872.81	1825723.63	1171.8
E19	36.9321097	-116.033048	20479926.86	1825604.46	1172.18
E20	36.9313969	-116.0331342	20479667.19	1825580.98	1175.43
E21	36.9314037	-116.0335427	20479668.88	1825461.56	1176.22
E22	36.9330878	-116.032764	20480283.51	1825685.1	1169.36
E23	36.9328037	-116.033065	20480179.5	1825597.8	1171.39
E24	36.9315931	-116.033307	20479738.3	1825530.01	1174.91
MNT01	36.9314115	-116.0338103	20479671.2	1825383.35	1177.51
MNT02	36.9311399	-116.0332551	20479573.39	1825546.28	1177.67
MNT03	36.9315414	-116.033037	20479719.98	1825609.04	1174.88
MNT04	36.9317802	-116.0335054	20479806.01	1825471.58	1175.08
MNT05	36.9320145	-116.0338653	20479890.6	1825365.81	1175.9
MNT06	36.9320585	-116.033833	20479906.69	1825375.16	1175.91
MNT07	36.9322319	-116.0341724	20479969.17	1825275.53	1176.37
MNT08	36.9321864	-116.0342128	20479952.53	1825263.82	1176.82
MNT09	36.9324184	-116.0339947	20480037.4	1825327.02	1174.89

Table D.1-9
CAS 06-15-03, Drilling Locations
(Page 2 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
MNT10	36.932618	-116.0338293	20480110.4	1825374.87	1173.81
MNT11	36.9328025	-116.0336499	20480177.93	1825426.86	1172.4
MNT12	36.9330159	-116.0334724	20480255.95	1825478.22	1171.23
MNT13	36.9330681	-116.03339	20480275.13	1825502.2	1170.98
MNT14	36.9325382	-116.03332	20480082.35	1825523.94	1172.34
MNT15	36.9322246	-116.0327354	20479969.32	1825695.53	1171.86
MNT16	36.9320111	-116.032127	20479892.75	1825873.88	1171.08
MNT17	36.9313399	-116.0318669	20479648.92	1825951.52	1174.21
MNT18	36.9315376	-116.0316847	20479721.24	1826004.3	1172.97
MNT19	36.9317094	-116.0315458	20479784.06	1826044.46	1171.97
MNT20	36.932159	-116.0319324	20479946.96	1825930.4	1171.14
MNT21	36.9322306	-116.0319129	20479973.08	1825935.91	1171
MNT22	36.9322479	-116.0319509	20479979.29	1825924.77	1171.13
MNT23	36.9326353	-116.0315367	20480121.16	1826044.88	1169.13
MNT24	36.9326526	-116.0315616	20480127.41	1826037.57	1169.52
MNT25	36.9334787	-116.0330355	20480425.28	1825604.8	1168.97

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

D.1.6 CAS 12-15-01, Sanitary Landfill

Locations at CAS 12-15-01 are shown on Figure A.8-1. Drilling and excavation coordinates are listed in Table D.1-11 and Table D.1-12, respectively. Monument coordinates are also shown in Table D.1-11.

D.1.7 CAS 20-15-01, Landfill

Locations at CAS 20-15-01 are shown on Figure A.9-1. Drilling and excavation coordinates are listed in Table D.1-13 and Table D.1-14, respectively. Monument coordinates are also shown in Table D.1-13.

Table D.1-10
CAS 06-15-03, Excavation Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
E01	36.9319711	-116.0340104	20479874.52	1825323.52	1177.49
E02	36.932152	-116.0342486	20479939.91	1825253.46	1177.41
E03	36.9321266	-116.0338879	20479931.39	1825358.94	1175.08
E04	36.9324483	-116.0339139	20480048.45	1825350.56	1173.87
E05	36.9323415	-116.0336952	20480009.98	1825414.75	1173.46
E06	36.9329353	-116.0335338	20480226.48	1825460.48	1171.67
E07	36.9329012	-116.0330859	20480214.94	1825591.45	1171.47
E08	36.9332294	-116.0330015	20480334.58	1825615.34	1169.88
E09	36.9331578	-116.0327998	20480308.92	1825674.46	1169.8
E10	36.93303	-116.032553	20480262.86	1825746.89	1169.81
E11	36.9326343	-116.0325237	20480118.87	1825756.42	1171.28
E12	36.9326232	-116.0318667	20480116.09	1825948.48	1169.85
E13	36.932447	-116.0314535	20480052.78	1826069.66	1170.07
E14	36.9321183	-116.0309613	20479934.04	1826214.31	1169.98
E15	36.9321039	-116.0318442	20479927.08	1825956.31	1171.65
E16	36.9318016	-116.0319762	20479816.78	1825918.47	1172.03
E17	36.9323975	-116.0320424	20480033.58	1825897.65	1171.48
E18	36.9319589	-116.0326407	20479872.76	1825723.87	1173
E19	36.9321092	-116.0330431	20479926.7	1825605.9	1173.19
E20	36.9313936	-116.0331304	20479666.01	1825582.11	1176.31
E21	36.931403	-116.0335374	20479668.64	1825463.13	1177.17

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-11
CAS 12-15-01, Drilling Locations
(Page 1 of 3)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
F01	37.1969162	-116.1485351	20576131.54	1791325.87	1531.31
F02	37.1968035	-116.1479993	20576091.34	1791482.14	1529.1
F03	37.1965508	-116.1467973	20576001.26	1791832.74	1522.4
F04	37.1967991	-116.1475636	20576090.44	1791609.06	1526.61
F05	37.1969174	-116.148058	20576132.72	1791464.83	1529.67
F06	37.1969357	-116.1477056	20576139.94	1791567.41	1527.67

Table D.1-11
CAS 12-15-01, Drilling Locations
(Page 2 of 3)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
F07	37.1968313	-116.1472337	20576102.69	1791705.06	1525.63
F08	37.1970083	-116.1467919	20576167.85	1791833.39	1523.08
F10	37.1971399	-116.1468968	20576215.6	1791802.56	1523.37
F11	37.197081	-116.1466542	20576194.53	1791873.35	1522.42
F12	37.1971811	-116.146451	20576231.3	1791932.33	1521.5
F13	37.1970945	-116.1460786	20576200.34	1792040.97	1520.05
F14	37.1970118	-116.1458546	20576170.6	1792106.37	1520.47
F15	37.1970072	-116.146	20576168.7	1792064.04	1521.07
F16	37.1967491	-116.1448456	20576076.58	1792400.78	1516.05
F17	37.1968576	-116.1459153	20576114.37	1792089.01	1520.61
F18	37.1968409	-116.1456807	20576108.67	1792157.36	1519.87
F19	37.1967937	-116.1449898	20576092.58	1792358.69	1516.45
F20	37.1969515	-116.1455351	20576149.16	1792199.56	1519.5
F21	37.1967968	-116.1479881	20576088.93	1791485.42	1529.03
F22	37.1970231	-116.1485077	20576170.5	1791333.64	1531.37
F23	37.1970463	-116.1480072	20576179.74	1791479.35	1529.44
F24	37.196937	-116.1477313	20576140.36	1791559.93	1527.97
F25	37.1967485	-116.1467914	20576073.26	1791834.05	1522.46
F26	37.196546	-116.1465054	20575999.98	1791917.75	1521.75
F27	37.1969552	-116.1478076	20576146.87	1791537.66	1528.45
F28	37.197063	-116.1467845	20576187.75	1791835.43	1523.15
F29	37.1971682	-116.1471095	20576225.53	1791740.57	1524.4
F30	37.1967896	-116.1451235	20576090.87	1792319.77	1517.11
F31	37.19683	-116.1452846	20576105.34	1792272.74	1517.95
MNT01	37.1965482	-116.1465358	20576000.74	1791908.91	1521.94
MNT02	37.1967495	-116.1467995	20576073.61	1791831.7	1522.72
MNT03	37.1966461	-116.1470661	20576035.52	1791754.24	1523.43

Table D.1-11
CAS 12-15-01, Drilling Locations
(Page 3 of 3)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
MNT04	37.1966543	-116.1473119	20576038.1	1791682.66	1524.51
MNT05	37.1967684	-116.1472814	20576079.71	1791691.31	1525.3
MNT06	37.1970535	-116.1481489	20576182.13	1791438.07	1529.94
MNT07	37.1970197	-116.1484986	20576169.27	1791336.27	1531.5
MNT08	37.1969905	-116.1490344	20576157.79	1791180.29	1532.94

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-12
CAS 12-15-01, Excavation Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Excavation (meters)
F01	37.1969162	-116.1485351	20576131.54	1791325.87	1531.31
F02	37.1968035	-116.1479993	20576091.34	1791482.14	1529.1
F03	37.1965508	-116.1467973	20576001.26	1791832.74	1522.4
F04	37.1967991	-116.1475636	20576090.44	1791609.06	1526.61
F05	37.1969174	-116.148058	20576132.72	1791464.83	1529.67
F06	37.1969357	-116.1477056	20576139.94	1791567.41	1527.67
F07	37.1968313	-116.1472337	20576102.69	1791705.06	1525.63
F08	37.1970083	-116.1467919	20576167.85	1791833.39	1523.08
F10	37.1971399	-116.1468968	20576215.6	1791802.56	1523.37
F11	37.197081	-116.1466542	20576194.53	1791873.35	1522.42
F12	37.1971811	-116.146451	20576231.3	1791932.33	1521.5
F13	37.1970945	-116.1460786	20576200.34	1792040.97	1520.05
F14	37.1970118	-116.1458546	20576170.6	1792106.37	1520.47
F15	37.1970072	-116.146	20576168.7	1792064.04	1521.07
F16	37.1967414	-116.144849	20576073.77	1792399.81	1517.6
F17	37.1968487	-116.1459148	20576111.12	1792089.18	1521.02
F18	37.1968389	-116.1456826	20576107.93	1792156.8	1521.3

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-13
CAS 20-15-01, Drilling Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
G01	37.2326413	-116.463447	20588789.16	1699579.62	1881.38
G02	37.2327492	-116.4629707	20588828.75	1699718.2	1882.51
G03	37.2326959	-116.4625644	20588809.58	1699836.53	1883.14
G04	37.2325449	-116.4629718	20588754.35	1699718.03	1882.31
G05	37.2326804	-116.4627129	20588803.88	1699793.3	1883.18
G06	37.2326581	-116.4629761	20588795.56	1699716.69	1881.13
G07	37.232646	-116.4632864	20588790.99	1699626.38	1881.55
MNT01	37.2330251	-116.4635618	20588928.82	1699545.91	1881.6
MNT02	37.2329696	-116.4617783	20588909.75	1700065.16	1884.82
MNT03	37.2323915	-116.4636401	20588698.1	1699523.62	1880.79
MNT04	37.2325254	-116.4617717	20588748.01	1700067.41	1884.09

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-14
CAS 20-15-01, Excavation Locations

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
G01	37.2326426	-116.4634454	20588789.65	1699580.1	1881.77
G02	37.2327489	-116.4629695	20588828.65	1699718.56	1882.32
G03	37.2327014	-116.4625614	20588811.58	1699837.38	1882.04
G04	37.2325475	-116.4629654	20588755.32	1699719.89	1881.81

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

D.1.8 CAS 23-15-03, Disposal Site

Locations at CAS 23-15-03 are shown on Figure A.10-1 for the disposal area and Figure A.10-2 for the landfill. Drilling and excavation coordinates are listed in Table D.1-15 and Table D.1-16, respectively. Monument coordinates are also shown in Table D.1-15.

Table D.1-15
CAS 23-15-03, Drilling
(Page 1 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
H01	36.6627445	-116.0153836	20381897.16	1831434.93	1099.07
H02	36.6622882	-116.0156653	20381730.48	1831353.43	1098.45
H03	36.6619938	-116.0153102	20381624.01	1831458.3	1099.11
H04	36.6615348	-116.0155356	20381456.47	1831393.34	1094.92
H05	36.6613946	-116.0158211	20381404.86	1831309.94	1094.19
H06	36.6609179	-116.0156937	20381231.57	1831348.47	1089.88
H07	36.6590898	-116.0149938	20380567.44	1831558.29	1083.1
H08	36.6594363	-116.0148833	20380693.79	1831589.84	1084.92
H09	36.6597261	-116.0146264	20380799.83	1831664.46	1085.85
H10	36.6600736	-116.0145297	20380926.51	1831691.98	1087.27
H11	36.6604422	-116.0143723	20381061.02	1831737.23	1088.12
H12	36.660731	-116.0141153	20381166.66	1831811.9	1089.78
H13	36.6602117	-116.0143667	20380977.12	1831739.44	1087.47
H14	36.6596015	-116.0146733	20380754.38	1831651.01	1085.99
H15	36.6610114	-116.0136917	20381269.59	1831935.43	1092.35
H16	36.6613975	-116.0132308	20381411.06	1832069.66	1095.61
H17	36.6609606	-116.0133714	20381251.75	1832029.5	1092.67
H18	36.660542	-116.0136235	20381098.86	1831956.6	1090.58
H19	36.6597832	-116.0140258	20380821.82	1831840.49	1087.17
H23	36.660066	-116.0135749	20380925.65	1831972.05	1089.27
H24	36.6606833	-116.0132567	20381151.04	1832063.84	1091.59
H25	36.6613833	-116.0130137	20381406.35	1832133.39	1095.77
H26	36.6613765	-116.0127448	20381404.41	1832212.26	1096.07
H27	36.6609296	-116.0128843	20381241.43	1832172.46	1093.23
H28	36.6604845	-116.0130747	20381079.02	1832117.71	1091.59
H29	36.6602157	-116.0132588	20380980.79	1832064.37	1090.56
H30	36.6602816	-116.0128804	20381005.54	1832175.19	1091.03
H31	36.6606906	-116.0127261	20381154.75	1832219.46	1093.67
H32	36.6606147	-116.0124543	20381127.65	1832299.35	1093.2
H33	36.6603603	-116.0125458	20381034.85	1832273.15	1091.58
H34	36.6601972	-116.0126224	20380975.34	1832251.08	1090.82
H35	36.6601384	-116.0119063	20380955.36	1832461.27	1091.49
H36	36.6596891	-116.014117	20380787.37	1831813.98	1086.66

Table D.1-15
CAS 23-15-03, Drilling
(Page 2 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
H37	36.6596579	-116.0138181	20380776.61	1831901.71	1086.77
H38	36.6592189	-116.0149337	20380614.56	1831575.59	1084.02
H39	36.6598246	-116.0140274	20380836.87	1831839.91	1087.35
H40	36.6597967	-116.0137458	20380827.27	1831922.57	1087.7
H41	36.6622342	-116.0149783	20381712.18	1831555.05	1100.35
H42	36.6627117	-116.0150437	20381885.89	1831534.7	1103.48
H43	36.6617103	-116.0153001	20381520.82	1831461.96	1096.89
H44	36.6612511	-116.015168	20381353.91	1831501.85	1094.28
H45	36.660694	-116.0143086	20381152.82	1831755.277	1090.16
H46	36.66037978	-116.0147753	20381037.5	1831619.183	1088.22
H47	36.66002234	-116.0148293	20380907.26	1831604.22	1086.74
H48	36.6597153	-116.0149544	20380795.24	1831568.283	1085.71
MNT01	36.6626738	-116.0149413	20381872.31	1831564.83	1103.55
MNT02	36.6627666	-116.0152599	20381905.44	1831471.16	1102.86
MNT03	36.6619551	-116.0151695	20381610.21	1831499.66	1098.42
MNT04	36.6620278	-116.0154335	20381636.15	1831422.05	1098.59
MNT05	36.65999508	-116.0147238	20380897.55	1831635.244	1087.61
MNT06	36.66054053	-116.0145716	20381096.42	1831678.534	1088.78

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Table D.1-16
CAS 23-15-03, Excavation Locations
(Page 1 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
H01	36.6627746	-116.0153677	20381908.14	1831439.51	1099.89
H02	36.6623259	-116.015658	20381744.21	1831355.48	1098.4
H03	36.6620316	-116.0152942	20381637.79	1831462.91	1098.47
H04	36.6615748	-116.0155236	20381471.05	1831396.76	1095.49
H05	36.66143	-116.015822	20381417.75	1831309.58	1093.86
H06	36.660962	-116.0156509	20381247.72	1831360.92	1090.47
H07	36.6590916	-116.0149877	20380568.1	1831560.06	1083.25
H08	36.6594405	-116.0148795	20380695.34	1831590.94	1084.44

Table D.1-16
CAS 23-15-03, Excavation Locations
(Page 2 of 2)

Location	Latitude	Longitude	Northing (feet)[a]	Easting (feet)[a]	Elevation (meters)
H09	36.6597219	-116.0146269	20380798.3	1831664.35	1086.74
H10	36.6600712	-116.0145346	20380925.65	1831690.53	1087.82
H11	36.6604387	-116.0143796	20381059.74	1831735.11	1088.69
H12	36.6607286	-116.0141178	20381165.8	1831811.18	1090.49
H13	36.6602084	-116.0143619	20380975.93	1831740.86	1088.17
H14	36.6596092	-116.0146591	20380757.19	1831655.17	1085.46
H15	36.6610244	-116.0136917	20381274.33	1831935.42	1091.68
H16	36.6613854	-116.0132155	20381406.69	1832074.19	1094.28
H17	36.6609792	-116.0133625	20381258.52	1832032.08	1092.1
H18	36.6605396	-116.0136222	20381097.99	1831956.99	1091.26
H19	36.6597855	-116.0140145	20380822.65	1831843.81	1086.6
H20	36.6594621	-116.0141725	20380704.62	1831798.25	1085.13
H21	36.6590471	-116.014641	20380552.6	1831661.86	1083.29
H22	36.659392	-116.0139446	20380679.54	1831865.28	1085.45
H23	36.6600688	-116.013513	20380926.79	1831990.18	1089.36
H24	36.6606803	-116.0132566	20381149.94	1832063.89	1092.27
H25	36.6613789	-116.0130003	20381404.75	1832137.3	1094.11
H26	36.6613685	-116.012724	20381401.55	1832218.37	1094.76
H27	36.6609481	-116.0128743	20381248.18	1832175.35	1092.59
H28	36.660487	-116.0130717	20381079.92	1832118.58	1091.82
H29	36.6600889	-116.0133081	20380934.55	1832050.25	1089.83
H30	36.6602726	-116.0129249	20381002.17	1832162.17	1091.07
H31	36.6607151	-116.0127267	20381163.65	1832219.21	1091.7
H32	36.6606352	-116.0124552	20381135.1	1832299.04	1091.6
H33	36.6603738	-116.0125662	20381039.72	1832267.12	1091.54
H34	36.6602026	-116.0126635	20380977.2	1832239.02	1090.89
H35	36.6601395	-116.0119007	20380955.75	1832462.9	1091.07
H36	36.6596921	-116.01411	20380788.47	1831816.02	1086
H37	36.6596585	-116.0138142	20380776.82	1831902.86	1086.65
H50	36.6612205	-116.012747	20381347.62	1832212.01	1094.98

[a]US State Plane 1983; Nevada Central 2702; NAD 1983 (CONUS)

Appendix E

Project Organization

E.1.0 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 Officers can be found in the appropriate plan. However, personnel are subject to change and it is suggested that the appropriate Department of Energy Project Manager be contacted for further information. The Task Manager will be identified in the FFACO Biweekly Activity Report prior to the start of field activities.

Appendix F

Geotechnical Data

(30 Pages)

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1] (θ, ρ_d, φ)	Saturated Hydraulic Conductivity[2]		Moisture Characteristics[3]					Unsaturated Hydraulic Conductivity	Particle Size[4]			Effective Porosity	Particle Density	Air Permeability	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH		DS	WS	H						
005-A401	X	X		X	X		X	X	X		X	X						
005-A402	X	X		X	X		X	X	X		X	X						
005-A403	X	X		X	X		X	X	X		X	X						
005-A404	X	X		X	X		X	X	X		X	X						
005-A405	X	X		X	X		X	X	X		X	X						
005-A406	X	X		X	X		X	X	X		X	X						
005-B401	X	X		X	X		X	X	X		X	X						
005-B402	X	X		X	X		X	X	X		X	X						
005-B403	X	X		X	X		X	X	X		X	X						
005-B404	X	X		X	X		X	X	X		X	X						
005-B405	X	X		X	X		X	X	X		X	X						
005-B406	X	X		X	X		X	X	X		X	X						
005-C401	X	X		X	X		X	X	X		X	X						
005-C402	X	X		X	X		X	X	X		X	X						
005-C403	X	X		X	X		X	X	X		X	X						

[1] θ = Initial moisture content, ρ_d = Dry bulk density, φ = Calculated porosity

[2] CH = Constant head, FH = falling head

[3] HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box

[4] DS = Dry sieve, WS = Wet sieve, H = Hydrometer

Daniel B. Stephens & Associates, Inc.

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1] (θ, ρ_d, ϕ)	Saturated Hydraulic Conductivity[2]		Moisture Characteristics[3]					Unsaturated Hydraulic Conductivity	Particle Size[4]			Effective Porosity	Particle Density	Air Permeability	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH		DS	WS	H						
005-C404	X	X		X	X		X	X	X		X	X						
005-C405	X	X		X	X		X	X	X		X	X						
005-C406	X	X		X	X		X	X	X		X	X						
005-D401	X	X		X	X		X	X	X		X	X						
005-D402	X	X		X	X		X	X	X		X	X						
005-D403	X	X		X	X		X	X	X		X	X						
005-D404	X		X	X	X		X	X	X		X	X						
005-D405	X	X		X	X		X	X	X		X	X						
005-D407	X	X		X	X		X	X	X		X	X						
005-E401	X	X		X	X		X	X	X		X	X						
005-E402	X	X		X	X		X	X	X		X	X						
005-E403	X	X		X	X		X	X	X		X	X						
005-E404	X	X		X	X		X	X	X		X	X						
005-E405	X	X		X	X		X	X	X		X	X						
005-E406	X	X		X	X		X	X	X		X	X						

[1] θ = Initial moisture content, ρ_d = Dry bulk density, ϕ = Calculated porosity

[2] CH = Constant head, FH = falling head

[3] HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box

[4] DS = Dry sieve, WS = Wet sieve, H = Hydrometer

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1] (θ, ρ_d, ϕ)	Saturated Hydraulic Conductivity[2]		Moisture Characteristics[3]					Unsaturated Hydraulic Conductivity	Particle Size[4]			Effective Porosity	Particle Density	Air Permeability	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH		DS	WS	H						
005-F401	X	X		X	X		X	X	X		X	X						
005-F402	X	X		X	X		X	X	X		X	X						
005-F403	X	X		X	X		X	X	X		X	X						
005-F404	X	X		X	X		X	X	X		X	X						
005-F406	X	X		X	X		X	X	X		X	X						
005-F407	X	X		X	X		X	X	X		X	X						
005-G401	X	X		X	X		X	X	X		X	X						
005-G402	X	X		X	X		X	X	X		X	X						
005-G403	X	X		X	X		X	X	X		X	X						
005-G404	X	X		X	X		X	X	X		X	X						
005-G405	X	X		X	X		X	X	X		X	X						
005-G406	X	X		X	X		X	X	X		X	X						
005-H401	X	X		X	X		X	X	X		X	X						
005-H402	X	X		X	X		X	X	X		X	X						
005-H403	X	X		X	X		X	X	X		X	X						

[1] θ = Initial moisture content, ρ_d = Dry bulk density, ϕ = Calculated porosity

[2] CH = Constant head, FH = falling head

[3] HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box

[4] DS = Dry sieve, WS = Wet sieve, H = Hydrometer

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1] (θ, ρ_d, ϕ)	Saturated Hydraulic Conductivity[2]		Moisture Characteristics[3]					Unsaturated Hydraulic Conductivity	Particle Size[4]			Effective Porosity	Particle Density	Air Permeability	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH		DS	WS	H						
005-H404	X	X		X	X		X	X	X		X	X						
005-H405	X	X		X	X		X	X	X		X	X						
005-H406	X	X		X	X		X	X	X		X	X						

[1] θ = Initial moisture content, ρ_d = Dry bulk density, ϕ = Calculated porosity

[2] CH = Constant head, FH = falling head

[3] HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box

[4] DS = Dry sieve, WS = Wet sieve, H = Hydrometer

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Initial Moisture Content Gravimetric (%, g/g)	Initial Moisture Content Volumetric (%, cm³/cm³)	Dry Bulk Density (g/cm³)	Wet Bulk Density (g/cm³)	Calculated Porosity (%)
005-A401	3.6	6.2	1.72	1.78	35.2
005-A402	3.6	6.0	1.67	1.74	36.8
005-A403	6.8	11.4	1.67	1.78	37.1
005-A404	2.4	4.4	1.84	1.88	30.6
005-A405	2.3	4.1	1.82	1.86	31.4
005-A406	1.7	3.1	1.83	1.86	30.9
005-B401	3.2	5.4	1.68	1.73	36.7
005-B402	4.2	6.3	1.50	1.57	43.3
005-B403	6.1	9.8	1.60	1.70	39.4
005-B404	5.9	9.5	1.62	1.71	39.1
005-B405	4.3	7.1	1.64	1.71	38.2
005-B406	3.2	5.2	1.60	1.65	39.6
005-C401	8.6	13.2	1.53	1.66	42.4
005-C402	13.5	19.7	1.47	1.66	44.7
005-C403	11.4	16.5	1.45	1.62	45.2
005-C404	4.7	8.1	1.71	1.79	35.6
005-C405	4.2	6.6	1.59	1.65	40.1
005-C406	3.0	5.7	1.91	1.97	27.8
005-D401	10.1	14.1	1.39	1.54	47.4

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

Sample Number	Initial Moisture Content Gravimetric (%, g/g)	Initial Moisture Content Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
005-D402	15.4	20.6	1.34	1.55	49.4
005-D403	9.2	13.5	1.47	1.60	44.6
005-D404	15.1	23.3	1.54	1.78	41.8
005-D405	7.5	11.0	1.47	1.58	44.4
005-D407	3.3	6.3	1.90	1.96	28.4
005-E401	11.4	16.2	1.42	1.59	46.3
005-E402	4.5	6.8	1.51	1.57	43.1
005-E403	4.6	7.3	1.59	1.66	40.0
005-E404	1.0	2.3	2.21	2.23	16.6
005-E405	9.2	14.1	1.54	1.68	41.9
005-E406	14.0	18.5	1.33	1.51	50.0
005-F401	7.4	11.0	1.49	1.60	43.6
005-F402	5.9	9.7	1.65	1.75	37.7
005-F403	6.7	11.3	1.67	1.78	37.0
005-F404	10.4	14.2	1.37	1.51	48.5
005-F406	9.3	12.6	1.36	1.49	48.7
005-F407	7.0	11.6	1.66	1.78	37.4
005-G401	13.0	16.9	1.30	1.47	50.8
005-G402	10.7	18.2	1.70	1.88	35.8

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity (Continued)

Sample Number	Initial Moisture Content Gravimetric (%, g/g)	Initial Moisture Content Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
005-G403	23.3	27.2	1.17	1.44	56.0
005-G404	9.3	12.8	1.38	1.50	48.0
005-G405	8.3	11.9	1.43	1.54	46.2
005-G406	16.1	24.4	1.51	1.76	42.9
005-H401	2.4	4.6	1.93	1.98	27.0
005-H402	3.2	5.7	1.80	1.86	32.1
005-H403	3.0	5.8	1.97	2.03	25.5
005-H404	4.1	7.0	1.71	1.78	35.3
005-H405	3.9	6.9	1.79	1.86	32.4
005-H406	2.6	5.1	1.93	1.98	27.2

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
005-A401	8.7E-04	X	
005-A402	3.6E-04	X	
005-A403	5.7E-05	X	
005-A404	1.4E-04	X	
005-A405	8.3E-05	X	
005-A406	5.1E-05	X	
005-B401	1.2E-05	X	
005-B402	7.6E-05	X	
005-B403	5.7E-05	X	
005-B404	7.7E-04	X	
005-B405	7.1E-05	X	
005-B406	9.3E-06	X	
005-C401	9.6E-05	X	
005-C402	1.0E-04	X	
005-C403	3.5E-04	X	
005-C404	1.3E-04	X	
005-C405	3.1E-04	X	
005-C406	1.3E-04	X	

Summary of Saturated Hydraulic Conductivity Tests (Continued)

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
005-D401	3.1E-04	X	
005-D402	7.4E-04	X	
005-D403	5.0E-04	X	
005-D404	1.8E-07		X
005-D405	3.2E-05	X	
005-D407	1.2E-05	X	
005-E401	5.2E-04	X	
005-E402	3.9E-06	X	
005-E403	3.0E-06	X	
005-E404	2.5E-04	X	
005-E405	1.4E-04	X	
005-E406	4.0E-04	X	
005-F401	5.4E-05	X	
005-F402	4.1E-06	X	
005-F403	1.1E-04	X	
005-F404	1.1E-04	X	
005-F406	3.1E-04	X	
005-F407	6.7E-06	X	

Summary of Saturated Hydraulic Conductivity Tests (Continued)

Sample Number	K_{sat} (cm/sec)	Method of Analysis: Constant Head	Method of Analysis: Falling Head
005-G401	7.5E-04	X	
005-G402	1.9E-04	X	
005-G403	1.4E-03	X	
005-G404	4.4E-04	X	
005-G405	7.0E-04	X	
005-G406	4.9E-05	X	
005-H401	1.9E-04	X	
005-H402	2.0E-04	X	
005-H403	2.2E-05	X	
005-H404	7.5E-05	X	
005-H405	9.9E-04	X	
005-H406	3.9E-05	X	

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-A401	0	33.4
	25	25.5
	51	20.3
	151	15.0
	510	11.8
	6221	6.4
	851293	2.6
005-A402	0	30.2
	21	22.8
	50	18.3
	150	15.3
	510	12.8
	9892	7.7
	851293	3.2
005-A403	0	35.1
	19	33.9
	47	28.0
	153	22.0
	510	19.2
	14991	10.8
	851293	4.2
005-A404	0	31.2
	11	29.4
	47	24.3
	162	15.8
	510	12.8
	8668	6.7
	851293	3.3

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-A405	0	27.5
	19	24.9
	44	22.8
	151	16.5
	510	12.7
	10402	6.4
	851293	2.8
005-A406	0	26.7
	18	24.2
	52	22.5
	154	17.4
	510	14.2
	11830	7.9
	851293	2.9
005-B401	0	29.8
	18	27.4
	52	26.5
	154	26.1
	510	17.4
	15807	8.2
	851293	2.3
005-B402	0	34.9
	11	32.7
	47	30.3
	162	22.1
	510	17.0
	16929	7.1
	851293	3.2

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-B403	0	33.7
	19	32.8
	47	25.0
	153	18.5
	510	16.3
	15093	7.3
	851293	2.3
005-B404	0	40.2
	11	37.3
	47	32.5
	162	28.3
	510	19.3
	9484	9.0
	851293	2.6
005-B405	0	30.4
	19	28.1
	44	25.4
	151	17.7
	510	13.9
	17948	5.6
	851293	2.2
005-B406	0	34.0
	19	31.5
	47	26.0
	153	20.5
	510	18.1
	13461	5.8
	851293	2.7

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-C401	0	40.4
	11	40.1
	47	36.6
	162	30.5
	510	23.0
	15909	13.2
	851293	4.4
005-C402	0	44.0
	21	41.2
	50	37.6
	150	32.9
	510	26.9
	9280	16.0
	851293	5.3
005-C403	0	36.6
	18	34.0
	52	31.0
	154	30.0
	510	21.4
	8566	12.0
	851293	4.5
005-C404	0	31.9
	19	30.5
	47	26.0
	153	17.7
	510	14.7
	1754	10.6
	851293	5.8

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-C405	0	34.7
	11	32.6
	47	30.2
	162	23.5
	510	16.4
	12849	7.4
	851293	2.1
005-C406	0	26.1
	19	24.4
	47	20.0
	153	14.8
	510	12.0
	16725	5.2
	851293	1.9
005-D401	0	43.9
	19	42.6
	47	37.0
	153	26.7
	510	24.2
	15399	12.8
	851293	5.1
005-D402	0	46.0
	19	43.7
	47	37.0
	153	28.3
	510	25.7
	17133	13.8
	851293	7.4

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-D403	0	39.4
	19	36.5
	44	31.9
	151	23.8
	510	19.3
	14175	8.7
	851293	6.2
005-D404	0	41.6
	29	41.3
	146	40.4
	510	36.9
	11932	20.8
	21008	20.0
	851293	11.2
005-D405	0	39.5
	11	38.0
	47	35.4
	162	30.4
	510	25.7
	14787	13.1
	851293	5.6
005-D407	0	26.7
	19	26.5
	47	22.1
	153	16.0
	510	14.1
	14991	7.1
	851293	2.3

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-E401	0	43.7
	19	39.4
	44	32.0
	151	25.0
	510	21.6
	15195	13.2
	851293	9.4
005-E402	0	38.8
	21	36.6
	50	32.6
	150	29.2
	510	26.2
	9688	17.0
	851293	7.8
005-E403	0	36.5
	21	35.1
	50	32.7
	150	26.7
	510	23.1
	15399	7.5
	851293	1.0
005-E404	0	18.9
	18	16.3
	52	13.0
	154	12.1
	510	10.5
	7852	5.6
	851293	1.6

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-E405	0	39.4
	11	39.0
	47	35.3
	162	29.1
	510	24.0
	14583	14.0
	851293	4.8
005-E406	0	46.1
	19	43.8
	44	38.9
	151	30.4
	510	25.6
	7241	18.1
	851293	8.1
005-F401	0	37.5
	18	34.3
	52	32.5
	154	31.6
	510	21.3
	7750	12.4
	851293	4.2
005-F402	0	35.7
	11	34.2
	47	32.7
	162	26.7
	510	22.8
	7750	12.0
	851293	4.2

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-F403	0	34.0
	19	31.9
	44	30.4
	151	23.7
	510	17.2
	17948	5.9
	851293	2.4
005-F404	0	47.0
	18	44.8
	52	41.0
	154	35.6
	510	28.9
	6323	13.5
	851293	6.5
005-F406	0	41.8
	21	40.7
	50	35.5
	150	28.3
	510	24.5
	11422	12.1
	851293	5.7
005-F407	0	34.7
	11	33.5
	47	31.4
	162	28.0
	510	23.1
	13155	9.8
	851293	3.7

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-G401	0	43.1
	18	40.0
	52	37.0
	154	31.3
	510	20.3
	6833	9.5
	851293	2.5
	851293	2.5
005-G402	0	36.4
	25	34.0
	51	30.9
	151	23.4
	510	19.1
	8464	10.7
	851293	2.9
005-G403	0	54.8
	11	50.3
	47	38.6
	162	32.3
	510	29.4
	16725	16.3
	851293	6.0
005-G404	0	38.1
	18	36.3
	52	33.5
	154	27.0
	510	17.6
	14073	7.4
	851293	2.8

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-G405	0	42.5
	25	41.0
	51	30.6
	151	18.9
	510	15.1
	6731	7.5
	851293	3.4
005-G406	0	39.0
	21	36.8
	50	33.4
	150	29.1
	510	25.1
	16521	11.2
	851293	4.7
005-H401	0	22.9
	19	21.0
	44	18.1
	151	13.3
	510	9.7
	18968	4.6
	851293	1.7
005-H402	0	26.2
	18	23.5
	52	21.5
	154	16.1
	510	12.0
	9178	4.6
	851293	2.2

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
005-H403	0	30.1
	19	28.1
	44	26.3
	151	22.5
	510	16.9
	15705	11.1
	851293	3.0
005-H404	0	31.5
	25	29.4
	51	26.9
	151	22.4
	510	16.2
	22640	7.7
	851293	2.0
005-H405	0	30.3
	21	27.9
	50	19.5
	150	14.6
	510	10.9
	16215	4.9
	851293	1.9
005-H406	0	26.3
	19	25.6
	47	22.0
	153	15.6
	510	13.4
	15297	5.3
	851293	1.7

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Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
005-A401	0.0855	1.3249	0.0202	0.3347
005-A402	0.2268	1.1900	0.0044	0.3020
005-A403	0.0509	1.2032	0.0075	0.3572
005-A404	0.0370	1.3824	0.0314	0.3129
005-A405	0.0346	1.2999	0.0174	0.2756
005-A406	0.0400	1.2061	0.0000	0.2674
005-B401	0.0081	1.2767	0.0000	0.2895
005-B402	0.0219	1.3212	0.0195	0.3459
005-B403	0.0471	1.2748	0.0110	0.3453
005-B404	0.0225	1.2723	0.0000	0.3928
005-B405	0.0311	1.3160	0.0129	0.3061
005-B406	0.0407	1.2481	0.0000	0.3416
005-C401	0.0219	1.2109	0.0000	0.4087
005-C402	0.0251	1.1930	0.0000	0.4380
005-C403	0.0142	1.2362	0.0067	0.3571
005-C404	0.0285	1.4440	0.0575	0.3237
005-C405	0.0187	1.3135	0.0073	0.3429
005-C406	0.0425	1.2862	0.0089	0.2648
005-D401	0.0393	1.2338	0.0203	0.4483
005-D402	0.0488	1.2299	0.0416	0.4670
005-D403	0.0337	1.3307	0.0482	0.3960
005-D404	0.0019	1.2745	0.0669	0.4164

Summary of Calculated Unsaturated Hydraulic Properties (Continued)

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
005-D405	0.0174	1.1968	0.0000	0.3914
005-D407	0.0413	1.2284	0.0000	0.2751
005-E401	0.0616	1.3135	0.0866	0.4405
005-E402	0.0391	1.1433	0.0000	0.3876
005-E403	0.0109	1.2997	0.0000	0.3611
005-E404	0.0842	1.1825	0.0000	0.1882
005-E405	0.0249	1.1919	0.0000	0.3977
005-E406	0.0463	1.2103	0.0411	0.4671
005-F401	0.0103	1.2794	0.0159	0.3632
005-F402	0.0152	1.2231	0.0000	0.3536
005-F403	0.0157	1.3366	0.0104	0.3380
005-F404	0.0126	1.3030	0.0341	0.4630
005-F406	0.0285	1.2389	0.0212	0.4247
005-F407	0.0089	1.2525	0.0000	0.3403
005-G401	0.0136	1.3606	0.0109	0.4233
005-G402	0.0313	1.2364	0.0000	0.3688
005-G403	0.1183	1.1699	0.0000	0.5524
005-G404	0.0137	1.4025	0.0238	0.3797
005-G405	0.0269	1.5940	0.0472	0.4375
005-G406	0.0197	1.2078	0.0000	0.3860
005-H401	0.0474	1.2571	0.0000	0.2321
005-H402	0.0242	1.3372	0.0107	0.2590

Summary of Calculated Unsaturated Hydraulic Properties (Continued)

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
005-H403	0.0297	1.1902	0.0000	0.3011
005-H404	0.0246	1.2451	0.0000	0.3172
005-H405	0.0454	1.4062	0.0221	0.3090
005-H406	0.0310	1.2795	0.0038	0.2685

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification
005-A401	0.042	0.22	0.32	7.6	0.90	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-A402	0.015	0.81	1.2	80	4.1	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-A403	0.050	0.18	0.45	9.0	0.18	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-A404	0.062	0.55	0.89	14	0.88	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-A405	0.045	0.44	0.74	16	0.87	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-A406	0.035	0.81	1.6	46	1.1	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-B401	0.055	0.32	0.59	11	0.60	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-B402	0.035	0.22	0.40	11	0.67	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-B403	0.051	0.26	0.48	9.4	0.49	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-B404	0.032	0.29	0.42	13	1.1	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-B405	0.038	0.39	0.62	16	1.2	WS/H	Classification by ASTM 2487 requires Atterberg test	NA

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification
005-B406	0.036	0.23	0.43	12	0.56	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-C401	0.024	1.1	2.6	108	0.23	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-C402	0.0056	0.093	0.16	29	2.6	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-C403	0.0068	0.12	0.23	34	1.4	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-C404	0.038	1.8	3.4	89	0.20	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-C405	0.032	1.7	3.8	119	0.12	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-C406	0.055	4.0	7.5	136	0.68	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-D401	0.018	0.98	2.5	139	0.80	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-D402	0.012	0.61	1.2	100	1.2	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-D403	0.013	1.1	2.5	192	1.00	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-D404	0.0070	0.46	1.2	171	0.88	WS/H	Classification by ASTM 2487 requires Atterberg test	NA

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification
005-D405	0.0026	0.33	0.91	350	1.6	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-D407	0.017	0.49	1.1	65	0.46	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-E401	0.059	1.2	2.1	36	1.2	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-E402	0.0012	0.12	0.28	233	4.1	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-E403	0.0066	0.33	0.96	145	0.80	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-E404	0.021	2.2	4.3	205	0.64	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-E405	0.024	0.79	1.8	75	0.59	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-E406	0.020	0.46	0.88	44	0.82	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-F401	0.14	4.2	7.3	52	0.96	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-F402	0.070	2.1	4.4	63	0.57	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-F403	0.040	0.95	2.1	53	0.74	WS/H	Classification by ASTM 2487 requires Atterberg test	NA

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification
005-F404	0.0049	1.2	2.9	592	3.1	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-F406	0.030	0.61	1.2	40	0.80	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-F407	0.013	0.47	0.89	68	1.5	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-G401	0.053	0.31	0.49	9.2	0.75	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-G402	0.045	0.32	0.40	8.9	1.4	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-G403	0.066	3.8	7.1	108	0.77	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-G404	0.055	0.33	0.51	9.3	0.91	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-G405	0.0085	0.29	0.54	64	2.1	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-G406	0.0058	0.20	0.34	59	2.7	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-H401	0.031	2.4	4.4	142	0.50	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-H402	0.049	5.2	10.0	204	0.24	WS/H	Classification by ASTM 2487 requires Atterberg test	NA

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification
005-H403	0.056	2.9	5.0	89	1.1	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-H404	0.060	3.4	5.8	97	0.84	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-H405	0.038	2.1	3.8	100	0.47	WS/H	Classification by ASTM 2487 requires Atterberg test	NA
005-H406	0.019	1.7	3.1	163	0.68	WS/H	Classification by ASTM 2487 requires Atterberg test	NA

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

Appendix G

Topographic Maps

(11 Pages)

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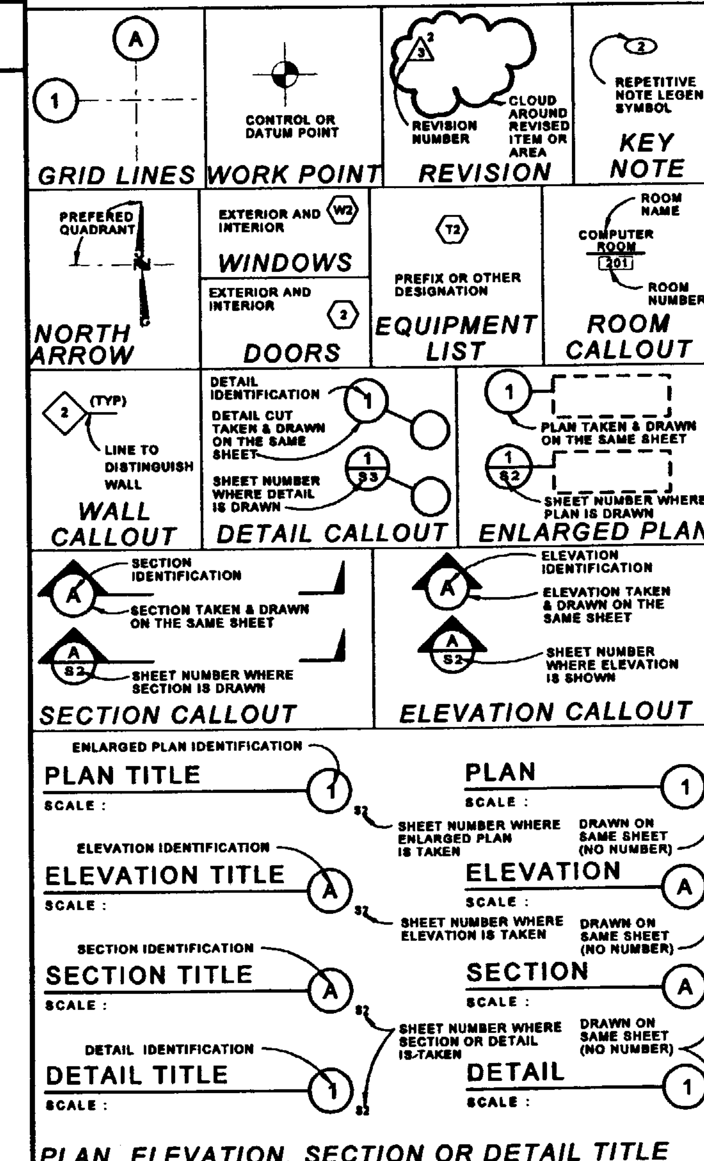
STANDARD SYMBOLS, LEGEND AND ABBREVIATIONS

SYMBOL	DESCRIPTION
N 710,000 E 700,000	NEVADA STATE COORDINATE SYSTEM
N01°30'30"E	CENTER LINE BEARING
— — (3935)— — —	EXISTING CONTOUR
—— 35 ——	FINISH CONTOUR
(3934.00)	EXISTING SPOT ELEVATION
3935.00 / FG	FINISH GRADE ELEVATION
5+00	CENTER LINE W/STATIONS
	AREA BOUNDARY LINE
	EXISTING DIRT ROAD
	EDGE OF EXISTING PAVING
	EDGE OF NEW PAVING
	EDGE EXISTING CONCRETE PAD
	EXISTING EARTH
	COMPACTED EARTH
	AGGREGATE BASE COURSE
	EXISTING FLOW LINE
	NEW FLOW LINE
	EXISTING AREA LIGHTING POLE
	NEW AREA LIGHTING POLE
	EXISTING POWER POLE
	EXISTING PAVEMENT REMOVAL
	EXISTING BUILDING OR STRUCTURE
	EXISTING CULVERT
	NEW CULVERT
—— x —— x ——	EXISTING FENCE
	NEW FENCE
	EXISTING SURVEY MONUMENT
— — - CUG — — —	EXISTING COMMUNICATIONS UNDERGROUND
—— POH ——	EXISTING POWER OVERHEAD
— — - PUG — — —	EXISTING POWER UNDERGROUND
—— CUG ——	NEW COMMUNICATIONS UNDERGROUND
—— POH ——	NEW POWER OVERHEAD
— — - PUG — — —	NEW POWER UNDERGROUND
— — - 8" W — — —	EXISTING WATER LINE W/SIZE
— — - 4" S — — —	EXISTING SEWER LINE W/SIZE
—— 8" W ——	NEW WATER LINE W/SIZE
—— 4" S ——	NEW SEWER LINE W/SIZE
	EXISTING FIRE HYDRANT
	EXISTING POST INDICATOR VALVE
	NEW FIRE HYDRANT
	NEW POST INDICATOR VALVE
Δ	DELTA (CENTRAL ANGLE)

GENERAL

APPROXIMATE	APPROX
BUILDING	BLDG
CORRUGATED METAL PIPE	CMP
COMMUNICATIONS	COMM
DRAWING	DWG
EAST	E
ELEVATION	EL, ELEV
EXISTING	EXST
GALLONS	GAL
KILOVOLT	kV
NORTHING	N
NUMBER	NO.
NEVADA TEST SITE	NTS
PROFESSIONAL LAND SURVEYOR	P.L.S.
TOP OF MANHOLE	TMH
TOP OF CONCRETE	TOC
TYPICAL	(TYP), TYP

DRAWING SYMBOLS



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NEVADA TEST SITE
AREA 5
CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT
STANDARD SYMBOLS, LEGEND AND ABBREVIATIONS

NNSA National Nuclear Security Administration Nevada Site Office

Bechtel Nevada

03011-006-133-T1

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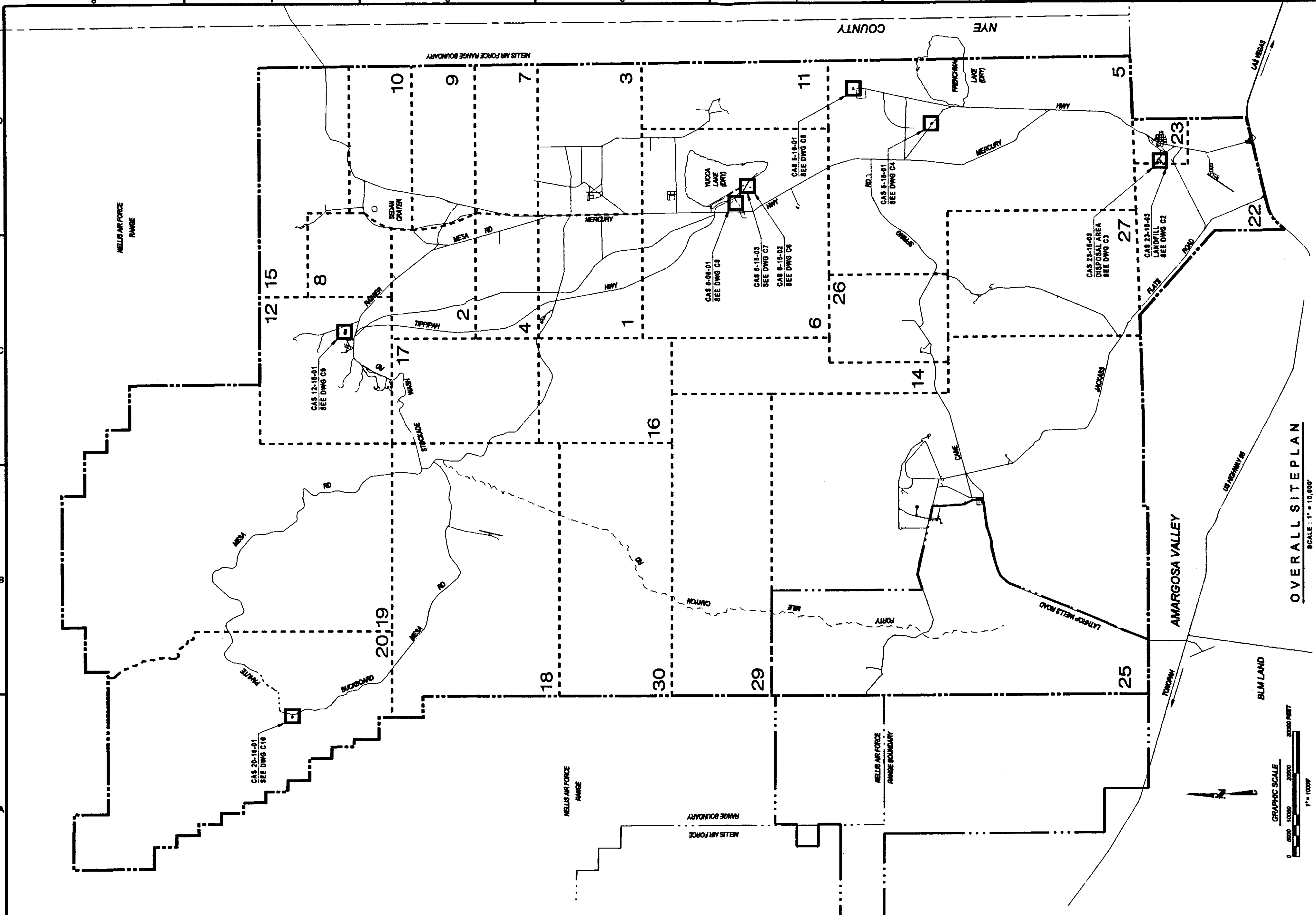

NEVADA TEST SITE
CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT

OVERALL SITEPLAN

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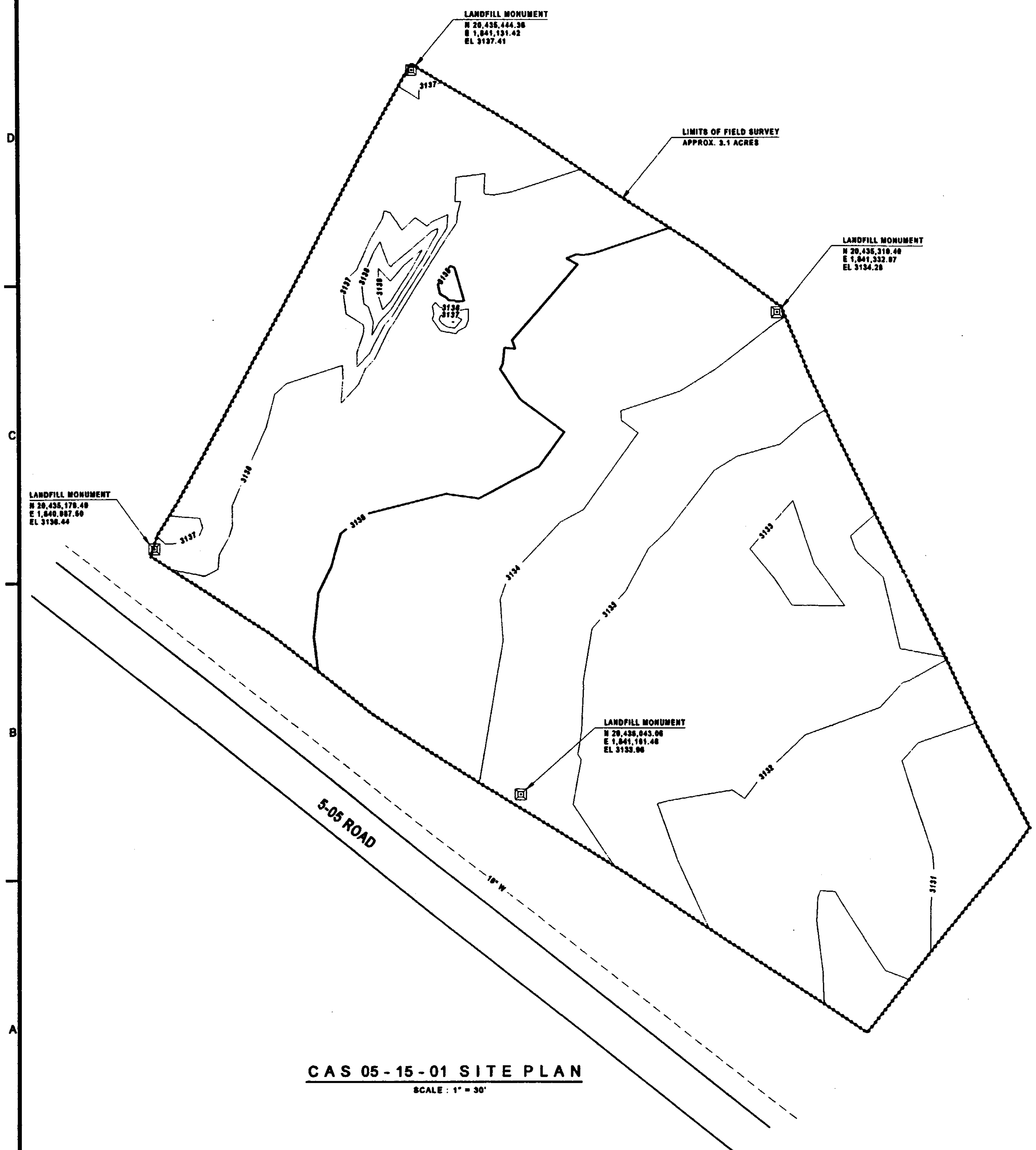

CAS 05-15-01 SITE PLAN
SCALE : 1" = 30'

NOTES:

1. CONTOURS GENERATED ONLY FROM GROUND ELEVATIONS. MONUMENT ELEVATIONS WERE NOT USED IN CREATING THE CONTOURS.
2. ALL COORDINATES BASED ON THE NEVADA STATE PLANE GRID, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983, FEET.
3. ALL ELEVATIONS BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1929, FEET.

SURVEYORS CERTIFICATE

I... SCOTTY J. ELLISON A PROFESSIONAL LAND SURVEYOR REGISTERED IN THE STATE OF NEVADA, DO HEREBY CERTIFY : THAT THIS MAP REPRESENTS A SURVEY DONE BY ME IN MARCH OF 2003. ALSO THAT THE MONUMENTS SHOWN FOR THE DATE OF MARCH 2003, ARE OF THE CHARACTER SHOWN AND DO OCCUPY THE POSITIONS INDICATED.

SCOTTY J. ELLISON P.L.S.
NEVADA CERTIFICATE NO. 7100

GRAPHIC SCALE
0 30 60 90 FEET
1" = 30'
CONTOUR INTERVAL = 1 FOOT

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NEVADA TEST SITE — AREA 5
CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT
CAS 05-15-01
SITE PLAN

APPROVAL BLOCK
N/A | 03011.090 | N/A | 5503P830

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NEVADA SITE OFFICE
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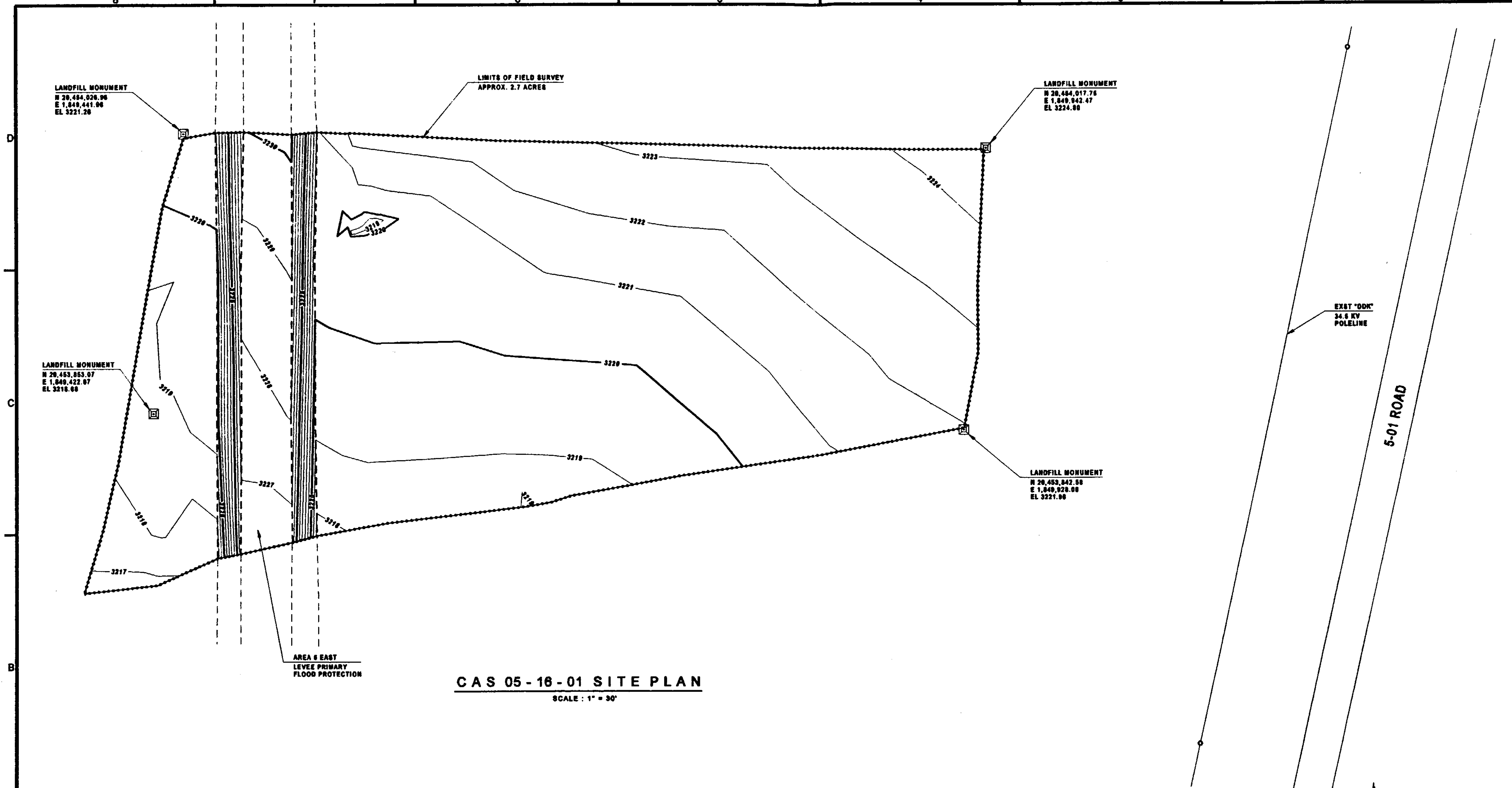

CAS 05-16-01 SITE PLAN

SCALE : 1" = 30'

NOTES:

1. CONTOURS GENERATED ONLY FROM GROUND ELEVATIONS. MONUMENT ELEVATIONS WERE NOT USED IN CREATING THE CONTOURS.
2. ALL COORDINATES BASED ON THE NEVADA STATE PLANE GRID, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983, FEET.
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SCOTTY J. ELLISON P.L.S.
NEVADA CERTIFICATE NO. 7188

GRAPHIC SCALE
0 30 60 90 FEET
1" = 30'
CONTOUR INTERVAL = 1 FOOT

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NEVADA TEST SITE — AREA 5
CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT
CAS 05-16-01
SITE PLAN

PROJECT NUMBER	ENGINEERING NUMBER	PROJECT AUTH NO	ACTIVITY CODE
N/A	03011.090	N/A	5803PB30

National Nuclear Security Administration
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Bechtel Nevada
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SCOTTY J. ELLISON P.L.S.
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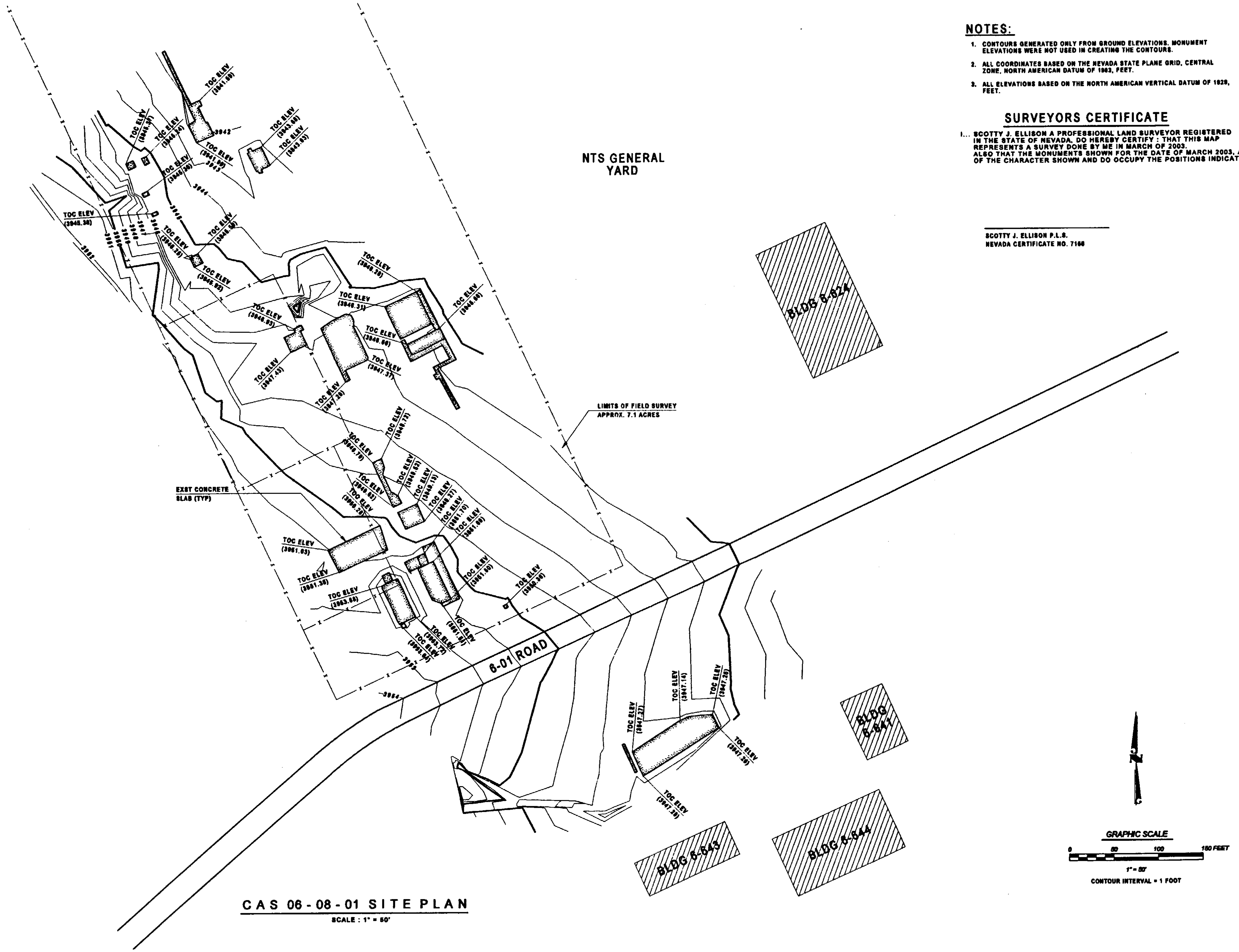

CAS 06-08-01 SITE PLAN

SCALE : 1" = 50'

NEVADA TEST SITE — AREA 6

CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT

CAS 06-08-01

SITE PLAN

NNSA — Bechtel Nevada

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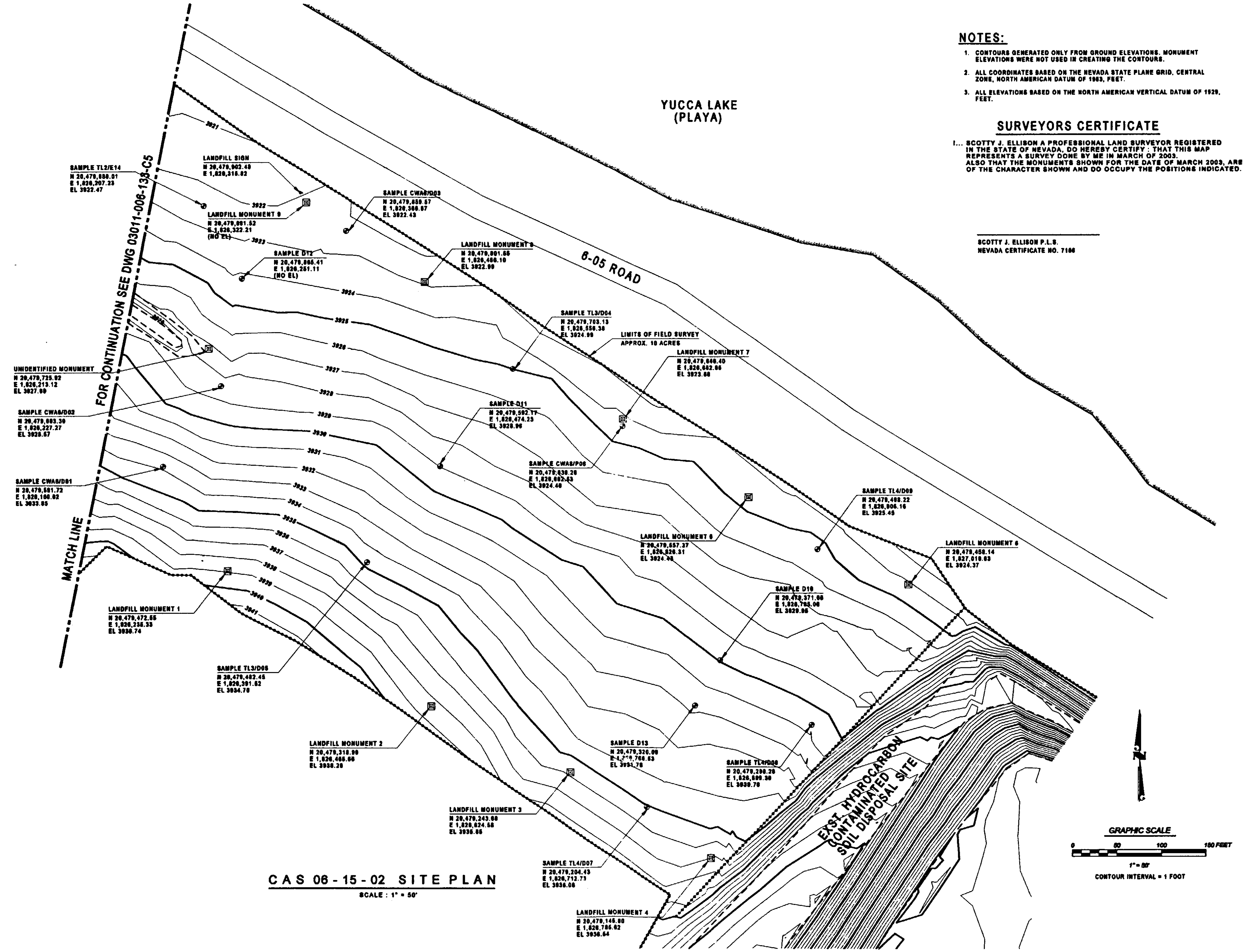

CAS 06-15-02 SITE PLAN

SCALE : 1" = 50'

NOTES:

1. CONTOURS GENERATED ONLY FROM GROUND ELEVATIONS. MONUMENT ELEVATIONS WERE NOT USED IN CREATING THE CONTOURS.
2. ALL COORDINATES BASED ON THE NEVADA STATE PLANE GRID, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983, FEET.
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SCOTTY J. ELLISON P.L.S.
NEVADA CERTIFICATE NO. 7166

NEVADA TEST SITE — AREA 6

CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT

CAS 06-15-02

SITE PLAN

National Nuclear Security Administration — Nevada Site Office

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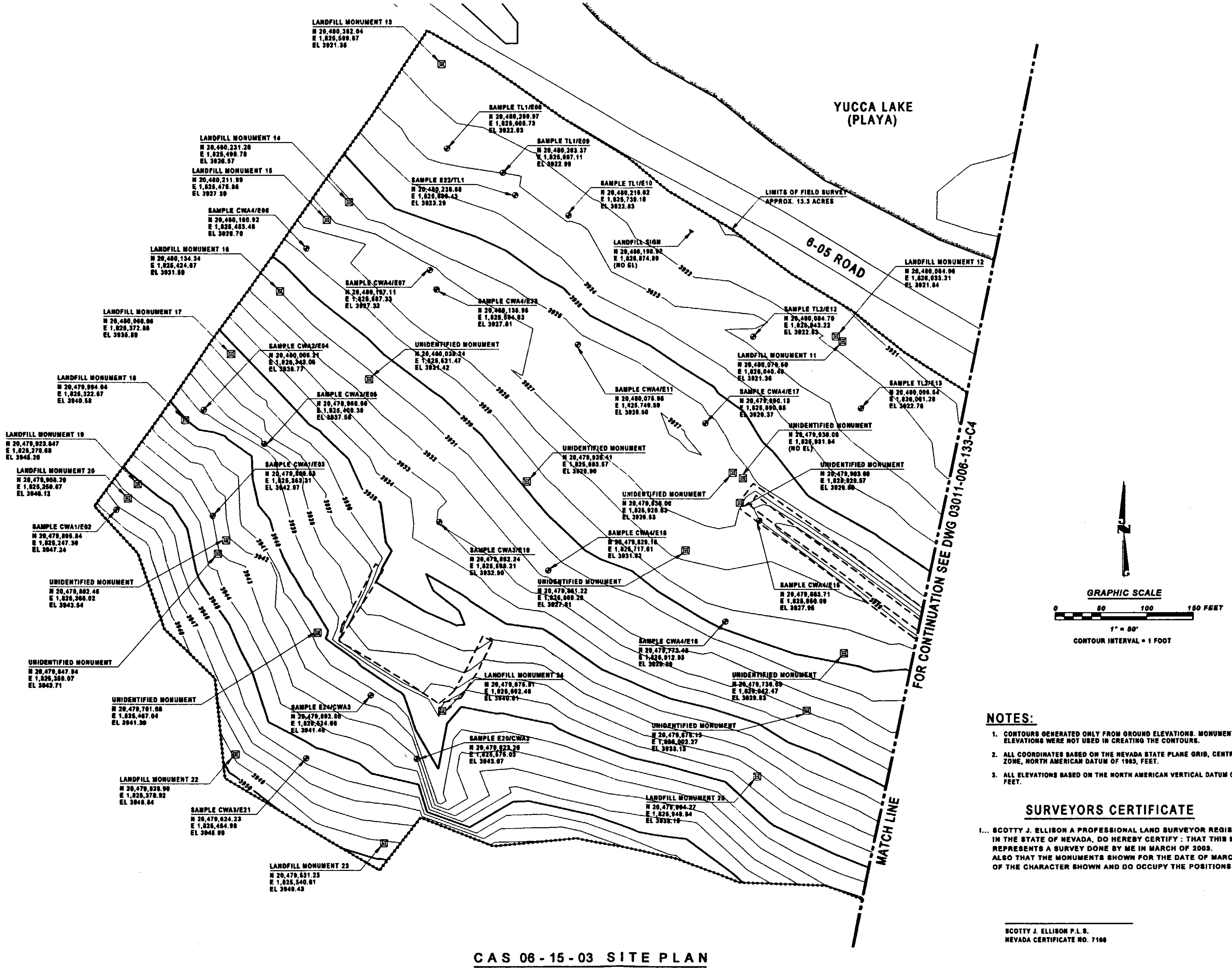

NOTES:

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2. ALL COORDINATES BASED ON THE NEVADA STATE PLANE GRID, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983, FEET.
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SCOTTY J. ELLISON P.L.S.
NEVADA CERTIFICATE NO. 7166

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NEVADA TEST SITE — AREA 6

CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT

CAS 06-15-03

SITE PLAN

NNSA National Nuclear Security Administration, Nevada Site Office

Bechtel Nevada

03011-006-133-C7

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NOTES:

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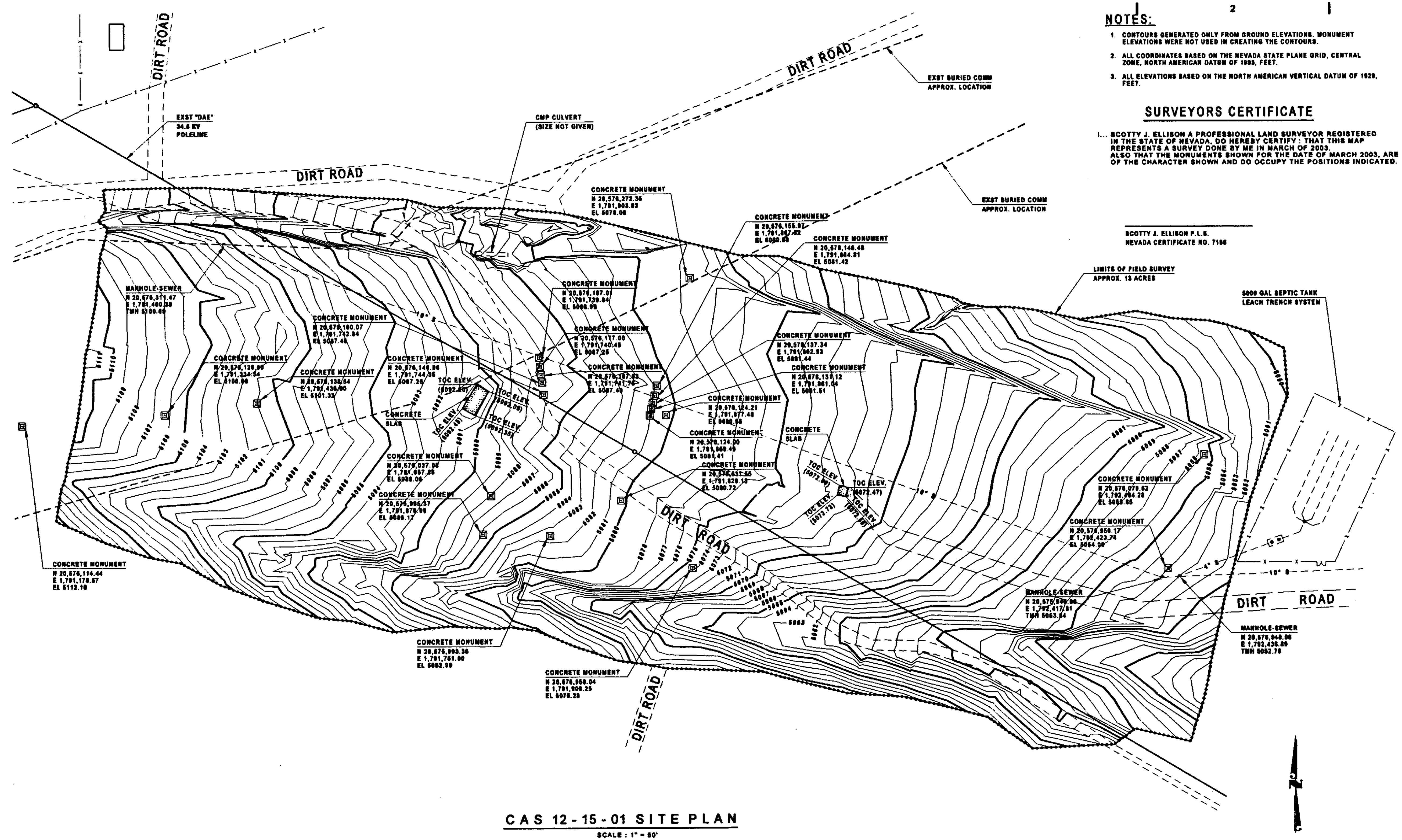
SCOTTY J. ELLISON P.L.S.
NEVADA CERTIFICATE NO. 7196



CAS 12-15-01 SITE PLAN

SCALE : 1" = 50'

GRAPHIC SCALE

0 50 100 150 FEET

1" = 50'

CONTOUR INTERVAL = 1 FOOT

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NEVADA TEST SITE — AREA 12

CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT

CAS 12-15-01

SITE PLAN

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NOTES:

1. CONTOURS GENERATED ONLY FROM GROUND ELEVATIONS. MONUMENT ELEVATIONS WERE NOT USED IN CREATING THE CONTOURS.
2. ALL COORDINATES BASED ON THE NEVADA STATE PLANE GRID, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983, FEET.
3. ALL ELEVATIONS BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1929, FEET.

SURVEYORS CERTIFICATE

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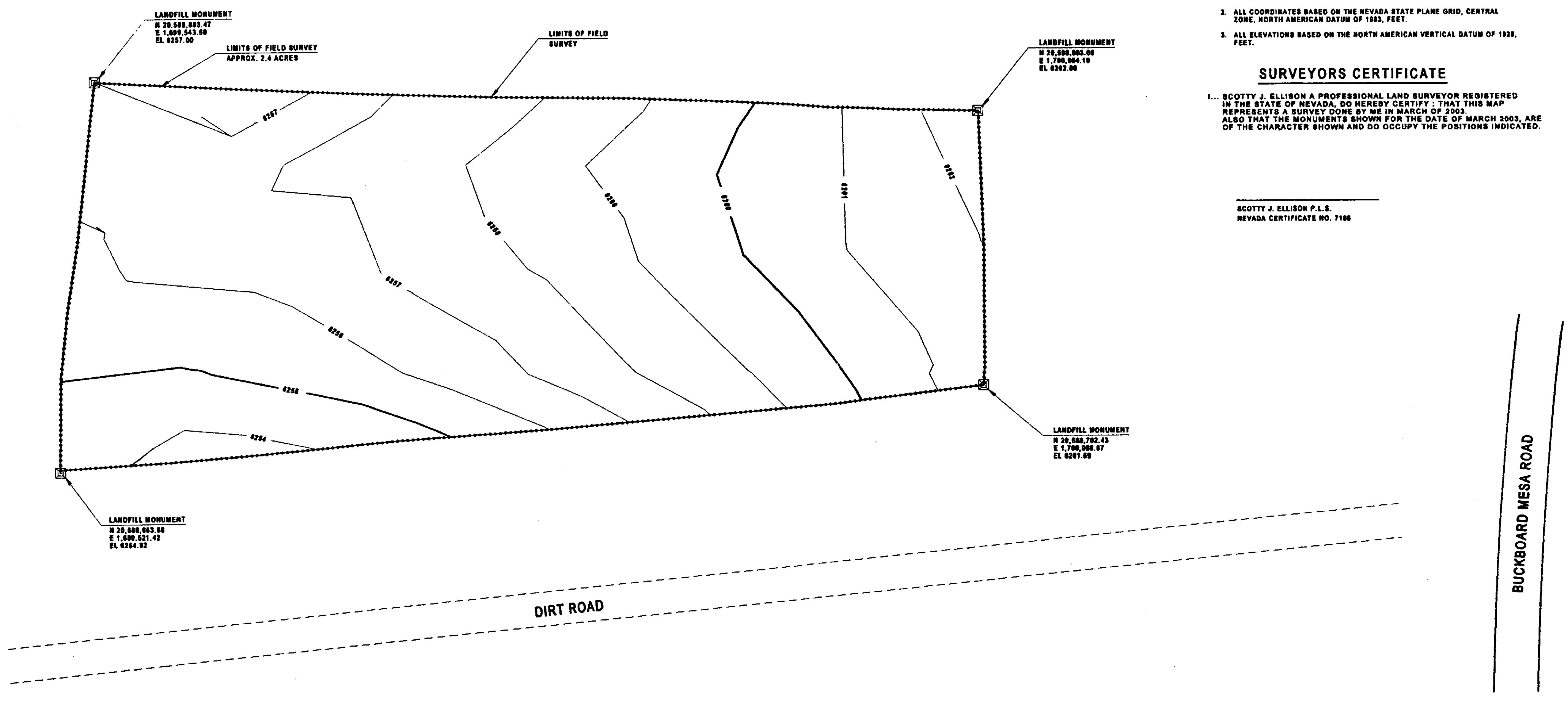
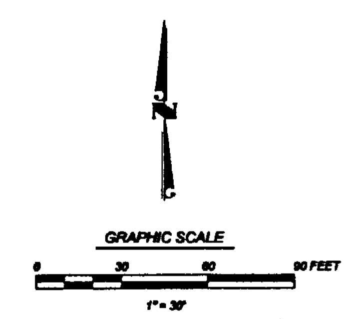
SCOTTY J. ELLISON P.L.S.
NEVADA CERTIFICATE NO. 7166



CAS 20 - 15 - 01 SITE PLAN

SCALE : 1" = 30'



NEVADA TEST SITE — AREA 20

CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT

CAS 20-15-01

SITE PLAN

National Nuclear Security Administration, NEVADA SITE OFFICE

Bechtel Nevada, P.O. BOX 98521 LAS VEGAS, NV 89193-8521

DESIGNED	DATE	ENGINEERING MANAGER	DATE
DRAWN	DATE	PROJECT ENGINEER	DATE
CHECKED	DATE	USER/OWNER	DATE
BN PROJECT NUMBER: N/A	ENGINEERING NUMBER: 03011.090	PROJECT AUTH NO: N/A	ACTIVITY CODE: 5803PB30

NO	REVISION DESCRIPTION
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DRAWING NUMBER: 03011-006-133-C10

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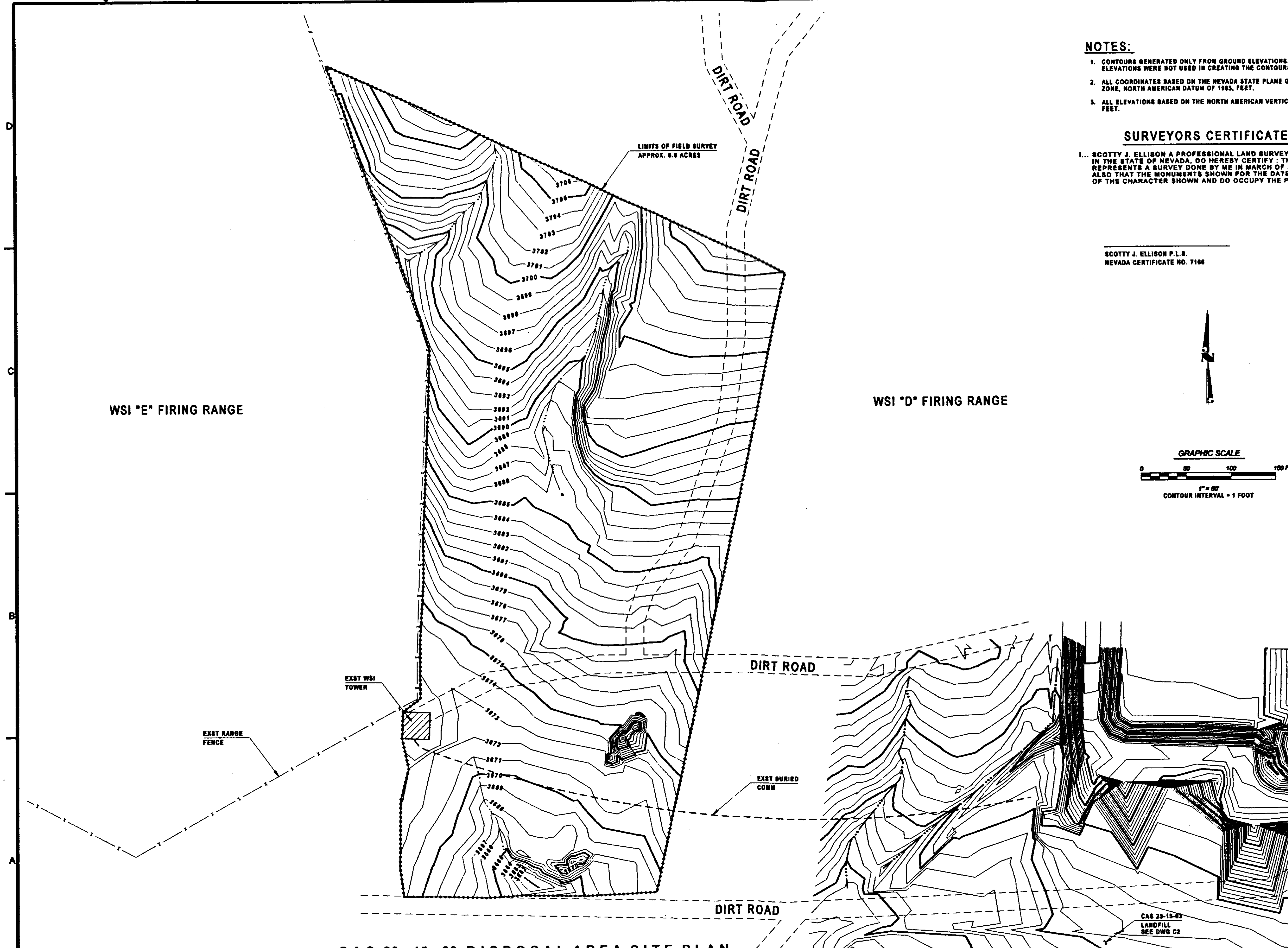

CAS 23-15-03 DISPOSAL AREA SITE PLAN

SCALE : 1" = 50'

NOTES:

1. CONTOURS GENERATED ONLY FROM GROUND ELEVATIONS. MONUMENT ELEVATIONS WERE NOT USED IN CREATING THE CONTOURS.
2. ALL COORDINATES BASED ON THE NEVADA STATE PLANE GRID, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983, FEET.
3. ALL ELEVATIONS BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1929, FEET.

SURVEYORS CERTIFICATE

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ALSO THAT THE MONUMENTS SHOWN FOR THE DATE OF MARCH 2003, ARE OF THE CHARACTER SHOWN AND DO OCCUPY THE POSITIONS INDICATED.

SCOTTY J. ELLISON P.L.S.
NEVADA CERTIFICATE NO. 7166

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SN PROJECT NUMBER	ENGINEERING NUMBER	PROJECT AFP/WO	ACTIVITY CODE
N/A	03011.090	N/A	5503P830

NEVADA TEST SITE — AREA 23

CAU5 SHAW INVESTIGATION AND CHARACTERIZATION SUPPORT

CAS 23-15-03 DISPOSAL AREA

SITE PLAN

NNSA National Nuclear Security Administration NEVADA SITE OFFICE

Bechtel Nevada

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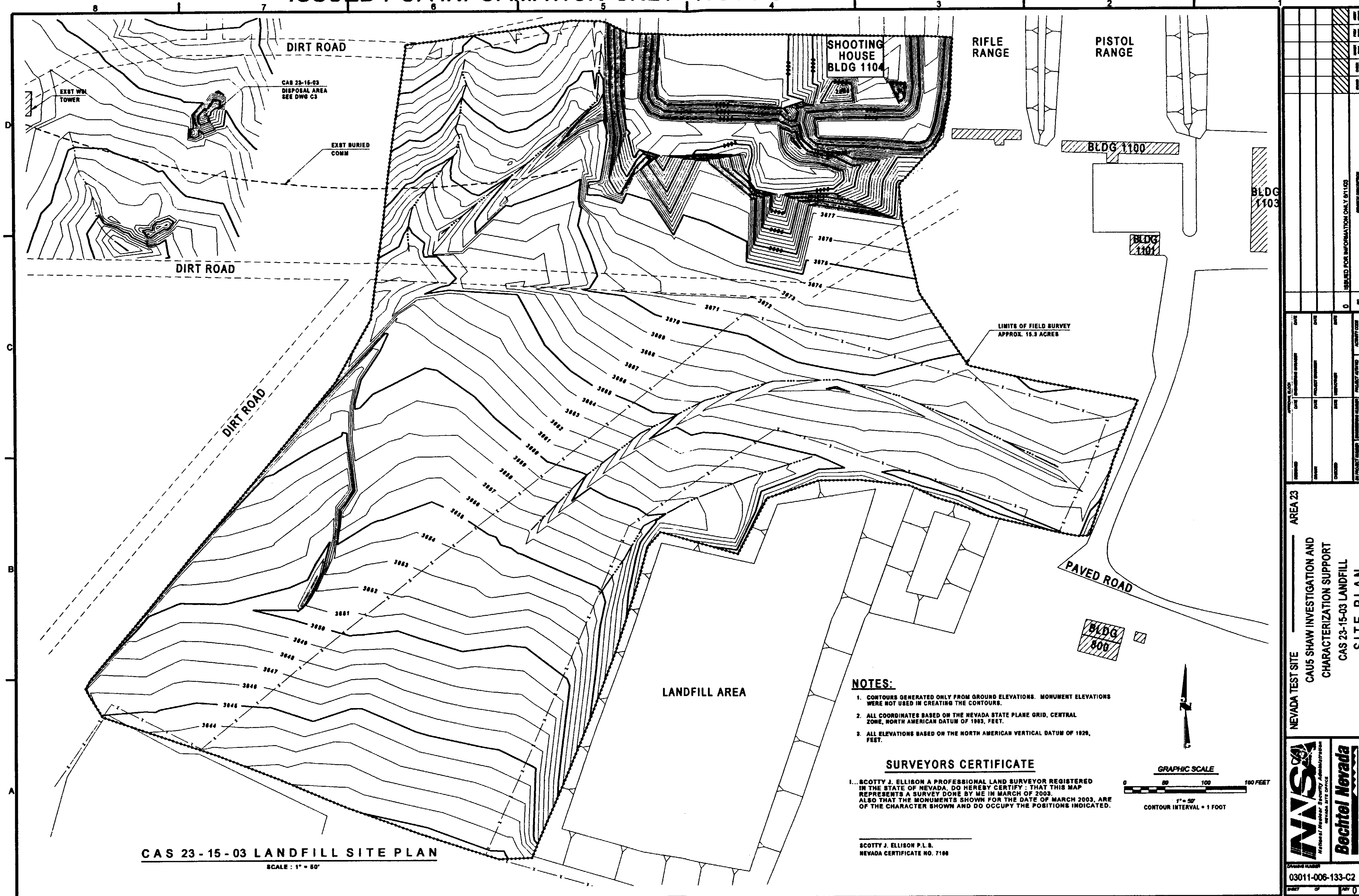

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Appendix H

Evaluation of Risk

H.1.0 Evaluation of Risk

The proposed corrective action alternative for CAS 12-15-01, Sanitary Landfill results in TPH DRO and GRO and two VOCs 1,2-Dichlorobenzene and 1,4-Dichlorobenzene remaining in the soil at concentrations exceeding PALs at one location within the CAS. An evaluation of risk for TPH and VOC concentrations in soil at CAS 12-15-01 is presented in the following sections. Because of the location adjacent to Yucca Lake and the recommended corrective action of close in place with use restriction, a concern exists for the potential inundation of CASs 06-15-02 and 06-15-03 during periods of intense precipitation and flooding of the lake. The evaluation of risk for this potential is also included in the following sections.

H.1.1 Human Health Screening General Approach

A human health screening evaluation is used in this analysis to identify the risk to human receptors from TPH and VOC levels in the soil present at CAS 12-15-01. The VOC and TPH contamination was evaluated by comparing actual contaminant levels in the subsurface soils at CAS 12-15-01 to human health risk-based concentrations as screening values for contaminants in soil. The TPH PAL is defined in the *Nevada Administrative Code* (NAC, 2003) as 100 mg/kg. The human health risked-based concentrations for VOCs are those derived by the EPA Region 9 as reported in *Region 9 Preliminary Remediation Goals* (PRGs) (EPA, 2000). The sample results above PALs for VOCs are shown in Table H.1-1 and the sample results above PALs for TPH are shown in Table H.1-2.

The potential for the flooding of Yucca Lake is addressed by evaluating the application for a permit to operate the Area 6 Hydrocarbon Disposal Site (NNSA/NSO, 2003) that is located adjacent to the two CASs. This is the basis of evaluating the potential risk to future receptors.

H.1.2 Risk Evaluation

Corrective Action Site 12-15-01 is located within Area 12 of the NTS. The NTS is a government-controlled, restricted-access area that is guarded on a 24-hour, 365-day per year basis. Corrective Action Site 12-15-01 is located within a nonresidential restricted-use zone classified as Nuclear and High Explosive Test Land-Use Zone" (DOE/NV, 1998). Under this land-use scenario, operations of NNSA/NSO and interagency programs and operations would continue as they have in

Table H.1-1
CAS 12-15-01, Soil Sample Results at Location F05

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)		
		1,2,3-Trichlorobenzene	1,2-Dichlorobenzene	1,4-Dichlorobenzene
Preliminary Action Levels[a]		**NI**	**370**	**8.1**
005F006	14 - 15	23	**390 (J)**	**160**
005F007	25 - 26	--	0.038	0.13

[a]Based on U.S. Environmental Protection Agency, *Region 9 Preliminary Remediation Goals (PRGs)* (EPA, 2000)

N_b = PAL has not been identified
ft bgs = Feet below ground surface
mg/kg = Milligrams per kilogram
J = Estimated value. Qualifier added to laboratory data; record accepted. Value exceeded the linear/calibration range of instrument. The reported value is from the dilution run.

the past. Currently, there are limited activities in Area 12 and there is no known construction scheduled in the area of this landfill. However, maintenance activities associated with nearby utilities should be made aware of site conditions through use restrictions. Because of the planned future land use, current institutional controls would continue. Therefore, an industrial exposure scenario is appropriate for this area.

Based on the field screening and laboratory analytical results, the depth of contamination exceeding the PALs for TPH or the two VOCs is between 8.5 and 30 ft bgs. Because the contamination is at this depth, the potential exposure to industrial and construction workers is limited. Under the Risk Assessment Guidance document (EPA, 1991) developed by EPA, the depth of excavation is limited to 10 feet for the construction worker scenario. The highest concentrations and volumes of the contamination is below the 10-ft depth and would not be considered in the exposure point concentration that would be used in a formal risk assessment. This further reduces the potential risk to industrial and construction workers.

Table H.1-2
CAS 12-15-01, Soil Sample Results for TPH Results

Sample Number	Depth (ft bgs)	Contaminants of Potential Concern (mg/kg)	
		Diesel-Range Organics	Gasoline-Range Organics
Preliminary Action Level[a]		100	
005F006	14 - 15	**7,600.0 (J)[b]**	**740 (J)[c]**
005F007	25 - 26	**180.0 (J)[d]**	--
005F008	30 - 31	--	--

[a]TPH PAL from *Nevada Administrative Code* (NAC, 2003)
[b]Qualifier added to laboratory data; record accepted. Surrogates diluted out. Total extractable petroleum hydrocarbons result quantitated from diesel standard calibration.
[c]Qualifier added to laboratory data; record accepted. Peak pattern for gasoline does not match.
[d]Qualifier added to laboratory data; record accepted. Total extractable petroleum hydrocarbons result quantitated from diesel standard calibration.

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

The exceedences of PALs occur at only one location (F05) and samples were collected at 26 other locations where the concentration of TPH and the two VOCs did not exceed the PALs. This demonstrates that the lateral extent of the contamination is limited to a localized area. In addition, the vertical extent of the DRO contamination is limited to 30 ft bgs. Under a formal risk assessment, the concentrations of contaminants that are less than the PALs would be averaged with the sample concentration at location F05 and further reduce the exposure point concentration that would be used for calculating the risk.

The concentrations of the COCs at CAS 12-15-01 are limited to an interval between 8.5 and 30 ft bgs. The depth to groundwater in this area of the NTS is approximately 1,540 ft bgs. Because of the limited precipitation at the NTS, there is a very limited potential for downward migration adversely impacting the groundwater beneath the site. The nearest drinking water supply to CAS 12-15-01 is 4 miles to the south.

The documentation prepared for the Area 6 Hydrocarbon Landfill, which is located adjacent and at approximately the same surface elevation as the two CASs in question, provides the information necessary to evaluate the potential risk. The ground surface at CAS 06-15-02 slopes from the southwest to the northeast at approximately 4.1 percent. The Area 6 Hydrocarbon Landfill, located at the east end of the site, rises approximately 8 ft above the surrounding surface. The study conducted to support the permit for the Area 6 Hydrocarbon Landfill demonstrated that the landfill and adjacent areas are not within the 100-year flood plain. It was further demonstrated that a 100-year, 6-hour rainfall would not raise the water level on the lake above 5 ft and CAS 06-15-02 is approximately 10 ft above the level of the lakebed. Therefore, it would take a significantly more intense rainfall than the 100-year, 6-hour event to cause flood water to inundate the site. In addition, there are no well-defined drainage channels in the vicinity that could generate run-on to CAS 06-15-02 (NNSA/NSO, 2003). Based on these data, the risk of flood water from the lake rising and inundating the two CASs is very small. The precipitation rate used in the evaluation is very conservative and actually represents rainfall rates in excess of the 100-year event. In addition, based on the calculations provided in the permit application, the time that standing water remains after a given precipitation event is relatively short. Because of the arid climate, the water recedes within a day or two well into the lakebed and presents no further risk of flooding the sites.

H.1.3 Uncertainty Analysis

Given the past and future uses of this site, it is unlikely that use of an industrial screening level would underestimate any potential impacts of exposure at this site. The methods used to develop the PRGs for VOCs and TPH are sufficiently conservative to result in a conservative PRG for screening purposes. Even in a worst-case scenario, with the removal of the buried debris, the PRGs are conservative because many of the assumptions used in the risk assessment exceed expected exposure scenarios at this site. Examples of conservative assumptions used in the risk assessment include:

- Risk assessment methods assume long-term exposure. Any realistic exposure scenario for this site would be of very limited duration.
- The concentration of TPH and the two VOCs in the vast majority of soils at the site (25 of 26 locations) are below PALs. Only the area around sample location F05 contains contaminant concentrations that exceed PALs.
- Risk assessments assume that no controls would be used during a potential exposure to the soils. Since the NTS will remain an active DOE site for the foreseeable future, work on the site without appropriate controls is exceedingly improbable.

- Since there is no reason to remove the debris in the landfill, based on the corrective action alternative evaluation, additional work at the site is very unlikely.
- The posting of the site further reduces any potential for exposure to the site soils.
- With respect to the two CASs along Yucca Lake, the two sites are not within the 100-year flood plain, but a 1,000-year event may cause flood waters to cover the sites.
- There is a minor amount of uncertainty that the waters may not recede as fast as the calculations suggest.

H.1.4 Interpretation

Analytical results indicate that 25 of 26 sample locations at CAS 12-15-01 are below PALs. One location in CAS 12-15-01 has TPH and VOC COCs between 8.5 and 30 ft bgs. Surrounding sample locations did not have TPH or VOCs levels at or above the minimum reporting limits. A scenario under which worker exposure is possible seems very unlikely. The methods used to calculate PALs assume exposure parameters that are even more unlikely to occur on this site. Based on these considerations, there is no likelihood of exposure resulting in adverse effects from this site.

Because the two CASs are not within the 100-year flood plain and the arid climate results in rapid receding of the water once it floods the lakebed, there is limited risk that the water will infiltrate the surface and drive contaminants out of the waste into the subsurface.

In conclusion, the potential exposure to industrial and construction workers is considered extremely low because of the limited lateral and vertical extent of the COCs, COC concentrations exceeding PALs between 8.5 and 30 ft bgs, and the depth to groundwater. No adverse impacts should result from leaving theses COCs at the site considering the institutional controls proposed in the remedial alternative. Given that the field screening and analytical results show the contamination is vertically confined from 8.5 to 30 ft bgs in sample location F05 and that the results from the surrounding sample locations indicate no additional contamination, it is highly unlikely that a receptor would encounter this contamination. If it were decided to remove the buried debris at CAS 12-15-01, the work would be under a work document controlling any exposure to workers during the removal process. Exposure during the removal process would also be of limited duration (less than 4 weeks). Given the depth of contamination, worker exposure during other activities does not appear realistic.

H.2.0 References

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

EPA, see U.S. Environmental Protection Agency.

NAC, see *Nevada Administrative Code*.

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Appendix I

Deviation of Background Based Preliminary Action Levels (PALs) for Radionuclides in Soil at the Nevada Test Site

(As Prepared by Shaw Environmental, Inc.)
(17 Pages)

Derivation of Background Based Preliminary Action Levels (PALs) for Radionuclides in Soil at the Nevada Test Site

by

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SUMMARY

The preliminary action level (PAL) is not a corrective action level but serves as conservative screening tool for site investigations. If the radionuclide concentration in the soil does not exceed the PAL, no additional characterization is required. If the concentration of a radionuclide exceeds the PAL, additional samples are collected and the boundary of the site investigation is expanded until samples are collected with radionuclide concentrations less than the PAL. After the nature and extent of contamination at the corrective action site are defined corrective actions are recommended, as appropriate. PAL concentrations in soil for radionuclides are listed in Table 1. The PALs are based upon the maximum concentration of a radionuclide, or a radionuclide in the same decay chain that is in secular equilibrium, reported in a soil sample collected from an undisturbed background location. The basis for the maximum concentration is the data listed in Appendix B of the *Environmental Monitoring Report for the Proposed Ward Valley California Low Level Radioactive Waste (LLRW) Facility* (US Ecology and Atlan-Tech, 1992) and *Off-Site Radiation Exposure Review Project Phase II Soils Program* (McArthur and Miller, 1989).

Table 1 lists for each radioisotope its decay chain where appropriate, the PAL concentration, the uncertainty in the PAL concentration, the isotope upon which the PAL is based, the reference used to select the PAL, sample number for the PAL, sample location, maximum concentration of the radioisotope, whether or not the PAL is different from the maximum concentration of the isotope at the 95 percent confidence level, and the quantitative difference.

The following sections of this report address why PALs are needed, naturally occurring radionuclides and their decay chains, the radioactive contaminants of concern at the Nevada Test Site corrective action sites (CAUs), and the selection of the PALs.

INTRODUCTION

Site characterization and investigation requires that the nature and extent of radioactive contamination at the site be defined. Nature is defined as the radionuclide contaminants present at the site and the distribution in the concentration of each radionuclide. Extent is defined as the vertical and horizontal boundary of the radioactive contamination, i.e., how far is the contamination spread. The nature and extent require that a radionculide concentration be specified that defines the presence of contamination. Simply stated, for each radionuclide a concentration criterion must be defined that represents contamination. If the concentration of a radionuclide is less than this criterion, the radionuclide concentration does not represent contamination. If the concentration of a radionuclide is equal to or exceeds this criterion, the radionuclide concentration represents contamination. The specified radionuclide concentration used to define contamination is the preliminary action level (PAL).

For example, uranium-234 (^{234}U) is found in a broad distribution of concentrations in all rocks and soils. In soils derived from ultrabasic igneous rocks the average concentration of ^{234}U is 0.010 picocuries per gram (pCi/g) while in soil derived from phosphate rock in Florida the average ^{234}U concentration is 40 pCi/g, a range of greater than three orders of magnitude (Lowder and Solon, 1956). In Areas 25 and 26 of the Nevada Test Site (NTS) nuclear rocket and nuclear ramjet programs were operative from 1959 through 1973. The nuclear reactors tested in these programs were fueled with ^{234}U. What concentration of ^{234}U should be defined as representing contamination (the PAL) if the natural concentration of ^{234}U ranges from 0.01 pCi/g to 40 pCi/g? If the PAL is set to low, closer to 0.01 pCi/g, resources are used to remediate soil that is not contaminated, has only background concentrations of ^{234}U, and does not represent an unacceptable risk to workers and other future land users. If the PAL is set too high, closer to 40 pCi/g, the risk to workers and other future land users may not be acceptable. At the present time the PALs are based upon the maximum concentrations reported in soil samples collected in undisturbed background locations in the western United States. The remaining sections of this report address natural radioactivity, the radionuclide contaminants of potential concern (COPC) at the NTS, and how the PAL values in Table 1 were derived.

NATURAL RADIOACTIVITY

About 340 nuclides have been found in nature, of which about 70 are radioactive and are found mainly among the heavy elements. All elements having an atomic number greater than 80 possess radioactive isotopes, and all isotopes of elements heavier than number 83 are radioactive. The radionuclides found in the soil may be listed into one of four major categories. Cosmogenic radionuclides are continuously produced by bombardment of stable nuclides by cosmic rays, primarily in the atmosphere. Primordial radionuclides have half-lives sufficiently long that they have survived since their creation. Secondary radionuclides are derived from radioactive decay of the primordials. The fourth group is the man-made radionuclides present in the environment from the atmospheric testing of nuclear weapons and releases from industrial processes using radioactive materials.

Cosmogenic Radionuclides

The cosmogenic radionuclides induced in the earths atmosphere and their typical concentrations in surface soil are listed in Table 2. It should be noted that the typical concentrations in soil of these radionuclides are less than the minimum detectable concentration reported by commercial laboratories for all radionuclides except carbon-14 and tritium. In addition, the typical concentrations are extraordinarily low and pose no risk to workers and future land users. Except for carbon-14 and tritium, any positive detection of the other radionuclides listed in Table 2 demonstrates contamination.

Primordial and Secondary Radionuclides

The primordial radionuclides that now exist are those that have half-lives at least comparable to the age of the universe. Radioisotopes with half-lives of less than about 10^8 years have become undetectable in the 30 or so half-lives since their creation, whereas, radionuclides with half-lives $>10^{10}$ years have decayed very little up to the present time.

The primordial radionuclides can be divided into those that occur singly (Table 3) and those that are components of one of the three chains of radioactive elements. The three chains of radioactive elements are classified as the uranium, thorium, and actinium chains. Of the primordial radionuclides that occur singly, potassium-40 (^{40}K) and rubidium-87 are the only radionuclides that are detected in soil samples collected from undisturbed background locations. It should be noted that potassium-40 could be a radioactive COPC at sites where large quantities of potassium compounds are released to the environment. Potash, a common ingredient in fertilizer with the chemical formula HKO, has a natural concentration of ^{40}K of 441 pCi/g. Potassium Borohydrate (BH_3K), used in the manufacturing of glass, and has a natural concentration of ^{40}K of 469 pCi/g. However, ^{40}K is not a radiological COPC at the NTS and is not a useful indicator of migration of radiological contaminants.

The uranium series chain, listed in Table 4, includes uranium-238 (^{238}U) and its secondary radionuclides created during radioactive decay. Uranium is found in all rocks and soils, though it concentration in any particular type of rock, or in soil derived from different types of rocks, varies more than three orders of magnitude. In the earth=s crust, ^{238}U is in radioactive equilibrium or near equilibrium with all of its decay products except protactinium-234.

Whenever the parent of a decay chain has a very long half-life while the radioactive decay products have a relatively short half-life, a condition of equilibrium will be reached for all practical purposes after a period of six half-lives of the longest half-life decay product. At this time the activity of the short-lived decay products will have been built up to a maximum value that is essentially equal to the radioactivity of the parent. This radioactive equilibrium is known as secular equilibrium. Mathematically, this equilibrium can be demonstrated based upon the fundamental relationship for radioactive decay.

If at any time t = 0 the number of radioactive atoms present in a sample is defined as $N_{(0)}$, the number of radioactive atoms decaying can be expressed in the following manner by the fundamental decay equation.

$$N \ \% \ N_{(0)} \quad \text{Equation 1}$$

Where
N = the number of atoms decaying during any period of time subsequent to time = 0
$N_{(0)}$ = the number of radioactive atoms present at time zero

It can be proved mathematically, for example see section 2-4 of Fitzgerald, Brownell and Mahoney (1967), that the exact number of radioactive atoms present in a sample at any subsequent time *t* can be expressed in the following manner.

$$N_{(t)} = N_{(0)}e^{-\lambda t} \quad \text{Equation 2}$$

Where
$N_{(t)}$ = The number of radioactive atoms present at time *t*
e = The exponential function where *e* is the limit as *x* approaches zero of the expression $(1 + x)^{1/x}$
λ = o2/(half-life of the radioactive atom)

Note that Equations 1 and 2 are functions based upon the number of radioactive atoms. The activity or rate of decay [i.e., $A_{(t)}$] is defined as dN/dt, the change in the number of radioactive items per unit of time. If Equation 2 is differentiated with respect to time, the following results are obtained:

$$dN_{(t)}/dt = d[N_{(0)}e^{-\lambda t}]/dt = -\lambda N_{(0)}e^{-\lambda t} \quad \text{Equation 3}$$
$$d/dt\ N_{(t)} = A_{(t)} = -\lambda N_{(t)} \quad \text{Equation 4}$$

The decay equation, Equation 2, is valid for the case of a stable decay product. Frequently, however, the decay product is itself radioactive, decaying, in turn to another radioactive decay product through a chain of 11 to 18 radionuclides. For example, the 18 members of the uranium decay chain are listed in Table 4. The 11 members of the thorium decay chain, defined as the decay chain created from the decay of thorium-232, are listed in Table 5. The 14 members of the actinium decay chain, defined as the decay chain created from the decay of uranium-235, are listed in Table 6. Tables 4 - 6 list each radionuclide in the decay chain, the half-life of each radionuclide, and the major particles emitted during its decay. In addition, where applicable, Tables 4 - 6 list the percentage of each alternative decay path for a radionuclide. For example, in the actinium decay chain actinium-227 decays 98.87 percent of the time via beta decay to thorium-227 and 1.38 percent of the time actinium-227 decays via alpha decay to francium-223.

It can readily be seen that the equations describing the number (or alternatively the activities) of various members of a long decay chain become very cumbersome. Attachment 1 presents the derivation of the differential equations for a decay chain of *n* members. This equation is used in the Microshield7 code to calculate the equilibrium concentration of each member of the uranium, thorium, and actinium decay chain (Grove Engineering, 1999). The results of the calculations for a decay time of 1.0E+9 years are listed in Tables 7 - 9, respectively. As shown in the Tables 7 - 9, the activity of nearly every decay product is equal to the activity of the parent radionuclide. The radionuclides are in secular equilibrium, even though they are far down the chain. Table 10 lists the build up of polonium-210 as a function of time from the decay of uranium-238. Even though polonium-210 is the 17th member of the decay chain, it reaches secular equilibrium in less than 2.0E+6 years.

Table 10
The Buildup of Po-210 as a Function of Time from 100 Ci of U-238

Decay Time (years)	U-238 (Ci)	Po-210 (Ci)	Po-210 Activity as a Percentage of U-238
0.0	100.00	0.000	0.000
10,000	100.00	0.079	0.079
50,000	99.999	2.414	2.414
100,000	99.998	8.414	8.414
250,000	99.996	32.595	32.596
500,000	99.992	64.884	64.889
750,000	99.988	82.487	82.497
1,000,000	99.984	91.331	91.346
2,000,000	99.969	99.429	99.460

The buildup of polonium-210 from the decay of ^{238}U as a function of decay time is displayed in Figure 1. Since ^{238}U has been decaying since the formation of the earth=s crust, greater than 1.0E+9 years, the concentration of every radionuclide in the uranium decay chain, except for protactinium-234, should equal the concentration of ^{238}U. The radionuclides in the thorium and actinium decay chains, with the exception of three radionuclides, should be essentially equal to the concentration as thorium-232 and uranium-235, respectively. Therefore, the concentration of any one of the radionuclides in a decay chain that is in secular equilibrium with the parent radionuclide should be equal in concentration to the primordial parent radionuclide and all of the other radionuclides in the chain that are in secular equilibrium with the primordial parent radionuclide.

Theoretically, a soil sample that is analyzed for any one of the radionuclides in a decay chain can be used to define the concentration of all of the other radionuclides in the decay chain. For example, assume that the gamma spectroscopy of a soil sample results in a bismuth-214 concentration of 3.47 pCi/g " 1.00 pCi/g. For this soil sample the concentration of all radionuclides in the uranium decay series that are in secular equilibrium with ^{238}U, down through polonium-210, and within the measurement uncertainty, with a 95 percent confidence level should have a concentration in the range of 2.47 pCi/g to 4.47 pCi/g with a mean of 3.47 pCi/g.

However, the concentration of a radionuclide in a soil sample, in comparison to its decay parent=s concentration, is dependent on the differences in their elemental chemistry, differences in their microenvironment, and to a lesser degree, the differences in their specific activity. The transport and diffusion of a parent and its decay progeny are influenced on site-specific factors such as rates and amounts of rainfall, drainage, soil chemistry, and biological processes in the soil (Eisenbud and Gesell, 1997 and Till and Meyer, 1983). In addition, the process of sampling and radioanalysis contributes to differences in the measured concentration from that predicted assuming the decay process of Equation 2. Radionuclides are associated with soil particles and are not uniformly distributed throughout the soil volume. Samples analyzed by gamma spectroscopy provide the average concentration in the volume of the sample, with a typical sample volume of 0.15 liters to 0.5 liters. Samples analyzed by alpha spectrometry provide the average concentration in a volume of 0.003 liters to 0.015 liters. Due to the lack of homogeneity in the distribution of the radionuclides, the average concentration in these two sets of sample volumes can vary significantly for radionuclides in the same decay chain, even though their concentrations do not vary within the measurement uncertainty if the concentrations were measured over larger volumes.

Man-Made Radionuclides

The fourth group of radionuclides present in soil is the radionuclides introduced from man-made activities such as the injection of fission products and transuranics into the atmosphere from the testing of nuclear weapons. Though these radionuclides have become endemic in the soil of the northern hemisphere, their distribution is highly variable. For example, after the Dixie atmospheric test at the NTS in April 1953, the highest fallout recorded in the United States was at Troy, New York, more than 2,000 miles from the NTS. The concentration of man-made radionuclides in surface soil may vary more than three to four orders of magnitude within an area 5 H 10^5 square miles while the concentration of the primordial radionuclides in the same region vary by less than one order of magnitude (McArthur and Miller, 1989).

The long-lived fission products, activation products, and transuranics still detectable in surface soil using commercial radioanalytical methods are: ^{137}Cs, ^{90}Sr, ^{60}Co, technetium-99 (^{99}Tc), tritium, and Plutonium-239/240 ($^{239/240}$Pu). The distribution of the concentration of each of these radionuclides is discussed in the following sections of this report.

Cesium-137

All or most of the weapons-produced ^{137}Cs have been shown to be present in the first five to ten centimeters (cm) layer of the surface soil, indicating that this radionuclide is not very mobile and is tightly fixed to the soil (Till and Meyer, 1983 and McArthur and Miller, 1989). In one study of the regions around 100 - 200 miles from the NTS, ^{137}Cs concentrations in the upper 2.5 cm layer of surface soil ranged from 1.32 pCi/g to 1.72 pCi/g (Romney et. al., 1983). In a study of the ^{137}Cs concentration in soil samples collected from 324 locations in the western United States, the ^{137}Cs concentration ranged from 0.01 pCi/g to 7.033 pCi/g, where the maximum concentration was measured in a sample collected from the North Rim of the Grand Canyon, more than 450 miles from the NTS (McArthur and Miller, 1989).

Strontium-90

Most or all of the ^{90}Sr activity in the soil is in the top two to five centimeters (Romney, et. al., 1983). Romney et. al., have surveyed the regions around the NTS and reported concentrations of ^{90}Sr at a distance of 200 miles to 230 miles from the NTS to be 1.4 pCi/g to 1.6 pCi/g. The ^{90}Sr activity concentrations in surface soil throughout the northern hemisphere are comparable to that of rubidium-87, approximately 1 pCi/g (NCRP, 1976). During the years of peak of maximum fallout, 1958 - 1964, the ground deposition of 90Sr in the midlatitudes of the northern hemisphere ranged from 60 to 80 mCi/km2. Assuming the ^{90}Sr is deposited in the top two centimeters of soil, an average soil density of 1.8, and 30 years of decay, the average ^{90}Sr concentration in the soil would be about 0.83 to 1.1 pCi/g. The ^{90}Sr concentration at the proposed low-level radioactive waste site in Ward Valley, California ranges from <0.03 pCi/g to a maximum of 1.17 " 0.14 pCi/g.

Cobalt-60

Cobalt-60 is rarely detected in soil samples collected from undisturbed background locations. This is due to its short half-life, 5.27 years, and the 40+ years since the United States ceased above ground testing. In addition, ^{60}Co is primarily created from neutron activation of the trace quantities of stable cobalt-59 in steel, not from fission. At the Ward Valley site ^{60}Co was detected in only one of 39 surface soil samples, even with a low minimum detectable concentration of 0.02 pCi/g.

Technetium-99

Technetium-99 is a highly mobile, long-lived (212,000 year half-life) radionuclide that typically is not detected in soil samples collected from undisturbed background locations. Though low concentrations of ^{99}Tc may be expected with nuclear fuel operations, the primary source of ^{99}Tc is in conjunction with medical and research applications. At the Ward Valley site ^{99}Tc was detected in only six of 39 soil samples. The maximum ^{99}Tc concentration reported is 4.00 " 1.5 pCi/g.

Tritium

Local and regional data on the concentration of tritium in the soil, or more properly the soil vapor, is not available. Tritium concentrations in precipitation at the NTS range from 29 to 36 pCi/L. Atmospheric tritium concentration in precipitation collected at Ottawa, Canada and Chicago, Illinois from 1955 to 1989 indicate that present tritium levels in precipitation in those regions should be near 30 pCi/L. The air moisture sample taken at the Ward Valley site had a concentration of 22.33 pCi/L, corrected to 2003 the tritium concentration is 10 pCi/L. The tritium concentration in surface soil moisture at the Ward Valley site, corrected to 2003, ranges from 2.0 - 8.8 pCi/L.

Plutonium-239/240

Plutonium-239/240 was injected into the atmosphere by nuclear explosions from the unfissioned plutonium in the device and the plutonium produced by neutron irradiation of ^{238}U in the device. Plutonium-239 and 240Pu are the most abundant of the plutonium radionuclides associated with nuclear detonations and because the pair cannot be distinguished by alpha spectrometry, the two nuclides are usually reported together. The average estimated deposition of $^{239/240}$Pu in the midlatitudes of the northern hemisphere is 0.08 pCi/g (Eisenbud and Gesell, 1997). At the Ward Valley site $^{239/240}$Pu was not detected above the minimum detectable concentration of 0.05 pCi/g. The $^{239/240}$Pu concentration in 324 soil samples collected from undisturbed background locations in the western United States ranged from 0.00491 to 0.19 pCi/g.

RADIOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The radiological COPCs in the soil at the NTS are a function of the activities performed at the site by the Department of Energy, the Department of Defense, and their predecessor agencies. The three most significant activities at the NTS include testing of nuclear reactors associated with the nuclear rocket and nuclear ramjet programs, detonation of nuclear weapons, and detonation of chemical explosives associated with plutonium safety shots. The radiological COPCs associated with each of these three activities are discussed in the following paragraphs of this report.

The nuclear reactors associated with the nuclear rocket and nuclear ramjet programs were highly enriched, on a per unit mass basis, with uranium-235 (^{235}U). Approximately 95 percent of the mass of the uranium fuel is ^{235}U. However, due to its high specific activity in comparison to ^{235}U, about 99 percent of the initial activity in the fuel is ^{234}U. The reactors operated for a very short time, in the range of minutes to hours, therefore there was little buildup of plutonium. Since the nuclear rocket and ramjet programs operated from 1959 to 1973, there is at least 30 years of decay in the fission and neutron activation products produced during testing. The most significant radiological COPCs associated with these programs are cesium-137, strontium-90, niobium-94, ^{234}U, and to a very small degree cobalt-60 and ^{235}U. The ^{234}U decay product with the maximum ingrowth from radioactive decay is thorium-230, with concentrations ranging from 0.027 percent to 0.04 percent of the ^{234}U concentration.

The radiological COPCs from above ground testing are the long-lived mixed fission and neutron activation products, plutonium, and their decay products. The most significant radiological COPCs in NTS soil associated with nuclear testing are cesium-137, strontium-90, europium-155, technetium-99, cobalt-60, plutonium-239/240, plutonium-238, plutonium-241, and americium-241.

Safety tests consisted of chemical explosions of mock weapons comprised of depleted uranium and plutonium weapon pits. The safety tests were used to evaluate weapon storage methods. The radiological COPCs from the safety tests are plutonium-239/240, plutonium-238, plutonium-241, americium-241, and to a significantly lower degree ^{238}U.

Few of the radionuclides listed in Tables 2 - 6, the cosmogenic, primordial, and secondary radionuclides that are potentially present in soil samples collected from undisturbed background locations, are radiological COPCs associated with the nuclear rocket, nuclear ramjet, nuclear detonation, and safety tests performed at the NTS.

None of the cosmogenic radionuclides listed in Table 2 nor any of the nonseries primordial radionuclides listed in Table 3 have been listed as radiological COPCs at the corrective action units on the NTS. The only series primordial radionuclide listed in Tables 4 - 6 that is a radiological COPC at the corrective action units on the NTS is ^{234}U. All other radiological COPCs associated with the corrective action units at the NTS are long-lived fission and activation products, plutonium isotopes, and americium-241 (^{241}Am)

SELECTION OF SOIL PALS

The PALs are the criteria used at corrective action sites (CAS) for determining whether the concentration of a radionuclide in an environmental sample represented man-made contamination that may present an unacceptable risk to human health. The PAL is presently defined as the maximum concentration of a radionuclide measured in a soil sample collected from an undisturbed background location off of the NTS (McArthur and Miller, 1989; US Ecology and Atlan-Tech, 1992). Based upon this definition the following guidelines are used to select the PAL for radionuclides detected in soil samples collected during site investigations.

- The maximum concentration of a radionuclide in a decay chain is selected as the PAL for all radionuclides in the decay chain that are in secular equilibrium with that radionuclide.
- The PAL for all other radionuclides, except potassium-40 (^{40}K), is the maximum concentration for that radionuclide listed in US Ecology and Atlan-Tech (1992) and McArthur and Miller (1989).
- The PAL for ^{40}K is 31.1 pCi/g, the 95th percent confidence level in the maximum concentration reported in McArthur and Miller (1989), sample BE32 collected from Beatty, Nevada.

CONCLUSION

The U. S. Department of Energy (DOE) has not defined radiological PALs for soil. The PAL is presently defined as the maximum concentration of a radionuclide measured in a soil sample collected from an undisturbed background location off of the NTS (McArthur and Miller, 1989; US Ecology and Atlan-Tech, 1992). The PALs are listed in Table 1.

Significant limitations have been identified for PALs based upon the maximum concentration of a radionuclide in a soil sample collected from undisturbed background locations. A significant limitation is there are no PALs for ten of the 26 radiological COPCs detected at the NTS. These 10 radionuclides have not been reported in soil samples collected from undisturbed background locations off of the NTS. These ten radionuclides are: aluminum-26, niobium-94, iodine-129, europium-152 and 155, uranium-235, plutonium-238 and 241, neptunium-237, and americium-241.

Another limitation in applying background-based PALs during site investigations is the radionuclide concentration of naturally occurring radionuclides in the NTS soil is elevated in comparison to soil off of the NTS. For example, much of the soil in Areas 25 and 26 of the NTS is derived from rock with significantly higher concentrations of uranium and thorium. Therefore, it may not be possible to distinguish soil contaminated due to activities that occurred at the CAS from soil with high concentrations of naturally occurring radionuclides. This results in increased investigation cost from collecting additional step-out soil samples, performing radioanalysis of the samples, and validation and verification of the data.

The most important reason for not basing PALs upon the background concentrations of radionuclides is because there is no regulatory basis for using background concentrations for PALs. The U. S. Nuclear Regulatory Commission (NRC), the U. S. Environmental Protection Agency (EPA), and the U. S. Department of Energy base their corrective action levels, and the NRC and EPA base their generic screening levels for radioactive contamination, upon the dose to hypothetical future land users of the site. The National Council on Radiation Protection and Measurements (NCRP) also base their recommended screening limits for radiological contaminated surface soil, on the dose to hypothetical land users.

The U. S. Nuclear Regulatory Commission (NRC) published a methodology for calculating screening level concentrations of radionuclides that, under specific conditions, may be used as initial cleanup goals or PALs (NRC, 1993 - 1999). Using the NRC methodology PALs for fission products, neutron activation products, uranium isotopes, and special nuclear material can be derived for CASs located on the Nevada Test Site. PALs for single isotopes can be calculated based of the requirement that the total effective dose equivalent to a hypothetical individual working on or in the immediate vicinity of the CAS should not exceed 25 mrem/yr. It is recommended that PALs be defined based on dose and calculated using the NRC guidance.

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NCRP See the National Council on Radiation Protection and Measurements

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Table 1
Preliminary Action Level Concentrations for Radionuclides

Isotope	Decay Chain	PAL (pCi/g)	Uncertainty (pCi/g)	Isotope PAL is based	Reference	Sample No. of PAL	Location	Maximum Concentration of Isotope	PAL different from Maximum at 95% CI?	If Different, by how much (pCi/g)
Be-7	NA	0.7	NA	Be-7	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.7	NA	NA
C-14	NA	0.44	0.1	C-14	US Ecolgy & Atlan-Tech (1992)	CB 9	Primary	0.44	No	NA
K-40	NA	30.7	0.43	K-40	McArthur & Miller (1989)	BE32	Beatty, NV	30.7 ∓ 0.43	No	NA
Mn-54	NA	0.06	0.04	Mn-54	US Ecolgy & Atlan-Tech (1992)	CB-9	Primary	0.06 ∓ 0.04	No	NA
Co-57	NA	0.02	NA	Co-57	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.02	NA	NA
Co-58	NA	0.02	NA	Co-58	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.02	NA	NA
Fe-59	NA	0.04	NA	Fe-59	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.04	NA	NA
Co-60	NA	0.1	0.05	Co-60	US Ecolgy & Atlan-Tech (1992)	BC-10-1	Baseline	0.1	No	NA
Sr/Y-90	NA	1.17	0.14	Sr/Y-90	US Ecolgy & Atlan-Tech (1992)	AD7-1	Archieved	1.17	No	NA
Zr-95	NA	0.04	NA	Zr-95	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.04	NA	NA
Tc-99	NA	4.00	1.5	Tc-99	US Ecolgy & Atlan-Tech (1992)	B9	Baseline	4.00	No	NA
Ru-106	NA	0.15	NA	Ru-106	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.15	NA	NA
I-129	NA	0.05	NA	I-129	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.05	NA	NA
Cs-134	NA	0.02	NA	Cs-134	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.02	NA	NA
Cs-137	NA	7.033	0.056	Cs-137	McArthur & Miller (1989)	KS10	N. Rim Grand Canyon, AZ	7.033 ∓ 0.56	No	NA
Ce-141	NA	0.04	NA	Ce-141	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.04	NA	NA
Ce-144	NA	0.1	NA	Ce-144	US Ecolgy & Atlan-Tech (1992)	all samples	All	<0.1	NA	NA
Eu-155	NA	1.35	0.23	Eu-155	US Ecolgy & Atlan-Tech (1992)	D-10-1	Primary	1.35 ∓ 0.23	No	NA
Tl-207	U-235	0.0698	0.0598	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Po-210	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
Bi-210	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
Pb-210	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
Po-211	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Bi-211	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Pb-211	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Po-212	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	Not reported	NA	NA
Bi-212	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	Not reported	NA	NA
Pb-212	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	2.90 ∓ 0.11	No	0.08
Po-214	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
Bi-214	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	3.47 ∓ 1.00	No	NA
Pb-214	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	1.37 ∓ 0.44	Yes	0.66
Po-215	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA

Table 1
Preliminary Action Level Concentrations for Radionuclides

Isotope	Decay Chain	PAL (pCi/g)	Uncertainty (pCi/g)	Isotope PAL is based	Reference	Sample No. of PAL	Location	Maximum Concentration of Isotope	PAL different from Maximum at 95% CI?	If Different, by how much (pCi/g)
Po-216	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	Not reported	NA	NA
Po-218	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
Ra-223	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Ra-224	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	Not reported	NA	NA
Ra-226	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	1.95 ± 0.29	YES	0.23
Ac-227	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Th-227	U-235	0.069	0.059	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Ac-228	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	3.64 ± 0.29	No	NA
Th-228	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	1.33 ± 0.19	YES	0.33
Ra-228	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	Not reported	NA	NA
Th-230	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	1.46 ± 0.22	YES	0.79
Th-231	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Pa-231	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
Th-232	Th-232	3.64	1.70	Ac-228	US Ecolgy & Atlan-Tech (1992)	A-10-1	Secondry	1.69 ± 0.24	YES	0.01
Th-234	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
U-234	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	2.6 ± 0.2	No	NA
Pa-234	U-238	0.0045	0.0013	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
Pa-234m	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	Not reported	NA	NA
U-235	U-235	0.07	0.06	U-235	US Ecolgy & Atlan-Tech (1992)	B-11	Baseline	Not reported	NA	NA
U-238	U-238	3.47	1.00	Bi-214	US Ecolgy & Atlan-Tech (1992)	BC-13-1	Secondary	3.21 ± 0.03	No	NA
Pu-238	NA	0.05	0.002	Pu-239/240	McArthur & Miller (1989)	AQ17	Albuqerque, NM	Estimate	NA	NA
Pu-239/240	NA	0.19	0.0085	Pu-239/240	McArthur & Miller (1989)	AQ17	Albuqerque, NM	0.19 ± 0.0085	No	NA
Am-241	NA	0.05	0.002	Pu-239/240	McArthur & Miller (1989)	AQ17	Albuqerque, NM	Estimate	NA	NA

Table 2
Typical Concentration of Radionuclides Created by Cosmic Rays in the Air[(a)]

Isotope	Half-life (years)	Major Particle Emissions	Typical Concentration in Soil (pCi/g)	Detectable Using Standard Radioanalytical Methods?
Beryllium-7	1.5E-01	gamma	5.4E-03	No
Aluminum-26	7.2E+05	positron	9.7E-08	No
Chlorine-36	3.0E+05	beta	4.9E-03	No
Chlorine-38	7.1E-05	beta	2.0E-02	No
Chlorine-39	1.1E-04	beta	6.7E-03	No
Carbon-14	5.7E+03	beta	.02 - 0.5	Yes
Silicon-32	6.5E+02	beta	1.9E-04	No
Tritium (H-3)	1.2E+01	beta	0.006 - .01	Yes[(b)]
Sodium-22	2.6E+00	positron	2.3E-06	No
Sodium-24	1.7E-03	beta	4.8E-05	No
Sulfur-35	2.4E-01	beta	8.7E-02	No
Sulfur-38	3.2E-04	beta	1.8E-04	No
Phosphorus-32	3.9E-02	beta	1.9E-04	No
Manganese-38	2.4E-03	beta	4.8E-03	No

Notes
(a) Eisenbud and Gesell (1997)
(b) Standard methods have H-3 MDC of 500 pCi/L, electrolytic enrishment gives minimum detectable concentration of 1.6 pCi/L

Table 3
Typical Soil Concentration of Nonseries Primordial Radionuclides[(a)]

Isotope	Half-life (years)	Major Particle Emissions	Typical Concentration in Soil (pCi/g)	Detectable Using Standard Radioanalytical Methods?
Potassium-40	1.26E+09	beta, gamma	10 - 30	Yes
Vanadium-50	6.0E+15	gamma	5.4E-07	No
Rubidium-87	4.8E+10	beta	1.9E+00	Yes
Cadmium-113	9.3E+15	beta	5.4E-08	No
Indium-115	6.0E+14	beta	5.4E-07	No
Tellurium-123	1.2E+13	x-rays	5.4E-09	No
Lanthium-138	1.1E+11	beta, gamma	5.4E-04	No
Cerium-142	>5E+16	unknown	<2.7E-7	No
Neodymium-144	2.4E+15	alpha	8.1E-06	No
Samarium-147	1.05E+11	alpha	1.89E-02	No
Gadolinium-152	1.10E+14	alpha	1.89E-06	No
Hafnium-174	2.00E+15	alpha	5.41E-09	No
Lutetium-170	2.20E+10	electrons	2.70E-04	No
Rhenium-187	4.30E+10	beta	2.70E-05	No
Platinium-190	6.90E+11	alpha	1.89E-09	No
Platinium-192	1.00E+15	alpha	8.11E-08	No
Bismuth-209	>2E+18	alpha	<1E-10	No

Notes
(a) Eisenbud and Gesell (1997)

Table 4
Uranium Series: Radioactive Decay Chain from Uranium-238[a]

Isotope	Half-life (years)	Major Particle Emissions
Uranium-238	4.47E+09	alpha
Thorium-234	6.60E-02	beta, gamma
Protactinium-234m	2.22E-06	beta
Protactinium-234	2.18E+01	beta, gamma
Uranium-234	2.45E+05	alpha
Thorium-230	7.70E+04	alpha
Radium-226	1.60E+03	alpha, gamma
Radon-222	1.04E-02	alpha
Polonium-218	5.80E-06	alpha
Lead-214 (99.98%)	5.10E-05	beta, gamma
Astatine-218 (0.02%)	6.34E-08	alpha, gamma
Bismuth-214	3.78E-05	beta, gamma
Polonium-214 (99.8%)	5.20E-12	alpha
Thallium-210 (0.02%)	2.47E-06	beta, gamma
Lead-210	2.23E+01	beta, gamma
Bismuth-210	1.37E-02	beta
Polonium-210 (~100%)	3.79E-01	alpha
Thalium-206 (0.0013%)	7.99E-06	beta

Note: Shleien, Slaback, Birky (1998)

Table 5
Thorium Series: Radioactive Decay Chain from Thorium-232[a]

Isotope	Half-life (years)	Major Particle Emissions
Thorium-232	1.40E+10	alpha
Radium-228	5.75E+00	beta
Actinium-228	6.99E-04	beta, gamma
Thorium-228	2.18E-04	alpha, gamma
Radium-224	4.18E-04	alpha, gamma
Radon-220	1.76E-06	alpha
Polonium-216	4.75E-09	alpha
Lead-212	1.21E-03	beta, gamma
Bismuth-212	1.15E-04	alpha, gamma
Polonium-210 (64%)	9.67E-15	alpha
Thalium-208 (36%)	5.84E-06	beta, gamma

Note: (a) Shleien, Slaback, Birky (1998)

Table 6
Actinium Series: Radioactive Decay Chain from Uranium-235[(a)]

Isotope	Half-life (years)	Major Particle Emissions
Uranium-235	7.04E+08	alpha, gamma
Thorium-231	2.91E-03	beta, gamma
Protactinium-231	3.73E+04	alpha, gamma
Actinium-227	2.18E+01	beta
Thorium-227 (98.87%)	5.12E-02	alpha, gamma
Francium-223 (1.38%)	4.14E-05	beta, gamma
Radium-223	3.13E-02	alpha, gamma
Radon-219	1.25E-07	alpha, gamma
Polonium-215	5.64E-11	alpha
Lead-211 (~100%)	6.86E-05	beta, gamma
Astatine-215 (0.00023%)	3.17E-11	alpha
Bismuth-211	4.07E-06	alpha, gamma
Polonium-211 (0.273%)	1.64E-08	alpha, gamma
Thallium-207 (99.73%)	9.07E-06	beta

Note: (a) Shleien, Slaback, Birky (1998)

Table 7
Activity of Uranium-238 Decay Products after 1.0E+9 Years of Decay of 100 Curies of Uranium-238

Isotope	Activity (Ci)	Percent of U-238 Activity
Bismuth-210	98.43	100.0
Bismuth-214	98.45	100.0
Protactinium-234	0.16	0.2
Protactinium-234m	98.46	100.0
Lead-210	98.43	100.0
Lead-214	98.45	100.0
Polonium-210	98.43	100.0
Polonium-214	98.43	100.0
Polonium-218	98.47	100.0
Radium-226	98.47	100.0
Radon-222	98.47	100.0
Thorium-230	98.47	100.0
Thorium-234	98.46	100.0
Uranium-234	98.47	100.0
Uranium-238	98.46	100.0

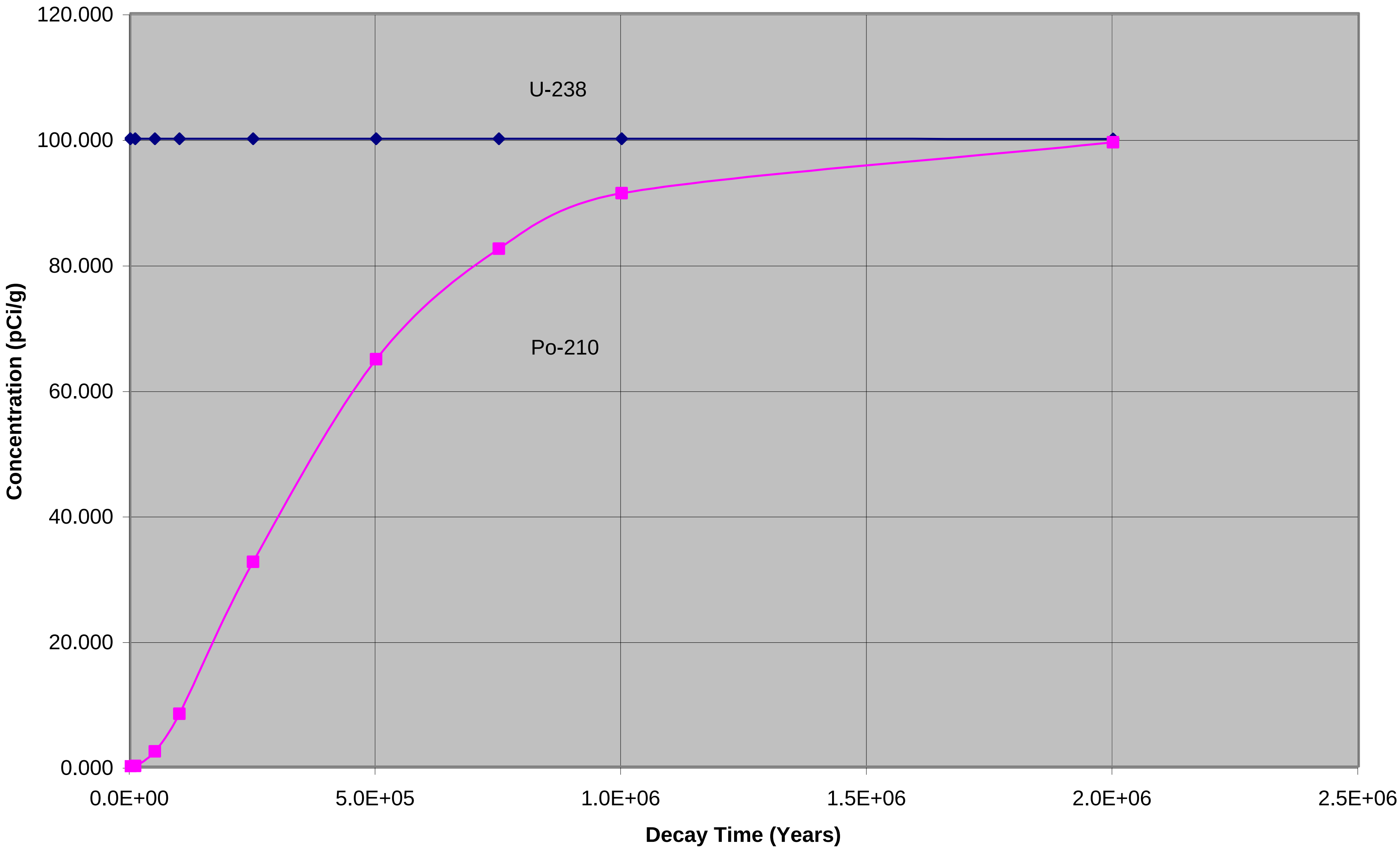
Table 8
Activity of Thorium-232 Decay Products after
1.0E+9 Years of Decay of 100 Curies of Thorium-232

Isotope	Activity (Ci)	Percent of Th-232 Activity
Actinium-228	99.51	100.0
Bismuth-212	99.51	100.0
Lead-212	99.51	100.0
Polonium-212	63.76	64.1
Polonium-216	99.51	100.0
Radium-224	99.51	100.0
Radium-228	99.51	100.0
Radon-220	99.51	100.0
Thorium-228	99.51	100.0
Thorium-232	99.51	100.0
Thalium-208	35.75	35.9

Table 9
Activity of Uranium-235 Decay Products after
1.0E+9 Years of Decay of 100 Curies of Uranium-235

Isotope	Activity (Ci)	Percent of U-235 Activity
Actinium-227	90.63	100.0
Bismuth-211	90.63	100.0
Francium-223	1.21	1.3
Protactinium-231	90.63	100.0
Lead-211	90.63	100.0
Polonium-211	0.25	0.3
Polonium-215	90.63	100.0
Radium-223	90.63	100.0
Radon-219	90.63	100.0
Thorium-227	89.37	98.6
Thorium-231	90.62	100.0
Thalium-207	90.38	99.7
Uranium-235	90.62	100.0

Fig. 1 Po-210 and U-238 as a Function of Time



Appendix J

NDEP Comment Responses

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: Draft Corrective Action Decision Document for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada
2. Document Date: August 2003
3. Revision Number: 0
4. Originator/Organization: Shaw Environmental, Inc.
5. Responsible DOE/NV ERP Project Mgr: Janet Appenzeller-Wing
6. Date Comments Due: September 12, 2003
7. Review Criteria: Full
8. Reviewer/Organization/Phone No: Donald R. Elle, NDEP, 486-2874
9. Reviewer's Signature

10. Comment Number/ Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
1) Section 2.2.1 Summary of Characterization Data Entire Section Pages 14 - 22		In addition to the information presented, it must be demonstrated that the CAU 5 Corrective Action Sites (CASs) meet Nevada Administrative Code (NAC) Sections 444.743 and 444.6894. All landfills must show positive drainage and the cover must be less permeable than that of the bottom soil and the surrounding soil. The level of the cover can vary.	Additional details on each CAS has been provided in Section 2.2.1. This information provide a discussion relating to the permeability of the surface and subcell soils with respect to the regulatory requirements.	Yes
2) Section 2.3.2 CAS 05-16-01 Landfill Page 24		Explain how the flood dike and the desert tortoise habitat will be affected by the corrective action required.	Section 2.3.2. has been modified to identify that the integrity of the flood dike must be maintained during any corrective actions and that impacts to the habitant of the desert tortoise be minimized. The detailed controls that will implemented for the flood dike and to minimize the impact to nearby desert tortoise habitat will be included in the Corrective Action Plan that will be developed by the M&O contractor.	Yes
3) Section 2.3.4 CAS 06-15-02 Sanitary Landfill Page 25 and Section 2.3.5 CAS 06-15-03 Sanitary Landfill Burn Pit Pages 25 and 26		A risk analysis is needed to evaluate the contamination potential in the event of flooding. Protection from flooding or clean closure of the flood prone portions of the sites should be considered as possible remedies to evaluated risk.	Additional risk evaluation and detail have been included in the two referenced sections to address the flood prone areas of the two CASs located along Yucca Lake.	Yes

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to DOE/NV Environmental Restoration Division, Attn: QAC, M/S 505.

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

Document Title/Number Draft Corrective Action Decision Document for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada   Revision Number 0

Reviewer/Organization Donald R. Elle, NDEP, 486-2874

10. Comment Number/ Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
4) Section 2.3.6 CAS 12-15-01 Sanitary Landfill Page 26		A detailed explanation is needed of the potential impacts of closure due to the sewer line that transects the site, the access road, and the overhead power lines. Mitigation steps must also be addressed.	The text has been changed to reflect that the Corrective Action Plan (CAP) must include controls to mitigate any potential impact to the utilities, septic system, and access road. These activities are typically dealt with in the CAP and only mentioned as needing to be evaluated in the CADD.	Yes
5) Section 2.3.7 CAS 23-15-03 Landfill Pages 27 and 28		A detailed explanation is needed of the potential impacts that the travel corridors, underground utilities, drainage areas, and CAU 112 use restriction will have on remediation. Mitigation steps musts also be addressed.	The text has been changed identify that impacts to the corrective action may result form these utilities. The text also states that the CAP must address these features and provide mitigation strategies. These features are identified in the CADD as having to be dealt with but the actual mitigation should be presented in the CAP.	Yes
6) Section 3.3 Development of Corrective Action Alternatives, Section 3.4 Evaluation and Comparison of Alternatives, and Section 4.0 Recommended Alternatives Pages 34 - 47		These sections must be revised to incorporate the above comments. Additionally, note that references to post-closure monitoring must include at least 30 years of maintenance.	The referenced sections have been changed to include the information presented concerning the landfill covers and subcell soil with respect to the regulatory requirements presented in NAC 444.743, 6891, and 6894. The term of monitoring post closure has been changed to 30 years instead of 25. This information has been included throughout the document where applicable.	Yes

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to DOE/NV Environmental Restoration Division, Attn: QAC, M/S 505.

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

Document Title/Number Draft Corrective Action Decision Document for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada

Revision Number 0

Reviewer/Organization Donald R. Elle, NDEP, 486-2874

10. Comment Number/ Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
7) Appendix A Tables A.3-3; A.4-3, A.5-5, A-6.5, A.7-4, A.8-6, A.9-3, and A.10-9		The footnotes for the Preliminary Action Levels (PALs) listed in these tables states that the numbers were based on background concentrations listed in the Environmental Monitoring report for the Proposed Ward Valley, California, Low-Level Radioactive (LLRW) Facility by US Ecology and Atlan-Tech, 1991. These PALs could not be found in the referenced report. Table III.A.5.5.c of the reference does contain Defined Baseline values, which do not agree with the PALs listed in the draft CADD. In the event the CADD PALs are incorrect, evaluation and discussion of the radionuclides will have to be changed throughout the CADD report.	The PALS presented for the naturally occurring gamma emitting isotopes Actinium-228 (Ac-228), Bismuth-214 (Bi-214), Lead-212 (Pb-212) and Lead-214 (Pb-214) are based on characterization soil samples from a similar environment measured by gamma spectroscopy. The measured values are applied across a decay chain using the assumption of secular equilibrium in the Thorium-232 (Th-232) and Uranium-238 (U-238) decay series. The decay series for both isotopes is as follows with the isotopes highlighted in **bold**: • Th-232>Ra-228> **Ac-228**>Th228>>Ra-224>Rn-220>Po-218>**Pb-212**>Bi-212>(Po-212 and Tl-208)>Pb-208 • U-238>Th-234>Pa-234>U-234>Th-230>Ra-226>Ra-222>Po-218>**Pb-214>Bi-214**>Po-214>Pb-210>Bi-210>Po-210>Pb-206 The PALs presented for Ac-228 and Pb-214 of 3.64 pCi/g and Pb-214 and Bi-214 of 3.47 pCi/g were established from the characterization gamma spectroscopy data reported in the Environmental Monitoring Report for the Proposed Ward Valley, California Low Level Radioactive Waste (LLRW) Facility by US Ecology and Atlan-Tech (1991). The maximum measured value for any radionuclide in a decay chain is taken as the PAL for all the radionuclides in the decay chain under the assumption of secular equilibrium. The following maximum measured values can be found in Table III.B.3.3.4.b of the US Ecology and Atlan-Tech (1991) report: • Ac-228 activity of 3.64 pCi/g @ sample location A-10-1; and • Bi-214 activity of 3.47 pCi/g @ sample location BC-13-1. The given PALs for Thallium-208 (Tl-208) and Potassium-40 (K-40) were established as the maximum measured value of these isotopes from the characterization gamma spectroscopy data reported in	Yes

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NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

Document Title/Number Draft Corrective Action Decision Document for Corrective Action Unit 5: Landfills, Nevada Test Site, Nevada   Revision Number 0

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			US Ecology and Atlan-Tech (1991). The following maximum measured values can be found in Table III.B.3.3.4.b of the referenced document: • Tl-208 activity of 3.38 pCi/g @ sample location D-10-1; and • D-40 activity of 97.70 pCi/g @ sample location BC-13-1. Upon further evaluation, the background concentration and related PAL for K-40 is better represented by samples collected in Beatty, Nevada and reported in McArthur and Miller (1989). This PAL, presented in the Final CADD, is 31.1 pCi/g and represents the 95[th] percent confidence level in the maximum concentration reported by McArthur and Miller. A full discussion of the development of these PALs is included in the Derivation of Background Based preliminary Action Levels (PALs) for Radionuclides in Soil at the Nevada Test Site by Shaw Environmental (2003). This document is included as Appendix I of the CAU 5 CADD.	
8) Appendix H Evaluation of Risk Pages H-1 through H-4		The risks associated with the flooding of CAS 06-15-02 and CAS 06-15-03 must be incorporated within this section.	A discussion of the risk associated with the flooding of Yucca Lake has been included in Appendix H.	Yes

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