RECORD OF TECHNICAL CHANGE

Technical Change No. 1 Page 1 of 2

Project/Job No. 840294.03030095 Date: 7 January 2003

Project/Job Name CAU 527, Horn Silver Mine Corrective Action Investigation Plan

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

David C. Stahl — Task Manager
(Name) (Title)

(Description of change)

Section 4.2.3 Determining if Groundwater Exists

1. Change the title of this section to "Determine If Groundwater or Vadose Zone Flows Exist"
2. For the second paragraph of the subject section, substitute:

"The monitoring well will be equipped with a sensor that will be capable of detecting groundwater in the borehole. This sensor will be connected to a data logger that will be programmed to trigger a sampling device that will collect a groundwater sample when sufficient volumes are detected. Established and approved SOPs for measuring groundwater in wells and collecting samples will be used. After a one-year field investigation period, a determination will be made whether additional monitoring is necessary. This determination will consider groundwater-level measurements results, a comparison of total precipitation for the year to historical annual precipitation totals, and the occurrence of significant precipitation events during the year. The necessity to continue monitoring will be determined and documented by representatives of NNSA/NV and NDEP.

In addition to monitoring for the presence of groundwater in the borehole, monitoring for precipitation induced vadose zone flows will be conducted. A continuous monitoring device and data logger, capable of detecting and recording changes in borehole water vapor, will be maintained and compared to groundwater measurements. Additional event specific water vapor sampling will be conducted following significant precipitation events that could contribute to the transportation of moisture through the system. Significant precipitation events will be detected and recorded by a rain gage located at the site in conjunction with other gages or monitoring at the NTS. Specific monitoring procedures will be submitted to NDEP prior to the monitoring equipment being installed."

(Justification of change)

Revisions were requested as part of the NDEP review of the subject document. Document was approved with the above listed comments in correspondence dated 29 December 2002.

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

Applicable Project-Specific Document(s):

Corrective Action Investigation Plan (CAIP)
for Corrective Action Unit 527

Horn Silver Mine

Nevada Test Site, Nevada DOE/NV--858-REV 1

Approved By: [signature] Date 2/6/03
Project Manager
Industrial Sites Project

[signature] Date 2/7/03
Division Director
Environmental Restoration Division

Client Notified Yes x No __ Date 1/15/03
NDEP Concurrence Yes X No __ Date
NDEP Signature [signature] 2/10/03

Contract Change Order Required Yes X
__ No ____

Contract Change Order No. TBD

•A change control may be required to complete additional testing as required by NDEP comment. The activities are currently being estimated.

C:\DOCUMENTS AND SETTINGS\CABBLER_DEAL SETTINGS\TEMPORARY INTERNET FILES\OLK\DCALL_R07_ROTCFORM.WPD

RECORD OF TECHNICAL CHANGE

Technical Change No. 2

Project/Job No. IS04-190

Project/Job Name CAU 527, Horn Silver Mine, CAIP

Page 1 of 3

Date 10/27/03

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

Al Wickline (Name)

Task Manager (Title)

(Description of change)

1. A.1.7 Step 7 - Optimize the Design for Obtaining Data Change the reference from drilling the angle boring on the foot wall side of the fault to the following:

The angle borehole will be drilled starting at launch pad at the RBIFF facility , south of the mineshaft. This will allow the angle boring to terminate closer, vertically, to the base the mine shaft than starting from the northern side. This location will also allow for intercepting the fault and crossing into the foot wall side and allow the detection of perched water in the same geologic formation that the mineshaft is in. Installing the angled borehole so it crosses the fault at a nearly perpendicular angle will intercept the fracture planes that are expected to be largely parallel to the plane of the fault. Therefore, a borehole that intercepts the fractures will be more likely to collect percolating groundwater.

Justification for change

This location will allow the angle boring to terminate closer to the base the mine shaft because the surface elevation is approximately 40 feet below the original location selected to the north of the mineshaft. In addition a significant amount of earth work would be necessary to build the drill pad at the original location. The borehole will cross the fault at least 150 feet from the mine and allow for evaluating and testing for the presence of moisture in the same geologic formation that the mine is in. This also results in a significant savings in terms of cost because extensive site preparation work will not be required.

2. Change all reference to drilling the vertical boreholes in the vicinity of the mineshaft as follows:

Executive Summary
In the vicinity of and near the mineshaft refers to between 95 and 130 ft of the shaft.

Section 4.2.8. Determining the Extent of Contamination
The spatial boundaries that apply to CAU 527 for the determination of extent of investigation activities are as follows:

- Laterally - Between 95 and 130 feet from the 8 ft perimeter of the mineshaft
- Vertically - ground surface to 130 ft below the waste in the mineshaft..

If contamination extends beyond these boundaries, work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be reevaluated.

Section A.1.4.2. Identify the Spatial and Temporal Boundaries
The spatial boundaries are as follows:

- Laterally - 95 to 130 ft laterally from the outer perimeter of the 8-by 8-foot mineshaft.
- Vertically - from ground surface to 130 ft below the waste.

Justification of change

Constructing a drill pad that will allow for the drilling of the two borings, between 50 and 60 ft from the mineshaft, as originally specified , will require that the natural drainage beside the mine shaft be filled and graded. This construction will require a significant volume of soil (approximately 4,000 yd^3) to be hauled and placed at the site and approximately 3 weeks to complete the construction. Because of the potential environmental damage from diverting the drainage, the expense of hauling this soil, and the time required to construct the pads, the two vertical boring locations have been moved. The distance from the borings to the mine shaft is now expected to be to 96 ft for the 500-ft boring and 126 ft for the 300-ft boring. This will allow for the construction of the drilling pad(s) without extensive damage to the wash and not require excessive volumes of soil to be hauled. The relocation of the borings is not anticipated to have any adverse effect on the characterization of the vapor potentially present in the two drifts.

3. Change all references to the depth of drilling and location of boreholes as follows:

<u>Section 4.2.2 Drilling</u>

To explain the underground environs (i.e., determine if perched water exist, and if contaminant migration has occurred or is possible) two vertical boreholes will be drilled in biased location between 95 and 130 ft from the mineshaft. The vertical boreholes will extend to a depth of 500 and 300 ft, respectively. To determine if contaminant migration has occurred through the base of the mine shaft one angled borehole will be drilled to a depth of approximately 130 ft below the base of the mineshaft.

<u>Table A.1-2. Information needs to Resolve the Decision: Determine if Transport Mechanisms are Present.</u>

Information Needs	Information Source	Collection method	Data Type/Metric
Criterion 1: Data must be collected in an area that demonstrates that groundwater could make direct contact with the waste (e.g., borehole location must represent the geology of the mineshaft).			
Presence and location of groundwater near the mineshaft	Historical research of the Horn Silver Mine construction	Review of 1928 and 1929 correspondence documenting mine construction; 1934 newspaper article	Qualitative: Reliance on veracity of historical records
	Subsurface investigation	Drill two vertical boreholes parallel to the mineshaft. The 300 ft hole will be approximately 130 ft from the mine shaft. The 500 ft boring will be approximately 96 ft from the mine shaft. Drill on angle borehole that will not come closer than 50 ft to the waste to a depth of approximately 130 ft below the mine shaft.	Qualitative: Field observation of drill cutting and core will determine if borehole geology matches descriptions of rock adjacent to mine shaft.

<u>A.1.7 Step 7 - Optimize the Design for Obtaining Data</u>

Vertical boreholes will be drilled parallel to the mineshaft, at a distance between 95 and 130 ft. One vertical borehole will extend to [redacted] the second vertical borehole will extend to a [redacted] vertical boreholes will be positioned to attempt to intercept the drifts at 300 and 500 ft bgs (Figure A.7-1)

The angle borehole will be drilled such that the borehole will be completed no closer than 50 ft to the mineshaft and to a depth of [redacted]

Justification of change

Drilling 10 ft below the floor of the two drifts will allow for the installation of a 2-inch monitoring well to collect perched or infiltrating water. The angled borehole will provide the information required for contaminant migration from the waste and the evaluation of moisture or pore water in the same geologic formation as the mine. Establishing the angled borehole entirely within the foot-wall side of the fault may not capture percolating water that is moving through the waste and the fault plane.

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

Applicable Project-Specific Document(s): FI, SSHASP

CC:

Approved By: Janet Appenzeller-Wing, Project Manager, Industrial Sites Project Date 11/12/03

Runore C. Wycoff, Division Director, Environmental Restoration Division Date 11/12/03

NDEP Concurrence Yes X No __ Date 11/10/03
NDEP Signature
Contract Change Order Required Yes __ No __
Contract Change Order No. ______

RECORD OF TECHNICAL CHANGE

Technical Change No. 3 Page 1 of 3

Project/Job No. 1S04-190 Date 11/09/03

Project/Job Name CAU 527, Horn Silver Mine, CAIP

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

Al Wickline	Task Manager
(Name)	(Title)

(Description of change)

1. Change the reference from conducting fracture flow tests within each of the vertical boreholes to the following.

To ensure that the fracture flow data is representative of the rock formation adjacent to the waste, pressure/injection testing will be conducted in the lower portion of the angled boring on the footwall side of the fault (the side where the waste is located). The test will consist of sealing off sections of the angled borehole with packers, or other appropriate methods, and conducting injection pressure test on the selected interval.

2. Change all reference to conducting tracer testing in the two vertical boreholes as follows:

Executive Summary.

Page ES-2 - To determine if fracture flow is possible, a pressure/injection test will be conducted within the portion of the angled boring that is on the foot side of the fault. The test will consist of sealing off a fractured section of the angled borehole with packers, or other appropriate methods, and conducting pressure/injection tests to determine the capability of the fractures to transmit vapor or volatile contaminants.

Section 1.2 Scope

Page 4 - To determine if fracture flow is possible, a pressure/injection test will be conducted within the lower portion of the angled boring the foot side of the fault. The test will consist of sealing off a selected section of the angled borehole with packers, or other appropriate methods, and conducting pressure/injection tests to determine the capability of the fractures to transmit vapor or volatile contaminants.

Section 3.3.2.2 Vapor

Page 26 of 54 - To determine if fracture flow is possible, a pressure/injection test will be conducted in an interval of the in the angled boring that is on the foot side of the fault. The test will consist of sealing off a selected section of the angled borehole with packers, or other appropriate methods, and conducting pressure/injection tests to determine the capability of the fractures to transmit vapor or volatile contaminants.

Section 4.2.5 Determine if Fracture Flow is Feasible

Page 32 of 54 - To determine if fracture flow is possible, a pressure/injection test will be conducted in an interval of the in the angled boring that is on the foot side of the fault. The test will consist of sealing off a selected section of the borehole with packers, or other appropriate methods, and conducting pressure/injection tests to determine the capability of the fractures to transmit vapor or volatile contaminants.

Section A.1.1.3.1 General Conceptual Site Model

Replace Figure A.1-1 with the attached revised Conceptual Site Model (Figure 2).

Table A.1-2. Information needs to Resolve the Decision: Determine if Transport Mechanisms are Present.

Information Needs	Information Source	Collection method	Data Type/Metric
Criterion 3: Data collection method must be adequate to determine the potential of contaminant migration.			
Fractures are interconnected to allow extensive contaminant migration	Conduct fracture pressure and injection test.	Isolate a selected fractured interval of the angled borehole with packers and conduct an injection/pressure test	Quantitative: Following procedures for measuring the transmissivity of the fractures and rock.

Step 3 - Identify the Inputs to the Decision

Section A.1.3.3; Page A-25 of A-40- To determine if fracture flow is possible, a pressure/injection test will be conducted in an interval of the angled boring that is on the foot side of the fault. The test will consist of sealing off a selected section of the borehole with packers, or other appropriate methods, and conducting pressure/injection tests to determine the capability of the fractures to transmit vapor or volatile contaminants. Additional intervals of the angle boring may be tested, if necessary. If volatile contamination is determined to be migrating from the mineshaft, the data will be used to support the modeling to determine the extent of the contamination migration.

Step 7 - Optimize the Design for Obtaining Data

Section 1.7; Page A-35 of A-40 - The potential for vapor transport will be investigated by attempting to conduct a pressure/injection test in an interval of the angled boring that is on the foot side of the fault. The fractures will be investigated by isolating selected intervals and conducting pressure/injection tests to support modeling to determine the extent of vapor migration.

Justification of change

As indicated in the historic documentation, the mining operations at the Horn Silver Mine were initiated at the surface expression of the fault that is present at the top of the mineshaft. The fault is reported to dip approximately 60 degrees to the southeast. Drifts were developed at four levels (i.e., 60 ft, 160 ft, 300 ft, and 500 ft bgs) during the active life of the mine. With the exception of the upper drift (60 feet bgs), the workings were mainly developed to the southeast of the main shaft and developed out from the shaft to the suspected location of the ore. The mining records indicate that ore was associated with the fault. Each deeper drift, beginning at the 160-foot level, was extended further from the main shaft and the surficial expression of the fault. The attached figure developed by Lawry and sent to Wingfield in 1928 supports the theory that the ore body was associated with the fault. An excerpt from a letter from Lawry (Mine Supervisor) to Wingfield (the owner) suggests that the ore was suspected to be present along the footwall of the fault. "At present, the advance in the crosscut is *about 9 feet per day, and it is expected, therefore, that it should reach the vein tomorrow or Wednesday, provided that the estimate of 64 feet from the shaft to the footwall of the vein proves to be fairly correct*". This document does not specify the depth at which this digging was occurring but does suggest that the footwall of the fault and the vein were closely related.

Figure 1 shows the relationship of the mine drifts to the fault and the two vertical borings. Based on the measurements from the mine maps, the 300- and 500-foot drifts are shown on the figure where the drift begins to turn and run approximately parallel to the reported fault line. The distances from the main shaft are approximately 40 feet for the 300-foot drift and approximately 95 feet for the 500-foot drift. Further evaluation of this figure also shows that an approximate dip of the fault to be 60 degrees to the southeast. It should be noted that the fault, although recorded to be dipping 60 degrees to the southeast, will not be exactly 60 degrees across the entire length, but will vary with rock type and other geologic conditions. It should be understood that this is a two-dimensional representation of a three- dimensional relationship. Therefore, although the 500-foot boring is shown at the approximate location to the drift and distance from the mineshaft where it will be drilled, the 300-foot boring is not shown exactly where it will be drilled with respect to the 300-foot drift. The 300-foot boring actually will be approximately 106 feet from the shaft but positioned parallel to the 500-foot boring and without the offset would not be visible on this figure.

With this information the conceptual site model has been revised to more accurately reflect the expected site conditions (Figure 2). Although not to scale, the CSM has been modified to show that the fault intercepts the drift at the points where they are generally following the strike of the fault.

Based on this information and the new locations of the planned vertical borings, both borings are expected to intercept the respective drift at or very near the fault. If the fault is crossed prior to encountering the drift, it is expected to be very close to the targeted drift and it is doubtful that there will be adequate distance to conduct the double packer injection test in the rock on the foot side (waste side) of the fault. It is also expected that if the fault is intercepted before the drift, the rock will be highly fractured and the seating of a double packer system will not be possible. Therefore, to ensure that the geotechnical samples and the injection data are collected, the lower 40 feet of the angle boring will be cored and the injection test will be conducted in fracture intervals in the portion of the boring that is on the foot side of the fault.

The two vertical borings, because of the new locations, are not expected to penetrate the foot side of the fault and not intercept the rocks that are adjacent to the waste. However, conducting the pressure/injection testing in the angle boring will allow the testing of the rock formation and fractures that are adjacent to the mineshaft and closer to the waste. This will satisfy the DQO requirement in Section A.1.3.1, *Information Needs and Information Sources*, that the data must be collected in an area that demonstrates that liquid or vapor from waste disposal activities could have migrated through open fracture (e.g., borehole location must represent the geology of the mineshaft).

However, if it is determined, during the drilling of the vertical borings, that there is an adequate distance between the drift and the overlying fault an injection test will be attempted. In order to attempt the injection test, on the vertical borings, there must be a fracture zone present above the drift that is on the foot side of the fault and separated from the drift by a minimum of 5 feet of competent non-fractured rock. If these conditions are not met, the test will not be attempted.

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

Applicable Project-Specific Document(s): FI, SSHASP

CC:

Approved By: Kevin Cabble for
Janet Appenzeller-Wing, Project Manager
Industrial Sites Project
Date 11-14-03

Janet Appenzeller-Wing for
Runore C. Wycoff, Division Director
Environmental Restoration Division
Date 11/14/03

NDEP Concurrence Yes X No ___ Date 11/14/03
NDEP Signature [signature]
Contract Change Order Required Yes ___ No ___
Contract Change Order No. ___

RECORD OF TECHNICAL CHANGE

Technical Change No. 4

Project/Job No. IS04 - 200 Date 3/10/04

Project/Job Name Corrective Action Investigation Plan for CAU 527: Horn Silver Mine

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

Al Wickline (Name) Task Manager (Title)

Description of Change

1. **Section 3.3.3 Remedial Alternatives Preliminary Action Levels.** Change the last paragraph of the section to the following:

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

2. **Section 3.4 DQO Process Discussion:** Change the last sentences in the section to the following:

- "The Minimum Detectable Concentrations (MDCs) for radiological analytes have been developed considering the PALs. The MDC for each radiological analytes is less than or equal to the corresponding PAL."

3. **Section A.1.3.2.5 Remediation Alternatives Preliminary Action Levels**. Change the second paragraph to the following:

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

Eliminate Potassium-40 as a radionuclide COPC within the Gamma Spectrometry analysis discussion.

4. **Section A.1.3.3 Potential Sampling Techniques and appropriate Analytical Methods** Replace the 5th column (including related notes) in Table A.1.5 with the following PALs for the corresponding analytes in soil:

- Cesium-137 7.30E+00
- Cobalt-60 1.61E+00
- Nobium-94 2.43E+00
- Plutonium-238 7.78E+00
- Plutonium-239/240 7.62E+00
- Strontium-90 5.03E+02
- Uranium-234 8.59E+01
- Uranium-235 1.05E+01
- Uranium-238 7.78E+00

5. **Sections 8.0 and A.2.0 References**. Add the following references:

- National Council on Radiation Protection and Measurements. 1999. *Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies*. NCRP Report No. 129. National Council on Radiation Protection and Measurements, Bethesda, MD.
- US Department of Energy (DOE). 1993. "Radiation Protection of the Public and the Environment". DOE Order 5400.5 Change 2. January 7, 1993.

Justification for change

Through ongoing discussions between DOE and NDEP it was determined that the PALs currently being used for the site investigations are not practical and should be replaced with dose-based action levels. In an agreement between NDEP and DOE (approved March 9, 2004) the PALs to be used for evaluating the potential radioactive contamination in soils will be based on an acceptable dose as specified by the NCRP Report No. 129 and DOE 5400.5 guidance rather than a comparison to background values. The use of the new radiological PALs has been accepted and approved for use in the planning and evaluation phase of the site investigations.

Potassium-40 (K-40) is a naturally occurring unstable isotope of potassium with a half-life of 1.3 x 10E+09 years. The abundance of K-40 is approximately 0.0118% of natural potassium. Because of the high abundance of potassium in the environment, K-40 is the predominant radionuclide in soil, foods, and human tissues. The average human male contains approximately 100,000 pCi of K-40. The human body strictly regulates the potassium content within the body and is not influenced by variations in environmental levels. Therefore, the internal dose from K-40 remains constant.

Potassium-40 is not considered to be a contaminant of potential concern due to its predominance in the environment. In addition, the only mechanism for K-40 to be a contaminant is through concentration. There are no reported activities at the NTS that would have concentrated K-40 or released it as a contaminant.

The CAI will not be expanded to delineate the extent of K-40, nor will K-40 be evaluated in the Corrective Action Decision Document.

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

Applicable Project-Specific Document(s): **Corrective Action Investigation Plan for Corrective Action Unit 527: Horn Silver Mine Nevada Test Site, Nevada, Revision 1, 2002.**

CC:

Approved By: *Kevin Cabble* Date 3-15-04

Kevin Cabble, Acting Project Manager
Industrial Sites Project

Janet Appenzeller-Wing Date 3/15/04

Janet Appenzeller-Wing, Acting Division Director
Environmental Restoration Division

NDEP Concurrence Yes__ No__ Date ______

NDEP Signature ______

Contract Change Order Required Yes__ No__

Contract Change Order No. ______

Justification for change

Through ongoing discussions between DOE and NDEP it was determined that the PALs currently being used for the site investigations are not practical and should be replaced with dose-based action levels. In an agreement between NDEP and DOE (approved March 9, 2004) the PALs to be used for evaluating the potential radioactive contamination in soils will be based on an acceptable dose as specified by the NCRP Report No. 129 and DOE 5400.5 guidance rather than a comparison to background values. The use of the new radiological PALs has been accepted and approved for use in the planning and evaluation phase of the site investigations.

Potassium-40 (K-40) is a naturally occurring unstable isotope of potassium with a half-life of 1.3 x 10E+09 years. The abundance of K-40 is approximately 0.0118% of natural potassium. Because of the high abundance of potassium in the environment, K-40 is the predominant radionuclide in soil, foods, and human tissues. The average human male contains approximately 100,000 pCi of K-40. The human body strictly regulates the potassium content within the body and is not influenced by variations in environmental levels. Therefore, the internal dose from K-40 remains constant.

Potassium-40 is not considered to be a contaminant of potential concern due to its predominance in the environment. In addition, the only mechanism for K-40 to be a contaminant is through concentration. There are no reported activities at the NTS that would have concentrated K-40 or released it as a contaminant.

The CAI will not be expanded to delineate the extent of K-40, nor will K-40 be evaluated in the Corrective Action Decision Document.

The project time will be (Increased)(Decreased)(<u>Unchanged</u>) by approximately 0 days.

Applicable Project-Specific Document(s): Corrective Action Investigation Plan for Corrective Action Unit 527: Horn Silver Mine Nevada Test Site, Nevada, Revision 1, 2002.

CC:

Approved By: [signature] Date 3-15-04
Kevin Cabble, Acting Project Manager
Industrial Sites Project

[signature] Date: 3/15/04
Janet Appenzeller-Wing, Acting Division Director
Environmental Restoration Division

NDEP Concurrence: Yes X No ___ Date: 3/19/04
NDEP Signature: [signature]
Contract Change Order Required Yes ___ No ___
Contract Change Order No. ___

Nevada
Environmental
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Project

DOE/NV--856--REV. 1

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 527: Horn Silver Mine Nevada Test Site, Nevada

Controlled Copy No.: ___
Revision No.: 1

December 2002

Environmental Restoration
Division

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DOE/NV--856--REV. 1

CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 527: HORN SILVER MINE NEVADA TEST SITE, NEVADA

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

Controlled Copy No.: ___

Revision No.: 1

December 2002

**CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 527:
HORN SILVER MINE
NEVADA TEST SITE, NEVADA**

Approved by: Signature Approved Date: 12-2-02

Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

Approved by: Signature Approved Date: 12-2-02

Runore C. Wycoff, Division Director
Environmental Restoration Division

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Appendix A - DQO Process

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List of Figures

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List of Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
bgs	Below ground surface
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
COC	Contaminant of concern
COPC	Contaminant of potential concern
CSM	Conceptual site model
CWD	Contaminated Waste Dump
DOE	U.S. Department of Energy
DoD	U.S. Department of Defense
DOP	Detailed operating procedure
DOT	U.S. Department of Transportation
dpm/100 cm^2	Disintegrations per minute per 100 square centimeters
DQI	Data quality indicators
DQO	Data quality objectives
EPA	U.S. Environmental Protection Agency
FFACO	*Federal Facility Agreement and Consent Order*
°F	Degrees Fahrenheit
FSL	Field-screening level
ft	Foot (feet)
ft^3	Cubic feet
gpd	Gallons per day
GPS	Global positioning system
HASP	Health and Safety Plan

List of Acronyms and Abbreviations *(Continued)*

HWAA	Hazardous waste accumulation area
IDW	Investigation-derived waste
in.	Inches
ISMS	Integrated Safety Management System
ITLV	IT Corporation, Las Vegas
LLW	Low-level radioactive waste
m^3	Cubic meter
mg/kg	Milligrams per kilogram
MDA	Minimum detectable activity
MDC	Minimum detectable concentration
mi	Mile
MRL	Minimum reporting limit
MS/MSD	Matrix spike/matrix spike duplicate
NAC	*Nevada Administrative Code*
NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
NNSA/NV	U.S Department of Energy, National Nuclear Security Administration Nevada Operations Office
NRS	*Nevada Revised Statutes*
NTS	Nevada Test Site
NTSWAC	Nevada Test Site Waste Acceptance Criteria
PAL	Preliminary action level
PCB	Polychlorinated biphenyls
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
PPE	Personal protective equipment
ppm	Parts per million

List of Acronyms and Abbreviations *(Continued)*

PRG	Preliminary remediation goal
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RCA	Radiological controlled area
RCRA	*Resource Conservation and Recovery Act*
RMA	Radioactive materials area
ROTC	Record of Technical Change
SAA	Satellite accumulation area
SDWS	*Safe Drinking Water Standards*
SOP	Standard operating procedure
SSHASP	Site-specific health and safety plan
SVOC	Semivolatile organic compound
TPH	Total petroleum hydrocarbons
VOC	Volatile organic compound

Executive Summary

This Corrective Action Investigation Plan contains project-specific information including facility description, environmental samples collection objectives, and criteria for documenting site investigating activities at Corrective Action Unit 527: Horn Silver Mine, Nevada Test Site, Nevada. Field investigation results will support a defensible evaluation of a close in place corrective action in the Corrective Action Decision Document.

The corrective action alternative supported by the Corrective Action Investigation Plan is the close in place corrective action alternative, which is based on the following considerations:

- Due to the known radioactive constituents in waste, the no further action corrective action alternative is not appropriate.
- Access restrictions associated with the waste, as well as safety concerns with removing the waste, eliminate a clean closure corrective action alternative.

Corrective Action Unit 527 has one Corrective Action Site: 26-20-01, Contaminated Waste Dump #1. The Horn Silver Mine is in Area 26 of the Nevada Test Site. The data quality objective process was used to identify and define the type and quality of data needed to complete the investigation phase of the Corrective Action Unit 527 corrective action process.

Historical documentation indicates that between 1959 and the 1970s, nonliquid classified material and unclassified waste was placed in the Horn Silver Mine's shaft. Some of this waste is known to be radioactive; however, it is unknown if hazardous wastes were disposed of in the mine. Documentation indicates that the waste is present from 150 feet (ft) to the bottom of the mine, which is 500 ft below ground surface (bgs).

The decision statement required for this site investigation is, "Determine if significant contaminant transport mechanisms (i.e., groundwater and vapor transport) exist near CAU 527 or if contamination migration has occurred within open fractures or drifts." The presence of groundwater would be considered to be a primary contaminant transport mechanism. Two vertical boreholes and one angled borehole will be drilled in the vicinity of the mineshaft to determine the presence or absence of perched groundwater within the geologic strata associated with the material and/or waste. Drill hole logs will determine the lithology of the sites, and water

level measurements will confirm the absence or presence of groundwater. The boreholes will provide monitoring locations near the mine. If no groundwater is evident after the boreholes are established, the boreholes will be monitored for one year. A determination will be made after one year, if additional monitoring is required.

Another contaminant transport mechanism that will be investigated is vapor transport. Contamination with high vapor pressure may volatilize and the resulting vapors could be transported through the open drifts and fractures. The vapor transport will be investigated by attempting to drill into the open drifts at 300 and 500 ft bgs to collect pore gas samples. Detection of nonnaturally occurring COPCs in pore gas samples will determine that vapor transport has occurred.

To determine if fracture flow is possible, a fracture flow test will be conducted within each of the vertical boreholes. The test will consist of sealing off sections of the borehole with packers, or other appropriate methods, and injecting a tracer gas. Additional sections of the borehole, above and possibly below the injection point, will also be sealed using packers, and pore gas samples will be collected to determine fracture flow rate and distance.

Intermittent contaminant migration may occur as a result of pulses of infiltrated precipitation. This intermittent driver for contaminant migration may have left residual contaminants of potential concern (COPCs) within the open fractures. This will be investigated by sending core samples or cuttings for laboratory analysis. Samples of drilling core may also be submitted for geotechnical analysis.

If groundwater is discovered during the subsurface investigation at a depth that would allow the water to contact waste, or if significant vapors are found, then a nature and extent investigation will be conducted using modeling. Samples of any groundwater found, drilling core or cuttings, and pore gas will be taken for analysis to determine if contaminants of concern (COCs) have migrated from the waste. Contaminants of concern are COPCs that are present in samples at concentrations above preliminary action levels (PALs) and are defined in Table 3-1. If no COCs are identified, no further characterization will be necessary. The COCs will be modeled in the appropriate validated groundwater flow models and vapor flow models.

Sampling activities will include collecting quality control samples for laboratory analyses to ensure that the data generated from the analysis of investigation samples meet the requirements of the data quality indicators. To comply with regulatory requirements for waste disposal, samples will be collected from investigation–derived waste, as needed, and submitted for laboratory analysis.

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

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains criteria for conducting site investigations at Corrective Action Unit (CAU) 527, Horn Silver Mine, Corrective Action Site (CAS) 26-20-01, Contaminated Waste Dump #1, Nevada Test Site (NTS), Nevada. Project-specific information including facility description, site investigation objectives, and assumptions are included. The Horn Silver Mine was previously referred to as "CAU 168, Area 25 and 26 Contaminated Materials and Waste Dumps, CAS 26-20-01, Contaminated Waste Dump #1 (CWD-1)." This CAIP refers to the site as CAU 527 or the Horn Silver Mine; however, U.S. Department of Energy (DOE) documents may refer to the site as CAU 168 or CWD-1. Other names for the Horn Silver Mine found in the historical references include the Wingfield mine (or shaft) and the Wahmonie mine (or shaft).

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

The NTS is approximately 65 miles (mi) northwest of Las Vegas, Nevada. The NTS has been used for various research and development projects including nuclear weapons testing. Corrective Action Unit 527 is an abandoned mine site in Area 26 (Figure 1-1).

1.1 Purpose

Historical documentation indicates that between 1959 and the 1970s, nonliquid classified material and unclassified waste was placed in the Horn Silver Mine's shaft. Some of this waste is known to be radioactive; however, it is unknown if hazardous materials and/or wastes were disposed of in the mine. Documentation indicates that material is present from 150 feet (ft) below ground surface (bgs) to the bottom of the mine, which is 500 ft bgs.

Corrective Action Unit 527 is being investigated because hazardous constituents migrating from materials and/or wastes disposed of in the Horn Silver Mine may pose a threat to human health and the environment. This CAU is identified in the FFACO (1996) and is being investigated to assess potential impacts associated with potential releases from the waste.

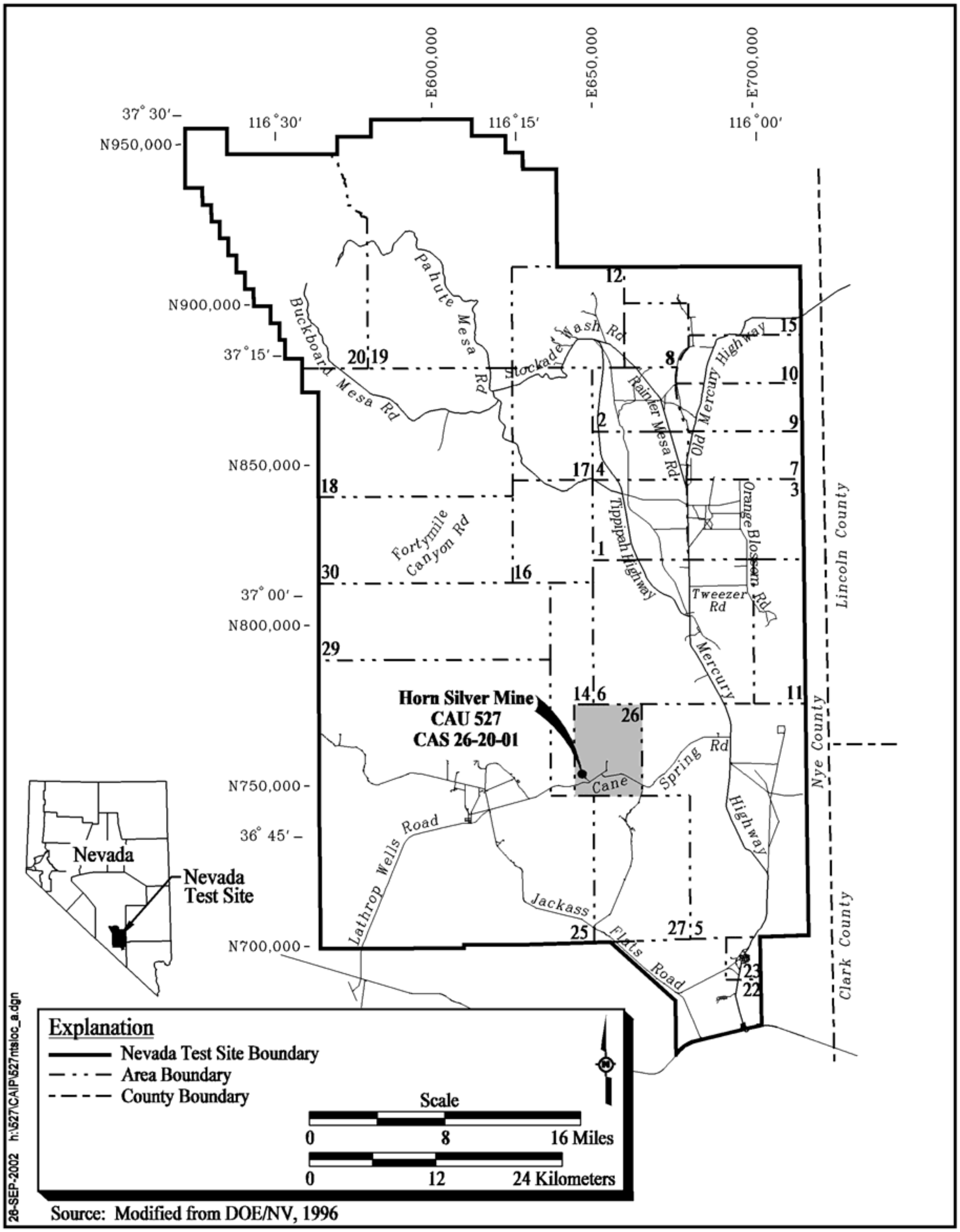

Figure 1-1
Nevada Test Site and CAU 527 Location

The CAU 527 will be investigated based on data quality objectives (DQOs) developed by representatives of the Nevada Division of Environmental Protection (NDEP) and the DOE National Nuclear Security Administration Nevada Operations Office (NNSA/NV). The DQOs are used to identify and define the type and quality of data needed to develop and evaluate appropriate corrective actions for CAU 527. This CAIP will describe the investigation developed to collect these data and present a plan to ensure that adequate data is collected to provide sufficient and reliable information to identify, evaluate, and technically defend potentially viable corrective actions. The DQO strategy for CAU 527 is as follows:

- Determine if a significant contaminant transport mechanism (e.g., groundwater transport, vapor transport, or other mechanism) is present.
- Determine if significant contaminant migration has occurred within open fractures or drifts.
- Determine the extent of contamination if contaminant migration has occurred.

1.2 Scope

The scope of this investigation is to generate the information needed to resolve the decision statement identified in the DQO process described in Appendix A. A decision statement with one alternative action has been developed for this CAU.

The decision statement required for this site investigation is, "Determine if significant contaminant transport mechanisms (i.e., groundwater and vapor transport) exist near CAU 527 or if contamination migration has occurred within open fractures or drifts." The presence of groundwater would be considered to be a primary contaminant transport mechanism. Two vertical boreholes and one angled borehole will be drilled in the vicinity of the mineshaft to determine the presence or absence of perched groundwater within the geologic strata associated with the material and/or waste. Drill hole logs will determine the lithology of the sites, and water level measurements will confirm the absence or presence of groundwater. The boreholes will provide monitoring locations near the mine. If no groundwater is evident after the boreholes are established, the boreholes will be monitored for one year. A determination will be made after one year, if additional monitoring is required.

Another contaminant transport mechanism that will be investigated is vapor transport. Contamination with high vapor pressure may volatilize and the resulting vapors could be transported through the open drifts and fractures. The vapor transport will be investigated by attempting to drill into the open drifts at 300 and 500 ft bgs to collect pore gas samples. Detection of nonnaturally occurring COPCs in pore gas samples will determine that vapor transport has occurred.

To determine if fracture flow is possible, a fracture flow test will be conducted within each of the vertical boreholes. The test will consist of sealing off sections of the borehole with packers, or other appropriate methods, and injecting a tracer gas. Additional sections of the borehole, above and possibly below the injection point, will also be sealed using packers, and pore gas samples will be collected to determine fracture flow rate and distance.

Intermittent contaminant migration may occur as a result of pulses of infiltrated precipitation. This intermittent driver for contaminant migration may have left residual contaminants of potential concern (COPCs) within the open fractures. This will be investigated by sending core samples or cuttings for laboratory analysis. Samples of drilling core will also be submitted for geotechnical analysis.

If groundwater is discovered during the subsurface investigation at a depth that would allow the water to contact waste, or if significant vapors are found, then a nature and extent investigation will be conducted using modeling. Samples of any groundwater found, drilling core or cuttings, and pore gas will be taken for analysis to determine if contaminants of concern (COCs) have migrated from the waste. Contaminants of concern are COPCs that are present in samples at concentrations above preliminary action levels (PALs) and are defined in Table 3-1. If no COCs are identified, no further characterization will be necessary. The COCs will be modeled in the appropriate validated groundwater flow models and vapor flow models.

Sampling activities will include collecting quality control (QC) samples for laboratory analyses to ensure that the data generated from the analysis of investigation samples meet the requirements of the data quality indicators (DQI). To comply with regulatory requirements for waste disposal, samples will be collected from investigation–derived waste (IDW), as needed, and submitted for laboratory analysis.

1.3 CAIP Contents

The managerial aspects of this project are discussed in the *Project Management Plan* (DOE/NV, 1994) and the site-specific field management plan that will be developed prior to field activities. Health and safety requirements and activities are described in the CAIP and are also in the *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002a). The health and safety aspects of this project are documented in the IT Corporation, Las Vegas Office (ITLV), *Health and Safety Plan* (HASP) (IT, 2001), and will be supplemented with a site-specific health and safety plan written prior to the start of field work. Public involvement activities are documented in the "Public Involvement Plan," Appendix V of the FFACO (FFACO, 1996).

This CAIP includes the following sections and information:

Section 1.0 - Introduction

Section 2.0 - Facility Description

Section 3.0 - Objectives

Section 4.0 - Field Investigation

Section 5.0 - Waste Management

Section 6.0 - Quality Assurance/Quality Control

Section 7.0 - Duration and Records Availability

Section 8.0 - References

Appendix A - DQO Summary

Appendix B - Project Organization

Appendix C - Technical Guidance Documents

Appendix D - Response to NDEP Comments

2.0 Facility Description

Corrective Action Unit 527 consists of CAS 26-20-01, Horn Silver Mine. The following subsections discuss the facility.

2.1 Physical Setting

The following sections describe the physical setting of CAS 26-20-01, Horn Silver Mine, and the surrounding area.

2.1.1 Climate

Area 26 lies within the most arid part of Nevada. Area precipitation is measured at Cane Spring, about 4 mi to the southeast. The average annual precipitation was 8 inches (in.) annually from 1965 to 1992 (WRCC, 2002). From 1984 to 2000, the weather station at Mercury, Nevada, recorded average maximum temperatures ranging from 55 to 98 degrees Fahrenheit (°F); average minimum temperatures from 32 to 70°F; and total annual snowfall at 3 in. Evaporation rates for the NTS/Yucca Mountain region are approximately 66 in. per year (DOE/OCRWM, 2002). The high evaporation and low precipitation rates create a negative water balance for the area.

2.1.2 Geology

The general geology of the NTS is comprised of three major geologic units. A complexly folded and faulted sedimentary rock of Paleozoic age overlain at many places by volcanic tuffs and lavas of Tertiary age, which in valleys are covered by alluvium of late Tertiary and Quaternary age, which was derived from erosion of the nearby hills of Tertiary and Paleozoic rocks. The volcanic rocks in the valley are down dropped and tilted along steeply dipping normal faults of late Tertiary age.

The Horn Silver Mine was sunk into an early Tertiary intrusive that is part of the Wahmonie Formation (Plate 1). The geology of the area is typified by early Tertiary intrusives, largely monzonite porphyry, and later basalt flows. The Wahmonie Formation is a maximum of 5,700-ft thick. The principal lithology of the Wahmonie Formation is hydrothermally altered calc-alkaline volcanic rocks including andesite, latite, and dacite volcanic breccia (lava and nonwelded tuff). Rhyolite (quartz and alkalic feldspar) intrusions are found locally in the granitic porphyry

(Kral, 1951). High-grade, gold-silver mineralization associated with a zone of alteration can be traced on the surface for 3 mi to the northeast and 5 mi to the southwest of the Horn Silver Mine (Quade and Tingley, 1983). The area is intensely fractured (Tingley, 1982). Prospectors were attracted to the area by exposed, mineral-rich rhyolite. A normal fault, trending N30E and dipping 60 degrees to the southeast, runs through the mineshaft opening (Lawry, 1928).

Most of the surface soils at the NTS have developed on the alluvial deposits under conditions of high temperatures and low precipitation. They exhibit characteristics of desert soils including coarse texture, an accumulation of carbonates within a few feet of the surface contributing to formation of a caliche layer, and low organic matter content (REECo, 1980). The immediate area of the mine is surrounded by mining overburden.

2.1.3 Hydrology

Generally, water movement in the Wahmonie Formation is characterized as being in poorly connected fractures. Interstitial porosity and permeability are negligible, and the coefficient of transmissibility is estimated at less than 500 gallons per day (gpd) per ft. Minor perched water was detected in the foothills between Frenchman Flat and Jackass Flats during studies completed in the 1960s (Winograd and Thordardson, 1975). The Wahmonie Formation includes a tuff confining unit that contains perched water near Cane Spring and Pavits Spring (Laczniak et al., 1996). Perched groundwater exists sporadically ranging from 77 to 182 ft in some, but not all, of the Pluto wells drilled approximately 3 mi to the east of the Horn Silver Mine (Johnson and Ege, 1964). The lithology of these drill holes is tertiary igneous dacite porphyry.

The nearest surface water is 4 mi to the southeast at Cane Spring (Kral, 1951). Historical documentation notes that in 1928 a new source of supply was discovered on Skull Mountain, closer than Cane Spring, at an elevation that would provide the mining camp a gravity service (Tonopah Daily Times, 1928b). The location of that source is unknown.

Plate 1 shows the water levels documented near CAU 527. No groundwater wells are currently being monitored in Area 26 (USGS, 2002a). The water table in the Wahmonie flat and the Horn Silver Mine is at approximately 1,900 ft bgs (Winograd and Thordardson, 1975). The closest groundwater monitoring well is Well J-11 WW, which is 7 mi to the southwest of the Horn Silver Mine.

Well J-11 WW shows groundwater at 1,037.5 ft bgs in volcanic rock (USGS, 2002b; Walker et al., 1961). Well USGS "F" is 5 mi to the southeast of Horn Silver Mine and groundwater was found from 1,560 to 1,871 ft bgs (West and Garber, 1961). Well Ue5m is 8 mi to the southeast and groundwater was found at 660 and 1,100 ft bgs (Healey et al., 1967).

It is documented in correspondence from the time of mining operations that no groundwater or moisture existed from ground surface to 500 ft bgs in the immediate vicinity of the CAU 527. The following correspondence from Mr. Lawry and Mr. Sharp to Mr. Wingfield documenting the mine development states that no groundwater was encountered during mineshaft and drift development:

- The June 15, 1928, letter from Mr. Sharp to Mr. Wingfield states, "There is no signs of moisture yet." (Sharp, 1928)
- The October 29, 1928, letter from Mr. Lawry to Mr. Wingfield states, "I am sorry to say that it is impossible for us to give any estimate in this connection, for the reason that even on the 300-ft level both the formation and the vein matter appear to be as dry as on the levels above, and there is no more indication of moisture now than at any time before. Moreover, there is no data available along this line which could guide us in any way in forming some opinion as to the possible position of the water level." (Lawry, 1928)
- The January 28, 1929, letter from Mr. Lawry to Mr. Wingfield states, "There does not appear to be any indication of increased moisture in the formation at this time." (Lawry, 1929b)

The dryness of the mine is also documented in an April 20, 1934, *Tonopah Daily Times* newspaper account of the recovery of a man who fell to his death from the bottom of the mineshaft. The article's subheading states: "No water in shaft."

No groundwater or moisture was found during mineshaft or drift development. The drifts radiate from the mineshaft at least 50 ft in most directions.

The site is on a leveled area of a gradual slope (Figure 2-1). Surface runoff is diverted from the shaft by a concrete pad that surrounds the mineshaft, opening and its locked steel cover.

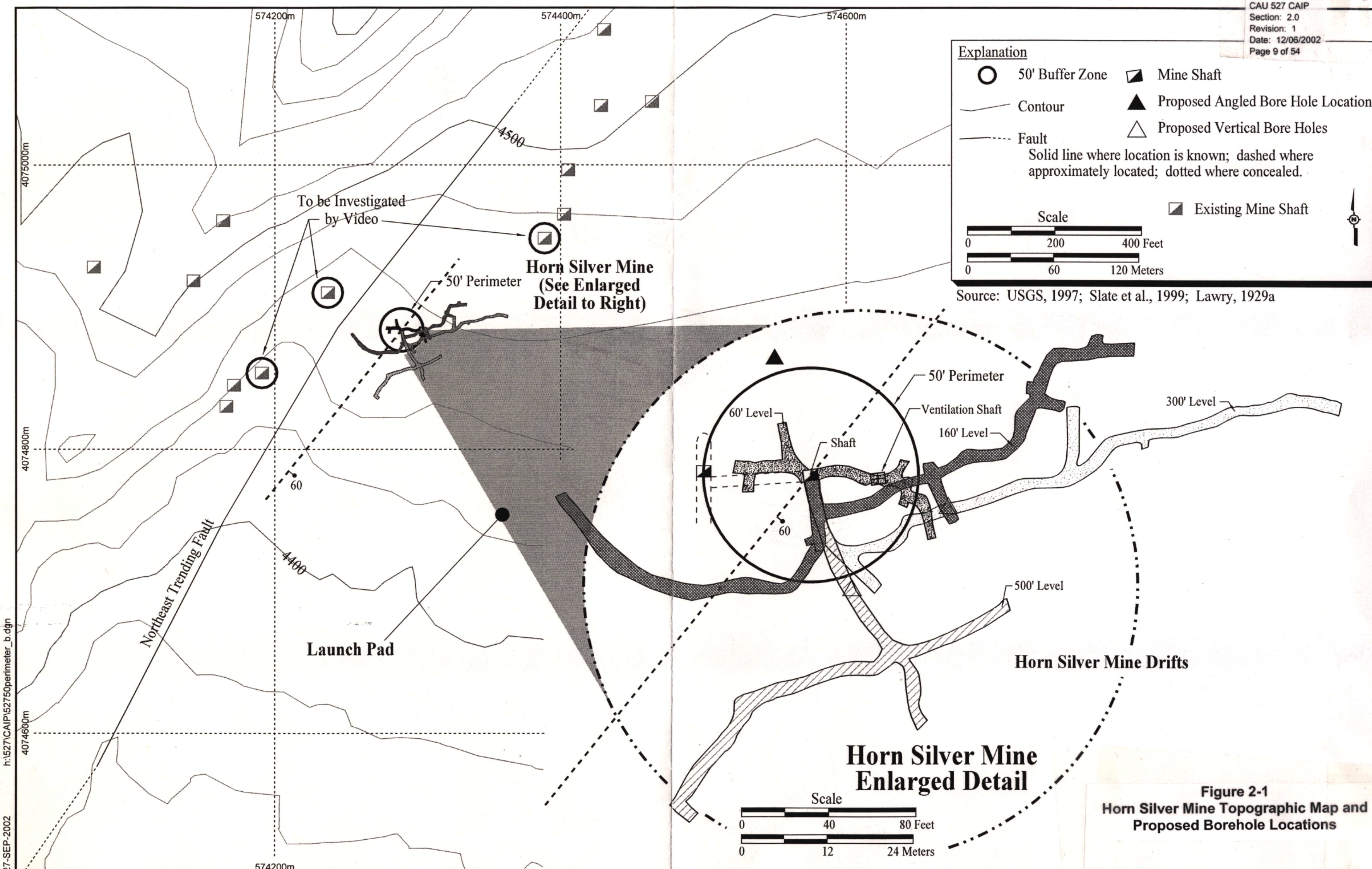

Figure 2-1
Horn Silver Mine Topographic Map and Proposed Borehole Locations

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2.2 Operational History

2.2.1 Historical Mining History

Corrective Action Unit 527, Horn Silver Mine, is in the Wahmonie mining district, which lies in the southwestern quadrant of Area 26. In the 1850s and again in the late 1920s, the Wahmonie mining district was prospected for minerals. The Wahmonie mine workings cover an area about three square miles (Tonopah Daily Times, 1928a) and consists of the Horn Silver Mine and at least six shallow shafts (Quade and Tingley, 1983). Correspondence from the mine superintendent Mr. Lawry to Mr. Wingfield (who financed the mining operations in 1928 and 1929) documents that ore production occurred in 1928 when a high-grade, silver-gold ore was discovered at the Horn Silver Mine, but that ore production was limited and the mine was abandoned in 1929 (Lawry, 1929a and b).

The mine entrance sits on a flattened area of sloping terrain. The coordinates, collected in North American Datum 27, are as follows:

- UTM Easting 0574289, UTM Northing 4074884
- Latitude 36.818720300, Longitude -116.167065200
- Elevation 1,333 m (4,373 ft)

The mineshaft is relatively narrow and deep. The mineshaft is approximately 8 by 8 ft wide. Although several DOE documents previously stated the mineshaft's depth was 200 ft, correspondence from Mr. Lawry to Mr. Wingfield dated April 18, 1929, describes the sinking of the mineshaft to a depth of 500 ft and describes the development of drifts at 60, 160, 300, and 500 ft bgs (Lawry, 1929a). Approximately 1,340 ft of workings were developed (Mines, 1931).

A historical plan indicates that two small shafts were associated with the Horn Silver Mine. The first shaft is approximately 30 ft east of the main shaft and is believed to be associated with the 60 ft bgs drift. The purpose of this shaft is unclear. The second shaft is approximately 50 ft west of the main shaft and is believed to be the result of limited surface excavation. Both of these shafts appear to have been covered by the spoils pile around the main shaft, and there are no current surface indications of either shaft. These shafts are not considered to be open conduits for contaminant transport from waste disposal activities in the Horn Silver Mine; therefore, they are not considered to be part of the CSM.

Reviewed documents identify at least six shallow shafts in the vicinity of the Horn Silver Mine (Quade and Tingley, 1983). A recent site visit located 13 covered shafts in the immediate vicinity of the Horn Silver Mine (see Figure 2-1). In addition to the covered shafts, there are numerous shallow (less than 10-ft deep) exploratory holes. Historical records indicate that the covered shafts or workings were of limited depth (i.e., less than 100 ft). The depth and presence or absence of drifts will be verified in the mines closest to the Horn Silver Mine using a video camera, if possible. The mines to be investigated are shown on Figure 2-1. The other open mine shafts in the vicinity of the Horn Silver Mine are not believed to be connected to the Horn Silver Mine. Therefore, they are not considered to be viable transport conduits for contaminant transport from waste disposal activities in the Horn Silver Mine and are not considered to be part of the conceptual site model. A concrete collar pad with a locked steel cover was installed on the shaft to protect the shaft from surface runoff and to control access. The 20- by 20-ft concrete pad surrounding the cover is fenced and locked (Figure 2-2). The NNSA/NV has established a 50-ft perimeter around the waste that may not be penetrated during any subsurface investigations. There is no evidence of surface soil contamination at CAU 527.

Figure 2-2
CAU 527 Looking South

2.2.2 Waste Disposal History

Wastes and fill were deposited in the mineshaft by the DOE (and its predecessor) beginning in approximately 1959 through 1972 from 500 to 150 ft bgs. Specific information about the material disposed of in the mineshaft is classified and not described in this report. Previously published, unclassified documents state that radioactive debris was buried at the bottom of the shaft during the Pluto Program, which was conducted from 1959 to 1964. Between 1960 and 1964, the mineshaft was used by NTS for the disposal of wastes and materials from the Tory Reactor Facility, which was associated with the Pluto Program (DOE, 1988; Penwell, 2002). Unclassified waste disposal records are discussed in Section 2.3.

The mine was listed in the April 1988 *Environmental Survey Preliminary Report* as an inactive underground classified material burial site that was used to accumulate radioactive waste from the local area.

2.3 Waste Inventory

Available information about waste disposed in CAU 527 includes the following:

- In April 2002, NNSA/NV (Cabble, 2002) provided the following information:
  - Radioactive wastes were deposited in the shaft from 500 to 292 ft bgs
  - 10 ft of fill was placed from 292 to 282 ft
  - A 3-ft thick concrete plug was placed from 282 to 279 ft
- *Records for Land Burial of Solid Radioactive Waste, VII. January, 1963 – December, 1966* (REECo, 1978) include 29 radioactive waste disposal records for waste disposed in the Horn Silver Mine from 1966 to 1972. The approximate total volume of wastes disposed is 789 cubic feet (ft^3). No liquids were reported to have been disposed in the mine.
- The *Environmental Survey Preliminary Report, Nevada Test Site, Mercury Nevada* (DOE, 1988) provides the following information:
  - Wastes were placed in the mineshaft to approximately 150 ft bgs. A concrete plug was poured on top, and the remaining shaft was filled with clean soil.

- During the 1960s, the mineshaft was used by NTS personnel for the disposal of solid wastes from the Tory Reactor Facility. Information is classified regarding the nature and quantity of wastes disposed of in the mineshaft.
- The mine was listed as an inactive contaminated waste dump.

- The *Radioactive Solid Waste Inventories at United States Department of Energy Burial and Storage Sites* (DOE/ID, 1987) lists total waste volume of NTS Horn Silver Mine as 13 cubic meters (m^3) (450 ft^3). Total radionuclides buried is 7.5 curies of low-level waste fission products.

- *An Assessment of the Nevada Test Site for Low-Level Waste Management* (DOE/NV, 1978) states that a concrete plug has been poured over the waste in the partially filled shaft at a depth of about 128 m (420 ft). The shaft is approximately square with a width of about 2.4 m (8 ft), and the remaining volume is about 700 m^3 (24,720 ft^3).

- The *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (DOE, 1977) states, "The shaft has been designated as a disposal site for classified radioactive waste. A concrete plug has been poured over waste in the partially filled mineshaft at a depth of about 128 m (420 ft). A concrete collar (or pad) with a steel cover and lid with a security lock has been installed at the opening to the shaft. This prevents the entrance of surface drainage water."

- *The Environmental Restoration and Waste Management Site Specific Plan for Fiscal Years 1993 – 1997* (DOE/NV, 1991) states that the Horn Silver Mine contains miscellaneous radioactive waste disposed at this site between 1959 and 1964.

An inconsistency exists between the referenced volume of waste in two of the source documents that has not been resolved. The *Records for Land Burial of Solid Radioactive Waste, VII, January, 1963 – December, 1966* (REECo, 1978) indicates a total volume of wastes disposed is 789 ft^3. The *Radioactive Solid Waste Inventories at United States Department of Energy Burial and Storage Sites* (DOE/ID, 1987) lists the total waste volume of NTS Horn Silver Mine as 13 m^3 (450 ft^3). It is not known how much of a duplication is included within these documents. Therefore, it is assumed that there is no duplication and the total amount of waste disposal recorded in these two documents is present in the Horn Silver Mine. The information provided in the 1978 report specific to the Horn Silver Mine is summarized in Table 2-1 (REECo, 1978).

There is a discrepancy between the reported volume of waste disposed in the Horn Silver Mine and the total possible volume. There is 22,400 ft^3 of volume in the 8- by 8-ft shaft from 500 to 150 ft bgs. The reported volumes summarized in Section 2.3 add up to 1,239 ft^3. The depths of waste and fill

Table 2-1
Summary of Radioactive Waste Disposal Records for Horn Silver Mine 1966 to 1972*
(Page 1 of 2)

Date	Description	Origin of Waste	Quantity and Type of Containers	Appr. Total Volume (ft^3)	MR/Hr @ 1 ft (each container)	Estimated Radioactivity (Millicuries)
06/06/1966	(blank)	LRL H&S	medium size plastic bag	2	.08	40,000 cpm (alpha) .003.6 (sic)
08/10/1967	Area 401	410 LRL	7 plastic bags	2	0.3, 0.4, 0.6, 0.1, 0.3, 0.5, 0.4	0.52
02/14/1968	^{131}I, ^{60}Co, MFP, ^{137}Cs	Bldg. 2105	plastic bags 10, 34" x 54" 6, 24"x 36" 8, 12" x 24"	80	1 @ 0.2 remainder @ 0.02	0.14
02/20/1968	classified lab waste	SWRHL-USP HS	4 plastic bags	4	.08	0.256
04/19/1968	Biological samples containing MFP	SWRHL	3, 3' x 18" double plastic bags 1, 2'x 1' double plastic bags 2 boxes (large), 2 small boxes	30	.08	0.128
06/04/1968	^{131}I and MFP	SWRHL	plastic container within double plastic bags 6, 24" x 36", large packages	25	.06	<1
08/01/1968	^{3}H, ^{131}I, MFP, classified	USPHS lab	7 plastic bags	28	2 @ 0.05 2 @ 0.3 2 @ 0.06 1 @ 0.2	5
08/01/1968	MFP classified	USPHS	11 wooden boxes 3' x 1 ½' x 10" 2 boxes 2' x 2' x 6"	36	0.05	0.06
08/30/1968	misc waste from LRL Core Library	LRL Core Library	32 plastic bags 10 wooden boxes	310	500	1.0×10^4
09/10/1968	^{3}H, ^{131}I, SRD soil samples from Project Buggy	USPHS (SWRHL)	2, 34 x 54 bags 3, 24 x 36 bags, 5 cardboard boxes	20	1 bag @ 0.1 1 bag @ 0.05, rest background	0.03
9/18/1968	Classified material	Tweezer	1 plastic bag, 1 cardboard box	5	classified	classified
10/30/1968	MFP SRD samples	SWRHL	14 large plastic bags	70	.05	<1
11/01/1968	detectors classified	U12N	3 cardboard boxes	24	5 (total)	1.0
11/29/1968	SRD vegetation and soil samples, MFP	USPHS SWRHL	10 boxes 1 ¼' x 1 ¼' x 2 ½'	60	.04	<1

Table 2-1
Summary of Radioactive Waste Disposal Records for Horn Silver Mine 1966 to 1972*
(Page 2 of 2)

Date	Description	Origin of Waste	Quantity and Type of Containers	Appr. Total Volume (ft^3)	MR/Hr @ 1 ft (each container)	Estimated Radioactivity (Millicuries)
12/13/1968	^{131}I and MFP	USPHS SWRHL	5, 24 x 36 bags 3, 34 x 54 bags 4 cardboard boxes	15	3 @ 0.1 3 @ 0.2 4 @ 0.05	0.22
01/24/1969	classified	NTS	1 Styrofoam box and loose material	1	no reading	(blank)
03/06/1969	classified electronics	NTS test support	Plastic bags	3	0.1	0.02
04/10/1969	classified	LRL Core Library A-12	7 plastic bags, one cardboard box	30	1,000 (total)	200.0
05/01/1969	helium container	A-11	1 cardboard box	1	classified	classified
05/28/1969	classified	Sandia-BEEZ	1 cardboard box	2	.05	<0.001
09/18/1969	soil samples	Sedan Crater	(5 or 8?) 9 x 14 plastic bags	1	0.2	0.32
11/03/1969	classified	Cypress	1 box	0.5	0.1	0.02
02/16/1970	Project 15.1 & 16.1 residue	U-3ev	4 each plastic bags	16	5	4
04/15/1970	Sedan soil and rock, air filters from other events	Sedan and other events	8, ½ ft^3 bags, 3, 1 ft^3 bags	7	8 @ 0.06 3 @ 0.03	0.11
05/18/1970	classified	Pantex Plant, Area II	2 cardboard boxes	9	0	classified
06/17/1970	classified	LRL 410	one wrapped package, 3" x 18" x 18"	<1	0.04	0.0
09/23/1971	classified soil samples	Ceto	sealed 5 gal cans, five cans	2.5	max 5	5
10/19/1971	classified SRD exempt	Bldg. 5310	1	1	0.3	0.06
10/12/1972	(blank)	410	2 pl. bags	3	0.02 0.03	0.01
Total				789		

Notes:
MFP – Mixed fission products
SRD – Secret Restricted Data
SWRHL – Southwestern Radiological Health Laboratory

*REECo, 1978

also vary from 500 to 279 ft bgs, from 500 to 420 ft bgs, and to 150 ft bgs. Based on these reported volumes and intervals, it is assumed that there are unknown specific volumes and thicknesses of waste and clean fill from 500 to 150 ft bgs. The records for waste disposal are not complete. Although more specific information on wastes placed into the Horn Silver Mine is not available due to access restrictions, it is believed that existing information is sufficient to conduct the CAI.

2.4 Release Information

The preliminary assessment process did not identify any releases from CAU 527 or from adjacent localities that may have impacted CAU 527. The following subsections discuss potential release mechanisms, migration routes, exposure pathways, and affected media.

2.4.1 Transport Mechanisms

Groundwater (perched water and intermittent percolation) and vapor transport, if present, are considered to be the only significant transport mechanisms. Limited transport may have occurred from pulses of infiltrated precipitation. Vapor transport may have also occurred from any material with a high vapor pressure that would result in volatilization at subsurface temperatures.

A contaminant transport mechanism not considered as part of the conceptual site model (CSM) is biota intrusion. Vegetation in the area is primarily creosote. Creosote bushes have extensive root systems that can extend 12 ft or more from the plants. Most of these roots are shallow to access any near-surface water. In sandy soils, the plants can also produce tap roots to obtain water from deeper in the soil profile (Helios, 2002). There is little surface soil near the mine, so deep tap roots are not likely. Burrowing animals could also move contaminated wastes, but the mine was drilled into hard rock, and burrowing animals are assumed to be near the surface and not near the waste.

2.4.2 Preferential Pathways

Two preferential pathways for contaminant migration have been identified. If groundwater is present or large volumes of volatile waste disposal occurred, contaminant migration through the open drifts is considered to be the most likely pathway. Fracture flow in the rock is the only other significant feasible preferential pathway.

2.4.3 Affected Media

It is assumed that surface and near-surface soils are not affected by the waste except by vapor transport/condensation. There is no evidence of surface soil contamination at CAU 527. The waste is contained in the mineshaft (covered by concrete, clean fill, and a locked cover), and is not exposed to the surface.

It is assumed that the subsurface rock is not affected by the waste. The rock surrounding the waste is hard, fractured, tertiary igneous rock. The waste is solid, nonmobile material with no potential for migration into the solid rock. It is assumed that no mechanism exists for the rock to become contaminated by the waste, other than limited surface contact where the waste physically contacts the sides of the mine shaft.

It is assumed that the groundwater, if present, may be affected by the waste. Historical research and nearby drill hole data show that there is no groundwater in the vicinity of CAU 527. There is a 1,400-ft separation between the bottom of the waste and the regional aquifer. There is no record of liquid waste disposal occurring at CAU 527.

2.4.4 Location of Contamination/Release

Any release that may have occurred would be limited to open drifts or fractures.

2.4.5 Lateral and Vertical Extent of Contamination

There may have been limited lateral and vertical contamination migration at the time disposal activities were conducted within open drifts or fractures. This migration could have occurred due to infiltration of precipitation. This contaminant migration could have occurred in pulses. These pulses would have limited effect on the surrounding environment. Vapor transport would also be very limited due to minimal movement of subsurface pore gas.

2.5 Investigative Background

No subsurface investigations have been performed at CAU 527. Surface investigations include a 1991 inventory of inactive and abandoned facilities at the NTS. Corrective Action Unit 527 was described as an abandoned facility used for disposal of radioactive contaminated material and waste (REECo, 1991).

Visual inspections were performed at the site in the 1990s. A 1993 environmental restoration sites inventory aerial photograph interpretation form was completed during a visit to the site (Wilson, 1993). In 1995 and in 1998, CAU 527 site assessments were performed (Harvey, 1995; IT, 1998). The assessments described the site as a 20- by 20-ft fenced off area with "underground radioactive materials" signs posted on all four sides and the locked metal casing. No surface staining or debris was evident during either assessment.

A demarcation survey was performed by Bechtel Nevada Radiological Control personnel at Area 26 in 1998. This demarcation survey consisted of a radiological and geographic survey for determining if radiological posting and barricades are required at NTS sites that are potentially contaminated with radioactive material. The contamination levels from the field gross alpha measurements were above the Electra background reading of 11 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) for one location. The contamination levels from the field gross beta measurements were above the Electra background reading of 806 dpm/100 cm^2 for three locations. The contamination levels from the final alpha measurements were above the Tennelec background reading of 0.3 dpm/100 cm^2 for one location, global positioning system (GPS) Flag #5. The contamination levels from the final beta measurements were above the Tennelec background reading of 24.7 dpm/100 cm^2 for zero locations. The low-energy gamma readings from the Field Instrument for the Detection of Low-Energy Radiation (FIDLER) measurements indicated six locations above the background levels. None of the readings that were elevated were significantly above background to warrant additional investigation (O'Donohue, 2000).

In 1988, DOE/Headquarters performed an environmental survey of the NTS. The resulting environmental survey finding stated that CAU 527 was used for shallow burial of solid waste (Fiore, 1992).

A preliminary assessment of CAU 527 was conducted in 2002 to support the DQO process. Additional research was done on the mine's history, depth, design, and waste in preparation of this CAIP.

In accordance with the NNSA/NV *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed prior to site investigation activities at CAU 527. This checklist will be used by NNSA/NV project personnel to evaluate the proposed project against a list of potential impacts which include air quality, chemical use, waste generation, noise level, and land use. Completion of the checklist results in a determination of the appropriate level of NEPA documentation by the NNSA/NV NEPA Compliance Officer.

3.0 Objectives

This section presents an overview of the DQOs for CAU 527 and the development of the general CSM. Also presented are the COPCs and PALs for this investigation.

3.1 Conceptual Site Model

The CSM describes the most probable scenario for current conditions at CAU 527 (Figure 3-1). It defines the assumptions that are the basis for the site investigation including the contaminant sources, release mechanisms, migration pathways, and exposure limits. The CSM was developed using historical background information as documented in Section 2.0 and knowledge from studies of similar sites. Section A.1.1.3 provides additional information on the CSM development.

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

3.1.1 Future Land Uses

Future land-use scenarios for Area 26, including CAU 527, are limited to industrial uses including research, test, and experimentation. This zone is designated for small-scale research and development projects; demonstrations; pilot projects; outdoor tests; and experiments for the development, quality assurance, or reliability of site conditions to support these activities. It includes compatible defense and nondefense research, development, and testing projects and activities (DOE/NV, 1998).

3.1.2 Exposure Scenarios

Exposure scenarios that are considered part of the CSM are contaminant migration by groundwater to the regional aquifer to a water supply well. The vapor exposure scenario is for vapor transport through open drifts or fractures to the surface.

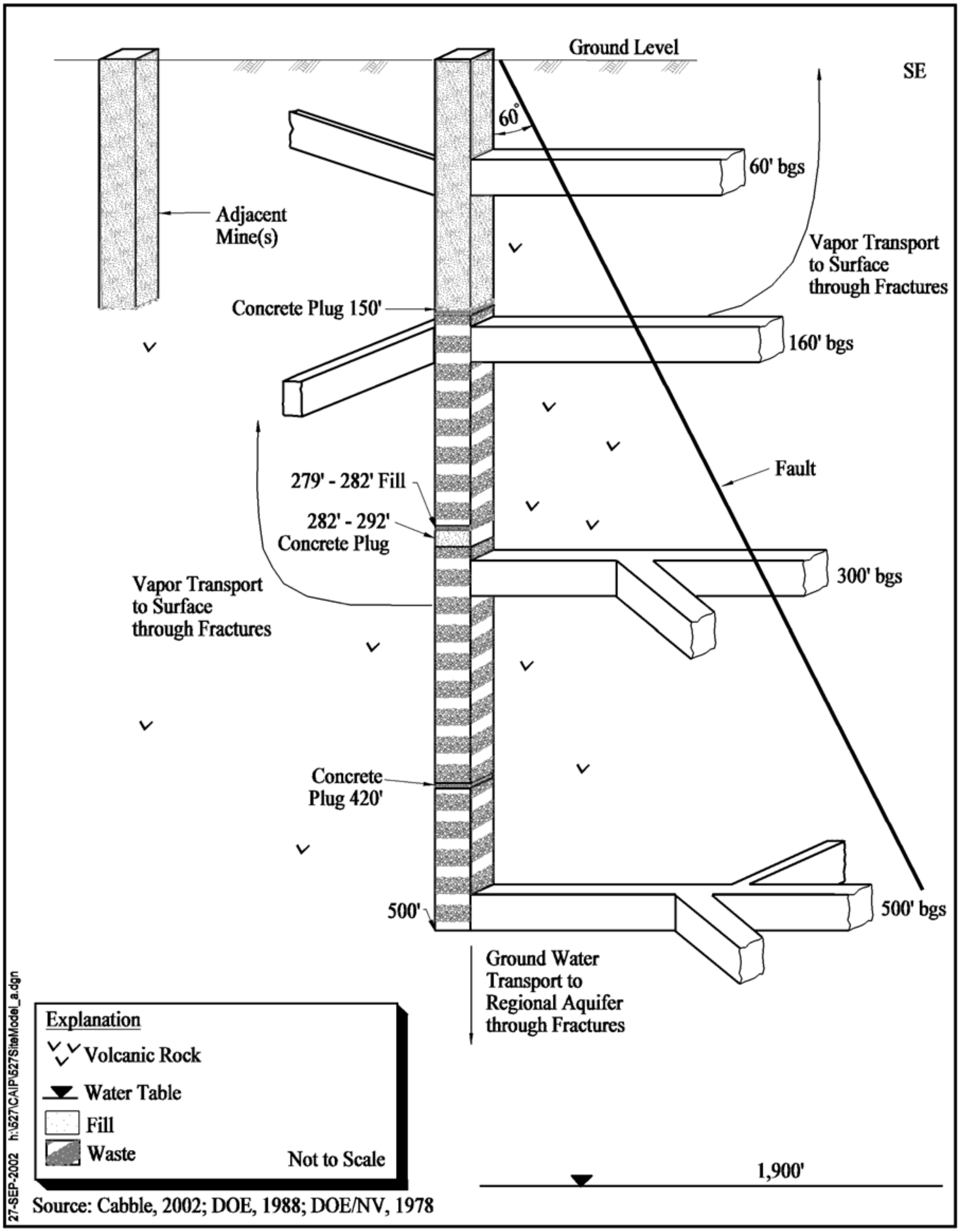

Figure 3-1
CAU 527 Conceptual Site Model

Direct contact with the waste for CAU 527 is prevented through institutional controls under noninvestigation scenarios. It is assumed that locked access to the CAU 527 site as well as the "Underground Radioactive Material" and "Security Area: Do Not Enter" signs will be maintained. Subsurface investigations near the mineshaft will be planned and conducted to avoid contact with the waste. Subsurface activities will be conducted no closer than 50-ft laterally or vertically from the waste based on DOE restrictions. However, during subsurface investigations contact with the waste in the mineshaft could be made by site workers if drilling activities caused inadvertent contact with the waste. Planning of field activities will include taking steps necessary to avoid direct contact with the waste, and health and safety plans will provide for a contingency if administrative controls to avoid contact with the waste fail.

3.1.3 Release Mechanisms and Migration Pathways

The following subsections discuss potential release mechanisms, migration routes, exposure pathways, and affected media.

Transport Mechanisms. Groundwater (perched water and intermittent percolation) and vapor transport, if present, are considered to be the only significant transport mechanisms. Limited transport may have occurred from pulses of infiltrated precipitation. Vapor transport may have also occurred from any material with a high vapor pressure that would result in volatilization at subsurface temperatures.

A contaminant transport mechanism not considered as part of the CSM is biota intrusion. Vegetation in the area is primarily creosote. Creosote bushes have extensive root systems that can extend 12 ft or more from the plants. Most of these roots are shallow to access any near-surface water. In sandy soils, the plants can also produce tap roots to obtain water from deeper in the soil profile (Helios, 2002). There is little surface soil near the mine, so deep tap roots are not likely. Burrowing animals could also move contaminated wastes, but the mine was drilled into hard rock, and burrowing animals are assumed to be near the surface and not near the waste.

Preferential Pathways. Two preferential pathways for contaminant migration have been identified. Contaminant migration through the open drifts, if groundwater is present or large volumes of volatile waste disposal occurred, is considered to be the most likely pathway. Fracture flow in the rock is the only other significant feasible preferential pathway.

Affected Media. It is assumed that surface and near-surface soils are not affected by the waste except by vapor transport/condensation. There is no evidence of surface soil contamination at CAU 527. The waste is contained in the mineshaft, which is covered by concrete, clean fill, a locked cover, and is not exposed to the surface.

It is assumed that the subsurface rock is not affected by the waste. The rock surrounding the waste is hard, fractured, tertiary igneous rock. The waste is solid, nonmobile material with no potential for migration into the solid rock. It is assumed no mechanism exists for the rock to become contaminated by the waste, other than limited surface area where the waste physically contacts the sides of the mine shaft.

It is assumed that the groundwater, if present, may be affected by the waste. Historical research and nearby drill hole data show that there is no groundwater in the vicinity of CAU 527. There is a 1,400-ft separation between the bottom of the waste and the regional aquifer. There is no record of liquid waste disposal occurring at CAU 527.

Location of Contamination/Release. Any release that may have occurred would be limited to open drifts or fractures.

Lateral and Vertical Extent of Contamination. There may have been limited lateral and vertical contamination migration at the time disposal activities were conducted within open drifts or fractures. Migration could have also occurred due to infiltration of precipitation. This contaminant migration would have occurred in pulses. These pulses would have limited effect on the surrounding environment. Vapor transport would also be limited due to minimal movement of subsurface pore gas.

3.1.4 Additional Information

Additional topographic information about CAU 527 will not be necessary because the data available is adequate to make a determination about the site.

The geology including stratigraphy and lithology will be observed and recorded during the corrective action investigation. Adjacent mineshafts that are within the possible zone of influence of the Horn Silver Mine will be investigated to verify depth, presence, and direction of drifts.

Climatic conditions for CAU 527 are well documented and have been addressed in the CSM. No additional information is required.

The hydrogeology will be observed and recorded during the corrective action investigation.

Existing floodplain studies are available and will be considered during corrective action, as necessary. No further information is required.

The presence of infrastructures is known; however, the investigation of CAU 527 will not impact any existing structures in proximity to the site.

3.2 Contaminants of Potential Concern

Types of contaminants that might be present in the waste were identified through a review of site history documentation, process knowledge, personal interviews, and inferred activities associated with CAU 527. The list of radioactive COPCs was created by personnel who researched available disposal records associated with waste. Hazardous COPCs were compiled by assuming that waste segregation was not rigorously practiced in the 1960s and 1970s and compiled through knowledge of COPCs commonly found at NTS disposal sites.

If a contaminant transport mechanism (perched groundwater) is found, laboratory analysis of groundwater will provide the means for quantitative measurement of the COPCs. Samples of core material or cuttings, pore gas, and other liquids will also be submitted for laboratory analysis for quantitative measurement of the COPCs. To assure that laboratory analyses are sufficient to detect contamination in these media at concentrations exceeding the minimum reporting limit (MRL), chemical and radiological parameters of interest have been selected for CAU 527. The COPCs for CAU 527 are listed in Table 3-1.

Table 3-1
Radiological Constituents and COPCs Associated with CAU 527

Chemical Parameters	Radiological Parameters
Analytes reported in: Volatile organic compounds Semivolatile organic compounds Polychlorinated biphenyls Petroleum hydrocarbons (gasoline- and diesel-range organics [C_6-C_{38}]) *Resource Conservation and Recovery Act* metals, plus beryllium, nickel, and zinc	Cesium-137* Cobalt-60* Plutonium Tritium* Strontium-90* Niobium-94 Uranium Mixed fission products*

*Known contaminants

3.3 Preliminary Action Levels

The preliminary action levels associated with the decision statement, "Determine if significant contaminant transport mechanisms (i.e., groundwater and vapor transport), exists near CAU 527 or if contamination migration has occurred within open fractures or drifts," will be established for each decision.

3.3.1 Contaminant Migration Preliminary Action Levels

To determine if contaminant migration has occurred, samples of pore gas, drill core or cuttings, or liquid will be collected and submitted for laboratory analysis. The basis to determine if contaminant migration has occurred will be detection of nonnaturally occurring chemicals or radionuclides greater than achievable detection limits. The minimum reporting limits are specified in Table A.1-4 and Table A.1-5 of Appendix A. If nonnaturally occurring chemicals or radionuclides are detected, then the extent will be determined through modeling.

3.3.2 Contaminant Transport Mechanism Preliminary Action Levels

3.3.2.1 Groundwater

To determine if groundwater is a viable contaminant transport mechanism, direct measurements of groundwater entering the monitoring wells will be made. The criteria for determining if groundwater is entering the monitoring well will be the detection of a water level increase in the monitoring well. This will be measured using a sounding device capable of detecting a 0.5-in. rise in water level. A 1-in. rise in water level within a 48-hour period following purging of the well will be considered to be greater than measurement error; therefore, it is sufficient to make the decision that groundwater exists.

If no water is measured, or if the volume is not sufficient to purge, monitoring will be conducted continuously for one year. The monitoring data will be logged once per 24-hour period to track trends and will consist of measuring groundwater levels in the borehole using electric sounder or electric depth gauge (to determine water level). Standard operating procedures (SOPs) for measuring groundwater in wells will be used.

3.3.2.2 Vapor

To determine if vapor transport has occurred, or is possible, pore gas samples will be collected from within the open drifts or fractures, if possible. To determine if fracture flow is possible, a fracture flow test will be conducted within each of the vertical boreholes. The test will consist of sealing off sections of the borehole with packers, or other appropriate methods, and injecting a tracer gas. Additional sections of the borehole, above and possibly below the injection point, will also be sealed using packers, and pore gas samples will be collected to determine fracture flow rate and distance. A decrease in the concentration of the injected tracer gas within the sealed section of the borehole or detection of the tracer gas outside of the sealed section, within 48 hours of the start of the injection test, will be considered to be sufficient to make the decision that fracture flow is possible.

3.3.3 Remediation Alternatives Preliminary Action Levels

The basis for the remediation alternatives PALs are as follows:

- U.S. Environmental Protection Agency (EPA) *Region 9 Risk-Based Preliminary Remediation Goals* (PRGs) for chemical constituents in industrial groundwater, soils, air (EPA, 2000)
- Background concentrations for *Resource Conservation and Recovery Act* (RCRA) metals will be used instead of PRGs when natural background exceeds the PRG, as is often the case with arsenic; background is considered the mean plus 2x the standard deviation of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the

Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999).

- The total petroleum hydrocarbon (TPH) action limit of 100 parts per million (ppm) per the *Nevada Administrative Code* (NAC) 445A.2272 (NAC, 2000f)
- The action limit of pH < 2 or > 12.5 per the NAC 444.843 (NAC, 2000b)

The PALs for radionuclides are isotope-specific and defined as the maximum concentration for that isotope found in samples from undisturbed background locations in the vicinity of the NTS (Atlan-Tech, 1992; McArthur and Miller, 1989). The PAL is equal to the minimum detectable concentration (MDC) for isotopes not reported in groundwater samples from undisturbed background locations or if the PAL is less than the MDC.

Table A.1-4 and Table A.1-5 provide the analytical methods for the COPCs.

The comparison of laboratory results to PALs will be discussed in the corrective action decision document (CADD). Laboratory results above action levels indicate the presence of COCs. The evaluation of potential corrective actions and the justification for a preferred action will be included in the CADD based on the results of this field investigation. Proposed monitoring and use restrictions will be presented in the CADD.

3.4 DQO Process Discussion

The DQOs are qualitative, semiquantitative, and quantitative statements that define the type, quantity, and quality of data required to support evaluations of potential closure alternatives for CAU 527. The DQOs were developed to identify data needs and clearly define the intended use of the environmental data, and to design a data collection program that will satisfy these purposes.

Details of the DQO process are presented in Appendix A. During the DQO discussion for this CAU, the informal inputs or data needs to resolve problem statements and decision statements were documented. Criteria for data collection activities were assigned. The analytical methods and reporting limits prescribed through the DQO process, as well as the DQIs for laboratory analysis such as precision and accuracy requirements, are provided in more detail in Section 6.0 of this CAIP. Resulting laboratory data will be assessed to confirm or refute the conceptual model and determine if the DQOs were met based on the following DQIs: precision, accuracy, representativeness, completeness, and comparability. Other DQIs, such as sensitivity, may be used.

The DQO decision flow process applied to the CAU 527 investigation is depicted in Figure A.2-1 (DQO Flow Process). This decision process will first determine if a significant contaminant transport mechanism (i.e., groundwater, vapor, or other mechanism), exists near CAU 527 that could transport contamination from the waste disposed in the mineshaft into the surrounding rock, water table, or to the surface. If groundwater exists, it will be tested for COPCs. Samples of drilling core or cuttings and pore gas will also be collected and analyzed for COPCs to determine if contaminant migration has occurred. If COPCs are not above PALs, no further characterization will be required. If contaminants are found in concentrations above PALs in groundwater, pore gas, or drilling core or cuttings, an investigation into the extent of contamination will be initiated. Analytical methods and MRLs for each chemical parameter are provided in Appendix A, Table A.1-4. The MRL is a practical reporting limit that ensures data generated by the laboratory will be usable by the investigation.

Radiological minimum reporting limits were developed considering both the minimum detectable activity (MDAs) and the PALs (Adams and Dionne, 2000). The MDAs, PALs, and MRLs for radionuclides are provided in Appendix A, Table A.1-5. The MDC is the smallest amount of activity of a particular parameter than can be detected in a sample with an acceptable level or error. The MDAs are typical default levels available for a commercial radioanalytical laboratory.

4.0 Field Investigation

This section of the CAIP contains the approach for investigating CAU 527.

4.1 Technical Approach

The technical approach for CAU 527 describes activities to be conducted during the investigation. This technical approach consists of, but is not limited to, the following activities:

- Perform geophysical surveys to verify location and condition of drifts, if feasible.
- Perform subsurface investigation by drilling two vertical boreholes and one angled borehole.
- Conduct gas transport tests to determine potential for contaminant transport through fractures.
- Collect samples of liquids, core materials or cuttings, and pore gas samples to check for possible contaminant transport.
- Take water level measurements to determine if groundwater flow exists following all approved documents for equipment calibration and use.
- Collect samples for analysis following all approved documents for sample collection and analysis, if groundwater exists.
- Collect waste characterization samples, as needed.
- Mark sample locations and collect coordinates in UTM, Zone 11, North American Datum 1927, meters coordinate system.

These activities may be conducted at any point during the investigation as deemed most efficient and appropriate by the site supervisor.

4.2 Field Activities

This section provides a description of the field activities for CAU 527. Field activities will be conducted in accordance with approved plans and procedures including, but not limited to: the field instructions, subcontractor procedures, and other internal Standard Quality Practises (SQPs). A partial listing of possible references is included in Appendix C, Technical Guidance Documents.

4.2.1 Site Preparation Activities

Site preparation may be required by the NTS Management and Operating contractor prior to the investigation. Site preparation may include improving a road up to the Horn Silver Mine and/or improving the drilling locations by leveling the ground.

4.2.2 Drilling

To examine the underground environs (i.e., determine if groundwater exists, and if contaminant migration has occurred or is possible) two vertical boreholes and one angled borehole will be drilled in biased locations no closer than 50 ft from the mineshaft and to a depth of 50 ft below the waste. The boreholes will be put in such that the geology of the borehole most closely approximates the geology of the mineshaft. The proposed locations for the boreholes are shown on Figure 2-2. The exact locations will be determined based on current site conditions and drilling objectives (i.e., intercepting open drifts).

Drilling will be done with a system that will not introduce water into the hole and can drill into the lithology to a depth of 50 ft below the waste (e.g., ODEX or air rotary methods). Exact method and other specific drilling information (e.g., borehole diameter, monitor well diameter, angle of angled borehole) will be determined by the drilling subcontractor selected for the project. Borehole development will likely include some or all the following logs and measurements:

- Electric sounder or electric depth gauge (to determine water level)
- Gyroscopic surveys to determine hole deviation (to maintain buffer perimeter from waste)
- Lithology logging to confirm that the rock is intrusive volcanics
- Caliper logging to measure the diameter and general borehole conditions of the borehole; caliper logging is necessary for more accurate interpretation of other wireline geophysical logs
- Televiewer to characterize fractures

Borehole development may also include the following logs and measurements:

- Gamma ray or spectral gamma ray to determine background (geologic contacts and mineralogy), identify fractures under certain conditions, and may determine where source term exists
- Epithermal neutron to identify formation water content and possibly alteration
- Dual lateralog (or dual induction) to determine lithology, alterations, degree of welding, and geologic contacts, correlation, and some porosity/permeability information
- Total magnetic intensity to identify geologic formations, determination of lithology mineralogy, geologic contacts, and degree of welding, correlation
- Video camera to determine conditions, lithology, contacts, and structural features

4.2.3 Determining if Groundwater Exists

After the first boreholes are established, water level measurements will be taken to determine if the boreholes are dry or, if wet, the water level using standard water level measuring equipment and SOPs. The criteria for determining if groundwater is entering the monitoring well will be the detection of a water level increase in the monitoring well. This will be measured using a sounding device capable of detecting a 0.5-in. rise in water level. A 1-in. rise in water level within a 48-hour period following purging of the well will be considered to be greater than measurement error; therefore, it is sufficient to make the decision that groundwater exists.

Monitoring will be conducted continuously for one year, and data will be logged once per 24-hour period to track trends. The data logging will consist of measuring groundwater levels in the borehole using electric sounder or electric depth gauge (to determine water level). The SOPs for measuring groundwater in wells will be used. A determination will be made after one year, if additional monitoring is required. The determination may be based on some or all of, but not limited to: groundwater-level measurement results and precipitation amounts (i.e., average, above or below average for the year). The decision to continue monitoring, or not, will be agreed upon by NNSA/NV and NDEP and documented.

4.2.4 Determine if Vapor Contamination Migration Has Occurred

Contamination with high vapor pressures may volatilize, and the resulting vapors could be transported through the open drifts and fractures. The vapor transport will be investigated by attempting to drill into the open drifts at 300 and 500 ft bgs to collect pore gas samples. To determine if vapor transport has occurred pore gas samples will be collected from within the open drifts or fractures, if possible.

4.2.5 Determine if Fracture Flow is Feasible

To determine if fracture flow is feasible, a fracture flow test will be conducted within each of the vertical boreholes. The test will consist of sealing off sections of the borehole with packers, or other appropriate methods, and injecting a tracer gas. Additional sections of the borehole, above and possibly below the injection point, will also be sealed using packers, and pore gas samples will be collected to determine fracture flow rate and distance.

4.2.6 Determine if Residual Contamination is Present

Intermittent contaminant migration may occur as a result of pulses of infiltrated precipitation or vapor flow. This intermittent driver for contaminant migration may have left residual COPCs within the open fractures. This will be investigated by sending core samples or cuttings for laboratory analysis.

Samples of any groundwater found, drilling core or cuttings, and pore gas will be taken for analysis to determine if COCs have migrated from the waste.

4.2.7 Determining the Nature of Contamination

To determine the presence and nature of contamination, groundwater, drilling core or cuttings, and pore gas found will be sampled for analysis. Tables A.1-4 and A.1-5 provide the analytical methods and laboratory requirements (i.e., detection limits, precision, and accuracy requirements) to be used when analyzing the COPCs. All sampling activities and quality control requirements for field and laboratory environmental sampling will be conducted in compliance with the Industrial Sites QAPP (NNSA/NV, 2002) and other applicable procedures. Other governing documents include the ITLV HASP (IT, 2001) and the site-specific health and safety plan (SSHASP) that will be prepared and approved prior to the field effort.

4.2.8 Determining the Extent of Contamination

To determine the extent of contamination, computer modeling will be done to estimate the groundwater regime and fate and transport of contaminants (if any contamination is found in liquid, pore gas, core samples, or cuttings). Drilling of the boreholes will consider the needed inputs for a computer model that will be used if groundwater is found. These data sources may include field examination of drill core to characterize the rock structure and mineralization. A borehole televiewer (i.e., soundwaves) will characterize fractures. Groundwater sampling data that determines that COCs are present will also be put into the model. The lateral and vertical extent of contamination will be bounded by a minimum of one laboratory analytical soil sample showing COC concentrations below PALs.

The spatial boundaries that apply to CAU 527 for the determination of extent of investigation activities are as follows:

- Laterally – 50 ft from the 8 ft perimeter of the mineshaft
- Vertically – ground surface to 50 ft below the waste

If contamination extends beyond these spatial boundaries, work will be temporarily suspended, NDEP will be notified, and the investigation strategy will be reevaluated.

Administrative Considerations. Modifications to the investigation strategy may be required should unexpected field conditions be encountered. Significant modifications will be justified in a record of technical change (ROTC). The NDEP's concurrence with the ROTC is required prior to proceeding with investigation activities significantly different from those described in this document. If vertical contamination is more extensive than anticipated, the maximum investigation depth will be limited by the capabilities of the equipment used to collect subsurface soil samples. If this occurs, the investigation will be rescoped.

As required by the DOE Integrated Safety Management System (ISMS) (DOE, 1997), these documents outline the requirements for protecting the health and safety of the workers and the public, and procedures for protecting the environment. The ISMS program requires that site personnel take every reasonable step to reduce or eliminate the possibility of injury, illness, or accidents, and to protect the environment during all project activities. The following safety issues will be taken into consideration when evaluating the hazards and associated control procedures for field activities discussed in the SSHASP:

- Potential hazards to site personnel include abandoned mineshafts in the immediate area, adverse and rapidly changing weather, remote location, motor vehicle and heavy equipment operations, and radionuclides and chemicals (i.e., COPCs).

- Proper training of all site personnel to recognize and mitigate the anticipated hazards.

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

- Occupational exposure monitoring to prevent overexposures to hazards such as radionuclides, chemicals, and physical agents (e.g., heat, cold, and high wind).

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

5.0 Waste Management

Management of IDW will be based on regulatory requirements, field observations, process knowledge, and the results of laboratory analysis of CAU 527 investigation samples. Disposable sampling equipment, PPE, and rinsate are considered potentially contaminated waste by virtue of contact with potentially contaminated media (e.g., soil) or potentially contaminated debris (e.g., construction materials). Decontamination activities will be performed according to approved procedures and as appropriate for the COPCs likely to be identified at CAU 527.

Sanitary, hazardous, radioactive, and/or mixed waste, if generated, will be managed and disposed of in accordance with DOE Orders, U.S. Department of Transportation (DOT) regulations, RCRA regulations, *Nevada Revised Statutes* (NRS), and agreements and permits between the DOE and NDEP. Asbestos-containing materials will be managed and disposed of in accordance with appropriate regulations. Materials that are thought to potentially contain the hantavirus will be managed and disposed of in accordance with appropriate health and safety procedures.

All waste from CAU 527 will be evaluated against characteristic standards, as no listed organic constituents have been identified. Process knowledge indicates that some CAU 527 locations may be contaminated with radioactive and hazardous constituents. To allow for the segregation of radioactive and nonradioactive waste and materials, radiological swipe and/or direct surveys may be conducted on reusable sampling equipment, PPE, and disposable sampling equipment waste streams exiting the controlled area. Removable contamination limits, as defined in Table 4-2 of the current *NV/YMP Radiological Control Manual* (DOE/NV, 2000), shall be used to determine the release status of such materials.

Applicable waste management regulations and requirements are listed in Table 5-1.

5.1 Waste Minimization

Corrective action investigation activities have been planned to minimize IDW generation. All IDW will be segregated to the greatest extent possible. Hazardous materials used at sites will be minimized to limit the unnecessary generation of hazardous and/or mixed wastes. Decontamination activities will be planned and executed to minimize the volume of rinsate.

Table 5-1
Waste Management Regulations and Requirements

Waste Type	Federal Regulation	Additional Requirements
Solid (nonhazardous)	NA	NRS 444.440 - 444.620[a] NAC 444.570 - 444.7499[b] NTS Landfill Permit SW13.097.02[c] State of Nevada Solid Waste Disposal Site Permit SW1309703[d]
Liquid/Rinsate (nonhazardous)	NA	NTS Waste Water Facility Permit GNEV93001, Rev. 3iii[e]
Hazardous	RCRA[f]	NRS 459.400 - 459.600[g] NAC 444.850 - 444.8746[h] POC[i]
Low-Level Radioactive	NA	DOE Orders and NTSWAC[j]
Mixed	RCRA[f]	NTSWAC[j] POC[i]
Polychlorinated Biphenyls	TSCA[k]	NRS 459.400 - 459.600[g] NAC 444.940 - 444.9555[l]
Asbestos	TSCA[m]	NAC 444.965-444.976[n]

[a]*Nevada Revised Statues* (NRS, 1998a)
[b]*Nevada Administrative Code* (NAC, 2002a)
[c]Area 6 Hydrocarbon Landfill, Nevada Division of Environmental Protection (NDEP, 1997b)
[d]Area 9 Solid Waste Landfill (NDEP, 1997c)
[e]State of Nevada Water Pollution Control Permit Nevada Division of Environmental Protection (NDEP, 1999)
[f]*Resource Conservation and Recovery Act* (CFR, 2001a)
[g]*Nevada Revised Statues* (NRS, 1998b)
[h]*Nevada Administrative Code* (NAC, 2002b)
[i]*Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995)
[j]Nevada Test Site Waste Acceptance Criteria, Revision 4 (NNSA/NV, 2002b)
[k]*Toxic Substance Control Act* (40 CFR 761) (CFR, 2001d)
[l]*Nevada Administrative Code* (NAC, 2002c)
[m]*Toxic Substance Control Ac*t (40 CFR 763) (CFR, 2001e)
[n]*Nevada Administrative Code* (NAC, 2002d)

NA = Not applicable

5.2 Potential Waste Streams

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

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

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

5.3 Investigation-Derived Waste Management

The on-site management and ultimate disposition of IDW may be guided by several factors, but not limited to: the analytical results of samples either directly or indirectly associated with the waste, historical site knowledge, knowledge of the waste generation process, field observations, field monitoring/screening results, and/or radiological survey/swipe results. Table 4-2 of the current *NV/YMP Radiological Control Manual* (DOE/NV, 2000) shall be used to determine if such materials may be declared nonradioactive. The IDW will be characterized as radioactive or “nonradioactive” based on results. Management requirements for sanitary, low-level, hazardous, or mixed wastes are discussed in the following sections.

5.3.1 Sanitary Waste

Sanitary waste will be contained in plastic bags or an appropriate receptacle and will be transported to a solid waste management unit. The IDW generated within the controlled area will be swiped and/or surveyed, as appropriate, to determine if the removable contamination is under the limits defined in Table 4-2 of the current *NV/YMP Radiological Control Manual* (DOE/NV, 2000). The IDW will be characterized as radioactive or "nonradioactive" based on results.

5.3.2 Hydrocarbon Waste

The action level for soil contaminated with hydrocarbons is 100 milligrams per kilogram (mg/kg) in the State of Nevada (NAC, 2002e). Soils and associated IDW with TPH levels above 100 mg/kg, provided that other regulated constituents are below regulatory limits, shall be managed as hydrocarbon waste and disposed of in accordance with all applicable regulations.

5.3.3 Hazardous Waste

This CAU will have hazardous waste accumulation areas (HWAAs) and/or satellite accumulation areas (SAAs) to accumulate waste that potentially is classified as hazardous. The HWAAs will be properly controlled for access and will be equipped with spill kits and appropriate spill containment. All containers in HWAAs will be managed consistent with the requirements of 40 CFR 265 Subpart I. A "Hazardous Waste Pending Analysis" (CFR, 2001a) marking will be placed on the containers of waste until such time that waste characterization is complete. Once the waste is characterized, containers of waste determined to be hazardous will be clearly marked or labeled with the words "Hazardous Waste." The HWAAs will be inspected weekly and will be covered under a site-specific emergency response and contingency action plan until such time that the waste is determined to be nonhazardous or all containers of hazardous waste have been removed from the accumulation area.

If SAAs are established, they will be managed in accordance with 40 CFR 262.34(c) (CFR, 2001c). The SAAs may be employed to temporarily accumulate small quantities of waste classified as potentially hazardous.

5.3.3.1 Personal Protective Equipment

Personal protective equipment, disposable sampling equipment, and debris will be visually inspected for gross contamination (e.g., clumps of soil) and segregated as it is generated. Grossly contaminated PPE/equipment will be managed as potentially "characteristic" hazardous waste. This segregated population of waste will either be (1) assigned characterization based on analysis of the soil that was sampled, (2) sampled directly, or (3) undergo further evaluation using the soil sample results to determine how much soil would need to be present in the waste to exceed regulatory levels. Waste that is determined to be hazardous will be entered into an approved waste management system (i.e., any appropriate facility used for the storage, treatment, or disposal of hazardous IDW generated during FFACO site investigations), where it will be managed and dispositioned according to the requirements of RCRA or subject to agreements between NNSA/NV and NDEP.

The PPE/equipment that is not visibly stained, discolored, or grossly contaminated will be managed as it is generated as nonhazardous waste, and disposed of as sanitary or LLW depending on the concentration of radioactive contamination, if present.

5.3.3.2 Rinsate

Decontamination rinsate will initially be evaluated using analytical results for samples associated with the rinsate (i.e., soil sample results from excavation or sampling activities associated with the generation of rinsate). Decontamination rinsate at this site will not be considered hazardous waste unless there is evidence that the rinsate displays a RCRA characteristic. Evidence may include such things as hazardous constituents in associated samples, the presence of a visible sheen, pH, or association with equipment/materials used to respond to a release/spill of a hazardous waste/substance. The regulatory status of the rinsate may also be determined through direct sampling. If determined to be hazardous, the rinsate will be entered into an approved waste management system where it will be managed and dispositioned according to the requirements of RCRA or subject to agreements between NNSA/NV and NDEP.

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

- Rinsate that is determined to be nonhazardous and contaminated to less than 5 times *Safe Drinking Water Standards* (SDWS) is not restricted as to disposal.
- Nonhazardous rinsate which is contaminated at 5 to 10 times SDWS will be disposed of in an established infiltration basin or solidified and disposed of as sanitary or low-level waste, depending on the concentration of radioactive contamination, if present.
- Nonhazardous rinsate which is contaminated at greater than 10 times SDWS will be disposed of in a lined basin, or solidified and disposed of as sanitary or low-level waste depending on the concentration of radioactive contamination, if present.

5.3.3.3 Field-Screening Waste

The use of field test kits and/or instruments may result in the generation of small quantities of hazardous wastes. If hazardous waste is produced by field screening, it will be segregated from other IDW and managed as a separate waste stream.

5.3.3.4 Soil

This waste stream consists of soil produced during soil sampling, excavation, and/or drilling. This waste stream is considered to have the same COPCs as the material remaining in the ground. Regardless of the COPCs at the site (i.e., listed or not listed), the preferred method for managing this waste stream is to place the material back into the borehole/excavation in the approximate location from which it originated. If this cannot be accomplished, the material will either be managed on site by placement next to the excavation with berming and covering or by placement in a container(s). Material that is containerized at a site where hazardous constituents are COPCs will be marked "Hazardous Waste Pending Analysis." The disposition of containerized material may be deferred until implementation of corrective action at the site.

5.3.4 Low-Level Waste

Suspected low-level waste will be managed in accordance with the contractor-specific waste certification program plan, contractor-specific procedures, and the *Nevada Test Site Waste Acceptance Criteria* (NTSWAC) (NNSA/NV, 2002b). The IDW will be staged at a designated radiological controlled area (RCA) or radioactive materials area (RMA) pending certification and disposal under NTSWAC requirements (NNSA/NV, 2002b). Waste drums will be labeled "Radioactive Material Pending Analysis."

If radiological COPCs are expected at any CAS addressed by this plan, waste may be characterized by incorporating the use of process knowledge, analytical results of direct or associated samples, visual examination, radiological surveys, and swipe results. Radiological swipe surveys and/or direct-scan surveys may be conducted on reusable sampling equipment, PPE, and disposable sampling equipment waste streams exiting a radiologically controlled area. This allows for the immediate segregation of radioactive waste from waste that may be unrestricted with regard to radiological release. Removable contamination limits, as defined in Table 4-2 of the current version of the *NV/YMP Radiological Control Manual* (DOE/NV, 2000), may be used to determine if such waste may be declared unrestricted regarding radiological release versus being declared radioactive waste. Direct sampling of the waste may be conducted to aid in determining if a particular waste unit (e.g., drum of soil) contains LLW, as necessary. Waste that is determined to be below the values of Table 4-2 of the current version of the *NV/YMP Radiological Control Manual* (DOE/NV, 2000), by either direct radiological survey/swipe results or through process knowledge, will not be managed as potential radioactive waste, but will be managed in accordance with the appropriate section of this plan. Wastes in excess of Table 4-2 of the current version of the *NV/YMP Radiological Control Manual* (DOE/NV, 2000) values will be managed as potential radioactive waste and be managed in accordance with Section 5.0 of this plan, the contractor-specific waste certification program plan, DOE Orders, and the requirements of the NTSWAC (NNSA/NV, 2002b). Potential radioactive waste drums containing soil, PPE, disposable sampling equipment, and/or rinsate shall be staged at a designated RMA when full or at the end of an investigation phase. The waste drums will remain at the RMA pending certification and disposal under NTSWAC requirements (NNSA/NV, 2002b).

5.3.5 Mixed Wastes

Mixed waste, if generated, shall be managed in accordance with RCRA (40 CFR 262) (CFR, 2001b) and State of Nevada requirements. These regulations, as well as NNSA/NV requirements for radioactive waste, are interpreted as follows. Where there is a conflict in regulations or requirements, the most stringent shall apply. For example, weekly inspections per RCRA regulations will be applied to mixed waste even though it is not required for radioactive waste.

In general, mixed waste shall be managed in the same manner as hazardous waste, with additional mandatory radioactive waste management program requirements. Pending characterization and confirmation of its regulatory status, suspected mixed waste will be managed in accordance with applicable regulations and requirements, and will be marked with the words "Hazardous Waste Pending Analysis." The potentially mixed waste will be managed and dispositioned according to the requirements of RCRA or subject to agreements between NNSA/NV and NDEP, and shall be transported via an approved hazardous waste transporter to the NTS transuranic waste storage pad for storage pending treatment or disposal. Mixed waste with hazardous waste constituents below land disposal restrictions may be disposed of at the NTS Area 5 Radioactive Waste Management Site, if the waste meets the requirements of the NTSWAC. Mixed waste not meeting land disposal restrictions will require development of a treatment and disposal plan under the requirements of the *Mutual Consent Agreement* between DOE and the State of Nevada (NDEP, 1995).

6.0 Quality Assurance/Quality Control

The primary objective of the characterization activities described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for CAU 527. Sections 6.1 and 6.2 discuss the QA and QC of the field sampling performance, including the collection of field QC samples, and the QA/QC requirements for laboratory performance and data quality (i.e., acceptability and usability) for use in the decision-making process to achieve closure. Data collected during the corrective action investigation will be evaluated against DQI-specific performance criteria to verify that the DQOs established during the DQO process (Appendix A) have been satisfied.

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

6.1 Quality Control Field Sampling Activities

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

- Trip blanks (1 per sample cooler containing volatile organic compound environmental samples)
- Equipment blanks (1 per sampling event for each type of decontamination procedure)
- Source blanks (1 per lot of source material that contacts sampled media)
- Field duplicates (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)
- Field blanks (1 per 20 environmental samples)
- Matrix spike/matrix spike duplicate (MS/MSD) (1 per 20 environmental samples or 1 per CAS per matrix, if less than 20 collected)

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

6.2 Laboratory/Analytical Quality Assurance

The DQOs (Appendix A) require laboratory analytical quality data be used for making critical decisions. Rigorous QA/QC will be implemented for all laboratory samples including documentation, data verification and validation of analytical results, and an assessment of DQIs as they relate to laboratory analysis.

6.2.1 Data Validation

Data verification and validation will be performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002a), except where otherwise stipulated in this CAIP. All nonradiological laboratory data from samples collected and analyzed will be evaluated for data quality according to *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 1994) and *EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999). Radiological laboratory data from samples that are collected and analyzed will be evaluated for data quality according to company-specific procedures. The data will be reviewed to ensure that all critical samples were appropriately collected, analyzed, and the results passed data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine if they meet the DQO requirements of the investigation and the performance criteria for the DQIs. The results of this assessment will be documented in the CADD. If the DQOs were not met, corrective actions will be evaluated, selected, and implemented (e.g., refine CSM or resample to fill data gaps).

6.2.2 Data Quality Indicators

Data quality indicators are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. The DQIs established to evaluate the quality of CAU 527 data are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Data quality indicators are used to evaluate the entire measurement system and laboratory measurement processes (i.e., analytical method performance) as well as to evaluate individual analytical results (i.e., parameter performance).

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

Representativeness and comparability are qualitative measures, and completeness is a quantitative measure. Representativeness, comparability, and completeness are used to assess the measurement system performance.

Table 6-1 provides the established analytical method/measurement system performance criteria for each of the DQIs and the potential impacts to the decision if the criteria are not met. The Industrial Sites QAPP (NNSA/NV, 2002a) requires conditions (i.e., nonconformances) that adversely affect data quality, both in the field and the laboratory, be documented. All DQI performance criteria deficiencies will be evaluated for data usability and impacts to the DQO decisions. These evaluations will be discussed and documented in the data assessment section of the CADD.

Table 6-1
Laboratory/Analytical Data Quality Indicators

Data Quality Indicator	Performance Criteria	Potential Impact on Decision if Performance Criteria Not Met
Precision	Uncertainty associated with each measurement system is sufficiently controlled to confidently compare analytical results to action levels.[a]	Estimated data within sample delivery group (SDG) will be evaluated for its usability. If data determined not usable, then data will not be used in decision and completeness criteria will not be met.
Accuracy	Uncertainty associated with each measurement system is sufficiently controlled to confidently compare analytical results to action levels.[b]	Estimated data within SDG will be evaluated for its usability. If estimated data is biased high or conservative, the data may be used in decision. If estimated data biased low and below the decision threshold, the data may not be used in decision and completeness criteria may not be met.
Sensitivity	Detection limits of laboratory instruments must be less than respective PALs.	Cannot determine if COCs are present at levels of concern; therefore, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives.
Nature of Contamination Completeness	100% of locations identified in DQOs are sampled. 100% of analyses are required by CAIP. 100% of critical parameters are valid. 80% of noncritical parameters are valid.	Cannot make decision on whether COCs are present above PALs with high confidence.
Extent of Contamination Completeness	100% of locations identified in DQOs are sampled. 100% of analyses are required by CAIP. 100% of critical parameters are valid. 80% of noncritical parameters are valid.	Decision of whether or not extent of contamination has been bounded cannot be determined.
Comparability	Consistent sampling, handling, preparation, analysis, reporting, and validation criteria will be used. Approved standard methods and procedures will be used to analyze and report the data.	Inability to compare results to established decision levels.
Representativeness	Correct analytical method performed for appropriate COPC; valid data reflects appropriate target population.	Cannot identify COC or estimate concentration of COC; therefore, cannot make decision(s) on target population.

[a]Variations between duplicates (field and lab and original sample should not exceed analytical method-specific criteria listed in Table A.1-4.
[b]Laboratory control sample results matrix spike results and surrogate results should be within analytical method-specific criteria established by the laboratory or listed in Table A.1-4.

7.0 Duration and Records Availability

7.1 Duration

After the submittal of the CAIP to NDEP (FFACO milestone date of December 2, 2002), the following is a tentative schedule of activities (in calendar days):

- Day 0: Preparation for field work will begin, including completion of geophysical surveys and, if necessary, the revision of planning documents based on geophysical survey results.
- Day 150: The field work, including sample collection activities, will commence. Samples will be shipped to meet laboratory holding times.
- Day 210: The field investigation will be completed.
- Day 275: The quality-assured laboratory analytical data will be available for NDEP review.
- The FFACO date for the CADD is March 31, 2004.

7.2 Records Availability

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

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WRCC, see Western Regional Climate Center.

Appendix A

DQO Process

A.1.0 Seven-Step DQO Process for CAU 527 Site Investigation

The DQO process is a strategic planning approach based on the scientific method that is used to prepare for site characterization data collection (EPA, 1994c). The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend potentially viable corrective actions (e.g., no further action or monitoring). The existing information about the nature and extent of contamination at CAU 527, CAS 26-20-01, Horn Silver Mine is insufficient to evaluate and select a preferred corrective action. This investigation will be based on DQOs developed by representatives of NDEP and NNSA/NV.

The investigation will determine if a significant contaminant transport mechanism (e.g., groundwater) exists in the vicinity of CAU 527. Without a transport mechanism, contamination cannot migrate or pose a threat to human health or the environment. If groundwater flow is present, samples will be collected to determine if COPCs are present at concentrations above PALs. In addition, the investigation will determine if contaminant migration pathways exist in open fractures or drifts.

If migration mechanisms are present, the investigation will determine if significant contaminant migration (i.e., liquid or vapor) has occurred near CAU 527. Samples of liquid, pore gas, and core material will be sampled to determine if COPCs are detected, and, if so, at concentrations above PALs.

A.1.1 Seven-Step DQOs Process for the Contaminant Transport Mechanisms Investigation

This section discusses the DQO process for the contamination transport mechanism investigation for CAU 527.

Step 1 – State the Problem

This section identifies the DQO planning team members, states the problem that initiated the CAU 527 site investigation, and develops a CSM.

A.1.1.1 Planning Team Members

The DQO planning team consists of representatives from NDEP, NNSA/NV, ITLV, and Bechtel Nevada. The primary decision-makers include NDEP and NNSA/NV representatives. Table A.1-1 lists representatives from each organization in attendance for the June 5, 2002, DQO kickoff meeting.

Table A.1-1
DQO Meeting Participants

Participant	Title/Affiliation
Beckley, Karen	NDEP
Cabble, Kevin	NNSA/NV
Cooper, Malu	ITLV
Doyle, Gregory	BN
Elle, Don	NDEP
Emer, Dudley	BN
Johnson, Jeff	ITLV
Kidman, Lynn	ITLV
Liebendorfer, Paul	NDEP
Tinney, Joseph	ITLV
Fowler, John	ITLV

BN = Bechtel Nevada
NNSA/NV = U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office
NDEP = Nevada Division of Environmental Protection
ITLV = IT Corporation, Las Vegas

A.1.1.2 Describe the Problem

CAU 527 is being investigated to determine if radioactive and/or hazardous constituents from waste and material disposed in the Horn Silver Mine pose an unacceptable risk to human health and the environment.

A.1.1.3 Develop Conceptual Site Model

The CSM describes the most probable scenario for current conditions at a site and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. An accurate CSM serves as the basis for all subsequent inputs and decisions throughout the DQO process. If the CSM is found to be inaccurate during the site investigation, the DQOs will be revised.

Future Land-Use Scenarios. Future land-use scenarios limit future uses of CAU 527 and Area 26 to industrial research, tests, and experiments (DOE/NV, 1998). This zone is designated for small-scale research and development projects; demonstrations; pilot projects; outdoor tests; and experiments for the development, quality assurance, or reliability of conditions. It includes compatible defense and nondefense research, development, and testing projects and activities. It is assumed that, for the foreseeable future, the controlled access to the CAU 527 site as well as the "Underground Radioactive Material" and "Security Area: Do Not Enter" signs will be maintained.

Human exposure scenarios for sites located within the NTS boundaries are limited by the future land-use scenarios to site workers who may be exposed to COPCs through oral ingestion, inhalation, or dermal contact due to inadvertent disturbance of these wastes.

A.1.1.3.1 General Conceptual Site Model

Figure A.1-1 shows the generalized CSM. The CAU 527 CSM was developed using historical background information including correspondence from Mr. Lawry (mining superintendent to Mr. Wingfield, mine financier) (Lawry, 1929a and b), which documents the development of the Horn Silver Mine in 1928 and 1929. This correspondence provides drawings and accurate descriptions of the depth of the mineshaft and the location of the mine drifts. It also provides detailed information about the geology including the volcanic lithology; fault location, strike, and dip; and provides statements that no groundwater was encountered during mine development. Information on the waste location, volume, and types was identified through DOE documents. The current site conditions, including location of other mines in the area, were documented during site visits. Specific elements of the conceptual site model are discussed in the following subsections.

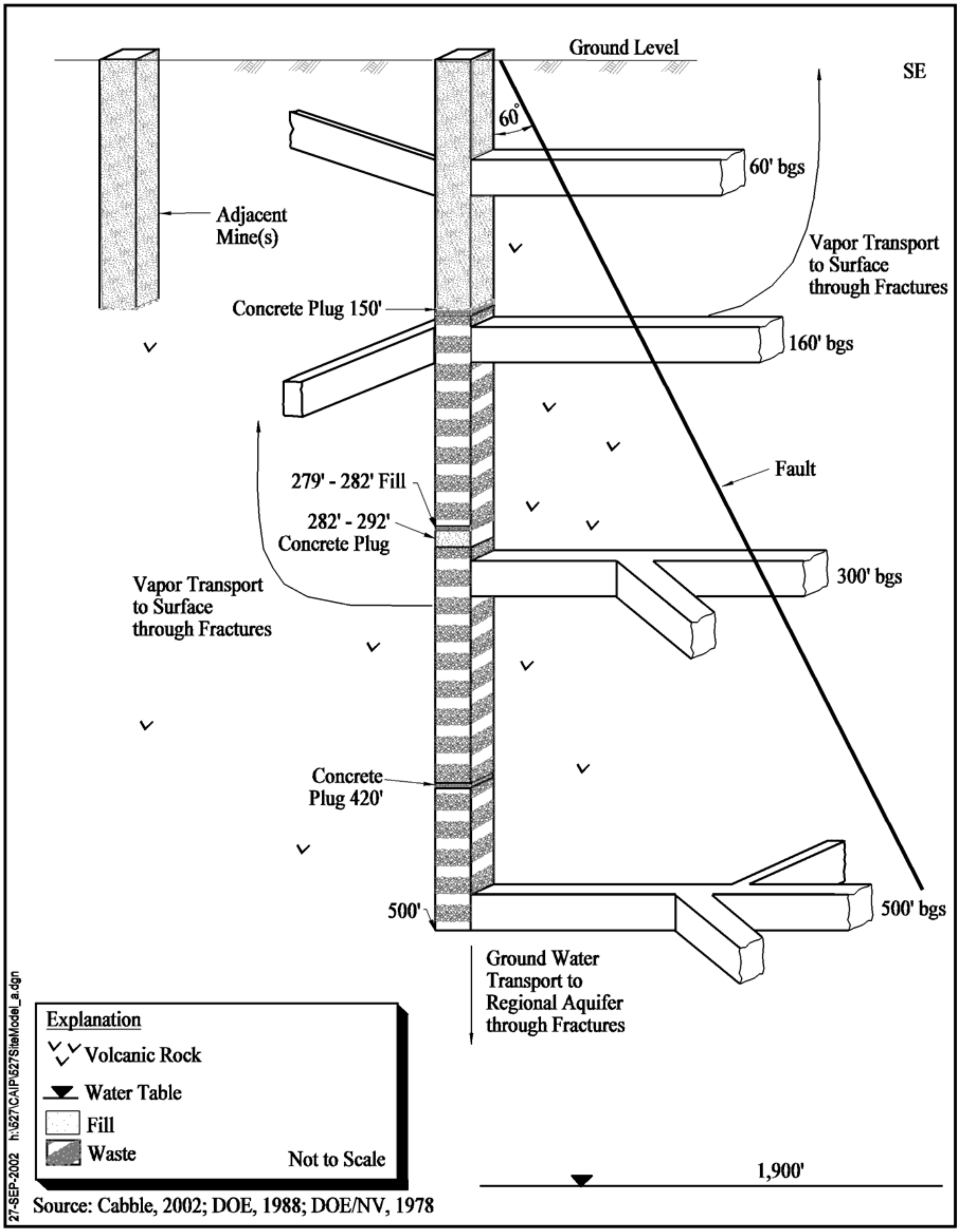

Figure A.1-1
CAU 527 Conceptual Site Model

Geology. The Horn Silver Mine was sunk into an early Tertiary intrusive that is part of the Wahmonie Formation (Plate 1). The geology of the area is typified by early Tertiary intrusives, largely monzonite porphyry, and later basalt flows. The Wahmonie Formation is a maximum of 5,700-ft thick. The principal lithology of the Wahmonie Formation is hydrothermally altered calc-alkaline volcanic rocks including andesite, latite, and dacite volcanic breccia (lava and nonwelded tuff). Rhyolite (quartz and alkalic feldspar) intrusions are found locally in the granitic porphyry (Kral, 1951). High-grade, silver-gold mineralization associated with a zone of alteration can be traced on the surface for 3 mi northeast and 5 mi southwest of the Horn Silver Mine (Quade and Tingley, 1983). The area is intensely fractured (Tingley, 1982). Prospectors were attracted to the area by then exposed, mineral-rich rhyolite. A normal fault, trending N30E and dipping 60 degrees to the southeast, runs through the mineshaft opening (Lawry, 1928).

Most of the surface soils at the NTS have developed on the alluvial deposits under conditions of high temperatures and low precipitation. They exhibit characteristics of desert soils: coarse texture, an accumulation of carbonates within a few feet of the surface contributing to formation of a caliche layer, and low organic matter content (REECo, 1980). The immediate area of the mine is surrounded by mining overburden.

Historical Mining Information. Corrective Action Unit 527, Horn Silver Mine, is in the Wahmonie mining district, which lies in the southwestern quadrant of Area 26. In the 1850s and again in the late 1920s, the Wahmonie mining district was prospected for minerals. The Wahmonie mine workings cover an area of approximately three square miles (*Tonopah Daily Times*, 1928) and consists of the Horn Silver Mine and at least six shallow shafts (Quade and Tingley, 1983). Correspondence from the mine superintendent Mr. Lawry to Mr. Wingfield (who financed the mining operations in 1928 and 1929) documents that ore production occurred in 1928 when a high-grade, silver-gold ore was discovered at the Horn Silver Mine, but that ore production was limited and the mine was abandoned in 1929 (Lawry, 1929a and b).

The mineshaft is relatively narrow and deep. The mineshaft is approximately 8- by 8-ft wide. Although several DOE documents state the mineshaft's depth was 200 ft, correspondence from Mr. Lawry to Mr. Wingfield dated April 18, 1929, describes the sinking of the mineshaft to a depth of 500 ft. The document also describes the development of drifts at 60, 160, 300, and 500 ft bgs

(Lawry, 1929a). Approximately 1,340 ft of workings were developed (Mines, 1931). The mine was sunk into highly mineralized, hard, fractured, tertiary igneous rock.

A historical plan indicates two small shafts associated with the Horn Silver Mine. The first shaft is approximately 30 ft east of the main shaft and is believed to be have been associated with the 60 ft bgs drift. The purpose of this shaft is unclear. The second shaft is approximately 50 ft west of the main shaft and is believed to be the result of limited surface excavation. Both of these shafts appear to have been covered by the spoils pile around the main shaft, and there are no current surface indications of either shaft. These shafts are not considered to be open conduits for contaminant transport from waste disposal activities in the Horn Silver Mine; therefore, they are not considered to be part of the CSM.

Reviewed documents identify at least six shallow shafts in the vicinity of the Horn Silver Mine (Quade and Tingley, 1983). A recent site visit located 13 covered shafts from approximately 190 to 1,000 ft from the Horn Silver Mine. In addition to the covered shafts, there are numerous shallow (less than 10 ft deep) exploratory holes. Historical records indicate that the covered shafts or workings were of limited depth (i.e., less than 100 ft). Only one of the other mines have documented drifts. The other open mine shafts in the vicinity of the Horn Silver Mine are not believed to be connected to the Horn Silver Mine. Therefore, they are not considered to be viable transport conduits for contaminant transport from waste disposal activities in the Horn Silver Mine, and are not considered to be part of the CSM.

Groundwater. An important element of this CSM is the presence/absence of groundwater from ground surface to 500 ft bgs and throughout the lengths of the drifts at 60, 160, 300, and 500 ft bgs. This is due to the type of waste disposed (i.e., solid waste with no liquid waste).

Water movement in the Wahmonie Formation is generally characterized as being in poorly connected fractures; interstitial porosity and permeability are negligible; coefficient of transmissibility is estimated less than 500 gpd per foot. Minor perched water was detected in the foothills between Frenchman Flat and Jackass Flats during studies completed in 1960 (Winograd and Thordardson, 1975). The Wahmonie Formation includes a tuff confining unit that contains perched water near Cane Spring and Pavits Spring (Laczniak et al., 1996). Perched groundwater exists sporadically ranging from 77 to 182 ft in some, but not all, of the Pluto wells drilled approximately 3 mi to the east of the Horn Silver Mine (Johnson and Ege, 1964). The lithology of these drill holes is tertiary igneous dacite porphyry.

Plate 1 shows the water levels documented near CAU 527. No groundwater wells are currently being monitored in Area 26 (USGS, 2002a). The water table in Wahmonie Flat and the Horn Silver Mine is approximately 1,900 ft bgs (Winograd and Thordardson, 1975). The closest groundwater monitoring well is Well J-11 WW, located 7 mi to the southwest of the Horn Silver Mine. Well J-11 WW shows groundwater at 1,037.5 ft bgs in volcanic rock (USGS, 2002b; Walker et al., 1961). Well USGS “F” is 5 mi to the southeast of Horn Silver Mine and groundwater was found from 1,560 to 1,871 bgs (West and Murray, 1961). Well Ue5m is 8 miles to the southeast and groundwater was found at 660 ft and 1,100 ft bgs (Healey et al., 1967).

The following evidence indicates that no groundwater is expected in the vicinity of CAU 527:

- Correspondence from Mr. Lawry to Mr. Wingfield states that no groundwater was encountered during mine development (Lawry, 1929a and b). Additionally, a 1934 *Tonopah Daily Times* newspaper account of the retrieval of a body from the bottom of the mineshaft stated that the mine was dry at the bottom (*Tonopah Daily Times*, 1934).
- Perched groundwater exists sporadically from 77 to 182 ft bgs in the Pluto wells, located about 3 mi east of the Horn Silver Mine (Johnson and Ege, 1964). The lithology of the Pluto wells is tertiary igneous dacite porphyry. Water movement in the Wahmonie Formation is generally characterized as being in poorly connected fractures; interstitial porosity and permeability are negligible; coefficient of transmissibility is estimated less than 500 gpd per ft, and contains minor perched water in foothills between Frenchman Flat and Jackass Flats (Winograd and Thordardson, 1975). The Wahmonie Formation includes a tuff confining unit that contains perched water near Cane Spring and Pavits Spring (Laczniak et al., 1996).
- The water table in the Wahmonie Flat and the Horn Silver Mine is estimated to be approximately 1,900 ft bgs (Winograd and Thordardson, 1975). No wells currently are being monitored in Area 26 (USGS, 2002a). Well J-11 WW in the northeast portion of Area 25 is the closest groundwater monitoring well. Well J-11 WW measures water level in an aquifer in volcanic rocks and indicates groundwater is approximately 1,040 ft bgs (USGS, 2002b).

Waste Disposal. The Horn Silver Mine was used for disposal of waste and classified materials by the DOE, its predecessor agencies, and its contractors. Available information regarding waste disposed of in CAU 527 includes the following:

- In April 2002, NNSA/NV (Cabble, 2002) provided the following information:
  - Radioactive wastes were deposited in the shaft from 500 to 292 ft bgs.
  - 10 feet of fill was placed from 292 to 282 ft.
  - A 3-ft thick concrete plug was placed from 282 to 279 ft.
- *Records for Land Burial of Solid Radioactive Waste, VI, January, 1963 – December, 1966* (REECo, 1978) include 29 radioactive waste disposal records for waste disposed of in the Horn Silver Mine from 1966 to 1972. The approximate total volume in cubic feet of each disposal event was recorded. The total volume of wastes disposed of is 789 ft^3. No liquids were reported to have been disposed of in the mine. Historically, liquid disposal practices at the NTS used drains and leachfields near their generation point. Therefore, large volumes of liquid waste were not containerized and moved to other disposal areas.
- The *Environment Survey Preliminary Report, Nevada Test Site, Mercury Nevada* (DOE, 1988) provides the following information:
  - Wastes were placed in the mineshaft to approximately 150 ft bgs. A concrete plug was poured on top and the remaining shaft was filled with clean soil.
  - During the 1960s, the mineshaft was used by NTS personnel for the disposal of solid wastes from the Tory Reactor Facility. Information is classified regarding the nature and quantity of wastes disposed of in the mineshaft.
  - The mine was listed as an inactive contaminated waste dump.
- The *Radioactive Solid Waste Inventories at United States Department of Energy Burial and Storage Sites* (DOE/ID, 1987) lists total waste volume of the NTS Horn Silver Mine as 13 m^3 (450 ft^3). Total radionuclides buried is 7.5 curies of low-level waste fission products.
- *An Assessment of the Nevada Test Site for Low-Level Waste Management* (DOE/NV, 1978) states that a concrete plug has been poured over the waste in the partially filled shaft at a depth of about 128 m (420 ft). The shaft is approximately square with a width of about 2.4 m (8 ft), and the remaining volume is about 700 m^3 (24,720 ft^3).
- The *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (DOE, 1977) states, “The shaft has been designated as a disposal site for classified radioactive waste. A concrete plug has been poured over waste in the partially filled mineshaft at a depth of about 128 m (420 ft). A concrete collar (or pad) with a steel cover and lid with a security lock has been installed at the opening to the shaft. This prevents the entrance of surface drainage water.”

- *The Environmental Restoration and Waste Management Site Specific Plan for Fiscal Years 1993 – 1997* (DOE/NV, 1991) states that the Horn Silver Mine contains miscellaneous radioactive waste disposed of at this site between 1959 and 1964.

An inconsistency exists between the referenced volume of waste in two of the source documents that has not been resolved. The *Records for Land Burial of Solid Radioactive Waste, VII, January, 1963 – December, 1966* (REECo, 1978) indicates a total volume of wastes disposed is 789 ft^3. The *Radioactive Solid Waste Inventories at United States Department of Energy Burial and Storage Sites* (DOE/ID, 1987) lists the total waste volume of the NTS Horn Silver Mine as 13 m^3 (450 ft^3). It is not known how much of a duplication is included within these documents. Therefore, it is assumed that there is no duplication and the total amount of waste disposal recorded in these two documents is an accurate representation of the volume of waste in the Horn Silver Mine. The information provided in the 1978 report specific to the Horn Silver Mine is summarized in Table 2-1 of the CAIP (REECo, 1978).

There is a discrepancy between the reported volume of waste disposed in the Horn Silver Mine and the total possible volume. There is 22,400 ft^3 of volume in the 8- by 8-ft shaft from 500 to 150 ft bgs. The reported volumes summarized in Section 2.3 add up to 1,239 ft^3. The depths of waste and fill also vary from 500 to 279 ft bgs, from 500 to 420 ft bgs, and to 150 ft bgs. Based on these reported volumes and intervals, it is assumed that there are unknown specific volumes and thicknesses of waste and clean fill from 500 to 150 ft bgs. The records for waste disposal are not complete. Although more specific information on wastes placed into the Horn Silver Mine are not available due to access restrictions, it is believed that existing information is sufficient to conduct the CAI.

Known Radiological Constituents and Contaminants of Potential Concern. The list of known and potential radioactive COPCs was developed by personnel who researched available records associated with waste.

Waste disposal records indicate that the following radionuclides are present in the waste disposed of in the Horn Silver Mine: cesium-137, cobalt-60, strontium-90, tritium, and mixed fission products. Iodine-131 was recorded as having been in the waste, but its 8-day half-life eliminates it from being considered a COPC.

References to other wastes and classified material disposed of in the Horn Silver Mine indicate the potential presence of other radionuclides including plutonium, uranium, and niobium-94. These, as well as the known radiological constituents except tritium, if present, will be detected with gross alpha/beta and gamma spectrometry readings. Additional identification of specific isotopes can be achieved using isotopic analysis, if required.

There are no known chemical COPCs associated with CAU 527.

Unknown Radiological Constituents and Contaminants of Potential Concern. The waste disposal records for CAU 527 are incomplete and sometimes conflicting. Access to some disposal records is limited. Therefore, the list of known radiological constituents covers most, if not all, naturally occurring, man-made, or decay products of radiological constituents that were used or produced at the NTS with half-lives long enough to still be detected. Therefore, the analytical methods proposed for the known radiological constituents are adequate to cover any additional unknown radiological constituents.

No known chemical COPCs were identified in the disposal records that were reviewed. Based on past disposal practices at the NTS, it is assumed that there was limited disposal of hazardous material in the Horn Silver Mine. Disposal of hazardous materials would be primarily associated with disposal of radiological materials. Hazardous COPCs were determined by assuming waste segregation was not rigorously practiced in the 1960s and 1970s. Therefore, the list includes hazardous COPCs commonly found or assumed to be found at other NTS disposal sites.

Table 3-1 of the CAIP provides a list of the COPCs identified for CAU 527. The table specifies which COPCs are known and which are unknown.

Transport Mechanisms. Groundwater (perched water and intermittent percolation) and vapor transport, if present, are considered to be the only significant transport mechanisms. Limited transport may have occurred from pulses of infiltrated precipitation. Vapor transport may have also occurred from any material with a high vapor pressure that would result in volatilization at subsurface temperatures.

A contaminant transport mechanism not considered as part of the CSM is biota intrusion. Vegetation in the area is primarily creosote. Creosote bushes have extensive root systems that can extend 12 ft or more from the plants. Most of these roots are shallow to access any near-surface water. In sandy soils, the plants can also produce tap roots to obtain water from deeper in the soil profile (Helios, 2002). There is little surface soil near the mine, so deep tap roots are not likely. Burrowing animals could also move contaminated wastes, but the mine was drilled into hard rock, and burrowing animals are assumed to be near the surface and not near the waste.

Preferential Pathways. Two preferential pathways for contaminant migration have been identified. Contaminant migration through the open drifts, if groundwater is present or large volumes of volatile waste disposal occurred, is considered to be the most likely pathway. Fracture flow in the rock is the only other significant feasible preferential pathway.

Affected Media. It is assumed that surface and near-surface soils are not affected by the waste except by vapor transport/condensation. There is no evidence of surface soil contamination at CAU 527. The waste is contained in the mineshaft; covered by concrete, clean fill, and a locked cover; and is not exposed to the surface.

It is assumed that the subsurface rock is not affected by the waste. The rock surrounding the waste is hard, fractured, tertiary igneous rock. The waste is solid, non-mobile material with no potential for migration into the solid rock. It is assumed no mechanism exists for the rock to become contaminated by the waste, other than limited surface contact where the waste physically contacts the sides of the mine shaft.

It is assumed that the groundwater, if present, may be affected by the waste. Historical research and nearby drill hole data show that there is no groundwater in the vicinity of CAU 527. There is a 1,400-ft separation between the bottom of the waste and the regional aquifer. There is no record of liquid waste disposal occurring at CAU 527.

Location of Contamination/Release. Any release that may have occurred would be limited to open drifts or fractures.

Lateral and Vertical Extent of Contamination. There may have been limited lateral and vertical contamination migration at the time disposal activities were conducted within open drifts or fractures. This migration could have occurred due to infiltration of precipitation. This contaminant migration could have occurred in pulses. These pulses would have limited effect on the surrounding environment. Possible vapor transport would also be limited.

A.1.2 Step 2 – Identify the Decision

This section identifies the questions the site investigation will attempt to resolve and describes what actions may result.

A.1.2.1 Develop a Decision Statement

The decision statement required for this site investigation is: "Determine if significant contaminant transport mechanisms (i.e., groundwater and vapor transport) exist near CAU 527 or if contamination migration has occurred within open fractures or drifts." If no groundwater exists near CAU 527 and no contamination is found within open fractures or drifts, then it will be assumed that contamination has not migrated and will not pose a significant threat to human health and the environment, and no further characterization will be necessary.

If groundwater is found to exist near CAU 527 or if significant contamination is found within the open drifts or fractures, then the decision statement for the extent of contamination determination is: "Determine to what extent COCs from waste have migrated." Figure A.2-1 identifies decisions and alternative actions appropriate for the site investigation.

A.1.2.2 Alternative Actions to the Decision

If groundwater is encountered during drilling activities, water samples will be collected and analyzed to determine if any of the COPCs are above PALs, which will result in a COC. Samples of core material or cuttings from boreholes and pore gas samples from open drifts and fractures will be collected and analyzed to determine if any COPCs are above PALs, which will result in a COC. If COCs are not detected in the groundwater, drill core, and pore gas, additional samples will not be

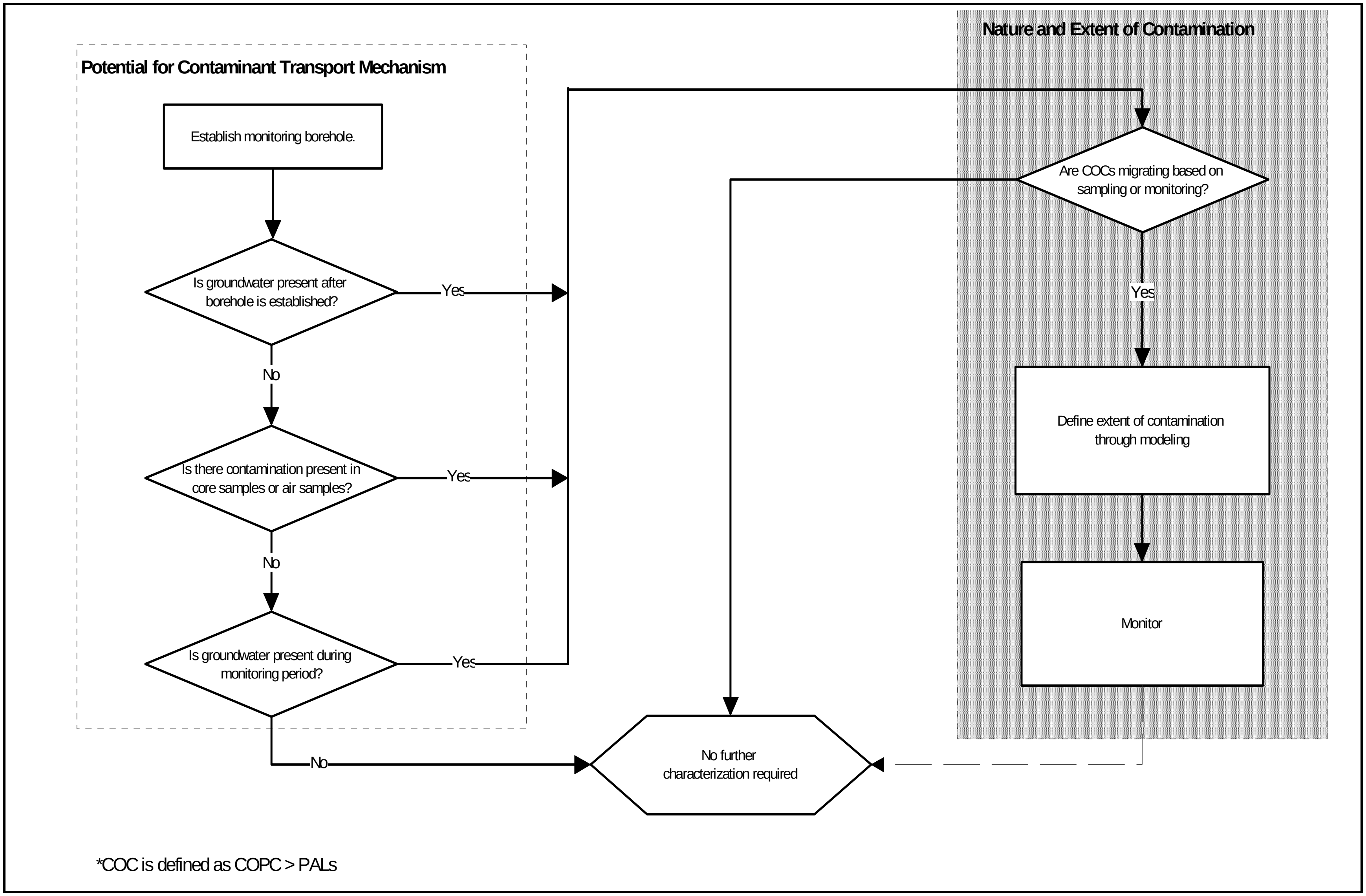

Figure A.2-1
DQO Decision Flow Process

required. If COCs are detected, the extent of contamination will be determined based on computer modeling. The basis for PALs are discussed in Section A.1.3.2.

A.1.3 Step 3 – Identify the Inputs to the Decision

This step identifies the information needed, determines sources for information, determines the basis for establishing the action level, and identifies sampling and analysis methods that can meet the data requirements.

A.1.3.1 Information Needs and Information Sources

Groundwater flow has been determined to be a primary contaminant transport mechanism at CAU 527. To determine if groundwater flow exists, data must be collected and analyzed following these two criteria: (1) data must be collected in an area that demonstrates that groundwater could make direct contact with the waste (e.g., borehole location must represent the geology of the mineshaft), and (2) data collection method must be adequate to detect groundwater.

Biasing factors to support this decision statement require that the lithology of the borehole match the lithology of the mineshaft, and that monitoring equipment for groundwater must be able to detect groundwater in the borehole.

Additional contaminant transport mechanisms at CAU 527 are liquid or vapor fracture flow within the open mineshaft drifts or fractures. To determine if fracture flow is possible, data must be collected and analyzed following these two criteria: (1) data must be collected in an area that demonstrates that liquid or vapor from waste disposal activities could have migrated through open fractures (e.g., borehole location must represent the geology of the mineshaft), and (2) data collection method must be adequate to detect fracture flow of liquids or vapors.

Biasing factors to support this decision statement include that the lithology of the borehole match the lithology of the mineshaft, and that monitoring equipment must be able to detect the gas injected as part of the fracture flow tests.

In order to determine the nature and extent of contamination, computer modeling based on inputs from data must be conducted and analyzed following these criteria:

- Data must be collected in areas likely to be contaminated by migration (i.e., in groundwater adjacent to the lateral and vertical extent of waste).
- Analytical suite selection must be sufficient to detect any contamination present in the samples.
- Computer modeling software must be adequate for the groundwater regime and waste type.

Tables A.1-2 and A.1-3 list the information needs, the source of information for each need, and the proposed methods to collect the data to resolve the decision statement, "Determine if a significant contaminant transport mechanism (i.e., groundwater) exists near CAU 527 or contamination migrated within open fractures or drifts." The last column addresses the QA/QC data type and associated metric. The data type is determined by the intended use of the resulting data in decision making. These data types are discussed below.

Quantitative Data. Quantitative data measure the quantity or amount of a characteristic or component within the population of interest. These data require the highest level of QA/QC in collection and measurement systems because the intended use of the data is to resolve primary decisions (i.e., rejecting or accepting the null hypothesis) and/or verifying closure standards have been met. Laboratory analytical data are generally considered quantitative.

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

Qualitative Data. Qualitative data identify or describe the characteristics or components of the population of interest. The QA/QC requirements are the least rigorous of data collection methods and measurement systems. The intended use of the data is for information purposes, to refine conceptual models, and to guide investigations rather than resolve primary decisions. This

Table A.1-2
Information Needs to Resolve the Decision:
Determine if Transport Mechanisms are Present

Information Need	Information Source	Collection Method	Data Type/Metric
Criterion 1: Data must be collected in an area that demonstrates that groundwater could make direct contact with the waste (e.g., borehole location must represent the geology of the mineshaft)			
Presence and location of groundwater near the mineshaft	Historical research of the Horn Silver Mine construction	Review of 1928 and 1929 correspondence documenting mine construction; 1934 newspaper article	Qualitative: Reliance on veracity of historical records
	Subsurface investigation	Drill two vertical boreholes parallel to the mineshaft, no closer than 50 ft, to a depth of 50 ft below the waste; drill one angled borehole that will not come closer than 50 ft to the waste	Qualitative: Field observations of drill cuttings and core will determine if borehole geology matches descriptions of rock in mineshaft
Criterion 2: Data collection method must be adequate to detect any groundwater			
Presence and location of groundwater in the vicinity of the mineshaft	Measuring water level in borehole(s)	Measuring water level with and electric sounder or electric depth gauge using SOPs Evaluate established boreholes for evidence of groundwater; monitor for one year	Quantitative: Following SOPs for measuring depth to groundwater using electric sounder or electric depth gauge
Criterion 3: Data collection method must be adequate to determine the potential of contaminant migration			
Fractures are interconnected to allow extensive contaminant migration	Conduct fracture gas transport test	Isolate select portions of boreholes with packers and inject tracer gas; measure tracer gas above and below isolated section to check for gas transport rate Evaluate established boreholes for evidence of groundwater; monitor for one year	Quantitative: Following SOPs for measuring gas concentrations
Open drifts are the most likely pathway for contaminant migration	Collect samples from within open drifts intercepted by drilling vertical boreholes	Samples of water, if found, from within intercepted drifts at 300 and/or 500 ft depth Collect samples of vapor from within intercepted drifts at 300 and/or 500 ft depth	Quantitative: Following SOPs for collecting samples

Table A.1-3
Information Needs to Resolve Alternative: Nature and Extent of Contamination

Information Need	Information Source	Collection Method	Data Type/Metric
Criterion 1: Data must be collected in areas likely to be contaminated by migration (i.e., in groundwater adjacent to the lateral and vertical extent of waste)			
Groundwater within the lateral and vertical extent of disposed waste	Three boreholes in proximity to mineshaft in similar lithology	Borehole logging	Qualitative: Field observations of drill cuttings and core will determine if borehole geology matches descriptions of rock in mineshaft
Criterion 2: Analytical suite selected must be sufficient to detect any contamination present in the samples			
Identification of potential contaminants	Radionuclides present in waste based on DOE information	Review of DOE documents and records of communications regarding waste disposed in the Horn Silver Mine	Qualitative: Reliance on veracity of historical records
	Hazardous wastes found in other NTS disposal areas	Knowledge of characterization at other NTS waste disposal locations	Qualitative: Generalizing data from characterization of other NTS disposal areas
Criterion 3: Computer modeling software must be adequate for groundwater regime and waste type			
Identification of appropriate model	Research models appropriate for geologic, hydrologic, and environmental conditions described in historical mine records	Review of 1928 and 1929 correspondence documenting mine construction, information from establishing first borehole	Qualitative: Reliance on veracity of historical records Quantitative: Field observations and data collected during drilling first borehole

measurement of quality is typically assigned to historical information and data where QA/QC may be highly variable or not known. Professional judgement is often used to generate qualitative data.

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

A.1.3.2 Determine the Basis for Preliminary Action Levels

The preliminary action levels associated with the decision statement, "Determine if significant contaminant transport mechanisms (i.e., groundwater and vapor transport), exists near CAU 527 or if contamination migration has occurred within open fractures or drifts," will be established for each decision.

A.1.3.2.1 Contaminant Migration Preliminary Action Levels

To determine if contaminant migration has occurred, samples of pore gas, drill core or cuttings, or liquid will be collected and submitted for laboratory analysis. The basis to determine if contaminant migration has occurred will be detection of nonnaturally occurring chemicals or radionuclides greater than achievable detection limits. The minimum reporting limits are specified in Table A.1-4 and Table A.1-5. If nonnaturally occurring chemicals or radionuclides are detected, then the extent will be determined through modeling.

A.1.3.2.2 Contaminant Transport Mechanism Preliminary Action Levels

A.1.3.2.3 Groundwater

To determine if groundwater is a viable contaminant transport mechanism, direct measurements of groundwater entering the monitoring wells will be made. The criteria for determining if groundwater is entering the monitoring well will be the detection of a water level increase in the monitoring well. This will be measured using a sounding device capable of detecting a 0.5-in. rise in water level. A 1-in. rise in water level within a 48-hour period following purging of the well will be considered to be greater than measurement error; therefore, it is sufficient to make the decision that groundwater exists.

If no water is measured, or if the volume is not sufficient to purge, monitoring will be conducted continuously for one year. The monitoring data will be logged once per 24-hour period to track trends and will consist of measuring groundwater levels in the borehole using electric sounder or electric depth gauge (to determine water level). The SOPs for measuring groundwater in wells will be used for this activity.

A.1.3.2.4 Vapor

To determine if vapor transport has occurred, or is possible, pore gas samples will be collected from within the open drifts or fractures, if possible. To determine if fracture flow is possible, a fracture flow test will be conducted within each of the vertical boreholes. The test will consist of sealing off sections of the borehole with packers, or other appropriate methods, and injecting a tracer gas. Additional sections of the borehole, above and possibly below the injection point, will also be sealed using packers, and pore gas samples will be collected to determine fracture flow rate and distance. A decrease in the concentration of the injected tracer gas within the sealed section of the borehole or detection of the tracer gas outside of the sealed section, within 48 hours of the start of the injection test, will be considered to be sufficient to make the decision that fracture flow is possible.

A.1.3.2.5 Remediation Alternatives Preliminary Action Levels

The basis for the remediation alternatives PALs are as follows:

- EPA Region 9 Risk-Based PRGs for chemical constituents in industrial groundwater, soils, and air (EPA, 2000)
- Background concentrations for RCRA metals will be used instead of PRGs when natural background exceeds the PRG, as is often the case with arsenic; background is considered the mean plus 2x the standard deviation of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999)
- The TPH action limit of 100 ppm per the NAC 445A.2272 (NAC, 2000b)
- The action limit of pH < 2 or > 12.5 per the NAC 444.843 (NAC, 2000a)

The PALs for radionuclides are isotope-specific and defined as the maximum concentration for that isotope found in samples from undisturbed background locations in the vicinity of the NTS (Atlan-Tech, 1992; McArthur and Miller, 1989). The PAL is equal to the MDCs for isotopes not reported in groundwater samples from undisturbed background locations, or if the PAL is less than the MDC.

Table A.1-4 and Table A.1-5 provide the analytical methods for determining the presence of COPCs.

The comparison of laboratory results to PALs will be discussed in the CADD. Laboratory results above action levels indicate the presence of COCs. The evaluation of potential corrective actions and the justification for a preferred action will be included in the CADD based on the results of this field investigation. Proposed monitoring and use restrictions will be presented in the CADD.

A.1.3.3 Potential Sampling Techniques and Appropriate Analytical Methods

Samples of core material will be collected at 50-ft intervals starting at approximately 150 ft bgs (i.e., the top of the waste disposal cell) and continuing to the bottom of each borehole. The samples will be screened and a minimum of five samples will be submitted for laboratory analysis based on field-screening results and visual observations. Samples will be submitted for radiological and chemical analysis. Selected samples will also be submitted for geotechnical and hydrological analysis.

Gas samples will be collected from within intercepted drifts at 300- and/or 500-ft depths. If drifts are not directly intercepted, then sections of the borehole will be isolated with packers at depths corresponding with the drifts, and gas samples will be collected.

Liquid samples (if sufficient volume is present) will be collected from within intercepted drifts at 300 and/or 500 ft.

Once the drilling is complete, monitoring will be conducted continuously for one year. Data from the monitoring will be logged once per 24-hour period to track trends and will consist of measuring groundwater levels in the borehole using an electric sounder or electric depth gauge (to determine

Table A.1-4
Analytical Requirements for CAU 527
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Parameter/Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision[a]	Percent Recovery (%R)[b]
ORGANICS						
Total Volatile Organic Compounds (VOCs)	Aqueous Soil	8260B[c]	Parameter-specific estimated quantitation limits[d]	Not Applicable (NA)	Laboratory-specific[e]	Laboratory-specific[e]
Toxicity Characteristic Leaching Procedure (TCLP) VOCs						
Benzene	Aqueous	1311/8260B[c]	0.050 mg/L[d]	0.5 mg/L[f]	Laboratory-specific[e]	Laboratory-specific[e]
Carbon Tetrachloride			0.050 mg/L[d]	0.5 mg/L[f]		
Chlorobenzene			0.050 mg/L[d]	100 mg/L[f]		
Chloroform			0.050 mg/L[d]	6 mg/L[f]		
1,2-Dichloroethane			0.050 mg/L[d]	0.5 mg/L[f]		
1,1-Dichloroethene			0.050 mg/L[d]	0.7 mg/L[f]		
Methyl Ethyl Ketone			0.050 mg/L[d]	200 mg/L[f]		
Tetrachloroethene			0.050 mg/L[d]	0.7 mg/L[f]		
Trichloroethene			0.050 mg/L[d]	0.5 mg/L[f]		
Vinyl Chloride			0.050 mg/L[d]	0.2 mg/L[f]		
Total Semivolatile Organic Compounds (SVOCs)	Aqueous Soil	8270C[c]	Parameter-specific estimated quantitation limits[d]	NA	Laboratory-specific[e]	Laboratory-specific[e]
TCLP SVOCs						
o-Cresol	Aqueous	1311/8270C[c]	0.10 mg/L[d]	200 mg/L[f]	Laboratory-specific[e]	Laboratory-specific[e]
m-Cresol			0.10 mg/L[d]	200 mg/L[f]		
p-Cresol			0.10 mg/L[d]	200 mg/L[f]		
Cresol (total)			0.30 mg/L[d]	200 mg/L[f]		
1,4-Dichlorobenzene			0.10 mg/L[d]	7.5 mg/L[f]		
2,4-Dinitrotoluene			0.10 mg/L[d]	0.13 mg/L[f]		
Hexachlorobenzene			0.10 mg/L[d]	0.13 mg/L[f]		
Hexachlorobutadiene			0.10 mg/L[d]	0.5 mg/L[f]		
Hexachloroethane			0.10 mg/L[d]	3 mg/L[f]		
Nitrobenzene			0.10 mg/L[d]	2 mg/L[f]		
Pentachlorophenol			0.50 mg/L[d]	100 mg/L[f]		
Pyridine			0.10 mg/L[d]	5 mg/L[f]		
2,4,5-Trichlorophenol			0.10 mg/L[d]	400 mg/L[f]		
2,4,6-Trichlorophenol			0.10 mg/L[d]	2 mg/L[f]		
Polychlorinated Biphenyls (PCBs)	Aqueous Soil	8082[c]	Parameter-specific (CRQL)[g]	NA	Laboratory-specific[e]	Laboratory-specific[e]
Total Petroleum Hydrocarbons (TPH) [C_6-C_{38}]	Aqueous Gasoline	8015B modified[c]	0.1 mg/L[h]	NA	Laboratory-specific[e]	Laboratory-specific[e]
	Soil Gasoline		0.5 mg/kg[h]			
	Aqueous DRO		0.5 mg/L[h]			
	Soil DRO		25 mg/kg[h]			

Table A.1-4
Analytical Requirements for CAU 527
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Parameter/Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision[a]	Percent Recovery (%R)[b]
INORGANICS						
Total Metals						
Arsenic	Aqueous	6010B[c]	10 µg/L[h, i]	NA	20[i]	Matrix Spike Recovery 75-125[i] Laboratory Control Sample Recovery 80 - 120[i]
	Soil	6010B[c]	1 mg/kg[h, i]		35[m]	
Barium	Aqueous	6010B[c]	200 µg/L[h, i]		20[i]	
	Soil	6010B[c]	20 mg/kg[h, i]		35[m]	
Beryllium	Water	6010B[c]	5 µg/L[i]		20[i]	
	Soil	6010B[c]	0.5 mg/kg [i]		35[m]	
Cadmium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil	6010B[c]	0.5 mg/kg[h, i]		35[m]	
Chromium	Aqueous	6010B[c]	10 µg/L[h, i]		20[i]	
	Soil	6010B[c]	1 mg/kg[h, i]		35[m]	
Lead	Aqueous	6010B[c]	3 µg/L[h, i]		20[i]	
	Soil	6010B[c]	0.3 mg/kg[h, i]		35[m]	
Mercury	Aqueous	7470A[c]	0.2 µg/L[h, i]		20[i]	
	Soil	7471A[c]	0.1 mg/kg[h, i]		35[m]	
Nickel	Aqueous	6010B[c]	40 µg/L[h, i]		20[i]	
	Soil	6010B[c]	4 mg/kg[h, i]		35[m]	
Selenium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil	6010B[c]	0.5 mg/kg[h, i]		35[m]	
Silver	Aqueous	6010B[c]	10 µg/L[h, i]		20[i]	
	Soil	6010B[c]	1 mg/kg[h, i]		35[m]	
Zinc	Aqueous	6010B[c]	20 µg/L[h, i]		20[i]	
	Soil	6010B[c]	2 mg/kg[h, i]		35[m]	
TCLP RCRA Metals						
Arsenic	Aqueous	1311/6010B[c] 1311/7470A[c]	0.10 mg/L[h, i]	5 mg/L[f]	20[i]	Matrix Spike Recovery 75-125[i] Laboratory Control Sample Recovery 80 - 120[i]
Barium			2 mg/L[h, i]	100 mg/L[f]		
Cadmium			0.05 mg/L[h, i]	1 mg/L[f]		
Chromium			0.1 mg/L[h, i]	5 mg/L[f]		
Lead			0.03 mg/L[h, i]	5 mg/L[f]		
Mercury			0.002 mg/L[h, i]	0.2 mg/L[f]		
Selenium			0.05 mg/L[h, i]	1 mg/L[f]		
Silver			0.1 mg/L[h, i]	5 mg/L[f]		
RADIOCHEMISTRY						
Gamma-Emitting Radionuclides	Aqueous	EPA 901.1[j]	The Minimum Reporting Limits and Minimum Detectable Activities for Radionuclides are laboratory specific	NA	Relative Percent Difference (RPD) 20% (Aqueous) 35% (Soil)[n] Normalized Difference (ND) -2<ND<2[k]	Laboratory Control Sample Recovery 80-120[i]
	Soil	HASL-300[l]				
Gross Alpha/Beta-Emitting Radionuclides	Aqueous	EPA 900.0[j]				
Isotopic Plutonium	Aqueous	ASTM D3865-02[m]				Chemical Yield 30-105[n]
	Soil	HASL-300[l]				
Strontium-90	Aqueous	ASTM D5811-00[m]	The Minimum Reporting Limits and Minimum Detectable Activities for Radionuclides are laboratory specific	NA	Relative Percent Difference (RPD[a]) 20% (Aqueous)[n] 35% (Soil)[l] Normalized Difference (ND) -2<ND<2[k]	Chemical Yield 30-105[n] Laboratory Control Sample Recovery 80-120[i]
	Soil	HASL-300[l]				

Table A.1-4
Analytical Requirements for CAU 527
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Parameter/Analyte	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision[a]	Percent Recovery (%R)[b]
Geotechnical and Hydrological Properties	Soil	Laboratory-specific	NA	NA	Laboratory-specific	Laboratory-specific

[a]Relative percent difference (RPD) is used to calculate precision. Precision is estimated from the RPD of the concentrations measured for the matrix spike and matrix spike duplicate or of laboratory, or field duplicates of unspiked samples. It is calculated by:
RPD = 100 x $\{(|A_1-A_2|)/[(A_1+A_2)/2]\}$, where
A_1 = Concentration of the parameter in the initial sample aliquot
A_2 = Concentration of the parameter in the duplicate sample aliquot
[b]The %R is used to calculate accuracy. Accuracy is assessed from the recovery of parameters spiked into a blank or sample matrix of interest, or from the recovery of surrogate compounds spiked into each sample. The recovery of each spiked parameter is calculated by: %R = 100 x (A_s-A_u/A_n), where
A_s = Concentration of the parameter in the spiked sample
A_u = Concentration of the parameter in the unspiked sample
A_n = Concentration increase that should result from spiking the sample
[c]The EPA *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, 3rd Edition, Parts 1-4, (SW-846) CD ROM, Washington, DC (EPA,1996)
[d]Estimated Quantitation Limit as given in SW-846 (EPA, 1996)
[e]In-House generated RPD and %R Performance Criteria. It is necessary for laboratories to develop in-house performance criteria and compare them to those in the methods. The laboratory begins by analyzing 15 to 20 samples of each matrix and calculating the mean %R for each parameter. The standard deviation (SD) of each %R is then calculated, and the warning and control limits for each parameter are established at ± 2 SD and ± 3 SD from the mean, respectively. If the warning limit is exceeded during the analysis of any sample delivery group (SDG), the laboratory institutes corrective action to bring the analytical system back into control. If the control limit is exceeded, the sample results for that SDG are considered unacceptable. These limits are reviewed after every quarter and are updated when necessary. The laboratory tracks trends in both performance and control limits by the use of control charts. The laboratory's compliance with these requirements is confirmed as part of an annual laboratory audit. Similar procedures are followed in order to generate acceptance criteria for precision measurements.
[f]Title 40 *Code of Federal Regulations* (CFR) Part 261, "Identification and Listing of Hazardous Waste" (CFR, 2001a)
[g]EPA *Contract Laboratory Program (CLP) Statement of Work for Organic Analysis* (EPA, 1988; 1991; and 1994b)
[h]*Industrial Sites Quality Assurance Project Plan* (NNSA/NV, 2002)
[i]EPA *Contract Laboratory Program Statement of Work for Inorganic Analysis* (EPA, 1988a; 1994b; and 1995)
[j]*Prescribed Procedures for Measurements of Radioactivity in Drinking Water*, EPA-600/4-80-032 (EPA, 1980)
[k]Normalized Difference (ND) is not RPD, it is another measure of precision used to evaluate duplicate analyses. The ND is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties:
Evaluation of Radiochemical Data Usability (Paar and Porterfield, 1997)
[l] *Environmental Measurements Laboratory Procedures Manual*, HASL-300 (DOE, 1997)
[m]Sampling and Analysis Plan (Field Sampling and Quality Assurance Project Plan) with Guidance EPA Region 1X (EPA, 2000)
[n]*General Radiochemistry and Routine Analytical Services Protocol* (GRASP) (EG&G Rocky Flats, 1991)

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

Table A.1-5
Minimum Detectable Concentrations, Preliminary Action Levels, and Minimum Reporting Limits for Radionuclides in Samples Collected at CAU 527

Parameter/ Analyte	Matrix	Analytical Method	MDC[a]	PAL[b]	MRL[c]	Laboratory Precision	Percent Recovery
Cesium-137	Water	EPA 901.1[d]	10 pCi/L	10 pCi/L	10 pCi/L	Relative Percent Difference (RPD) 20% water 35% soil Normalized Difference (ND) -2<ND<2[g]	Laboratory Control Sample Recovery 80 – 120[h] Percent Recover (%R) Chemical Yield 30 – 105 %R[i]
	Soil	HASL-300[e]	0.5 pCi/g	7.0 pCi/g	2.5 pCi/g		
Cobalt-60	Water	EPA 901.1[d]	10 pCi/L	10 pCi/L	10 pCi/L		
	Soil	HASL-300[e]	0.5 pCi/g	0.5 pCi/g	0.5 pCi/g		
Niobium-94	Water	EPA 901.1[d]	10 pCi/L	10 pCi/L	10 pCi/L		
	Soil	HASL-300[e]	0.5 pCi/g	0.5 pCi/g	0.5 pCi/g		
Plutonium 238	Water	ASTM D3865-02[f]	0.1 pCi/L	0.16 pCi/L	0.1 pCi/L		
	Soil	HASL-300[e]	0.05 pCi/g	0.05 pCi/g	0.05 pCi/g		
Plutonium 239/240	Water	ASTM D3865-02[f]	0.1 pCi/L	9.0 pCi/L	0.5 pCi/L		
	Soil	HASL-300[e]	0.05 pCi/g	0.106 pCi/g	0.05 pCi/g		
Strontium-90	Water	ASTM D5811-00	1.0 pCi/L	1.0 pCi/L	1.0 pCi/L		
	Soil	HASL-300[e]	0.05 pCi/g	1./17 pCi/g	0.5 pCi/g		
Tritium	Water	EPA 906.0[d]	400 pCi/L	560 pCi/L	400 pCi/L		
	Soil	Lab Specific	1.0 pCi/g	1.0 pCi/g	1.0 pCi/g		
Uranium 234	Water	ASTM D3972.02[j]	0.1 pCi/L	8.92	0.1 pCi/L		
	Soil	C1000-00[k]	0.05 pCi/g	3.47	0.05 pCi/g		
Uranium 235	Water	ASTM D3972.02[j]	0.1 pCi/L	0.36	0.1 pCi/L		
	Soil	C1000-00[k]	0.05 pCi/g	0.07	0.05 pCi/g		
Uranium 238	Water	ASTM D3972.02[j]	0.1 pCi/L	9.39	0.1 pCi/L		
	Soil	C1000-00[k]	0.05 pCi/g	3.47	0.05 pCi/g		

[a]MDC is the minimum detectable concentration. It is the lowest concentration of a radionuclide, if present in a sample that can be detected with a 95-percent confidence level.
[b]PAL is the preliminary action level and is defined as the maximum concentration listed in the literature for a sample taken from an undisturbed background location (McArthur and Miller, 1989; Atlan-Tech, 1992; and DOE/NV, 1999). The PAL is equal to the MDC for a isotopes not reported in soil samples from undisturbed background locations or if the PAL is less than the MDC.
[c]MRL is the minimum reporting level. It is set equal to 5 times the MDC, or if 5 times the MDC is greater than the PAL, the MRL is set equal to the MDC.
[d]*Prescribed Procedures for Measurements of Radioactivity in Drinking Water*, EPA-600/4-80-032 (EPA, 1980)
[e]*Environmental Measurements Laboratory Procedures Manual*, HASL-300 (DOE,1997)
[f]ASTM D3865-02, *Standard Test Method for Plutonium in Water*
[g]Normalized Difference (ND) is not RPD, it is another measure of precision used to evaluate duplicate analyses. The ND is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties. Evaluation of Radiochemical Data Usability (Paar and Porterfield, 1997).
[h]*EPA Contract Laboratory Program Statement of Work for Inorganic Analysis* (EPA, 1988a, 1994a, and 1995)
[i]*General Radiochemistry and Routine Analytical Services Protocol (GRASP)* EG&G Rocky Flats, 1991). The chemical yield only applies to plutonium, uranium and strontium.
[j]ASTM D3972-02, *Standard Test Method for Isotopic Uranium in Water by Radiochemistry*
[k]ASTM C1000-00, *Standard Test Method for Radiochemical Determination of Uranium Isotopes in Soil by Alpha Spectrometry*

pCi/g = Picocuries per gram
pCi/L = Picocuries per liter

water level). The monitoring will follow approved procedures for measuring groundwater in wells. A determination will be made after one year, if additional monitoring is required.

To determine if fracture flow is possible, a fracture flow test will be conducted within each of the vertical boreholes. The test will consist of sealing off sections of the borehole with packers or other appropriate methods, and injecting a tracer gas. Additional sections of the borehole, above and possibly below the injection point, will also be sealed using packers, and pore gas samples will be collected to determine fracture flow rate and distance.

A.1.3.4 Potential Sampling Techniques and Appropriate Analytical Methods

Sampling: SOPs and other approved documents (e.g., field instructions, detailed operating procedures [DOPs]) for sampling groundwater or other liquids, pore gas, and drill core will be used. To assure that laboratory analyses are sufficient to detect contamination in samples, chemical and radiological parameters will be selected based on the nature of contamination analytical data.

The analytical methods for COPCs will include analysis that will identify potentially harmful radiological and hazardous constituents in water and solid samples.

Water samples will be analyzed for gross alpha/beta and for tritium. If the gross alpha/beta screening results exceed EPA *Safe Drinking Water Standards'* maximum contaminant levels, testing for specific isotopes (e.g., uranium and plutonium) will be conducted. If the gross beta results exceed 15 picocuries per liter (pCi/L), testing for strontium-90 (and other isotopes, if indicated), gamma spectroscopy will be conducted.

Solids will be analyzed using gamma spectroscopy and isotopic analysis for strontium-90, uranium, plutonium, and tritium.

Solid and liquid samples will be analyzed for a comprehensive suite of hazardous constituents typically found at other waste disposal sites at the NTS including: volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs); polychlorinated biphenyls (PCBs); petroleum hydrocarbons (diesel- and gasoline-range organics [C6-C38]); RCRA metals; as well as beryllium, nickel, and zinc.

Gas samples will be analyzed for VOCs, SVOCs, and petroleum hydrocarbons (diesel- and gasoline-range organics [C6-C38]).

Computer modeling: Models will be used to combine existing information such as water levels, aquifer properties, and contaminant concentrations into a model of the potential contamination plume. Models used will be calibrated and will allow for an estimation of the location and concentration of contaminants at spatial locations where current measurements do not exist.

Four types of models may be used as part of this investigation. Geologic models define the spatial distribution of the geologic layers through which groundwater flows. Geologic units are expected to have unique properties governing groundwater and chemical interaction with contaminants. Flow models simulate the movement of groundwater, and calculate the water levels at any location in the model, and how much water enters or leaves the groundwater system. Transport models simulate the migration of contaminants by the groundwater system. The transport model uses the geologic, flow, and source model results, and adds chemical interaction and dispersion processes to calculate the concentration of contaminants in the flow system.

A.1.4 Step 4 - Define the Boundaries of the Study

This section defines the target population of interest, specifies the spatial and temporal features of that population that are pertinent for decision making, determines practical constraints on data collection, and defines the scale of decision making relevant to target populations.

A.1.4.1 Define the Target Population

The target population is the open drifts and fractures within the subsurface area adjacent to the Horn Silver Mine where, if groundwater exists, it could saturate the waste in the mineshaft and transport contamination from the mineshaft's boundaries. In addition, liquids or vapors from waste disposal activities, if present, could have resulted in contaminant migration to possible receptors.

A.1.4.2 Identify the Spatial and Temporal Boundaries

The spatial boundaries are as follows:

- Laterally - 50 to 100 ft laterally from the outer perimeter of the 8- by 8-ft Horn Silver mineshaft
- Vertically - from ground surface to 50 ft below the waste

The presence of groundwater may be influenced by seasonal precipitation and temperature changes. A one-year monitoring program will be conducted if no groundwater is found during or immediately after borehole establishment. Significant temporal constraints for subsurface investigations due to weather conditions are not expected in Area 26.

Spatial boundaries are limited to sampling of any groundwater or other liquid, drill core, and pore gas in the three boreholes. Computer modeling will have no lateral boundaries and the vertical boundary will include the regional aquifer. No temporal boundaries exist for this nature and extent investigation.

A.1.4.3 Identify Practical Constraints

Several practical constraints will affect the subsurface investigation at CAU 527. The NNSA/NV has established a 50-ft buffer around the waste that must be maintained, and has denied a request that the locked steel cover be opened.

Other practical constraints include open mineshafts and sloping topography in the immediate investigation area. A survey for utilities will be completed before site work begins.

A.1.4.4 Define the Scale of Decision Making

The scale of decision making for CAS 26-20-01, Horn Silver Mine.

A.1.5 Step 5 - Develop a Decision Rule

This section integrates outputs from previous steps, with the inputs developed in this step into a decision rule (“If..., then...”) statement. It describes the conditions under which possible alternative actions would be chosen. It also defines the statistical parameter of interest, specifies the action level, and integrates the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions.

A.1.5.1 Specify the Population Parameter

The population parameters are a discrete, measurable amount of groundwater during establishment or monitoring of the borehole; or evidence of contaminants in drill core, pore gas, or liquid in the open drifts or fractures.

The population parameter is the nature and extent of contamination estimated by the computer model.

A.1.5.2 Choose an Action Level

The PAL associated with the decision statement, "Determine if a significant contaminant transport mechanism (i.e., groundwater or vapors) exists near CAU 527. . ." is a direct measurement of groundwater entering the monitoring well. The corresponding action levels are defined on Table A.1-4 and Table A.1-5.

A.1.5.3 Measurement and Analysis Methods

The criteria for determining if groundwater is entering the monitoring well will be the detection of a water level increase in the monitoring well. This will be measured using a sounding device capable of detecting a 0.5-inch rise in water level. A 1-inch rise in water level within a 48-hour period following purging of the well will be considered to be greater than measurement error; therefore, it is sufficient to make the decision that groundwater exists.

If no water is measured, or if the volume is not sufficient to purge, monitoring will continue.

Sample collection and handling activities will follow the applicable SOPs. The Industrial Sites QAPP (NNSA/NV, 2002) provides analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy requirements).

Inputs to the computer model are dictated by SOPs.

A.1.5.4 Decision Rule

If, during initial drilling, no evidence of groundwater is found or if evidence is inconclusive, borehole monitoring will be conducted for one year. If any time during the monitoring period groundwater is measured as described in measurement and analysis methods, samples will be collected for laboratory analysis. A determination will be made after one year if additional monitoring is required.

If no evidence of contamination is found in samples of core, liquids, or pore gas collected from within the boreholes, open drifts, or fractures, then no further characterization will be necessary.

If the groundwater model estimates that COPCs exceed PALs (i.e., COCs) beyond the mineshaft, then migration has occurred. The model will estimate the extent to where the plume boundary no longer exceeds PALs.

If contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Table A.1.4.2, then work will be suspended and the investigation strategy will be reevaluated.

A.1.6 Step 6 - Specify the Tolerable Limits on Decision Errors

This section defines the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.

The approach for resolving the decision relies on assuming that historical records are accurate and confirming that no groundwater exists near the mineshaft. Direct water measurements will be used to determine if groundwater exists.

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

Baseline condition. Groundwater or hazardous vapors exist and contamination migration that could harm human health or the environment has occurred.

Alternate condition. No groundwater exists near the mineshaft and no contaminant migration has occurred.

Only validated analytical and modeling results (quantitative) will be used to determine COC extent.

The baseline condition (i.e., null hypothesis) and alternative condition for the presence and nature of contamination investigation are as follows:

Baseline condition. The nature and extent of a COC has not been defined.

Alternate condition. The nature and extent of a COC has been defined.

A.1.6.1 False Rejection Decision Error

The false rejection decision error (alpha) would mean deciding that groundwater or hazardous vapors is not present when it really is, increasing risk to human health and the environment.

A false rejection decision error (where consequences are more severe) is controlled by having a high degree of confidence that the investigation borehole will detect if groundwater is present by using established drilling and casing techniques that have been demonstrated to produce groundwater bearing holes. Using monitoring techniques per established SOPs and experienced personnel will provide a high level of confidence that groundwater will be detected.

To satisfy these criteria, data will be collected in areas most likely to present groundwater saturation. To accomplish this, the following characteristics are considered: location of waste in the mineshaft, lithology surrounding the waste, and the location of fault.

These characteristics were considered during the development of the CSM.

Accepting that the nature and extent of a COC has been defined when it has not, significantly increasing risk to human health and environment.

A false rejection decision error (where consequences are more severe) is controlled by having a high degree of confidence that the investigation borehole will detect if groundwater is present, using monitoring techniques that will detect groundwater, and using experienced technical staff who are knowledgeable in water level measuring techniques.

A.1.6.2 False Acceptance Decision Error

The false acceptance (beta) decision error would mean deciding that groundwater flow is present when it really is not, resulting in increased costs for unnecessary characterization.

A false acceptance decision error (where consequences are less severe) is controlled by having a high degree of confidence that the investigation borehole will detect if groundwater is present. The borehole will be purged prior to measuring the water level to ensure that the water measured is from geologic formation in the borehole (e.g., not condensation, surface infiltration). Experienced technical staff and established water level measuring techniques per SOPs will also be used.

The false acceptance (beta) decision error would mean accepting that the nature and extent of a COC has not been defined when it really has, resulting in increased costs for unnecessary characterization.

A false acceptance decision error (where consequences are less severe) is controlled by having a high degree of confidence that the investigation borehole will detect if groundwater is present, using monitoring techniques that will detect groundwater, and using experienced technical staff who are knowledgeable in water-level measuring techniques.

A.1.6.3 Quality Assurance/Quality Control

Groundwater level measurement SOPs will be followed using equipment that has been field checked and calibrated, as appropriate.

Sampling and analysis of groundwater or other liquids, core, and pore gas will be conducted per SOPs and other approved documents (e.g., field instructions, DOPs).

Groundwater modeling software will be validated per SOPs and other approved documents (e.g., field instructions, DOPs).

A.1.7 Step 7 - Optimize the Design for Obtaining Data

This section evaluates information from the previous steps and generates alternative data collection designs. It also describes the most resource-effective design that meets all DQOs.

Vertical investigation boreholes will be drilled parallel to the mineshaft, no closer than 50 ft, to a depth of 50 ft below the waste. The boreholes will be drilled to be within as much of the foot-wall side of the fault within the zone of waste disposal to ensure that any groundwater found in the boreholes would be in the same geologic environment as the mineshaft. The vertical boreholes will be positioned to attempt to intercept the drifts at 300 and 500 ft bgs (Figure A.7-1).

An angled investigation borehole will be drilled such that the borehole will be completed no closer than 50 ft to the mineshaft and to a depth of 50 ft below the waste. The borehole will be drilled on the foot-wall side of the fault to ensure that any groundwater found in the borehole would be in the same geologic environment as the mineshaft.

Drilling methods used will be appropriate to monitor for groundwater and collect computer modeling data. The established drill holes will be evaluated for evidence of groundwater. If no groundwater is found, the boreholes will be monitored for one year. A determination will be made after one year, if additional monitoring is required.

Core samples will be taken to collect geologic and hydrologic inputs into the model, if necessary.

Drilling will be done with a system that will not introduce water into the hole and can drill into the lithology to a depth of 50 ft below the waste (e.g., ODEX or air rotary methods). Exact method and other specific drilling information will be determined by the drilling subcontractor selected for the project. Borehole development will likely include some or all of the following logs and measurements:

- Electric sounder or electric depth gauge (to determine water level)
- Gyroscopic surveys to determine hole deviation (to maintain buffer perimeter from waste)
- Lithology logging to confirm that the rock is intrusive volcanics

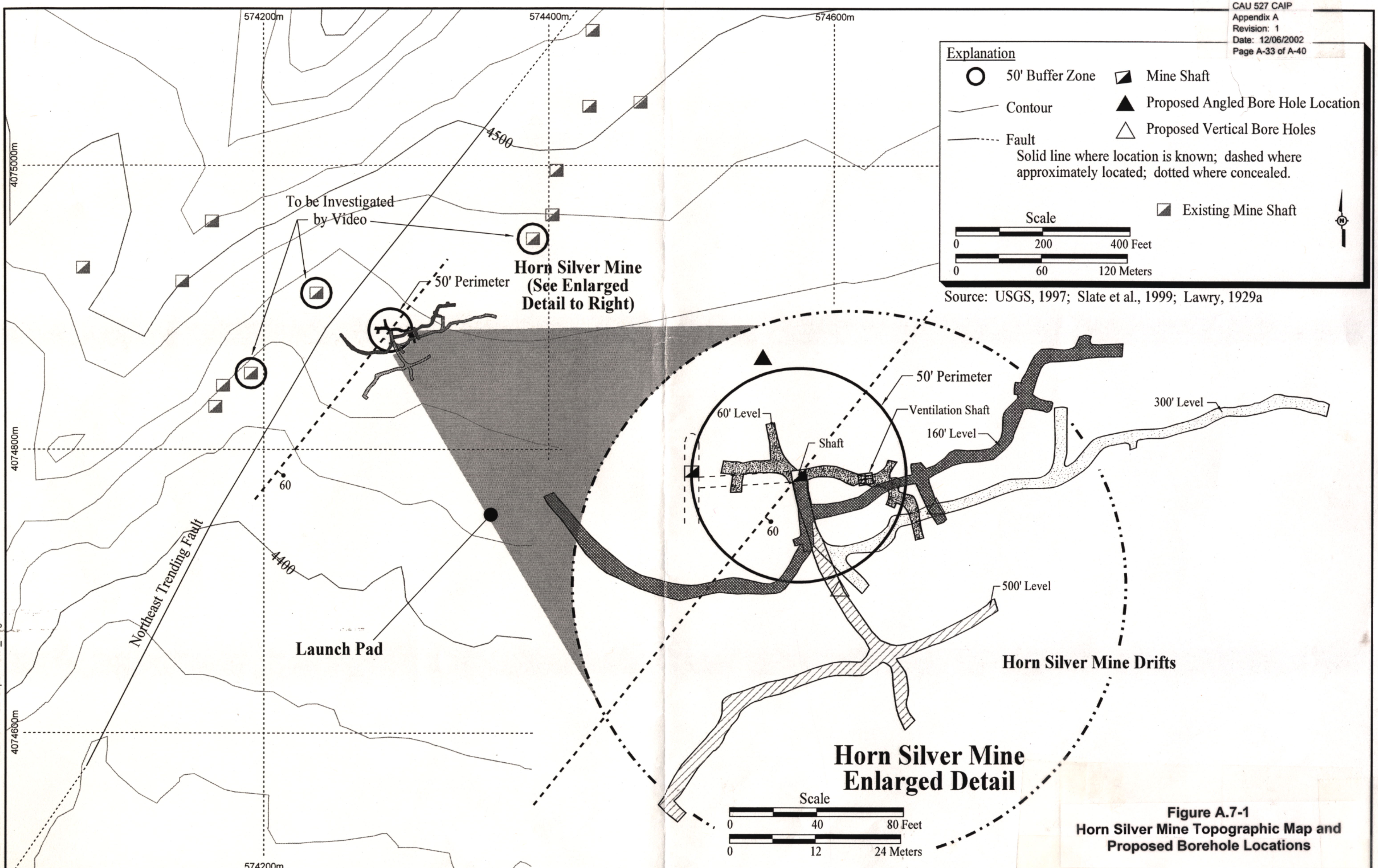

Figure A.7-1
Horn Silver Mine Topographic Map and Proposed Borehole Locations

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- Caliper logging to measure the diameter and general borehole conditions of the borehole; caliper logging is necessary for more accurate interpretation of other wireline geophysical logs
- Televiewer to characterize fractures

Borehole development may also include the following logs and measurements:

- Gamma ray or spectral gamma ray to determine background (geologic contacts and mineralogy), identify fractures under certain conditions, and may determine where source term exists
- Epithermal neutron to identify formation water content and possibly alteration
- Dual lateralog (or dual induction) to determine lithology, alterations, degree of welding, and geologic contacts, correlation, and some porosity/permeability information
- Total magnetic intensity to identify geologic formations; determination of lithology mineralogy, geologic contacts, degree of welding, and correlation
- Video camera to determine conditions, lithology, contacts, and structural features

After the first boreholes are established, water level measurements will be taken to determine if the boreholes are dry or, if wet, the water level using standard water level measuring equipment and SOPs. The criteria for determining if groundwater is entering the monitoring well will be the detection of a water level increase in the monitoring well. This will be measured using a sounding device capable of detecting a 0.5-inch rise in the water level. A 1-inch rise in water level within a 48-hour period following purging of the well will be considered to be greater than measurement error; therefore, it is sufficient to make the decision that groundwater exists.

Monitoring will be conducted continuously for one year, with data being logged once per 24-hour period to track trends. The data logging will consist of measuring groundwater levels in the borehole using an electric sounder or electric depth gauge (to determine water level). Applicable SOPs for measuring groundwater in wells will be used. A determination will be made after one year, if additional monitoring is required. The determination may be based on some or all of, but not limited to: groundwater-level measurement results and precipitation amounts (i.e., average, above or below average for the year). The decision to continue monitoring, or not, will be agreed upon by NNSA/NV and NDEP and documented.

Contamination with high vapor pressures may volatilize, and the resulting vapors could be transported through the open drifts and fractures. The vapor transport will be investigated by attempting to drill into the open drifts at 300 and 500 ft bgs to collect pore gas samples. The fractures will be investigated by isolating sections of the two vertical boreholes and injecting a tracer gas to check for the extent of open fractures.

Intermittent contaminant migration may occur as a result of pulses of infiltrated precipitation or vapor flow. This intermittent driver for contaminant migration may have left residual COPCs within the open fractures. This will be investigated by sending core samples for laboratory analysis.

Samples of any groundwater found, drilling core, and pore gas will be taken for analysis to determine if COCs have migrated from the waste.

A.2.0 References

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Appendix B

Project Organization

B.1.0 Project Organization

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

The identification of the project Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change and it is suggested that the appropriate DOE or Defense Threat Reduction Agency 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 C

Technical Guidance Documents

C.1.0 Technical Guidance Documents

Field activities will be conducted in accordance with approved plans, policies, or procedures including, but not limited to, the field instruction, subcontractor procedures, and other internal SQPs.

C.1.1 American Society for Testing and Materials Standards

Guide for Site Characterization for Environmental Purposes with Emphasis on Soil, Rock, the Vadose Zone and Ground Water. D 5730-96

Guide for Field Logging of Subsurface Explorations of Soil and Rock. D 5434-93

Guide for Soil Sampling from the Vadose Zone. D 4700-91

Practice for Diamond Core Drilling for Site Investigation. D 21113-83 (1993)

Guide for Soil Gas Monitoring in the Vadose Zone. D 5314-92

Guide for Pore Liquid Sampling from the Vadose Zone. D 4696-92

Test Method for Water Content of Soil and Rock In-Place by the Neutron Depth Probe Method. D 5220-92

C.1.2 Contractor Plans, Policies or Procedures

Appropriate contractor plans, policies, or procedures will be reviewed and approved prior to starting work. The following activities may require subcontractor performance to complete required tasks:

- Subsurface sampling during drilling
- Groundwater monitoring, well purging and sampling
- Drilling
- Borehole logging
- Monitoring well installation
- Vadose zone pore gas sampling

Appendix D

NDEP Comment Responses

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: Preliminary Corrective Action Investigation Plan for Corrective Action Unit 527: Horn Silver Mine, Nevada Test Site, Nevada	2. Document Date: August 2002
3. Revision Number: 0	4. Originator/Organization: IT Corporation
5. Responsible NNSA/NV ERP Project Mgr.: Janet Appenzeller-Wing	6. Date Comments Due:
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*	12. Comment	13. Comment Response	14. Accept
1. General		The plan seems to be very narrowly focused on direct contact with the groundwater as the only pathway being considered as noted in the Scope, first and second paragraph. The potential pathways to the groundwater (vapor, fracture flow, rain events, etc.) should be considered and evaluated. Further the PAL discussion begins with reference to measurements in the groundwater as the pathway and the only item of interest.	The discussion of potential contaminant transport mechanisms was expanded to include liquids and vapors. The discussion of potential contaminant migration pathways was expanded to include flow of liquid or vapor through open drifts or fractures. The discussion of PALs was expanded to include discussion of chemical and radiological PALs.	Yes
2. General		The Conceptual Site Model (CSM) continues to be less than fully developed. The Horn Silver mine itself is referenced as the CSM without reference to other shafts and potential connections between the drifts and shafts in the area. In the DQO discussion there is reference to six shallow shafts but these are not identified on the maps/drawings. In fact, they are explicitly excluded from the CSM. The state believes that this is a serious shortcoming in the development of the CAIP and the CSM.	The mines in the immediate vicinity of the Horn Silver Mine were added to Figure 2-1. The discussion of the historical mining activities was expanded to include a more detailed discussion of the adjacent mines.	Yes
3. General		In the discussion of the waste inventory, inconsistencies in the inventory are noted but not discussed.	The discussion of the waste disposal volumes in the main document and Appendix A were rewritten to clarify the discrepancy between reported volumes and total possible volume. Also the waste types were reviewed and clarified.	Yes
4. Page 3, 1st Bullet		Phrasing should be modified to read ...groundwater **or** vapor transport **or other mechanism.**	The text was modified as indicated.	Yes

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
5. Page 4, 25, A-23-24		In sending core samples to the laboratory, it is expected that any fractures themselves would be examined not just the bulk core sample. This may need to be clarified.	The text was clarified to discuss visual inspection of the fractures in the field and laboratory analysis.	Yes
6. Page 4, 24		Additional explanation of the tracer gas injection process and potential or expected results is needed such as that included on pages A.23-24.	The discussion of the tracer gas test was expanded.	Yes
7. Page 7, A		The surface elevation of the Horn Silver Mine should be related to the groundwater elevations in the area, perhaps at Pluto as well to create a better picture of the site.	The surface elevations of the Horn Silver Mine and wells in the vicinity of the Horn Silver Mine are shown on Plate 1.	Yes
8. Page 8		How well known is it that surface water is diverted by the concrete pad over the shaft. Are there gaps around the cap or is it, in fact, truly covering the shaft opening.	No gaps were found during visual inspection of the concrete pad. Historical records indicate that the mine shaft was 8 x 8 ft. The pad is 20 x 20 ft. It is assumed that the pad effectively prevents direct infiltration into the mine shaft.	Yes
9. Page 25		PALs established at PRGs are acceptable to identify contamination levels that require remediation but are not considered to be sufficiently sensitive to identify potential transport routes in or through fracture flow. Similarly, are identified radioactive levels sufficiently sensitive?	The PALs used to determine contaminant migration were clarified to be the detection of nonnaturally occurring chemical or radiological COPCs.	Yes
10. Page A-16		Table A.1-2 doesn't reference the angled borehole. Perhaps it belongs in Criteria 3.	The angled borehole was added to Table A.1-2, Criteria 1.	Yes
11. Page 3		Line 16 **the presence of groundwater would be considered** would be a better selection of words than the absolute statements being made about transport mechanisms.	The text was modified as indicted.	Yes
12. Page 3		Line 21 it is not clear that one year of monitoring is all that should be done.	The text discussing the monitoring duration was expanded to include a decision being made after the first year of monitoring.	Yes
13. Page 7		2nd Paragraph - seems to be unconnected the Horn Silver Mine Site. Last paragraph - the absolute statement about groundwater could be better stated as ...documented **in correspondence at the time of mining operations that no groundwater existed...**	The second paragraph was modified. This is a general discussion of the formation of surface soils at the NTS. The text was modified as indicated.	Yes

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
14. Figure 2-1		Need other shafts on the map.	The adjacent mines were added to the figure.	Yes
15. Page 10		Discuss other shafts and drifts.	The discussion of the historical mining activities was expanded to include a more detailed discussion of the adjacent mines.	Yes
16. Page 12, Last Paragraph		What is the inconsistency?	The discussion of the inconsistencies was clarified and expanded.	Yes
17. Page 15, 2nd Paragraph		Is an absolute statement and should be better written in terms of “if” present **are to be considered to be...**	The text was modified as indicated.	Yes
18. Page 16, 2nd Paragraph		Is very presumptive and conclusionary.	The text was modified.	Yes
19. Page 20, Section 3.1.4		It is not agreed that additional topographical information is not needed. The CSM should be better developed in terms of other shafts and drifts.	The topographical information was not modified. The need for additional information about the adjacent mines shafts and drifts was added to the geology section.	Yes
20. Page 22, Line 1		It is not clear that the decision statement is the correct one. Isn’t it more correct to decide if transport has occurred or some other variation of that?	Discussion of the additional decision statement for contaminant migration has occurred and was added.	Yes
21. Page 30, 2nd Paragraph		Rather than “determine” could it be to **examine the underground environs,** two vertical...	The text was modified as indicated.	Yes
22. Page 31		Similar concerns with statements about groundwater.	The text discussing the monitoring duration was expanded to include a decision being made after the first year of monitoring.	Yes
23. Page A-3		The CSM is limited and should be more fully addressed.	Additional text discussing the assumptions for the CSM was added.	Yes
24. Page A-5		The second paragraph doesn’t seem to fit with the rest of the discussion.	The second paragraph was modified. This is a general discussion of the formation of surface soils at the NTS.	Yes

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
25. Page A-6		The discussion of the area around the site should be expanded. Last paragraph - other transport mechanisms should not be excluded so summarily.	The discussion of the historical mining activities was expanded to include a more detailed discussion of the adjacent mines. The discussion of the groundwater and vapor transport mechanisms were expanded. The justification for excluding the biota transport mechanism was expanded.	Yes
26. Page A-7, 3rd Paragraph		No groundwater is **expected** rather than present.	The text was modified as indicated.	Yes
27. Page A-9, 1st Paragraph		Need to define what the inconsistency is.	The discussion of the inconsistencies was clarified and expanded.	Yes
28. Page A-10, Last Two Paragraphs		What supports the assumptions made here?	There is no indication of surface contamination based on surface surveys. The assumption is made based on the records for the type of waste disposed in the mine and the geology of the area.	Yes
29. Page A-14, 1st Paragraph		Rather than "**the** primary" isn't groundwater "**a** primary" transport mechanism?	The text was modified as indicated.	Yes
30. Page A-16		Revise the tables to include multiple boreholes.	The tables were modified as indicated.	Yes
31. Figure 2		Need the rest of the information about shafts on it.	The adjacent mines were added to the figure.	Yes

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

Return Document Review Sheets to NNSA/NV Environmental Restoration Division, Attn: QAC, M/S 505.

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number: Preliminary Corrective Action Investigation Plan for Corrective Action Unit 527: Horn Silver Mine, Nevada Test Site, Nevada	2. Document Date:
3. Revision Number: 0	4. Originator/Organization: IT Corporation
5. Responsible NNSA/NV ERP Project Mgr.: Janet Appenzeller-Wing	6. Date Comments Due:
7. Review Criteria: Full	
8. Reviewer/Organization/Phone No.: Paul Liebendorfer, NDEP, (775) 687-9388	9. Reviewer's Signature:

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1. Page 13 and A-8		The discussion of waste streams potentially placed in the Horn Silver Mine notes discrepancies in volumes. Of particular concern is the relationship between the volumes of waste reported as disposed, and the volume of the hole that was filled. The CAIP must provide additional clarification of this topic.	The discussion of the waste disposal volumes in the main document and Appendix A were rewritten to clarify the discrepancy between reported volumes and total possible volume. Also the waste types were reviewed and clarified.	Yes
2. Page 13 and A		There seems to be confusion about the reference REECo 1978 or REECo 1988 and the text that discusses the reference. Correct the discussion and the reference.	The reference was corrected to read 1978.	Yes
3. Page 24 and A-12		The report is unclear whether the intent is to utilize PRG values to determine whether or not contaminant transport has occurred. A characterization process utilizing PRGs as an action level would not be accepted as sufficiently sensitive criteria for making these determinations. A greater emphasis on the proposed criteria, as implied by the statement on page A-18 "...detection of nonnaturally occurring..." in the text, may alleviate this concern.	The PAL discussions in the main document and Appendix A were rewritten to clarify when the different PALs are appropriate.	Yes
4. Page 28 and A-10		The technical approach discussed in this section is primarily focused on groundwater as the means of transport. Provide more detailed presentation of other transport processes, such as gaseous flows, fracture flows or vapor transport and how those will be investigated in the field.	The section in the main document and Appendix A was rewritten to clarify the technical approach. Contaminant transport through fractures by either vapor or liquid is addressed. The transport could occur as intermittent pulses.	Yes

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
5. Pages 30 and A-33		Expand the discussion of the proposed one year monitoring to reflect the potential for required longer periods of monitoring to insure the results will be reflective of wet years or around climatically significant events.	The text was expanded in the main document and Appendix A.	Yes
6. Page 32		The first bullet is missing “feet” after 50.	The text was corrected.	Yes
7. General		Make reference to specific SOPs or procedures for vapor transport determination, fracture analysis, pressure tests in the borehole and other specialized processes unique to this site. Additionally, reference the content of the field instruction for completeness.	A list of technical guidance documents was added in Appendix C.	Yes

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

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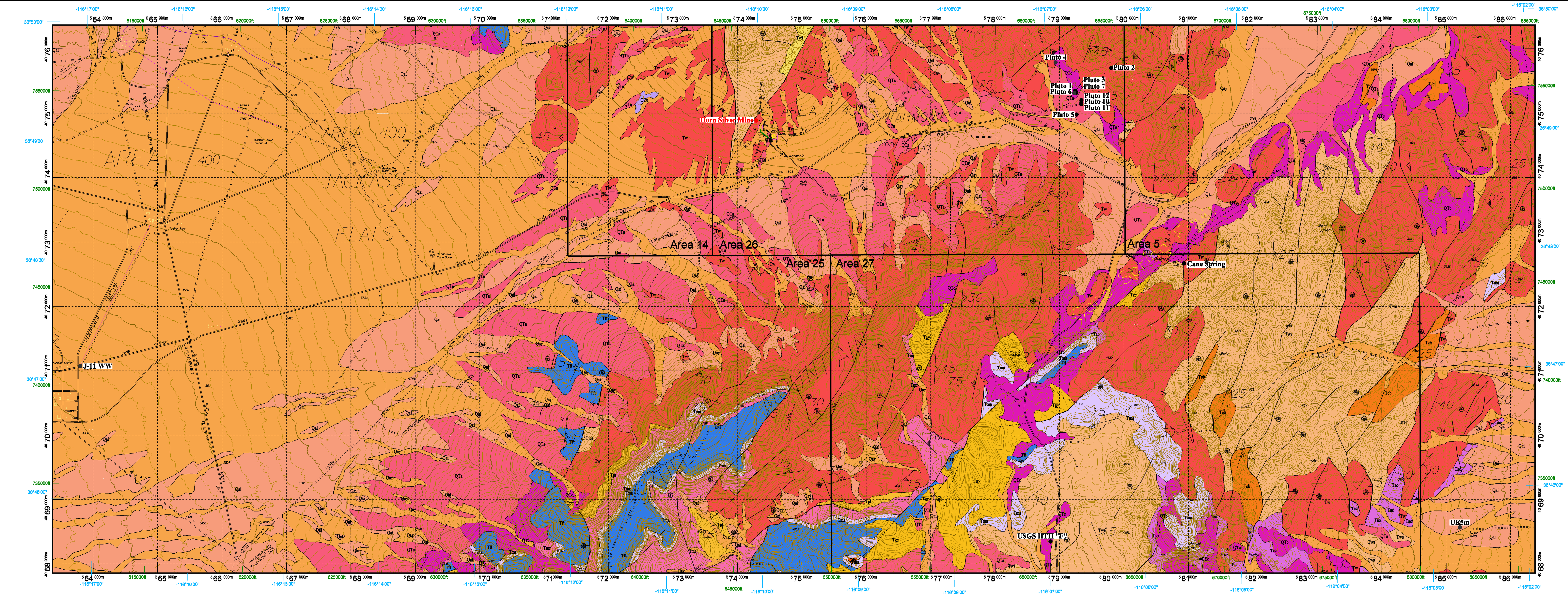
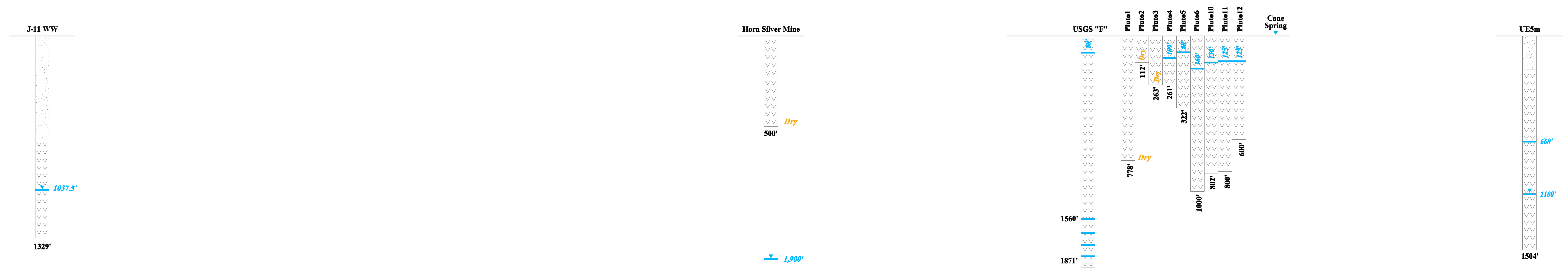
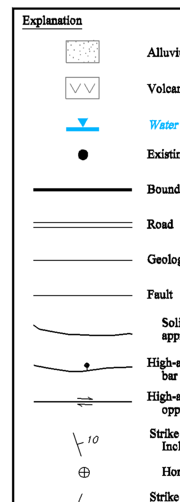
Color Table = B:\nts\nts_geology2.ctb *** SCALE = 579.12M:1"





Explanation



- Alluvium
- Volcanics
- Water Level
- Existing Well Location
- Boundary of the NTS
- Road
- Geologic Contact
- Fault
  - Solid line where location is known; dashed where approximately located; dotted where concealed
- High-angle normal fault
  - bar and ball on downthrown side
- High-angle strike-slip fault
  - opposing arrows indicate relative lateral slip
- Strike and dip of beds
  - Inclined
  - Horizontal
- Strike and dip of foliation
  - Inclined

Geology

Qay	Young alluvial deposits (Holocene)
QTc	Colluvium (Holocene, Pleistocene, and Pliocene)
QTu	Undifferentiated surficial deposits (Holocene, Pleistocene, and Pliocene)
Qai	Intermediate alluvial deposits (early Holocene? and Pleistocene)
QTa	Old alluvial deposits (middle to early Pleistocene and Pliocene?)
Tgy	Basin-fill sediments, undivided (Pliocene and upper Miocene)
Tft	Intermediate-age basalt (Miocene)
Tfb	Beatty Wash Formation
Tma	Ammonia Tanks Tuff
Tmr	Rainier Mesa Tuff
Tpt	Topopah Spring Tuff
Tac	Calico Hills Formation (Miocene)
Tw	Wahmonie Formation (Miocene)
Twi	Intrusive rocks of Wahmonie (Miocene)
Tws	Salyer Formation (Miocene)
Tgp	Pre-basin-range sedimentary rocks, undivided (Miocene)
Tcb	Bullfrog Tuff

Projection and grid: Universal Transverse Mercator, Zone 11, 1927 North American Datum, Meters

Nevada Coordinate System, Central Zone, 1927 North American Datum, Feet

Geographic (Longitude, Latitude) is shown for reference only

Scale

0 1,900 3,800 Feet

0 580 1,160 Meters

SOURCES: J-11 - WW Lithology - (Walker et al., 1961) Water Level - (USGS, 2002b); Horn Silver Mine - Lithology - (Lawry, 1928; 1929a and b) Water Level - (Winograd and Thordson, 1975); Pluto Wells - (Johnson and Ege, 1964); USGS HTH "F" - (West and Garber, 1964) UE5m - (Healy et al., 1967); USGS map - (Slate et al., 1999; BN, 1997)

PLATE 1
CAU 527 GEOLOGY MAP
AND DRILL HOLE INFORMATION

DATE	DRAWING NUMBER
12-DEC-2002	h:\527\CAIP\527locmap_a.dgn

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