Nevada
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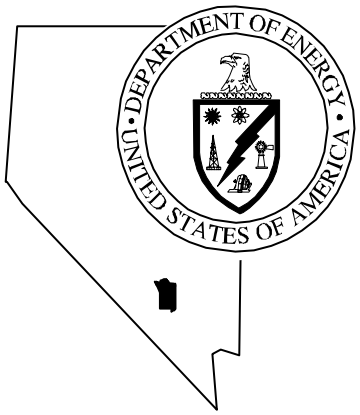

Corrective Action Decision Document for Corrective Action Unit 423: Building 03-60 Underground Discharge Point, Tonopah Test Range, Nevada

Controlled Copy No.: Uncontrolled
Revision No.: 0

June 1998

Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

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CORRECTIVE ACTION DECISION DOCUMENT FOR CORRECTIVE ACTION UNIT 423: BUILDING 03-60 UNDERGROUND DISCHARGE POINT, TONOPAH TEST RANGE, NEVADA

DOE Nevada Operations Office
Las Vegas, Nevada

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CORRECTIVE ACTION DECISION DOCUMENT
FOR CORRECTIVE ACTION UNIT 423:
BUILDING 03-60 UNDERGROUND DISCHARGE POINT,
TONOPAH TEST RANGE, NEVADA

Approved by: Janet Appenzeller-Wing Date: 6/17/98

Janet Appenzeller-Wing, Project Manager
Industrial Sites Subproject

Approved by: Robert M. Bangerter Jr. Date: 6/17/98

for Runore C. Wycoff, Project Manager
Nevada Environmental Restoration Project

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List of Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
BOA	Basic Ordering Agreement
bgs	Below ground surface
BN	Bechtel Nevada
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CADD	Corrective Action Decision Document
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter(s)
cm/sec	Centimeter(s) per second
COA	Certificate(s) of analysis
COC	Contaminant(s) of concern
COPC	Contaminant(s) of potential concern
CRDL	Contract-required detection limit
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DQO	Data quality objectives
EDT	Electronic data transfer
EPA	U.S. Environmental Protection Agency
FFACO	*Federal Facility Agreement and Consent Order*
ft	Feet (foot)
ft^2	Square feet (foot)
GPR	Ground-penetrating radar

List of Acronyms and Abbreviations *(Continued)*

ICP	Inductively coupled plasma
IDL	Instrument detection limit
IDW	Investigation-derived waste
in.	Inch(es)
kg	Kilogram(s)
km	Kilometer(s)
lbs	Pound(s)
LCS	Laboratory control sample
m	Meter(s)
MD	Matrix duplicate
MEK	Methyl ethyl ketone
m^2	Square meter(s)
mg/kg	Milligram(s) per kilogram
mi	Mile(s)
MS	Matrix spike
MSD	Matrix spike duplicate
NAC	*Nevada Administrative Code*
NDEP	Nevada Division of Environmental Protection
NRS	*Nevada Revised Statutes*
O&M	Operation and maintenance
PAL	Preliminary action levels
PCB	Polychlorinated Biphenyl(s)
ppm	Part(s) per million
PU	Polyurethane
PID	Photoionization detector
PRG	Preliminary remediation goals

List of Acronyms and Abbreviations *(Continued)*

QA	Quality assurance
QAPP	*Industrial Sites Quality Assurance Project Plan*
QC	Quality control
RCRA	*Resource Conservation and Recovery Act*
RPD	Relative percent difference
SDG	Sample delivery group
SVOC	Semivolatile organic compound(s)
TPH	Total petroleum hydrocarbons
TTR	Tonopah Test Range
UDP	Underground Discharge Point
USACE	U.S. Army Corps of Engineers
UST	Underground storage tank
VOC	Volatile organic compound(s)
µg/kg	Microgram(s) per kilogram

Executive Summary

This Corrective Action Decision Document has been prepared for the Area 3 Building 03-60 Underground Discharge Point (Corrective Action Unit 423) in accordance with the *Federal Facility Agreement and Consent Order* of 1996 (FFACO, 1996). Corrective Action Unit 423 is located at the Tonopah Test Range and is comprised of Corrective Action Site 03-02-002-0308. The purpose of this Corrective Action Decision Document is to identify and provide a rationale for the selection of a recommended corrective action alternative for Corrective Action Unit 423.

The scope of this Correction Action Decision Document consists of the following:

- Develop corrective action objectives.
- Identify corrective action alternative screening criteria.
- Develop corrective action alternatives.
- Perform detailed and comparative evaluations of the corrective action alternatives in relation to the corrective action objectives and screening criteria.
- Recommend and justify a preferred corrective action alternative for the Corrective Action Unit.

In January 1998, a corrective action investigation was performed as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit No. 423: Building 03-60 Underground Discharge Point, Tonopah Test Range, Nevada* (DOE/NV, 1997). A hydrocarbon plume was found to emanate from near the bottom of the Underground Discharge Point to the west. The plume encompasses approximately 65 square meters (700 square feet). The highest total petroleum hydrocarbon level detected was 2,400 milligrams per kilogram. No other contaminants were detected above preliminary action levels. Details of the investigation can be found in Appendix A of this document.

Based on the potential exposure pathways identified during the Data Quality Objectives process, the following corrective action objectives have been identified for Corrective Action Unit 423:

- Prevent or mitigate human exposure to subsurface soil containing contaminants of concern.
- Prevent adverse impacts to groundwater quality.

Based on the review of existing data, future land use assumption, and current operations at the Tonopah Test Range, the following alternatives were developed for consideration at the Building 03-60 Underground Discharge Point:

- Alternative 1 - No Action
- Alternative 2 - Closure in Place with Administrative Controls
- Alternative 3 - Partial Excavation, Disposal, and Administrative Controls
- Alternative 4 - *In Situ* Bioremediation

The corrective action alternatives were evaluated based on four general corrective action standards and five remedy selection decision factors. Based on the results of this evaluation, the preferred alternative for Corrective Action Unit 423 is Alternative 2, Closure in Place with Administrative Controls.

The preferred corrective action alternative was evaluated on technical merit, focusing on performance, reliability, feasibility, and safety. The alternative was judged to meet all requirements for the technical components evaluated. The alternative also meets all applicable state and federal regulations for closure of the site and will reduce potential future exposure pathways to the contaminated soils.

1.0 Introduction

This Corrective Action Decision Document (CADD) has been prepared for Corrective Action Unit (CAU) 423, Building 03-60 Underground Discharge Point (UDP) in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) of 1996 that was agreed to by the U.S. Department of Energy, Nevada Operations Office (DOE/NV); the Nevada Division of Environmental Protection (NDEP); and the U.S Department of Defense (FFACO, 1996). The CADD provides or references the specific information necessary to recommend a preferred corrective action for the single Corrective Action Site (CAS), 03-02-002-0308, within CAU 423.

Corrective Action Unit 423 is located at the Tonopah Test Range (TTR), Nevada. The TTR is approximately 255 kilometers (km) (140 miles[mi]) northwest of Las Vegas, Nevada (Figures 1-1 and 1-2). The UDP is approximately 73 meters (m) (240 feet [ft]) northwest of the northwest corner of Building 03-60, the Auto Maintenance Shop. Corrective Action Unit 423 is comprised of the UDP and an associated discharge line extending from Building 03-60. The UDP received waste oil products from the Auto Maintenance Shop, a light-duty fleet maintenance shop in the Area 3 compound, from 1965 to 1989 or 1990 (DOE/NV, 1997).

1.1 Purpose

This CADD identifies potential corrective action alternatives and provides a rationale for the selection of a recommended alternative for the CAU. The need for these alternatives is based on process knowledge and the results of investigative activities conducted in accordance with the *Corrective Action Investigation Plan for Corrective Action Unit No. 423: Building 03-60 Underground Discharge Point, Tonopah Test Range, Nevada* (DOE/NV, 1997).

1.2 Scope

The scope of this CADD consists of the following:

- Develop corrective action objectives.
- Identify corrective action alternative screening criteria.

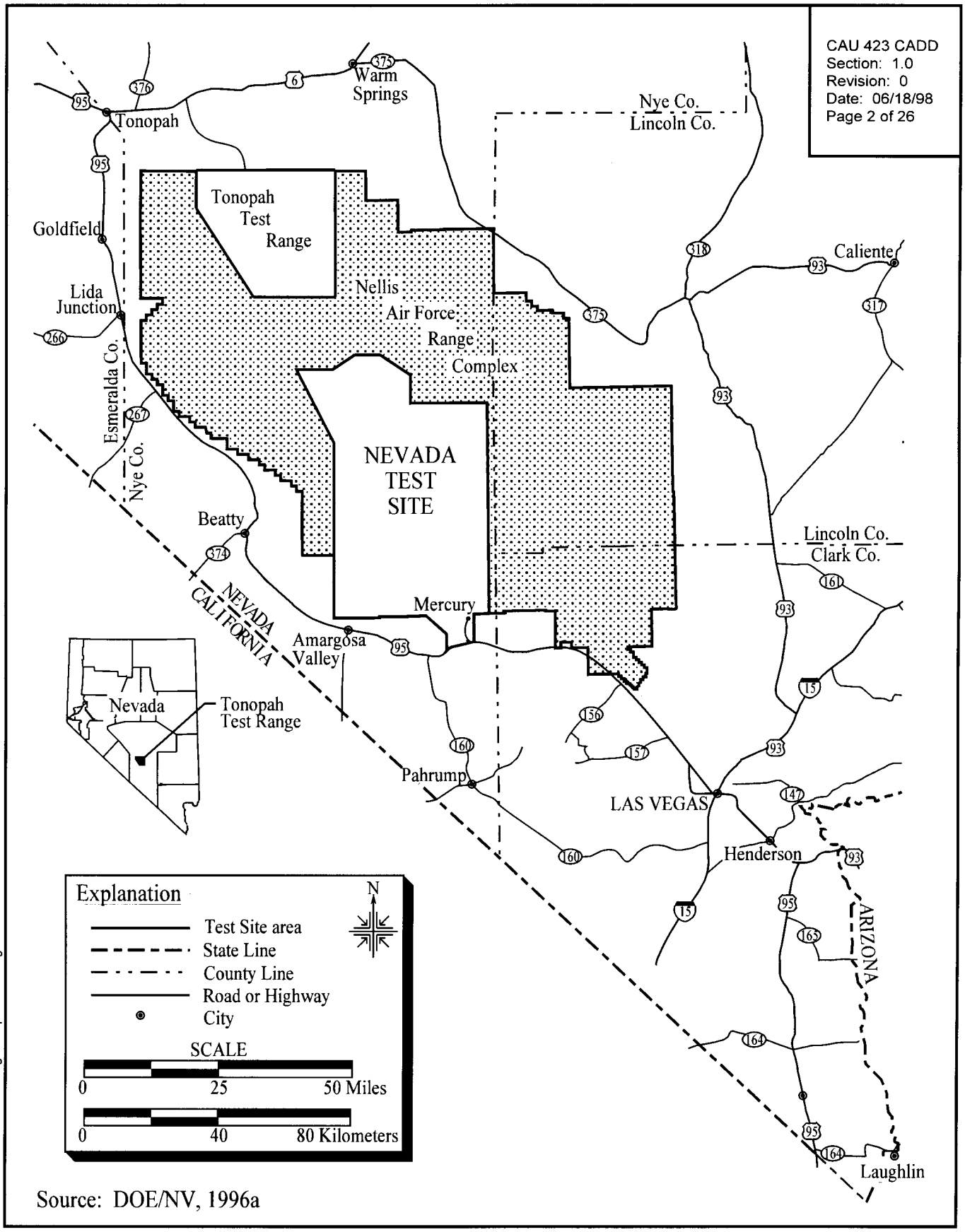
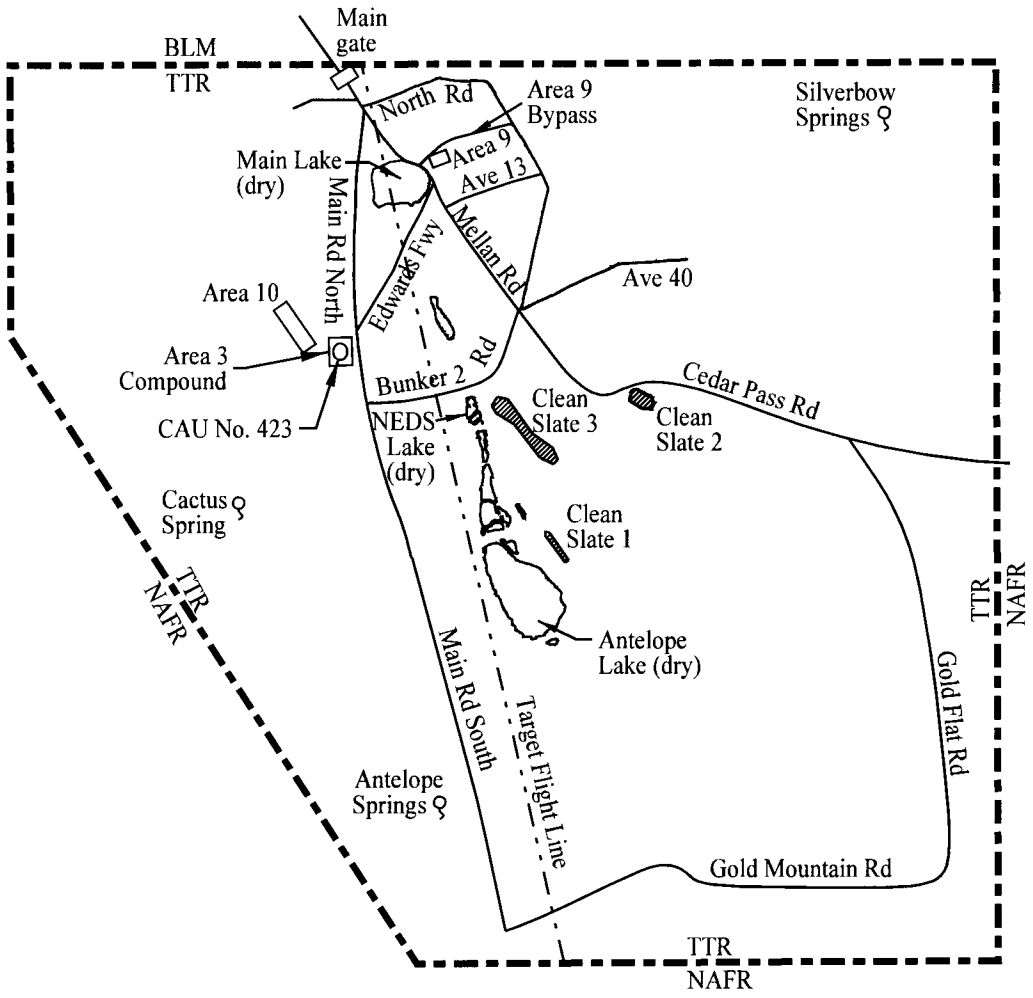


Figure 1-1
Tonopah Test Range Location Map



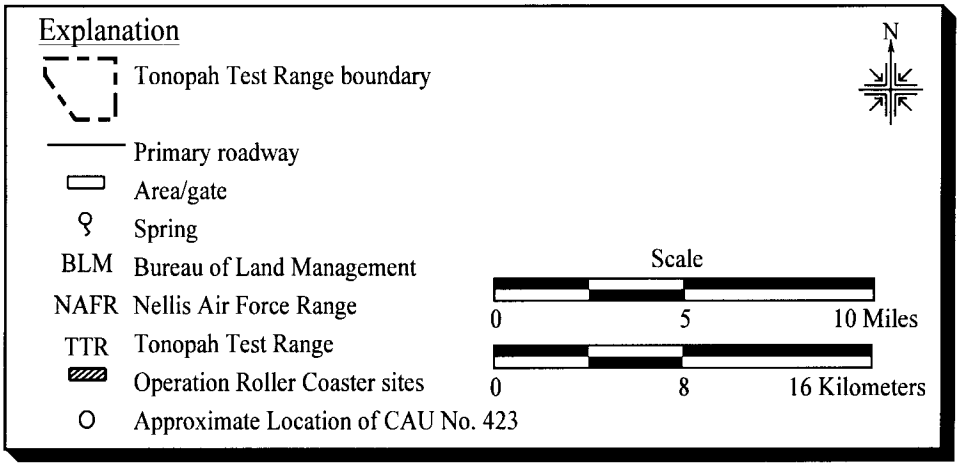


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Figure 1-2
Location of Area 3, Tonopah Test Range

- Develop corrective action alternatives.
- Perform detailed and comparative evaluations of corrective action alternatives in relation to corrective action objectives and screening criteria.
- Recommend and justify a preferred corrective action alternative for the CAU.

1.3 CADD Contents

This CADD is divided into the following sections:

- Section 1.0 - Introduction: summarizes the purpose, scope, and contents of this CADD
- Section 2.0 - Corrective Action Investigation Summary: summarizes the investigation field activities, the results of the investigation, and the need for corrective action
- Section 3.0 - Evaluation of Alternatives: documents steps taken to determine a preferred corrective action alternative
- Section 4.0 - Recommended Alternative: presents the preferred corrective action alternative and the rationale for its selection based on the corrective action objectives and alternative screening criteria
- Section 5.0 - References: provides a list of all referenced documents
- Appendix A: *Corrective Action Investigation Report for CAU 423: Building 03-60 UDP, TTR*
- Appendix B: Soil Boring Logs
- Appendix C: Cost Estimates

All work was performed in accordance with the following documents:

- *Corrective Action Investigation Plan for Corrective Action Unit No. 423: Building 03-60 Underground Discharge Point, Tonopah Test Range, Nevada* (DOE/NV, 1997)
- *Industrial Sites Quality Assurance Project Plan* (DOE/NV, 1996b)
- *Corrective Action Unit Work Plan for the Tonopah Test Range* (DOE/NV, 1996a)

- FFACO (FFACO, 1996)
- *Project Management Plan* (DOE/NV, 1994)

2.0 Corrective Action Investigation Summary

The following sections describe and summarize the results of the investigation activities conducted at CAU 423. For detailed investigation results, please refer to Appendix A.

2.1 Investigation Activities

In January 1998, corrective action investigation activities were performed as defined in the Corrective Action Investigation Plan (CAIP) (DOE/NV, 1997). The purpose of the investigation was to:

- Determine the UDP configuration.
- Identify the nature and presence of possible contaminants of concern (COCs) within the UDP.
- Determine the vertical and lateral extent of possible contaminant migration.
- Provide sufficient information and data from which corrective action alternatives may be developed in this CADD for this CAS.

The following items summarize the investigation activities (details of the investigation are presented in Appendix A):

- Drilled eight investigation borings in and around the UDP to a maximum depth of 27 m (90 ft) using the sonic drilling method.
- Collected samples from each of the borings for field screening and laboratory analysis (Figure A.2-3 in Appendix A shows boring locations).
- Analyzed environmental samples from the investigation borings for total volatile organic compounds (VOCs), total semivolatile organic compounds (SVOCs), total *Resource Conservation and Recovery Act* (RCRA) metals, total petroleum hydrocarbons (TPH), and total polychlorinated biphenyls (PCBs).

- Performed tests on bioassessment samples to ascertain pH levels, moisture content, background nutrient concentrations, microbial enumerations, and microbial stimulation response.

- Analyzed geotechnical samples from investigation borings for initial moisture content, dry bulk density, calculated porosity, saturated/unsaturated hydraulic conductivity, particle size distribution, and water-release curve.

2.2 Results

The corrective action investigation results indicated the following:

- Total petroleum hydrocarbons were identified above the 100 milligrams per kilogram (mg/kg) action level specified in *Nevada Administrative Code* (NAC) 445A (NAC, 1996a) in a plume emanating from the UDP (Table A.3-3; Figures A.2-3 and A.3-1). The plume is approximately 6 m (20 ft) by 11 m (35 ft) in area and extends from about 4 m (14 ft) to 20 m (65 ft) below ground surface (bgs). The highest TPH concentration detected was 2,400 mg/kg at 6 m (20 ft) bgs in boring B6. Only 9 of the 38 samples collected and analyzed for TPH had concentrations above 100 mg/kg.

- No other COCs were identified above preliminary action levels (NAC, 1996a).

- Detected VOCs and SVOCs were below the preliminary action levels outlined in the CAIP (DOE/NV, 1997) (Tables A.3-4 and A.3-5). While most VOCs were not detected, those that were detected were either common laboratory contaminants or associated with hydrocarbon products such as benzene, toluene, ethylbenzene, and xylenes (BTEX). Detected SVOCs were also associated with hydrocarbon products.

- Reported levels for all total RCRA metal samples were below the preliminary action levels established in the CAIP (DOE/NV, 1997) or below corresponding background levels (in the case of arsenic) (Table A.3-6). The analytical results for all detected metals are generally indicative of the naturally occurring background levels for this area based on results from the background samples collected in other Area 3 investigations (DOE/NV, 1998).

- A single detection of PCBs was noted in sample TTR001151 in Boring B8 at a depth of 24 m (80 ft). The concentration was well-below the preliminary action level.

- Bioassessment indicates that favorable conditions exist for biological degradation and for the implementation of a bioremediation system.

- Geotechnical results indicate the presence of a lower permeability layer below the plume with higher permeabilities in the plume area (Table A.3-9).

Details of the methods used and results found during the investigation are presented in Appendix A.

2.3 Need for Corrective Action

Analytes detected during the corrective action investigation were evaluated against action levels to determine COCs for CAU 423. Total petroleum hydrocarbons were detected above the 100 mg/kg action level (NAC 445A) (NAC, 1996a) in samples taken from soil below and around the UDP. No other COCs were identified above preliminary action levels as specified in the CAIP; therefore, potential corrective actions will be identified and evaluated in this CADD to ensure worker, public, and environmental protection against potential exposure to the TPH contamination in accordance with NAC 445A (NAC, 1996a).

3.0 Evaluation of Alternatives

The purpose of this section is to present the corrective action objectives for CAU 423, to describe the general standards and decision factors used to screen the corrective action alternatives, and to develop and evaluate a set of corrective action alternatives that could be used to meet the corrective action objectives.

3.1 Corrective Action Objectives

The corrective action objectives are media-specific goals for protecting human health and the environment. Based on the potential exposure pathways (see Section 3.1.2), the following corrective action objectives have been identified for CAU 423:

- Prevent or mitigate human exposure to subsurface soil containing COCs.
- Prevent adverse impacts to groundwater quality.

3.1.1 Contaminants of Concern

Contaminants of potential concern (COPCs) were determined in the Data Quality Objectives (DQO) process as outlined in the CAIP (DOE/NV, 1997). Analytical results obtained from the corrective action investigation were evaluated to determine if COPCs were detected above preliminary action levels and would, therefore, be COCs for CAU 423 that must be addressed by corrective action. Based on the results of this evaluation, elevated levels of TPH were identified above preliminary action levels (see Section A.3.0 of Appendix A). No other COCs were identified.

3.1.2 Potential Exposure Pathways

As identified in the DQO process, the future land use for the UDP area is assumed to be light industrial. As part of the CAIP (DOE/NV, 1997), a conceptual model for CAU 423 was developed which identified the potential exposure pathway as ingestion of soils under occupational scenarios (see Figure 3-1 in the CAIP [DOE/NV, 1997]). This pathway includes inhalation of vapors and dermal contact.

3.2 Screening Criteria

The screening criteria used to evaluate and select the preferred corrective action alternatives are identified in the U.S. Environmental Protection Agency (EPA) *Guidance on Resource Conservation and Recovery Act Corrective Action Decision Documents* (EPA, 1991) and the *Final Resource Conservation and Recovery Act Corrective Action Plan* (EPA, 1994).

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

The general corrective action standards are:

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

The remedy selection decision factors are:

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

3.2.1 Corrective Action Standards

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

Protection of Human Health and the Environment

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

Compliance with Media Cleanup Standards

Each corrective action alternative must have the ability to meet the proposed media cleanup standards as set forth in applicable regulations (NAC 445A.2272 [NAC, 1996a]). This regulation prescribes an appropriate level of concentration that is based on the protection of public health and safety and the environment. The appropriate level must be based on the Integrated Risk Information System. For this CAU, the EPA's Region IX Preliminary Remediation Goals, which are derived from the Integrated Risk Information System, are the basis for establishing the preliminary action levels (EPA, 1996).

Control of the Source(s) of the Release

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

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

During implementation of any corrective action alternative, all waste management activities must be conducted in accordance with applicable state and federal regulations (e.g., *Nevada Revised Statutes* [NRS] 459.400 - 459.600 [NRS, 1995]; RCRA 40 *Code of Federal Regulations* [CFR] 261 - 281 [CFR, 1996]; 40 CFR 268, "Land Disposal Restrictions;" and NAC 459.9974, "Disposal and Evaluation of Contaminated Soil" [NAC, 1996b]). The requirements for management of the waste, if any, derived from the corrective action will be determined based on applicable state and federal regulations, field observations, process knowledge, characterization data, and data collected and analyzed during corrective action implementation. Administrative controls (e.g., decontamination procedures and corrective action strategies) will minimize waste generated during site corrective action activities. Decontamination activities will be performed in

accordance with approved procedures as specified in the NDEP-approved TTR work plan (DOE/NV, 1996a) and will be designated according to the contaminants present at the site.

3.2.2 Remedy Selection Decision Factors

The following describe the remedy selection decision factors used to evaluate the corrective action alternatives:

Short-Term Reliability and Effectiveness

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

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

Reduction of Toxicity, Mobility, and/or Volume

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

Long-Term Reliability and Effectiveness

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

Feasibility

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

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

Cost

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

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

Cost summaries for this CADD are provided in Appendix C.

3.3 Development of Corrective Action Alternatives

This section identifies and briefly describes the viable corrective action technologies and the corrective action alternatives considered for the affected media. Based on the review of existing

data, future land use, and current operations at the TTR, the following alternatives have been developed for consideration at the Building 03-60 UDP CAU:

- Alternative 1 - No Further Action
- Alternative 2 - Closure in Place with Administrative Controls
- Alternative 3 - Partial Excavation, Disposal, and Administrative Controls
- Alternative 4 - *In Situ* Bioremediation

The following analysis of NAC 445A.227 (2) (a-k) criteria (NAC, 1996a) supports the protection of groundwater from the CAU 423 COC; therefore, groundwater monitoring is not considered in the remainder of the document:

a. The depth to groundwater is 110 to 120 m (360 to 390 ft) (DOE/NV, 1996a). The source of contaminant release to the UDP has been permanently eliminated; therefore, a source no longer exists to contribute to plume size or migration. The precipitation for the area (13 to 15 cm [5 to 6 in.] annually) (DOE/NV, 1996a) does not significantly influence the movement of the contaminants. Based on the bioassessment, favorable conditions exist for natural attenuation of hydrocarbons and other organic constituents through biological degradation (Appendix A). While the contaminants may continue to migrate vertically due to gravity drainage, the rate will be slow due to the lack of other driving forces and the lower permeability layers under the plume.

b. The distance to the nearest drinking water well (Sandia 6) is 670 m (2,200 ft) southeast of the CAS. Groundwater in this area moves generally to the northwest (DOE/NV, 1996a). The total areal extent of the contaminated plume as determined in the site investigation is limited to approximately 65 square meters (m^2) (700 square feet [ft^2]) (see Figure A.2-3 in Appendix A); therefore, for the contaminants to affect the drinking water well, they will need to travel the vertical distance to the groundwater, then travel through the groundwater in a direction opposite normal groundwater flow to the radius of influence of the well. Lateral migration of the plume is to the west of the UDP (Figure A.3-1 in Appendix A); vertical migration appears to be confined by lower permeability layers. Based on the small plume size, the migration direction, and favorable natural decay conditions, the likelihood of any impacts to the well is minimal.

c. Geotechnical analysis of eight samples taken at the site from different horizons showed evidence of a lower permeability layer at 20 m (65 ft). The porosity measured in the analysis ranged from 35.2 percent to 41.3 percent. Permeabilities ranged from $1.6x10^{-3}$ to $1.2x10^{-7}$ centimeters/second (cm/sec) (Appendix A) and generally decreased with depth. The lower permeability layers limit downward migration, as seen in Figure A.3-1, and would allow additional retention time for biological degradation.

d. Annual precipitation averages 13 to 15 cm (5 to 6 in.). Annual evaporation is between 147 and 168 cm (58 and 66 in.) (DOE/NV, 1996a). The high evaporation and low precipitation create a negative water balance for the area; therefore, no driving force associated with precipitation is available to mobilize contaminants to groundwater. Ponding is not likely at the CAU because the ground surface slopes so that surface water runs off site.

e. The type of regulated substance released is petroleum hydrocarbons in the form of diesel and gasoline. Light, bulk hydrocarbons can migrate downward in unsaturated zone soil due to gravity and capillary forces. Downward migration is slowed by the following parameters which apply to this site:

- Volume of release
- Soil saturation
- Soil particle adsorption/desorption
- Low permeability of the soil
- Presence of lower permeability layers
- Natural degradation of the hydrocarbons

Analysis of eight subsurface soil samples obtained within the CAU resulted in permeabilities ranging from $1.6x10^{-3}$ to $1.2x10^{-7}$ cm/sec (Table A.3-9). A lower permeability layer was indicated by the chemical and geotechnical data starting at approximately 20 m (65 ft). All concentrations below this level were less than the 100 parts per million regulatory action level with the exception of an anomalous gasoline detection (Figure A.3-1). Because of the large distance to groundwater, the slow travel time associated with the gravity drainage mechanism for migration, the current size of the plume, and the biologically favorable environment, the contaminants are not likely to reach or impact the groundwater.

Without specific chemical analysis of the components of the waste oil at the CAU, a quantitative estimate of the risk is not possible. However, pathways to the TPH-contaminated zone do not currently exist. The only potential pathway is inadvertent intrusion which can be controlled.

The highest concentration of TPH detected in the investigation was 2,400 mg/kg at 6 m (20 ft) bgs. Only 9 of the 28 samples collected had TPH concentrations above 100 mg/kg (Appendix A).

f. The total lateral extent of contamination is estimated to be 65 m^2 (700 ft^2). The maximum vertical extent of contamination is approximately 20 m (65 ft). The movement of the contaminants laterally and vertically is significantly slowed because the source has been removed. Vertical movement is also significantly limited by the lower permeability layers previously discussed. Natural biological degradation of the TPH should further limit the potential for contaminants to reach groundwater.

g. Presently, the CAU is located in a government-controlled facility with the potential future land use similar to current use. The TTR is a restricted area that is guarded on a 24-hour, 365-day-per-year basis; unauthorized personnel are not admitted to the facility. The TPH plume is currently covered by a minimum of a 4 m (14 ft) of clean soil, preventing inadvertent access to high concentrations of contaminants. Alternatives will be evaluated for control of inadvertent intrusion to the contaminated zone.

h. Preferred routes of migration are nonexistent since the point sources of the TPH have been removed and the surface area is covered by a minimum of a 4 m (14 ft) clean soil. Inadvertent intrusion is the only pathway from the contaminants to potential receptors.

i. The subsurface contamination is located beneath a minimum of a 4-m (14-ft) clean soil. The UDP is bordered on the southeast by the Building 03-73 pad, and several boxcars are located to the north. Numerous aboveground (i.e., propane tanks) and underground utilities (e.g., gas and water lines, a telephone line, and an abandoned sewer line) are present (Figure A.2-1) in the UDP area.

j. The potential for a hazard related to fire, vapor, or explosion is very low because the TPH is located below the surface under approximately 4 m (14 ft) of clean soil. The fire and explosion potential for this TPH is moderate when exposed to fire or flame, neither of which are applicable to the buried contaminants at the CAU.

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

3.3.1 Alternative 1 - No Further Action

Under the No Further Action Alternative, no corrective action activities will be implemented. This alternative is used as a starting point to establish a baseline for comparison with the other corrective action alternatives. This alternative does not meet the corrective action objectives because no actions are taken to prevent human contact with the TPH plume. This alternative will not be compared to the other alternatives using the selection decision factors.

3.3.2 Alternative 2 - Closure in Place with Administrative Controls

Administrative controls are used to prevent inadvertent contact with contaminated media. Administrative controls would consist of land-use restrictions to prevent intrusive activities. The future use of the contaminated land associated with this CAU would be restricted from any activity that would alter or modify the containment control unless appropriate concurrence was obtained from NDEP. Based on the bioassessment for the site, the existing conditions are favorable to natural biological degradation (i.e., no enhancements applied) (Appendix A). Natural biological

activity will result in reduced concentrations of hydrocarbons with time. Administrative controls are commonly used and can effectively eliminate potential exposure pathways. Administrative controls are effective because TTR, including CAU 423, is a restricted-access facility. The implementation of administrative controls requires the coordination of all entities at a facility to ensure that the restrictions are enforced. An evaluation of NAC 445A.227(2)(a-k) (NAC, 1996a) requirements is presented in Section 3.3. This evaluation provides support that conditions at the CAU will not adversely impact the groundwater beneath the CAU or any nearby drinking water wells.

A 25-cm (10-in.) surface casing was installed to allow drilling of boring B1 through the center of the UDP (Figure A.2-2). This casing was left open pending corrective action decisions and will have to be addressed by either cutting the casing below ground surface and filling with a grout material or removing the casing and grouting the hole. An evaluation of the need to remove the surface casing prior to grouting will be made in the Corrective Action Plan. The piping from Building 03-60 to the UDP would also be closed in place.

3.3.3 Alternative 3 - Partial Excavation, Disposal, and Administrative Controls

Alternative 3 consists of removing the UDP casing, boring B1 casing, and the contaminated material (soil and leach rock) directly beneath and slightly to the west of the UDP (an assumed area of approximately 4.6 m [15 ft] in diameter to a depth of about 8 m [27 ft)]. Contaminated material and the removed casing would be disposed of at an approved disposal facility; clean soil removed during excavation would be used for backfill. Excavated areas will be backfilled with uncontaminated soils and recontoured to eliminate topographic depressions and allow runoff. Excavation would be used to remove clean borrow soil from a proximal location for placement at the remaining void. Following excavation, administrative controls would be instituted to preclude inadvertent intrusion to the remaining TPH at the CAU. The discharge line would be closed in place.

Utilities and the nearby slope present potential interferences to the excavation alternative. Shoring would be required to stabilize the slope, and utilities would have to be rerouted. These factors add to the difficulty and cost of this alternative.

3.3.4 Alternative 4 - In Situ Bioremediation

Alternative 4 consists of *in situ* bioremediation of the TPH plume at the UDP. The analysis of microbial parameters at the site indicated favorable conditions for bioremediation with minimal need for added components. Because of the relatively small plume size, a simplified system could be employed to provide oxygen to the contaminated zone to stimulate biological activity. This system would consist of two or three vadose zone wells; at least one extraction well would have a wind-powered (other power options such as electricity could also be used) turbine to induce a pressure differential across the plume. The system would be designed to limit air emissions. An open well opposite this extraction well would allow air flow into the plume and serve as a monitoring port. Fencing would be installed to protect the bioremediation well system. The gas samples from the system would be periodically collected to monitor respiration rates. As bioremediation progresses, injection of additional nutrients may be required. These would be introduced through the open well(s). The exact system configuration and monitoring scheme would be developed in the Corrective Action Plan. With time, the bioremediation system could result in reduction of TPH to preliminary action levels. After remediation, the wells would be closed according to State of Nevada requirements.

Similar to Alternative 2, the boring B1 casing would be cut and filled or removed.

3.4 Evaluation and Comparison of Alternatives

The general corrective action standards and remedy selection decision factors described in Section 3.2 were used to conduct a detailed evaluation of each corrective action alternative. A comparative evaluation was performed to compare each corrective action alternative to the other alternatives using the evaluation criteria. In this way, the advantages and disadvantages of each alternative are assessed to select a preferred alternative for CAU 423. Table 3-1 presents a summary of the detailed analysis of the alternatives. Table 3-2 presents the comparative analysis of alternatives. A summary of costs for the four alternatives is provided in Appendix C.

Table 3-1
Detailed Evaluation of Alternatives
(Page 1 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Administrative Controls	Alternative 3 Partial Excavation, Disposal, and Administrative Controls	Alternative 4 *In Situ* Bioremediation
Closure Standards				
Protection of Human Health and the Environment	• Only TPH identified above preliminary action levels • Does not meet corrective action objective of preventing inadvertent intrusion into contaminated soil zone • No worker exposure associated with implementation • Conditions favorable for natural biological degradation of TPH • NAC 445A.227 (2) (a-k) analysis (Section 3.3) shows groundwater is protected.	• Only TPH identified above preliminary action levels • Meets corrective action objectives • Prevents inadvertent intrusion • No worker exposure associated with implementation • Low risk to public because of remote location and controlled access to the TTR • Conditions favorable for natural biological degradation of TPH • NAC 445A.227 (2) (a-k) analysis (Section 3.3) shows groundwater is protected.	• Only TPH identified above preliminary action levels • Meets corrective action objectives • Prevents inadvertent intrusion • Highest risk to workers during implementation because of excavation requirement and exposure to COC • Low risk to public because of remote location and controlled access to the TTR • NAC 445A.227 (2) (a-k) analysis (Section 3.3) shows groundwater is protected.	• Only TPH identified above preliminary action levels • Meets corrective action objectives • COC reduced to preliminary action level over time; acceptable level reduced by active bioremediation system • Minimal risk to workers associated with installation of bioremediation wells and monitoring activities • Low risk to public because of remote location and controlled access to the TTR • NAC 445A.227 (2) (a-k) analysis (Section 3.3) shows groundwater is protected.
Compliance with Media Cleanup Standards	• Does not currently comply with media cleanup standards because TPH was identified above preliminary action levels; biological degradation may reduce TPH levels over time.	• Does not currently comply with media cleanup standards, but eliminates potential pathway to COC • Biological degradation may reduce TPH levels over time.	• Does not currently comply with media cleanup standards, but restricts pathway to COC • Biological degradation may reduce TPH levels over time. • Higher levels of COC removed	• Complies with media cleanup standards at the end of the bioremediation • Will be designed to limit air emissions

Table 3-1
Detailed Evaluation of Alternatives
(Page 2 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Administrative Controls	Alternative 3 Partial Excavation, Disposal, and Administrative Controls	Alternative 4 *In Situ* Bioremediation
Control of the Source(s) of Release	• The source to the UDP has been permanently closed.	• The source to the UDP has been permanently closed.	• The source to the UDP has been permanently closed. • Some potential for release of volatilized COC during excavation and disposal activities	• The source to the UDP has been permanently closed. • Some potential for release of COC during well installation and to the surface as gases associated with accelerated bioactivity; periodic gas monitoring at the surface will be required to assess system performance.
Compliance with Applicable Federal, State, and Local Standards for Waste Management	No waste generated	Minimal waste generated from removal of boring B1 casing	• Waste will be generated from removal of TPH-contaminated soil and casing material. • Will be handled and disposed of per applicable standards	• Minimal volume of waste generated during installation of bioremediation wells and monitoring activities and from removal of boring B1 surface casing • Will be handled and disposed of per applicable standards
Remedy Selection Decision Factors				
Short-Term Reliability and Effectiveness	Not evaluated	• No impacts to workers • Administrative controls prevent inadvertent intrusion • Public protected by remote location and TTR site access controls	• Moderate risk to workers associated with excavation and disposal activities and exposure to COC • Public protected by remote location and TTR site access controls	• Minimal risk to workers associated with installation of bioremediation wells and periodic monitoring • Public protected by remote location and TTR site access controls

Table 3-1
Detailed Evaluation of Alternatives
(Page 3 of 3)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Administrative Controls	Alternative 3 Partial Excavation, Disposal, and Administrative Controls	Alternative 4 *In Situ* Bioremediation
Reduction of Toxicity, Mobility, and/or Volume	Not evaluated	• TPH levels may naturally degrade, resulting in reduction of all three parameters	• TPH levels may naturally degrade, resulting in reduction of all three parameters. • Contaminated zone at bottom of UDP removed which will result in removal of higher levels of contaminated material	• Bioremediation system will effectively reduce all parameters
Long-Term Reliability and Effectiveness	Not evaluated	• Controls inadvertent intrusion • Biological degradation over time may reduce COC levels. • Administrative controls must be maintained.	• Controls inadvertent intrusion • Biological degradation over time may reduce COC levels. • Administrative controls must be maintained. • Higher levels of contamination removed	• TPH levels will be at or below preliminary action levels upon completion.
Feasibility	Not evaluated	• Easily implementable • Coordination of all entities is necessary to ensure compliance with administrative controls to prevent intrusion.	• Utilities and nearby embankment may hinder removal operations. • Depth of removal area would require significant excavation and shoring to protect workers on the project and structures in the area. • If removal by coring instead of excavation, equipment availability may be a concern • Coordination of all entities is necessary to ensure compliance with administrative controls to prevent intrusion.	• Easily implementable because plume is small, COC is relatively shallow, and biological conditions are favorable • Assumed period of operation is 3 to 10 years, depending on respiration rates (see Appendix C)
Cost	**$0**	**$36,416**	**$138,275**	**$213,221**

Table 3-2
Comparative Evaluation of Alternatives
(Page 1 of 2)

Evaluation Criteria	Comparative Evaluation
Closure Standards	
Protection of Human Health Environment	Alternatives 2, 3, and 4 meet corrective action objectives; Alternative 1 does not. Worker exposure to risks increases from no risk associated with Alternatives 1 and 2, to minor risk associated with Alternative 4, to highest risk associated with Alternative 3. An evaluation of NAC 445A.227 (2) (a-k) (Section 3.3; NAC, 1996a) demonstrates that waters of the State of Nevada are not endangered by site conditions. The relatively low levels of TPH and the depth to the contamination present minimal risk under each of the alternatives.
Compliance with Media Cleanup Standards	Alternative 4 will comply with media cleanup standards at the end of the bioremediation; the other alternatives rely on natural biological degradation for associated reduction in TPH levels. Alternatives 2 and 3 eliminate pathways to the COC; Alternative 1 does not.
Control of the Source(s) of the Release	The source of release to the UDP has been permanently eliminated. Alternative 3 has some potential for release of the COC associated with removal of contaminated soils and subsequent disposal. Alternative 4 has potential to release the COC associated with well installation and release of hydrocarbon gases associated with accelerated bioactivity.
Compliance with Applicable Federal, State, and Local Standards for Waste Management	Alternative 1 does not generate any waste. Alternative 2 generates minimal waste associated with removal of the boring B1 casing. Alternative 4 generates minor amounts of waste associated with well installation and casing removal. Alternative 3 generates the largest amount of waste associated with the removal of contaminated soil, the boring B1 casing, and the UDP casing. All waste will be managed and disposed per applicable standards.

Table 3-2
Comparative Evaluation of Alternatives
(Page 2 of 2)

Evaluation Criteria	Comparative Evaluation
Remedy Selection Decision Factors	
Short-Term Reliability and Effectiveness	Worker exposure to risks increases from minor risk associated with Alternative 2, to somewhat higher risk associated with Alternative 4, to highest risk associated with Alternative 3.
Reduction of Toxicity, Mobility, and/or Volume	All alternatives may result in reduced toxicity, mobility, and volume due to natural biological degradation. Alternative 4 results in a reduction of all three parameters in less time. Alternative 3 results in some immediate reduction associated with removal of higher TPH levels.
Long-Term Reliability and Effectiveness	Residual risk for all alternatives is low. Alternatives 2 and 3 require some maintenance of administrative controls. Alternative 4 results in clean closure with no long-term monitoring requirements.
Feasibility	Alternatives 2 and 4 are feasible; Alternative 3 is less feasible because of the utilities in the area, the depth of the required excavation, nearby slope and buildings, the large amount of overburden, and the availability of coring or auguring equipment (if this method is used for removal of the UDP and contaminated soil).
Cost	The cost for Alternative 1 is $0. The cost for Alternative 2 is $36,416 for implementation of administrative controls. Alternative 3 is estimated to cost $138,275 for removal and disposal of contaminated soil and casing and implementation of administrative controls. The cost for Alternative 4 is $213,221 for installation and maintenance of an *in situ* bioremediation system.

4.0 Recommended Alternative

Based on the results of the detailed and comparative analysis of the potential corrective action alternatives presented in this document, the preferred corrective action alternative selected for implementation at CAU 423 is Alternative 2, Closure in Place with Administrative Controls. Alternative 2 was chosen for the following reasons:

- Only TPH was identified as a COC, and existing conditions are conducive to natural biological degradation (degradation will likely occur without addition of oxygen or nutrients).
- Short-term risks to workers are minimal under this alternative.
- Long-term risks are minimized by controlling access to the site and by reduction in TPH levels through natural biological activity.
- Only minimal wastes are generated.
- It is easily implementable using existing resources and technologies with minimal disturbances to surrounding areas.
- It provides the most cost-effective method for achieving protection and for meeting closure requirements.

The preferred corrective action alternative was evaluated on its technical merits, focusing on performance, reliability, feasibility, and safety. During corrective action implementation, this alternative will present minimal potential threat to site workers. However, appropriate health and safety procedures will be developed and implemented. The alternative was judged to meet all requirements for the technical components evaluated. The alternative meets all applicable state and federal regulations for closure of the site and will reduce potential future exposure pathways to subsurface TPH-contaminated soil.

The future use of any land related to this CAU, as described by this CADD, is restricted from any activity that may alter or modify the containment control as approved by the State of Nevada and identified in the CAU Closure Report or other CAU documentation unless appropriate concurrence is obtained in advance.

5.0 References

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 1996. Title 40 CFR Parts 260 - 281, "RCRA Regulations." Washington, DC: U.S. Government Printing Office.

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

EPA, see U.S. Environmental Protection Agency.

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

Federal Facility Agreement and Consent Order. 1996. Agreed to by the Nevada Division of Environmental Protection, the U.S. Department of Energy, and the U.S. Department of Defense.

NAC, see *Nevada Administrative Code*.

Nevada Administrative Code. 1996a. NAC 445A, "Water Pollution Control." Carson City, NV.

Nevada Administrative Code. 1996b. NAC 459, "Disposal and Evaluation of Contaminated Soil." Carson City, NV.

NRS, see *Nevada Revised Statutes.*

Nevada Revised Statutes. 1995. NRS 459.400-459-600, "Disposal of Hazardous Waste." Carson City, NV.

U.S. Department of Energy, Nevada Operations Office. 1994. *Project Management Plan*, Rev. 0. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996a. *Corrective Action Unit Work Plan for the Tonopah Test Range*, DOE/NV-426. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996b. *Industrial Sites Quality Assurance Project Plan*, DOE/NV-425. Las Vegas, NV: IT Corporation.

U.S. Department of Energy, Nevada Operations Office. 1997. *Corrective Action Investigation Plan for CAU No. 423: Building 03-60 Underground Discharge Point, Tonopah Test Range, Nevada*, Rev. 0. Las Vegas, NV: IT Corporation.

U.S. Department of Energy, Nevada Operations Office. 1998. *Corrective Action Decision Document for the Area 3 Landfill Complex, Tonopah Test Range, CAU 424*, Rev. 0. Las Vegas, NV: IT Corporation.

U.S. Environmental Protection Agency, Office of Research and Development. 1991. *Guidance on Resource Conservation and Recovery Act (RCRA) Corrective Action Decision Documents*, EPA/540/G-91/011. Washington, DC.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. 1994. *Final RCRA Corrective Action Plan*, EPA/520-R-94-004. Washington, DC.

U.S. Environmental Protection Agency. 1996. Memo from S. J. Smucker, regarding an update to the Region 9 Preliminary Remediation Goals (PRGs) Table, 1 August. San Francisco, CA: U.S. Environmental Protection Agency.

Appendix A

Corrective Action Investigation Report for CAU 423: Building 03-60 UDP, Tonopah Test Range

A.1.0 Introduction

The report contained in this appendix presents the investigation activities and analytical results from the corrective action investigation conducted at the Building 03-60 UDP, CAU 423. The UDP is presented as part of CAU 406 in Table 3-1 of the *Corrective Action Unit Work Plan, Tonopah Test Range, Nevada* (DOE/NV, 1996a) (hereafter referred to as the TTR Work Plan), but it was subsequently assigned the 423 CAU number. The CAU consists of CAS Number 03-02-002-0308, which includes the UDP and an associated waste oil discharge line connecting it to Building 03-60. The corrective action investigation (CAI) was conducted in accordance with the requirements set forth in the *Corrective Action Investigation Plan for Corrective Action Unit No 423: Building 03-60 Underground Discharge Point, Tonopah Test Range, Nevada* (DOE/NV, 1997) as developed under the FFACO (FFACO, 1996).

The CAU is located in the Area 3 compound of the TTR, Nye County, Nevada (see Figure 1-1 and Figure 1-2 of the CADD). The UDP was used between approximately 1965 and 1990 to dispose of waste fluids from the Building 03-60 automotive maintenance shop (DOE/NV, 1997). Additional information relating to the site history, planning, and scope of the investigation is presented in the CAIP (DOE/NV, 1997) and the TTR Work Plan (DOE/NV, 1996a) and is not repeated in this report.

A.1.1 Project Objectives

The primary objectives for this project were to identify the vertical and lateral extent of possible contaminant migration from the UDP and to provide sufficient information and data to develop appropriate corrective action alternatives for the UDP.

As part of the DQO process outlined in the CAIP (DOE/NV, 1997), potential routes of migration for possible contaminants associated with the UDP were proposed. The soil surrounding the UDP was investigated by conducting a subsurface drilling program and by collecting soil for field screening and environmental samples for laboratory analysis. The drilling locations were selected

based on the strategy devised in the DQO process and site conditions. The following tasks were performed to meet project objectives:

- Drilled borehole through the UDP to investigate impact on underlying soils
- Drilled step-out boreholes to constrain impact boundaries
- Field screened soil from boreholes to guide depth and areal extent of investigation
- Collected samples for laboratory and geotechnical analysis and bioassessment

A.1.2 Report Content

This corrective action investigation report is intended to provide information and data in sufficient detail to support the selection of a preferred corrective action alternative in the CADD. The contents of this report are as follows:

- Section A.1.0 describes the investigation background, objectives, and the report content.
- Section A.2.0 provides information regarding the field activities and sampling method.
- Section A.3.0 summarizes the results of the laboratory analysis from the investigation sampling.
- Section A.4.0 discusses the quality assurance (QA) and quality control (QC) procedures that were followed and the results of the QA and QC activities.
- Section A.5.0 summarizes the significant results pertaining to the Building 03-60 UDP corrective action investigation program.
- Section A.6.0 cites the references.
- Appendix B presents the soil boring logs and information pertinent to the corrective action decision process.

To make this report a concise summary, the complete field documentation and laboratory data, including Field Activity Daily Logs, Sample Collection Logs, Analysis Request/Chain-of-Custody Forms, soil sample descriptions, laboratory certificates of analyses, analytical results, and surveillance results are not contained in this report. These documents are retained in project files as both hard copy files and electronic media and will be supplied upon request.

A.2.0 Field Investigation and Sampling Activities

Field investigation and sampling activities were divided into three separate phases. The initial phase was the location of the UDP; the second phase was the discharge line video survey; and the third phase was the subsurface investigation. Details of the first two phases are discussed in the CAIP and are not documented in this report. The following is a brief summary of all CAI activities provided as background information:

- Conducted ground-penetrating radar (GPR) survey to determine UDP location (feature originally classified as an underground storage tank [UST]).
- Sampled and removed liquids from the UDP (9/96).
- Attempted waste oil discharge line camera survey; survey failed due to pipe damage and blockage by sludge. An attempt was made to flush the pipe by injecting water into the UDP end of the pipe. This water drained into the UDP.
- Sampled and removed liquids from the UDP; sampled sludge from discharge line and capped line (10/97).
- Drilled eight vertical boreholes
    - Conducted field screening for TPH, radiological constituents, and VOCs
    - Collected environmental samples for laboratory analysis
    - Collected soil samples for geotechnical analysis and bioassessment
    - Logged soil cuttings to assess site geology

The subsurface investigation and sampling program was managed in accordance with the requirements set forth in the CAIP (DOE/NV, 1997). The field activities were performed in accordance with an approved *Site-Specific Health and Safety Plan* (IT, 1997). The samples were collected and documented by following approved sampling, field activity documentation, sample collection documentation, decontamination, chain of custody, shipping, and radiation screening protocols and procedures as indicated in the CAIP (DOE/NV, 1997). Quality control samples (e.g., field blanks, equipment rinsate blanks, trip blanks, and sample duplicates) were collected as required by the *Industrial Sites Quality Assurance Project Plan* (QAPP) (DOE/NV, 1996b) and

approved procedures. During field activities, waste minimization practices were followed according to approved procedures, including segregation of the waste by waste stream.

A.2.1 Site Description and Conditions

The Building 03-60 UDP is located near the center of the Area 3 Compound at the TTR. Access to the UDP is limited by the Building 03-73 pad, a fence surrounding the Sandia warehouse area, and boxcars used for storage. Numerous aboveground (i.e., propane tanks) and underground utilities (e.g., gas and water lines, a telephone line, and an abandoned sewer line) are present (Figure A.2-1) in the UDP area.

The location of the UDP is currently marked by a 25-centimeter (cm) (10-inch [in.]) diameter surface casing with locking lid that extends approximately 46 cm (18 in.) above ground surface.

A.2.2 Subsurface Investigation

Eight vertical boreholes were drilled at the UDP to investigate the subsurface soils. The rotary sonic ("sonic") drilling method was used to produce continuous soil cores from vertical borings through and around the UDP. Recovery of continuous core allowed detailed field observations and sampling of the subsurface soil. Samples were collected from the cores at specified depth intervals for field-screening and laboratory analyses. Borings ranged from a minimum depth of 21 m (70 ft) bgs to a maximum depth of 27 m (90 ft) bgs. Field screening for radiation, TPH, and VOCs (headspace screening) was used to guide the areal extent and depth of the investigation in the field. Sampling intervals and sample submission frequency were based on minimum requirements established during the DQO process, field-screening results, and the discretion of the site supervisor.

A.2.2.1 Drilling

The sonic drilling method uses vibration and rotation of the drill string to advance a core barrel and an outer casing (Figure A.2-2). The casing is used to stabilize the hole and also minimizes potential cross contamination produced by soil from shallower levels falling down the hole (sloughing) as the core barrel is removed for cuttings extrusion. After the bit at the end of the core barrel reaches the

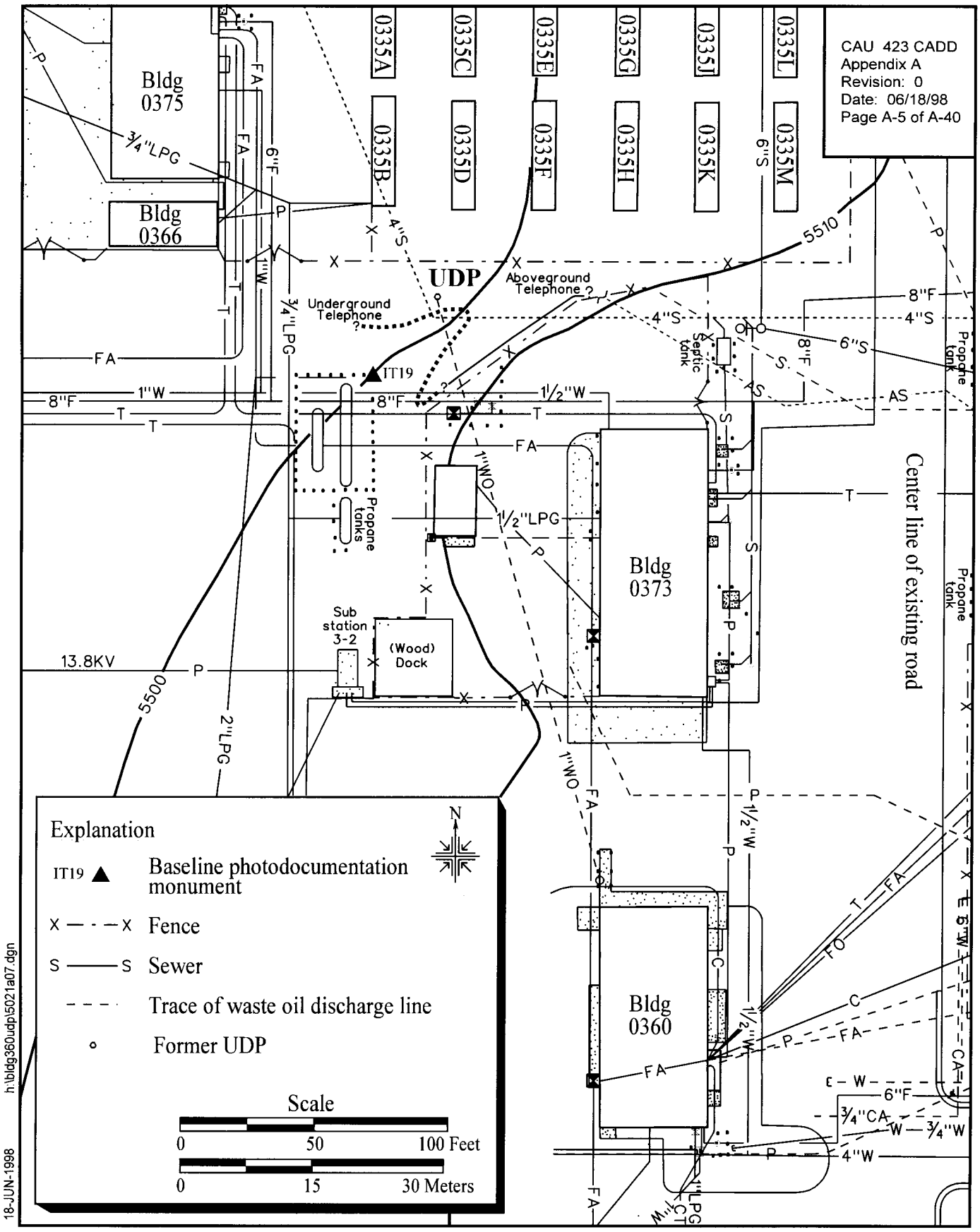

Figure A.2-1
CAU 423 Utilities - Active and Abandoned,
Area 3, Tonopah Test Range, Nevada

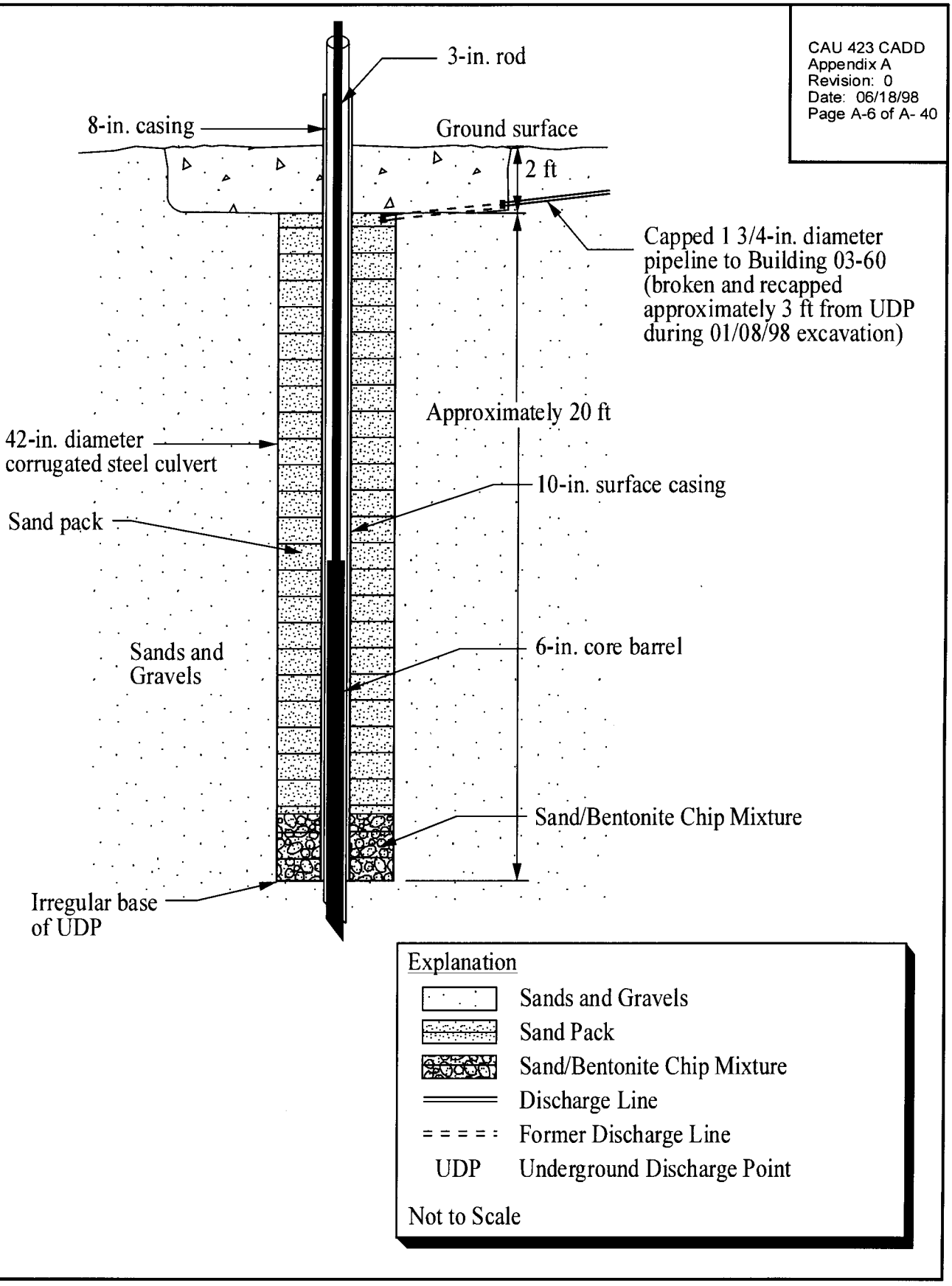

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Figure A.2-2
Configuration of Building 03-60 UDP and Drilling Strategy

specified depth, the core barrel is withdrawn from the borehole and the contents are extruded into polyurethane (PU) bags. While the sonic drilling method produced some heat from friction, the samples did not seem any hotter than if a hollow-stem auger had been used. The relatively large core barrel diameter and loose soils may have also reduced the effect of friction on the samples. For this project, 15-cm (6-in.) diameter core barrels and 20-cm (8-in.) diameter casing were advanced. The casing was removed, and the boreholes were filled with grout to complete each boring.

The borehole locations are shown on Figure A.2-3. Soil cuttings were delivered to the field geologist and sampling team in labeled PU bags in approximately 0.8-m (2.5-ft) long sections. The soil cuttings were suitable for field screening, sampling, and visual classification of the soil described in subsequent subsections.

The initial borehole was drilled through a 25-cm (10-in.) diameter surface casing secured with sand within the UDP. Approximately 340 kilograms (kg) (750 pounds [lbs]) of medium bentonite chips were mixed with the sand at the base of the UDP to seal the base of the surface casing from residual liquid present in the bottom of the UDP. The sand pack, surface casing, bentonite, and drilling casing were used to prevent this liquid from cross contaminating samples collected from boring B1. Initial core from B1 was unavoidably contaminated by liquid trapped inside the surface casing during installation. The interval from 6.9 m (22.5 ft) (base of surface casing) to 7.9 m (26 ft) bgs was described as “black sludge” and not sampled because the native soil was indiscernible from liquid from the UDP. Liquid within the UDP was sampled during preliminary phases of this investigation, and analytical results from these samples are maintained in the project-specific files. Native soil was encountered at 7.9 m (26 ft) bgs, and a sample was collected from 8.8 m (29 ft) to 9 m (30 ft) bgs according to the CAIP (DOE/NV, 1997). Field screening identified the deepest contamination in this borehole at approximately 18 m (60 ft) bgs. Boring B1 was completed at a depth of 24.8 m (81.5 ft).

Contamination detected above field-screening levels in boring B1 required three planned step-out borings to be drilled in a triangular pattern approximately 7.6 m (25 ft) from the UDP (boring B1). The location of these borings was controlled by a slope, buildings, fences, and both active and abandoned underground utilities at the site. Boring B2 was drilled 7.3 m (24 ft) southwest of boring B1. Boring B3 was abandoned approximately 1.5 m (5 ft) bgs due to a concrete obstruction

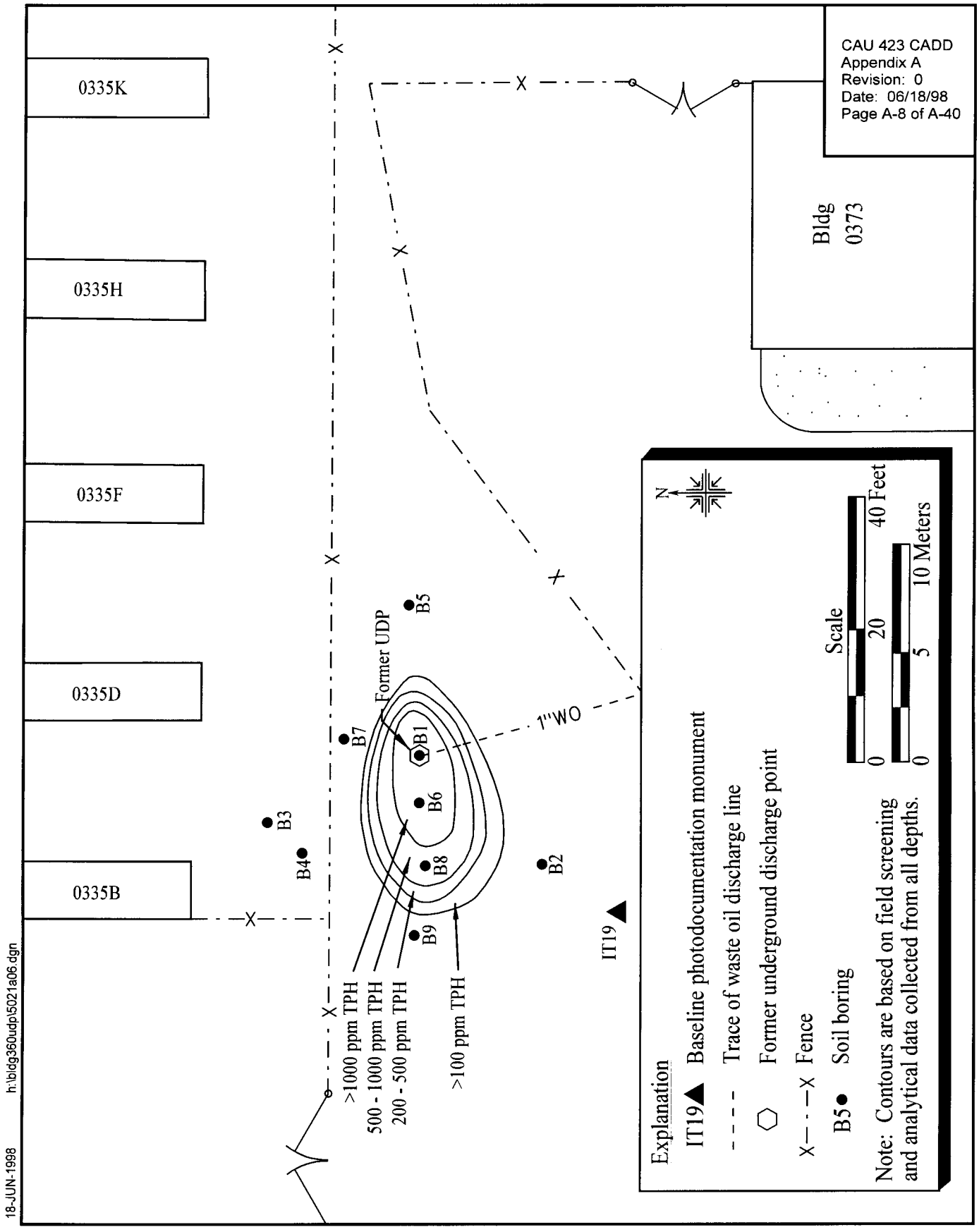


Figure A.2-3
Bldg. 03-60 UDP Borehole Locations and TPH Contamination Contour Map, Area 3, Tonopah Test Range, Nevada

(i.e., fill material, unidentified utility) and is disregarded in this report. Borings B4 and B5 were drilled approximately 6.9 m (22.5 ft) northeast and east, respectively, of boring B1.

Three TPH field-screening detections below the preliminary action level with no associated VOC field-screening detections were found in soil from approximately 12 m (40 ft) to 15 m (50 ft) bgs from boring B2. No contamination was found during field screening of borings B4 and B5. All three of these borings were drilled to a total depth of 21.3 m (70 ft).

Four additional boreholes were ultimately required to adequately investigate the site. Boreholes B6, B8, B9, and B7 were drilled 1.8, 4.9, and 7.9 m (6, 16, and 26 ft) west of the UDP, and 3.7 m (12 ft) northeast of the UDP, respectively. Boring B6 was drilled to a total depth of 27 m (90 ft). Borings B7, B8, and B9 were drilled to a total depth of 24 m (80 ft).

No field-screening detections were made in boring B7. This borehole demonstrates the asymmetric geometry of the contamination plume and guided further investigation to the west of the UDP. Field screening detected TPH and VOCs above preliminary action levels in borings B6 and B8. No contamination was detected by field screening in boring B9, 7.6 m (25 ft) west of the UDP.

A.2.2.2 Field Screening

The preliminary action level for TPH field-screening results was established at 100 mg/kg in accordance with the NDEP screening levels for TPH (NAC, 1996). The preliminary action level for VOC field-screening results was determined to be 20 parts per million (ppm) or 2.5 times background, whichever was higher. The preliminary action level for radiation monitoring results was established at two times background levels (DOE/NV, 1997). Field-screening preliminary action levels were established to guide the advancement of the borehole and to provide a basis for collecting unplanned environmental samples or drilling additional boreholes.

Field-screening methods were used to collect the semiquantitative radiological, VOC, and TPH data required to guide the total drilling depth for each boring. Field screening was performed at 1.5-m (5-ft) intervals to a depth of 15 m (50 ft) with subsequent field screening in 3-m (10-ft) intervals. Supplementary field screening was conducted at the discretion of the site supervisor at additional depths. The screening methods included:

- Radiological screening for alpha and beta radiation using an Electra instrument
- Headspace screening for VOCs using a Photoionization Detector (PID)
- TPH screening using the Hanby field testing kit manufactured by Hanby Environmental Laboratory Procedures, Inc.

While radiological and headspace screening was conducted in all instances described above, the TPH screening was omitted in some cases due to a reagent shortage. For boring B6, TPH field screening was not conducted until the first headspace measurement greater than 20 ppm was recorded. This occurred at 6 m (20 ft) bgs. The TPH field screening continued for this boring until 21 m (70 ft) bgs, where a reading of less than 10 mg/kg was measured using the TPH field-screening kit. Samples from 24 m and 27 m (80 and 90 ft) bgs (TTR01135 and TTR01137) were submitted to the laboratory without TPH screening to conserve reagent. Headspace measurements were below 20 ppm for both of these samples.

A similar strategy was used for the start of boring B7, but headspace measurements never exceeded 20 ppm in this boring. Field screening for TPH was initiated at 14 m (45 ft) bgs in anticipation of the expected contamination zone, but no contamination was detected by the TPH field screening in this boring. The TPH field screening was conducted according to the CAIP for the remainder of the investigation (DOE/NV, 1997).

The modified field screening should have a minimal effect on the quality of field-screening data collected at the UDP site. Good correlation between the Hanby and headspace methods was observed for all borings. The Hanby method identified TPH in only two cases where the headspace method did not produce measurements above background. The first case was two measurements of less than 10 mg/kg and one measurement of less than 50 mg/kg for a zone from 12 to 15 m (39 to 50 ft) bgs in boring B2. Two samples (TTR01112 and TTR01113) were submitted from this zone, but neither showed TPH or VOCs above minimum reporting limits (see Section 3.0). In the second case, a measurement of less than 10 mg/kg TPH by the Hanby method was not associated with an elevated headspace method measurement. It is possible that the Headspace method is not a reliable indicator of TPH at less than 50 mg/kg, but this level is less than half of the preliminary action level of 100 mg/kg (NAC, 1996).

A.2.2.3 Sampling

Sample collection followed the procedures specified in the CAIP (DOE/NV, 1997). Soil cores were moved from the boreholes to the sampling area in approximately 0.8-m (2.5-ft) lengths contained in PU bags. The bags were split open and screened for alpha and beta radiological contamination. The breathing zone was monitored for VOCs using a PID before and during sample collection. Samples were collected in appropriate containers with temporary sample labels and sealed with custody tape. Volatile samples (VOCs, TPH gasoline, TPH field screening, headspace field screening) were collected directly from the soil cores immediately after required radiation field screening and breathing zone monitoring for VOCs was conducted. The remainder of the samples were collected from soil representative of the sampling interval homogenized in a stainless steel bowl.

After samples were identified as laboratory samples, labels preprinted with the sample number, sample collection date/time, Chain-of-Custody number, sampling team members, container preservative, medium type, and requested analysis were attached to each of the containers. Each sample container was then sealed with custody tape, wrapped in protective bubble wrap (if applicable), placed into a Ziploc™ bag, and placed in an iced cooler with a trip blank (if applicable). Samples not submitted to the laboratory were containerized with other soil cuttings from the same boring after removing or defacing temporary sample labels and lids.

A.2.2.4 Waste Management

Investigation-derived waste (IDW) was segregated into the following five waste streams:

- PPE and sampling equipment that contacted potentially contaminated media
- Decontamination rinsate that contacted potentially contaminated media
- Soil and debris incidental to sample collection (e.g., soil cuttings, discarded samples)
- Plastic or other material (e.g., soil, absorbent materials) contaminated by equipment hydrocarbon leaks (i.e., minor amounts of hydraulic oil from the drilling rig)
- PPE, debris, solvent and rinsate generated from petroleum hydrocarbon field-screening kit

Potentially hazardous waste generated during site operations was labeled as such and transferred to a Hazardous Waste Accumulation Area daily. The IDW was documented using a hazardous waste log. All IDW confirmed as hazardous waste has been removed from TTR under Uniform Hazardous Waste Manifest number 98013. All IDW confirmed as nonhazardous waste has been removed from TTR under Nonhazardous Waste Manifest numbers 16660 (nonhazardous rinsate) and 16662 (nonhazardous soil).

A.2.3 Geology

The UDP site consists of reworked and compacted sands and gravels overlying native soils. Regional native surface soil consists of poorly graded, moderately consolidated alluvial silty sands with gravel and cobble-sized volcanic detritus (DOE/NV, 1996a). Field descriptions were performed for each boring by the field geologist and recorded on Visual Classification of Soil Logs (Appendix B) and augmented by laboratory analysis of eight geotechnical samples (Section A.3.6). The strata encountered below the UDP are summarized below:

- Well and poorly graded sands are the predominant lithology at the site.
- Well and poorly graded gravels in discontinuous lenses are common.
- Silt is present but typically composes less than 5 percent of the soil.

A.2.4 Hydrology

The Area 3 topography slopes gently to the northwest with surface drainage flowing in the same direction. Depth to groundwater beneath the Building 03-60 UDP is estimated at 110 to 120 m (361 to 394 ft) bgs (DOE/NV, 1996a). No saturated zones (e.g., perched water, contaminant saturation) were found in the subsurface at the Building 03-60 UDP. This investigation demonstrates that contamination associated with the UDP is restricted to a shallow vadose zone less than 20 m (65 ft) bgs.

A.3.0 Investigation Results

The analytical results of samples collected from the Building 03-60 UDP CAU have been compiled and evaluated to determine the presence and/or extent of contamination. The analytical results are summarized in the following subsections. The complete laboratory result data packages are available in the project files.

During the investigation activities, a total of 55 samples (38 soil and 17 liquid samples) were collected and submitted for laboratory analysis. Eight of the soil samples were submitted for bioassessment and geotechnical analysis. A list of the sample numbers (including field duplicate and other quality control samples) and their relationship to the boreholes is presented in Table A.3-1. The analytical parameters and laboratory analytical methods requested for this investigation are presented in Table A.3-2. The analytical parameters were selected through the application of site process knowledge according to the U.S. Environmental Protection Agency's *Guidance for the Data Quality Objectives Process* (EPA, 1994a). Preliminary action levels for off-site laboratory analytical methods were determined during the DQO process and are based on NAC 445A.2272 (NAC, 1996) and the EPA Region 9 Preliminary Remediation Goals (PRGs) (EPA, 1996a) for chemical parameters under the industrial scenario. The results of the DQO process are documented in the CAIP (DOE/NV, 1997) with the remainder of the documentation retained in the project files. Sampling activities were designed to detect constituents of potential concern and conducted to either confirm or disprove the assumptions made in the DQO process.

Samples collected from the Building 03-60 UDP were analyzed by DATACHEM in Salt Lake City, Utah. The geotechnical samples were analyzed by Daniel B. Stephens & Associates in Albuquerque, New Mexico. The bioassessment was performed by IT Corporation in Knoxville, Tennessee. Third-party data validation is currently underway with Lockheed Martin Technology Services in Las Vegas, Nevada.

A.3.1 Total Petroleum Hydrocarbon Results

The TPH compounds detected above minimum reporting limits as specified in the CAIP (DOE/NV, 1997) and the associated preliminary action levels are provided in Table A.3-3.

Table A.3-1
Samples Collected During the Building 03-60 UDP Subsurface Investigation
(Page 1 of 2)

Borehole Number	Sample Number	Depth (in feet bgs)	Sample Type	QC Comments
Startup	TTR01100	N/A	Trip Blank	--
	TTR01101	N/A	Source Blank	Lab MD, MS, MSD
B1	TTR01102	N/A	Trip Blank	--
	TTR01103	30	Soil	MS, MSD, Lab MD
	TTR01104	45	Soil	--
	TTR01105	70	Soil	Lab MS, MSD
	TTR01106	80	Soil	--
	TTR01107	80	Soil	TTR01106 Duplicate
	TTR01108	81.5	Geotechnical/ Bioassessment	--
	TTR01109	N/A	Trip Blank	--
	TTR01110	N/A	Equipment Rinsate Blank	--
B2	TTR01111	N/A	Trip Blank	--
	TTR01112	45	Soil	--
	TTR01113	50	Soil	--
	TTR01114	60	Soil	--
	TTR01115	70	Soil	--
	TTR01116	N/A	Trip Blank	--
	TTR01117	N/A	Field Blank	--
	TTR01118	N/A	Trip Blank	--
	TTR01119	31.5	Geotechnical/ Bioassessment	--
B4	TTR01120	61.5	Geotechnical/ Bioassessment	--
	TTR01121	60	Soil	--
	TTR01122	70	Soil	--
B5	TTR01123	NA	Trip Blank	--
	TTR01124	46.5	Geotechnical/ Bioassessment	--
	TTR01125	60	Soil	Lab MD, MS, MSD
	TTR01126	70	Soil	--

Table A.3-1
Samples Collected During the Building 03-60 UDP Subsurface Investigation
(Page 2 of 2)

Borehole Number	Sample Number	Depth (in feet bgs)	Sample Type	QC Comments
B6	TTR01127	N/A	Trip Blank	--
	TTR01128	46.5	Geotechnical/ Bioassessment	--
	TTR01129	61.5	Geotechnical/ Bioassessment	--
	TTR01130	N/A	Source Blank	--
	TTR01131	20	Soil	Lab D1
	TTR01132	30	Soil	Lab D1, MS, MSD
	TTR01133	45	Soil	Lab D1
	TTR01134	60	Soil	Lab D1
	TTR01135	80	Soil	--
	TTR01136	80	Soil	TTR01135 Duplicate
	TTR01137	90	Soil	--
B7	TTR01138	N/A	Trip Blank	--
	TTR01139	N/A	Equipment Rinsate Blank	Lab MD, MS, MSD
	TTR01140	N/A	Field Blank	--
	TTR01141	31.5	Geotechnical/ Bioassessment	--
	TTR01142	45	Soil	MS, MSD
	TTR01143	70	Soil	--
	TTR01144	80	Soil	--
B8	TTR01145	N/A	Trip Blank	--
	TTR01146	66.5	Geotechnical/ Bioassessment	--
	TTR01147	35	Soil	Lab MS, MSD
	TTR01148	45	Soil	--
	TTR01149	60	Soil	Lab R1, R2
	TTR01150	70	Soil	Lab MD, MS, MSD
	TTR01151	80	Soil	--
B9	TTR01152	N/A	Trip Blank	--
	TTR01153	70	Soil	--
	TTR01154	80	Soil	Lab MS, MSD

Soil samples collected from 1-ft interval ending at depth shown.
Geotechnical & bioassessment samples collected from 1.5-ft interval ending at depth shown.
MD = Matrix Duplicate (sample aliquot analyzed as duplicate sample)
MS = Matrix Spike
MSD = Matrix Spike Duplicate
D1 = Dilution No. 1
R1 = Replicate No. 1

Table A.3-2
Laboratory Analytical Methods Used for the Building 03-60 UDP Investigation Samples

Analytical Parameter	Analytical Method	
Total volatile organic compounds	EPA 8260[a]	
Total semivolatile organic compounds	EPA 8270[a]	
Total petroleum hydrocarbons - gasoline and diesel	EPA 8015 (modified)[a]	
Total RCRA metals (arsenic, barium, cadmium, chromium, lead, selenium, silver, and mercury)	EPA 6010/7470[a]	
Total polychlorinated biphenyls	EPA 8080[a]	
Geotechnical Parameter	**Proposed Method**	**Actual Method(s)**
Initial moisture content	ASTM[b] D 2216	ASTM[b] D 2216-92
Dry bulk density	EM[c]-1110-2-1906	ASTM[b] D 2937-94
Calculated porosity	EM[c]-1110-2-1906	MOSA[d] Chp. 18
Saturated hydraulic conductivity	ASTM[b] D 5084	ASTM[b] D 2434-68(74) MOSA[d] Chp. 28
Unsaturated hydraulic conductivity		Van Genuchten[e]
Particle-size distribution	ASTM[b] D 422	ASTM[b] D 422-63(90)
Water-release (moisture retention) curve	ASTM[b] D 3152	MOSA[d] Chp. 26 ASTM[b] D 2325-68(94) MOSA[d] Chp. 24 Karanthanasis and Hajek[f]
Atterberg limits	ASTM[b] D 4318-93	ASTM[b] D 4318-93
Bioassessment	**Method**	
Soil pH and Moisture	Laboratory Specific[g]	
Background Nutrient Concentrations		
Microbial Enumerations		
Microbial Stimulation Test		

[a] EPA *Test Methods for Evaluating Solid Waste*, 3rd Edition, Parts 1-4, SW-846 (EPA, 1996b)
[b] *Annual Book of American Society for Testing and Materials* (ASTM) *Standards*, Section 4, "Construction", Volume 04.08, "Soil and Rock (1)", and Volume 04.09, "Soil and Rock (11)", 1996
[c] United States Army Corps of Engineers (USACE), *Engineer Manual* (EM) 1110-2-1906, "Laboratory Soils Testing," Appendix II, 1970
[d] Methods of Soil Analysis, 2nd Edition, Part 1, Soil Science Society of America, 1986
[e] Van Genuchten, M. 1980. "A Closed Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils," *Soil Science Society of America Journal*, 44:892-898
[f] Karanthanasis, A.D. and B.F. Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays, *Soil Science Society of America Journal*, 46:1321-1325
[g] Techniques described in Bioassessment Report for Tonopah Test Range Building 03-60 UDP, IT Corporation, 1998

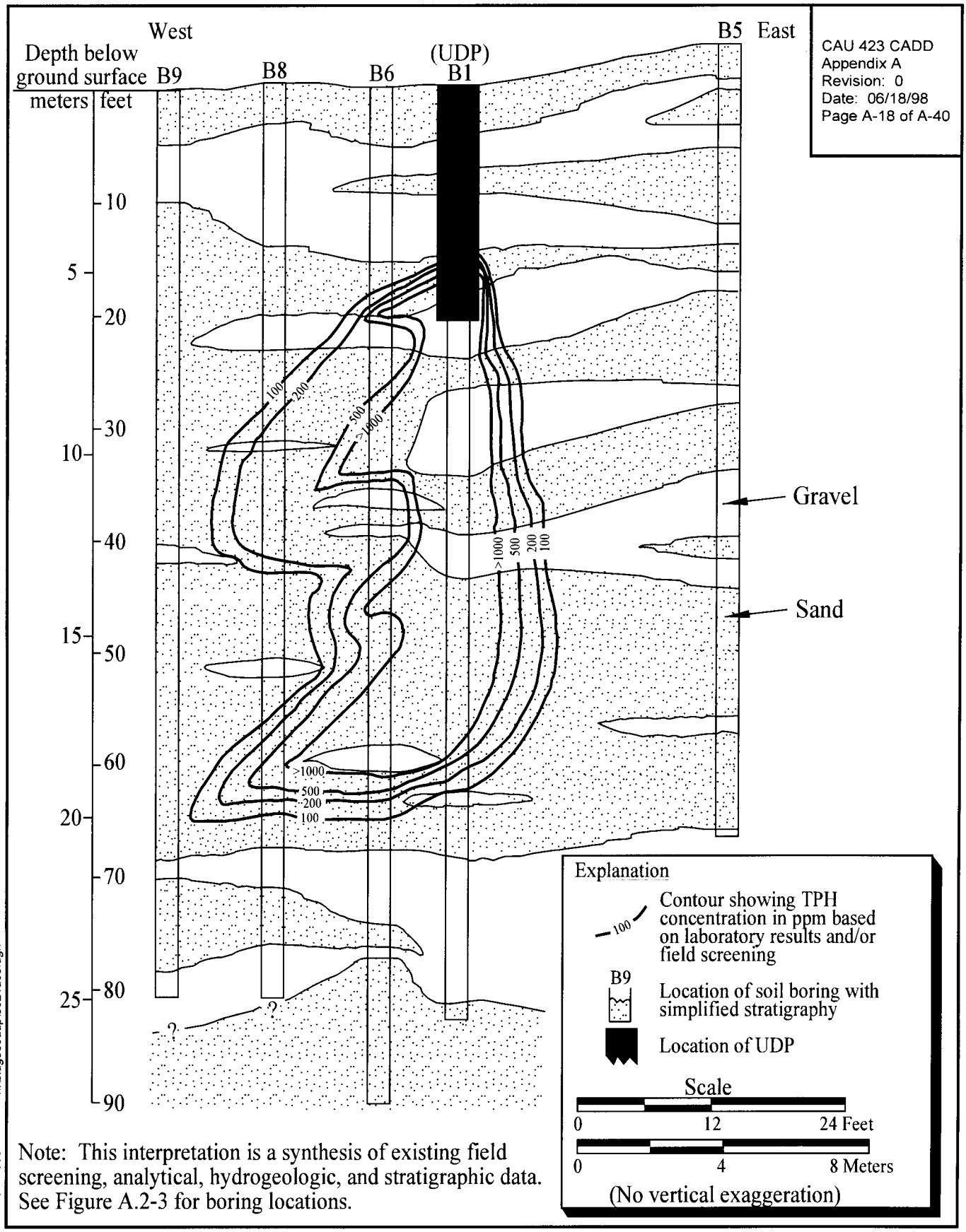
Petroleum hydrocarbon contamination was detected in boreholes B1, B6, and B8. Both diesel and gasoline range organics were detected. The contamination is confined to an asymmetrical, lobate plume (Figure A.3-1 and Figure A.2-2) with maximum length of 11 m (35 ft) and width of 6 m (20 ft). The maximum depth of the plume is approximately 20 m (65 ft) bgs and the minimum depth is approximately 4 m (14 ft) based on the interpretive cross-section shown in Figure A.3-1.

Table A.3-3
Soil Sample Results for TPH Compounds
Detected Above Minimum Reporting Limits, Building 03-60 UDP, TTR

Borehole Number	Sample Number	Sample Depth (feet)	Constituents of Concern in milligrams per kilogram (mg/kg)	
			TPH as Diesel	TPH as Gasoline
	Action Levels (mg/kg)		**100**	**100**
B1	TTR01103	30	2000	560
	TTR01104	45	1700	430
	TTR01105	70	21	--
B6	TTR01131	20	2400	640
	TTR01132	30	1400	550
	TTR01133	45	1400	670
	TTR01134	60	1800	760 (J)
	TTR01137	90	--	1400
B8	TTR01147	35	110	3 (J)
	TTR01149	60	520	68
	TTR01150	70	41	--

(J) = Estimated value
-- Not detected above minimum reporting limit as stated in CAIP (DOE/NV, 1997)

Data from field screening and analysis of samples submitted to the laboratory for TPH demonstrate that the TPH plume has two primary lobes, controlled in large part by the site geology. Discontinuous gravel lenses apparently delay or deflect contaminant migration due to lower porosity or permeability, a capillary break effect at the sand/gravel interface, or some other mechanism. These layers force the plume to develop lobes with maximum depths of approximately 13 m (43 ft) and 20 m (65 ft) concentrated on the west side of the plume. The geometry of the



Note: This interpretation is a synthesis of existing field screening, analytical, hydrogeologic, and stratigraphic data. See Figure A.2-3 for boring locations.

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Figure A.3-1
Interpretive West to East Cross Section Through Bldg. 03-60 UDP, Area 3, Tonopah Test Range, Nevada

plume is strongly asymmetric to the west because field screening detected no contamination in boring B7, located 4 m (12 ft) northeast of boring B1 (the UDP). The highest TPH concentrations detected by both TPH field screening and laboratory analysis are within the center of the plume in borings B1 and B6. A maximum concentration of 2,400 mg/kg diesel range organics was detected for sample number TTR01131 in boring B6 at a depth of 6 m (20 ft). The maximum concentration of gasoline range organics within the plume was 760 mg/kg for sample number TTR01134 in boring B6 at a depth of 18 m (60 ft).

A gasoline range organics detection of 1,400 mg/kg was detected well outside the plume boundary at a depth of 27 m (90 ft) in sample number TTR01137 from boring B6. The gasoline range organics detected are probably the result of cross contamination based on the following evidence:

- No TPH was detected in samples from similar depths in surrounding boreholes.
- Headspace screening did not indicate evidence of VOCs in this sample interval.
- The sample was collected below a zone of lower permeability based on geotechnical results.
- Cross-contamination from shallower depths above this sample is possible.
- This sample is the only gasoline range organics contaminated sample without associated diesel range organics contamination.

Sample number TTR01137 is undergoing third party validation as part of a QA/QC requirement specified in the Industrial Sites QAPP (DOE/NV, 1996b).

A.3.2 Total Volatile Organic Compound Analytical Results

The total VOC analytical results above minimum reporting limits as specified in the CAIP (DOE/NV, 1997), along with the associated preliminary action levels, are presented in Table A.3-4. The laboratory data indicate that constituents were either not present above the minimum reporting limits or, if present, were below the preliminary action levels.

Benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected in borings B1, B6, and B8. These detections suggest a plume moving down and to the west from the UDP in a similar fashion as the associated TPH plume (see Section A.3-1). The plume seems to terminate at the 18 m (60 ft) depth and is limited to single detections of toluene and xylenes in boring B8. The BTEX

Table A.3-4
Soil Sample Results for Total Volatile Organic Compounds Detected Above Minimum Reporting Limits, Building 03-60 UDP, TTR

Borehole Number	Sample Number	Sample Depth (feet)	Constituents of Concern in micrograms per kilogram (µg/kg)							
			Acetone	Benzene	2-Butanone	Ethylbenzene	Methylene Chloride	Tetrachloroethene	Toluene	Total Xylenes
	Preliminary Action Levels (µg/kg) (Industrial Soil PRG)[a]		8,800,000	1,400	27,000,000	230,000	18,000	17,000	880,000	320,000
B1	TTR01103	30	--	1200 (J)	--	11000	--	--	28000	68000
	TTR01104	45	2000 (J)	580 (J)	--	4700 (J)	--	--	16000 (J)	65000 (J)
	TTR01105	70	14	--	8 (J)	--	--	--	--	--
	TTR01106	80	20	--	13	--	--	--	--	--
	TTR01107	80	21	--	14	--	--	--	--	--
B6	TTR01131	20	--	1300 (J)	--	15000	--	--	38000	120000
	TTR01132	30	--	1200 (J)	--	9500	--	--	25000	62000
	TTR01133	45	--	1200 (J)	--	6700	--	--	19000	49000
	TTR01134	60	--	560 (J)	--	3700	--	--	18000	70000
	TTR01135	80	14	--	5 (J)	--	--	--	--	--
	TTR01136	80	17	--	7 (J)	--	--	--	--	--
	TTR01137	90	20	--	6 (J)	--	--	--	--	--
B7	TTR01143	70	--	--	--	--	5	--	--	--
B8	TTR01147	35	--	--	--	--	6	--	--	--
	TTR01148	45	--	--	--	--	5	--	--	--
	TTR01149	60	--		--	--	--	410 (J)	160 (J)	1500
	TTR01150	70	14	--	6 (J)	--	5	--	--	--
B9	TTR01153	70	12	--	8 (J)	--	13	--	--	--
	TTR01154	80	--	--	6 (J)	--	14	--	--	--

[a]U.S. Environmental Protection Agency, Region 9 Preliminary Remediation Goals (PRGs) (EPA, 1996a)

-- Not detected above minimum reporting limit as specified in the CAIP (DOE/NV, 1997)

(J) = Estimated value

concentrations appear to be associated with the TPH and not with disposal of solvents. The BTEX compound concentrations are much lower than the associated TPH gasoline concentrations. The BTEX compounds would have had relatively high concentrations if they were related to solvent disposal instead of or in addition to gasoline disposal.

Other VOCs detected during the investigation are limited to acetone, 2-butanone, methylene chloride, and tetrachloroethene. Except for one elevated acetone result from a depth of 14 m (45 ft) in boring B1, the acetone, 2-butanone, and methylene chloride are at very low levels indicative of potential laboratory contamination. These three constituents are all common laboratory contaminants (see Section A.4.7.1), and they do not correspond to any other elevated constituents detected during this investigation (Table A.3-3).

The tetrachloroethene is limited to a single detection in boring B8 (sample TTR01149) at the same depth as the toluene and xylene detections in that boring.

A.3.3 Total Semivolatile Organic Compound Analytical Results

The total SVOCs analytical results above minimum reporting limits as specified in the CAIP (DOE/NV, 1997), along with the associated preliminary action levels, are presented in Table A.3-5. The laboratory data indicate that constituents were either not present above the minimum reporting limits or, if present, were present below the preliminary action levels.

Detected SVOCs were identified within the TPH plume described in Section A.3.1 and probably represent chemicals associated with TPH constituents and degradation products.

A.3.4 Total RCRA Metals Results

The total RCRA metals detected above the minimum reporting limits are presented in Table A.3-6.The total RCRA metals results were all below the preliminary action levels for the metal constituents except for arsenic (EPA, 1996a). Arsenic was detected above the Industrial PRG (2.4 mg/kg) in many samples; however, arsenic was not detected above the maximum background concentration of 13.8 mg/kg established in background borehole BHB-3 drilled for the Area 3

Table A.3-5
Soil Sample Results for Total Semivolatile Organic Compounds Detected Above Minimum Reporting Limits
Building 03-60 UDP, TTR

Borehole Number	Sample Number	Sample Depth (feet)	Constituents of Concern in micrograms per kilogram (µg/kg)						
			Benzo(a)anthracene	Benzo(ghi)perylene	Bis(2-ethylhexyl)phthalate	Chrysene	1,2-Dichlorobenzene	Fluoranthene	2-Methylnapthalene
	Preliminary Action Levels (µg/kg) (Industrial Soil PRG)[a]		2600	Not Established	140,000	7200	700,000	27,000,000	Not Established
B1	TTR01103	30	820 (J)	--	--	670 (J)	2200 (J)	--	--
	TTR01104	45	--	--	5600 (J)	--	--	--	--
B6	TTR01131	20	1400 (J)	1100 (J)	4200 (J)	1100 (J)	2300	990 (J)	23000
	TTR01132	30	840 (J)	--	3100 (J)	--	1600 (J)	--	13000
	TTR01133	45	--	--	4300	--	1100 (J)	--	17000
	TTR01134	60	--	--	6700	--	--	--	9100
B8	TTR01147	35	--	--	800 (J)	--	--	--	--
	TTR01149	60	--	--	3400	--	--	--	--

Borehole Number	Sample Number	Sample Depth (feet)	Constituents of Concern in micrograms per kilogram (µg/kg)					
			2-Methylphenol	4-Methylphenol	Napthalene	Phenanthrene	Phenol	Pyrene
	Preliminary Action Levels (µg/kg) (Industrial Soil PRG)[a]		34,000,000	3,400,000	240,000	Not Established	100,000,000	100,000
B1	TTR01103	30	4300 (J)	10000 (J)	12000 (J)	1600 (J)	5700 (J)	1000 (J)
	TTR01104	45	--	--	5800 (J)	--	--	--
B6	TTR01131	20	3700	5200	14000	1600 (J)	800 (J)	1700 (J)
	TTR01132	30	1500 (J)	4700	7200	1100 (J)	1400 (J)	980 (J)
	TTR01133	45	--	680 (J)	8300	1200 (J)	--	850 (J)
	TTR01134	60	--	--	7400	--	--	930 (J)

[a]U.S. Environmental Protection Agency, Region 9 Preliminary Remediation Goals (PRGs) (EPA, 1996a)
-- Not detected above minimum reporting limit as stated in CAIP (DOE/NV, 1997)
(J) = Estimated value

Table A.3-6
Soil Sample Results for Total RCRA Metals Detected Above Minimum Reporting Limits
Building 03-60 UDP, TTR
(Page 1 of 2)

Borehole Number	Sample Number	Sample Depth (feet)	Constituents of Concern in milligrams per gram (mg/kg)				
			Arsenic	Barium	Chromium	Lead	Silver
	Preliminary Action Levels (mg/kg) (Industrial Soil PRG)[a]		**2.4**	**100,000**	**450**	**1,000**	**8,500**
B1	TTR01103	30	6.4 (U)	150 (J)	5.3 (J)	290 (J)	--
	TTR01104	45	--	140 (J)	3.1 (J)	21 (J)	--
	TTR01105	70	8.8	99 (J)	5.7 (J)	6.2 (J)	--
	TTR01106	80	--	74 (J)	3.0 (J)	9.2 (J)	--
	TTR01107	80	--	110 (J)	3.2 (J)	6.0 (J)	--
B2	TTR01112	45	--	140 (J)	4.7 (J)	9.9 (UJ)	--
	TTR01113	50	--	150 (J)	3.0 (J)	--	--
	TTR01114	60	--	170 (J)	2.5 (J)	5.3 (UJ)	--
	TTR01115	70	--	99 (J)	4.8 (J)	8.8 (UJ)	--
B4	TTR01121	60	10 (U)	150 (J)	3.3 (J)	8.3 (UJ)	2
	TTR01122	70	--	66	4.6	7.1 (U)	--
B5	TTR01125	60	--	270	3.4	10	--
	TTR01126	70	--	62	2.6	8.0 (U)	--
B6	TTR01131	20	7.2 (U)	110	3.8	62	--
	TTR01132	30	--	280	4.5	160	--
	TTR01133	45	6.5 (U)	120	4.6	63	--
	TTR01134	60	--	120	4.3	17	--
	TTR01135	80	--	190	5.1	13	--
	TTR01136	80	--	210	4.2	13	--
	TTR01137	90	6.9 (U)	730	3.4	12	--

Table A.3-6
Soil Sample Results for Total RCRA Metals Detected Above Minimum Reporting Limits
Building 03-60 UDP, TTR
(Page 2 of 2)

Borehole Number	Sample Number	Sample Depth (feet)	Constituents of Concern in milligrams per gram (mg/kg)				
			Arsenic	Barium	Chromium	Lead	Silver
	Preliminary Action Levels (mg/kg) (Industrial Soil PRG)[a]		**2.4**	**100,000**	**450**	**1,000**	**8,500**
B7	TTR01142	45	--	160	3.3	8.2 (U)	--
	TTR01143	70	8.1 (U)	60	4.0 (J)	12 (J)	--
	TTR01144	80	--	120	6.7	13	--
B8	TTR01147	35	--	120	4.2 (J)	7.5	--
	TTR01148	45	9.3 (U)	120	4.1 (J)	7.2	--
	TTR01149	60	9.7 (U)	140	5.2 (J)	11	--
	TTR01150	70	--	41	2.9 (J)	7.3	--
	TTR01151	80	--	130	3.6 (J)	5.2	--
B9	TTR01153	70	11 (U)	180	3.5 (J)	11	--
	TTR01154	80	--	59	3.9 (J)	9.5	--

[a]U.S. Environmental Protection Agency, Region 9 Preliminary Remediation Goals (PRGs) (EPA, 1996a)

-- Not detected above minimum reporting limit as specified in the CAIP (DOE/NV, 1997)
(U) = Not detected because analyte found in associated blank
(J) = Estimated value

Landfill Corrective Action Investigation (CAU 424) (DOE/NV, 1997b). Based on this information, the concentrations of arsenic are believed to be representative of ambient conditions at the site.

Other RCRA metals detected during the investigation are limited to barium, chromium, lead, and silver. Elevated levels of lead were detected in sample numbers TTR01103, TTR01104, TTR01132, and TTR01133 with concentrations of 290 mg/kg, 21 mg/kg, 160 mg/kg, and 63 mg/kg measured in samples collected from depths of 9 and 14 m (30 and 45 ft) in borings B1 and B6, respectively. All of these samples are within 8 m (25 ft) of the UDP base and are contained within the TPH plume described in Section A.3.1. With one possible exception (TR01137), the remainder of the RCRA metals detections seem to be representative of ambient conditions at the site. The elevated barium level detected in sample number TTR01137 from a depth of (90 ft) in boring B6 has no associated migration mechanisms and is a high statistical outlier representative of background conditions. Further analysis of this anomalous detection is not warranted because the concentration is significantly lower than the preliminary action level for barium.

A.3.5 Total PCB Analytical Results

A PCB was detected above minimum reporting limits at a depth of 24 m (80 ft) bgs in borehole B8. Aroclor-126 was detected in sample TTR01151 at 10.8 micrograms per kilogram (µg/kg), a substantially lower concentration than the PRG of 340 µg/kg. This result is probably a false positive based on its low value and the absence of other contaminants. Other detections for this sample are limited to barium and chromium at probable background levels. No PCBs were detected in any other samples.

A.3.6 Bioassessment and Geotechnical Analysis Results

Eight bioassessment and geotechnical samples (TTR01108, TTR01119, TTR01120, TTR01124, TTR01128, TTR01129, TTR01141, and TTR01146 [see boring logs provided in Appendix B for specific boreholes, locations and depths]) were collected. Each sample was collected in three 15-cm (6-in.) brass sleeves using a California Modified split-spoon sampler. In each case, the uppermost sleeve was submitted to the IT Technology Center for bioassessment and the remaining two sleeves to Daniel B. Stephens & Associates for geotechnical analysis.

The data were collected to provide input for closure options. The findings are summarized in this document, and both reports are maintained in the contractors files.

A.3.6.1 Bioassessment Results

A bioassessment was performed on eight soil samples to investigate bioremediation feasibility for contamination associated with the UDP (IT, 1998). Bioassessment is a series of tests designed to evaluate the physical, chemical, and microbiological characteristics of a site. The bioassessment consisted of determination of nutrient availability, pH, microbial population density, and the ability of the microbial populations to grow under enhanced conditions. Results of the bioassessment indicate that soil conditions are suitable for successful bioremediation of contaminated soil at the UDP site. The results of the bioassessment are summarized below:

- Viable microbial populations exist at the site and appear to be well-adapted to site conditions.
- Phosphate levels are high (360-640 ppm), and ammonia levels are less than the detection limit of 4 mg/kg.
- Hydrocarbon degraders responded very favorably to oxygenation, but the benefits of nutrient addition were not significant. Nutrient addition to the vadose zone will be required if *in situ* respiration rates decline.
- The soil pH is slightly higher than the optimal range of 6 to 8, but does not seem to adversely affect microbial activity.
- Moisture levels are acceptable.

A.3.6.2 Geotechnical Analysis Results

The methods used for the geotechnical analysis are equivalent or superior to those specified in the CAIP (DOE/NV, 1997) (see Table A.3-2). The results of the geotechnical observations suggest that the subsurface soil is primarily comprised of poorly graded sands and sands with gravel. Silty sand with gravel and well-graded sand with gravel are also present. The results of the laboratory analysis of the geotechnical samples are presented in Tables A.3-7 to A.3-9. All sample depths shown in the geotechnical parameter results tables represent the deepest sample collection point of the 0.5-m (1.5-ft) range for the bioassessment/geotechnical samples.

Table A.3-7
Summary of Particle Size Characterization

Borehole Number	Sample Number	Sample Depth (feet)	d_{10} (mm)[a]	d_{30} (mm)	d_{50}[b] (mm)	d_{60} (mm)	Cu[c]	Cc[d]	Method	Classification
B1	TTR01108	81.5	0.12	0.33	0.80	1.2	10.0	0.76	DS[e]	Poorly-graded sand
B2	TTR01119	31.5	0.19	0.94	2.6	4.1	22	1.1	DS	Well-graded sand with gravel
B4	TTR01120	61.5	0.13	0.29	0.58	0.83	6.4	0.78	DS	Poorly-graded sand
B5	TTR01124	46.5	0.12	0.32	0.89	1.5	13	0.57	DS	Poorly-graded sand
B6	TTR01128	46.5	0.22	0.48	1.2	2.0	9.1	0.52	DS	Poorly-graded sand with gravel
	TTR01129	61.5	0.14	0.48	0.96	1.3	9.3	1.3	DS	Well-graded sand
B7	TTR01141	31.5	0.12	0.30	0.69	1.1	9.2	0.68	DS	Poorly-graded sand
B8	TTR01146	66.5	0.0035	0.14	1.1	2.9	830	1.9	WS[f]/H[g]	Silty sand with gravel

[a]Millimeter(s)
[b]d_{50} = Median particle diameter
[c]Uniformity coefficient, $Cu = d_{60}/d_{10}$
[d]Coefficient of curvature, $Cc = (d_{30})^2/(d_{10})*(d_{60})$
[e]Dry sieve
[f] Wet sieve
[g]Hydrometer

Table A.3-8
Summary of Initial Moisture Content, Dry Bulk Density, Wet Bulk Density, and Calculated Porosity Results

Borehole Number	Sample Number	Sample Depth (feet)	Initial Moisture Content		Dry Bulk Density (g/cm^3)[c]	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)[d]
			Gravimetric (%, g/g)[a]	Volumetric (%, cm^3/cm^3)[b]			
B1	TTR01108	81.5	14.6	23.7	1.62	1.86	38.7
B2	TTR01119	31.5	9.2	15.0	1.63	1.78	38.3
B4	TTR01120	61.5	8.0	13.2	1.64	1.78	37.9
B5	TTR01124	46.5	13.2	20.6	1.56	1.76	41.3
B6	TTR01128	46.5	10.0	16.4	1.64	1.80	38.3
	TTR01129	61.5	11.8	20.3	1.72	1.92	35.2
B7	TTR01141	31.5	10.4	17.0	1.63	1.80	38.3
B8	TTR01146	66.5	20.8	34.5	1.66	2.01	37.2

[a]Percent, gram per gram
[b]Percent, cubic centimeter per cubic centimeter
[c]Gram(s) per cubic centimeter
[d]Percent

Table A.3-9
Summary of Hydrologic Parameters Test Results

Borehole Number	Sample Number	Sample Depth (feet)	Saturated Hydraulic Conductivity	Unsaturated Hydraulic Conductivity			
			Ksat[a] (cm/s)[b]	α^c (cm^{-1})[d]	**N**[c] (dimensionless)	Θr^e %[f]	Θs^g %[f]
B1	TTR01108	81.5	1.8E-06	0.0235	1.1780	0.0480	0.3684
B2	TTR01119	31.5	3.0E-03	0.0472	1.2757	0.0430	0.3333
B4	TTR01120	61.5	6.8E-03	0.0652	1.5217	0.0410	0.3974
B5	TTR01124	46.5	1.7E-04	0.0505	1.1675	0.0600	0.3841
B6	TTR01128	46.5	3.9E-03	1.6706	1.1255	0.0470	0.3794
	TTR01129	61.5	3.2E-05	0.2960	1.1459	0.0480	0.3452
B7	TTR01141	31.5	1.6E-03	0.0514	1.1925	0.0540	0.3546
B8	TTR01146	66.5	1.2E-07	0.0027	1.1833	0.0810	0.4073

[a]Saturated permeability
[b]Centimeter(s) per second
[c]Calculated parameter
[d]Unit(s) per centimeter
[e]Residual soil-water content
[f]Percent
[g]Saturated soil-water content

A.4.0 Quality Assurance

The results of quality assurance and quality control activities for the Building 03-60 UDP corrective action investigation sampling event are summarized in the following text. A discussion about measurement of the QA/QC objectives and documentation of nonconformances is also included. The QA/QC procedures related to geotechnical samples and analyses are contained in the *Standard Specifications for Transportation Materials and Methods of Sampling and Testing* (AASHTO, 1995) and are not discussed further in this text. Detailed information on the QA program for this sampling event is contained in the Industrial Sites QAPP (DOE/NV, 1996b).

Quality control results are typically discussed in terms of precision, accuracy, representativeness, completeness, and comparability, the five PARCC parameters as described in the following sections.

A.4.1 Precision

Precision is a quantitative measure of the variability of a group of measurements from their average value. Precision is assessed by collecting and analyzing duplicate field samples and comparing the results with the original sample. Precision is also assessed by creating, analyzing, and comparing laboratory duplicates from one or more field samples. Precision is reported as relative percent difference (RPD) which is calculated as the difference between the measured concentrations of duplicate samples, divided by the average of the two concentrations, and multiplied by 100. Any deviations from these requirements have been documented and explained and the related data qualified accordingly. The qualification process is described in Section A.4.7.1.

A.4.2 Accuracy

Analytical accuracy is defined as the nearness of a measurement to the true or accepted reference value. It is the composite of the random and systematic components of the measurement system and measures bias in a measurement system. The random component of accuracy is measured and documented through the analyses of spiked samples. Sampling accuracy is assessed by evaluating the results of spiked samples and laboratory control samples. Accuracy measurements are

calculated as percent recovery by dividing the measured sample concentration by the true concentration and multiplying the quotient by 100.

Field accuracy is assessed by confirming that the documents of record track the sample from origin, through transfer of custody, to disposal. The goal of field accuracy is for all samples to be collected from the correct locations at the correct time, placed in a correctly labeled container with the correct preservative, and sealed with custody tape to prevent tampering. All samples in this sampling event were properly collected and forwarded to the laboratory as described above.

A.4.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition (EPA, 1987). Sample representativeness was achieved through the implementation of a sampling program designed to ensure proper sampling locations, number of samples, and the use of validated analytical methods. Representativeness was assessed through analysis of duplicate samples. Representativeness of the samples taken in this sampling event was assured by collecting the required samples shown in Section A.2.0 and by analyzing them using the approved analytical methods shown in Table A.3-2.

A.4.4 Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid. A sampling and analytical requirement of 80 percent completeness was established for this project (DOE/NV, 1996b). The Building 03-60 UDP sampling data exhibit a high degree of completeness. The sampling and analytical program were executed in accordances with approved field sampling instructions (DOE/NV, 1997). The specified sampling locations were used as planned. All specified samples were collected, and all sample containers reached the laboratory intact and properly preserved (when applicable). For all samples, sample temperature was maintained during shipment to the laboratory, and sample chain of custody was maintained during sample storage and/or shipment (DOE/NV, 1996b).

A.4.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another (EPA, 1987). To ensure comparability, the Building 03-60 UDP field sampling activities were performed and documented in accordance with approved procedures; a standardized sampling approach and analytical methodology were used; and all samples were collected per the CAIP (DOE/NV, 1997). Approved standardized methods and procedures were also used to analyze and report the data (e.g., EPA SW-846 Methods and Contract Laboratory Program [CLP] [EPA, 1994b] and/or CLP-like data packages). This approach ensures that the data from this project can be compared to other data sets. Based on the minimum comparability requirements specified in the Industrial Sites QAPP (DOE/NV, 1996b), all requirements were met.

Sample-handling documentation, laboratory nonconformance reports, and the precision and accuracy of quality-control sample results were evaluated for their effect on the results of the associated environmental soil samples. The environmental sample results were then qualified according to processes outlined in the following section. Documentation of the data qualifications resulting from these reviews is retained in project files as both hard copy and electronic media and will be supplied upon request.

A.4.6 Data Evaluations

All laboratory data from samples collected at the Building 03-60 UDP have been evaluated for data quality according to EPA Functional Guidelines (EPA, 1994b; 1994c). These guidelines were implemented in a tiered process and are presented in the following text. Modifications to the laboratory-generated qualifiers were required to account for estimated values and associated blank contamination. No data rejected during the data evaluation process were used to reach the conclusions presented in Section A.3.0. Only detections, whether estimated (i.e., J-qualified) or not, were used in reaching conclusions.

Changes resulting from the data evaluation process are documented in project files and summarized in memoranda for each sample delivery group (SDG). These memoranda are maintained with the SDGs in the project files and are available for inspection upon request.

A.4.6.1 Tier I

Tier I evaluation for chemical analysis examines (but is not limited to):

- Sample count/type consistent with chain of custody
- Analysis count/type consistent with chain of custody
- Correct sample matrix
- Significant problems stated in cover letter or case narrative
- Completeness of certificates of analysis (COAs)
- Completeness of CLP or CLP-like packages
- Completeness of signatures, dates, and times on chain of custody
- Condition-upon-receipt variance form included
- Requested analyses performed on all samples
- Date received/analyzed given for each sample
- Correct concentration units indicated
- Correct detection limits achieved
- Electronic data transfer (EDT) supplied
- Results reported for field and laboratory QC samples
- Whether or not the deliverable met the overall objectives of the project

A.4.6.2 Tier II

Tier II evaluation for chemical analysis examines (but is not limited to):

- Sample date, preparation date, and analysis date for each sample
- Holding time criteria met
- QC batch association for each sample
- Cooler temperature upon receipt
- Sample pH for aqueous samples, as required
- Detection limits properly adjusted for dilution, as required
- Blank contamination evaluated and applied to sample results/qualifiers
- Matrix spike/matrix spike duplicate percent recoveries (%R) and RPDs evaluated and applied to laboratory results/qualifiers
- Field duplicate RPDs evaluated and applied to laboratory results/qualifiers
- Laboratory duplicate RPDs evaluated and applied to laboratory results/qualifiers
- Surrogate %Rs evaluated and applied to laboratory results/qualifiers
- Laboratory control sample (LCS) %Rs evaluated and applied to laboratory results/qualifiers

A.4.6.3 Tier III

Additional data quality considerations included in EPA data review functional guidelines are evaluated as a third party Tier III review. Tier III review of chemical results include the following additional evaluations:

- Mass spectrometer tuning criteria
- Initial and continuing calibration verification
- Internal standard evaluation
- Organic compound quantitation
- Inductively coupled plasma (ICP) interference check sample evaluation
- Graphite furnace atomic absorption quality control
- ICP serial dilution effects
- Recalculation of all laboratory results from raw data

Tier I and II data evaluations are summarized in a memorandum for each sample delivery group showing results and qualifiers that were changed and the reason for these changes.

A Tier III review of five percent of the analytical data was performed by Lockheed Analytical Services in Las Vegas, Nevada. Changes to the data resulting from this review have been documented in project files and are reflected in the analytical summary tables in Section A.3.0.

A.4.7 Quality Control Samples

Twenty-one quality control samples (i.e., trip blanks, equipment rinsate blanks, field blanks, source blanks, field duplicates, and matrix spike/matrix spike duplicates [MS/MSD]) were collected and submitted for laboratory analysis, as shown in Table A.3-1. The blanks and duplicates were assigned individual sample numbers and sent to the laboratory "blind." Additional samples were selected by the laboratory to be analyzed as laboratory replicates, duplicates, matrix duplicates, matrix spikes, and matrix spike duplicates. Documentation related to the collection and analysis of these samples is retained in project files and will be supplied upon request.

A.4.7.1 Field Quality Control Samples

All blanks except trip blanks (i.e., equipment rinsate blanks, field blanks, and source blanks) were analyzed for the parameters listed in Table A.3-2 (trip blanks were analyzed for VOCs only) and showed contamination associated with common laboratory contaminants (acetone, methylene chloride, 2-butanone, and phthalate esters as defined in the EPA Functional Guidelines) and with arsenic. These blank detections were used to qualify the results of the associated environmental samples according to EPA Functional Guidelines (EPA, 1994b; 1994c).

According to the EPA Functional Guidelines, no qualification action is taken if a compound is found in an associated blank, but not in the sample, or if a compound is found in the sample, but not in an associated blank. The action taken when a compound is detected in both the sample and the associated blank varies depending upon the analyte involved and is known as "The 5X/10X Rule."

For most VOCs, SVOCs, pesticides, and PCBs, an analyte detected in the sample that was also detected in an associated blank is qualified as undetected (U) if the sample concentration is less than five times (5X) the blank concentration. For the common laboratory contaminants (methylene chloride, acetone, 2-butanone [methyl ethyl ketone or MEK], and phthalate esters [especially bis(2-ehtylhexyl)phthalate]), the factor is raised to ten times (10X) the blank concentration. The sample result is elevated to the quantitation limit if it is not already reported at that level.

For inorganics (metals), sample results greater than the instrument detection limit but less than five times (5X) the amount found in an associated blank are qualified as undetected (U). There are no common metallic laboratory contaminants, so the sample result is never altered using a "10X rule."

Documentation of the data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media and will be supplied upon request.

Two field duplicate soil samples were sent as blind samples to the laboratory to be analyzed for the analytical parameters listed in Table A.3-2. For these samples, the duplicate results precision (i.e., relative percent differences between the environmental sample results and their corresponding field duplicate sample results) were compared to criteria set forth in EPA Functional Guidelines (EPA, 1994b; 1994c), and the associated environmental sample results were qualified accordingly.

The EPA Functional Guidelines give no required review criteria for field duplicate analyses comparability, but allow the data reviewer to exercise professional judgement. Both detections and nondetections have been qualified as estimated (J and UJ, respectively) if the relative percent difference between an environmental sample and its field duplicate fell outside established criteria.

Two field samples were selected for use as MS/MSD samples. The %R of these samples (a measure of accuracy) and the RPDs in these sample results (a measure of precision) were compared to EPA Functional Guideline (EPA, 1994b; 1994c) criteria, and the results were used to qualify associated environmental sample results accordingly.

The EPA Functional Guidelines for review of organic data state that no data qualification action is taken on the basis of MS/MSD results alone. The data reviewer exercises professional judgment in considering these results in conjunction with the results of laboratory control samples and other QC criteria in applying qualifiers to the data. Generally, if recovery criteria are greater than the upper acceptance limit, then positive sample results for the affected compounds are qualified as estimated (J), and nondetections are not qualified. If recovery criteria are less than the lower acceptance limit, then positive sample results for the affected compounds are qualified as estimated (J) and nondetections are qualified as unusable (R). The relative percent difference results of MS/MSD samples that fall outside established criteria are applied to qualify detections and nondetections as estimated (J and UJ, respectively).

The EPA Functional Guidelines for inorganic data review allow professional judgment to be applied in evaluating the results of both matrix spikes and laboratory duplicates. Generally, if spike recoveries are greater than the upper acceptance limit or less than the lower acceptance limit, positive results are qualified as estimated (J), and nondetections are either unqualified or qualified as estimated (UJ), respectively. If spike recoveries are grossly low (less than 30 percent), positive results are unqualified, and nondetections are unusable (R). The relative percent difference between the environmental sample and its laboratory duplicate are compared to established criteria to qualify detections and nondetections as estimated (J and UJ, respectively).

A.4.7.2 Laboratory Quality Control Samples

Analysis of method QC blanks and laboratory control samples was performed for each parameter analyzed by DATACHEM Laboratory. In addition, laboratory duplicate analysis was performed on several environmental samples per SDG. The results of these analyses were used to qualify associated environmental sample results according to EPA Functional Guidelines (EPA, 1994b; 1994c) as discussed above.

A.4.8 Nonconformances and Field Deficiencies

One nonconformance was initiated on in April 1998 for this project phase. Review of the preliminary draft for this report identified that data supplied by DATACHEM Laboratories (Salt Lake City, Utah) do not meet RCRA Metals project objectives for arsenic, lead, and selenium. An example of this problem is that the Contract-Required Detection Limit (CRDL) for arsenic is 1 mg/kg as stated in the Industrial Sites QAPP (DOE/NV, 1996b) and in the analytical services Basic Ordering Agreement (BOA), but a CRDL of 30 mg/kg was reported by the laboratory. The data can be used for this report, because they were provided based on the instrument detection limit (IDL) of 6 mg/kg, which is lower than the background value (13.8 mg/kg) for Area 3 (see Section A.3.4). If changes to the reported results are required after the CADD has been finalized, a letter indicating the changes will be issued.

No field deficiencies were identified for this project.

A.5.0 Summary

Analysis of the data generated from sampling activities conducted during corrective action investigation activities conducted at the Building 03-60 UDP indicates the following:

- A plume of TPH greater than 100 mg/kg TPH is associated with the UDP. The plume has maximum areal dimensions of 6 m by 11 m (20 ft by 35 ft) and ranges in depth from a minimum of 4 m (14 ft) to 20 m (65 ft). The plume is asymmetric and primarily west of and below the UDP.

- With the exception of arsenic, the preliminary action levels were not exceeded for total VOCs, total SVOCs, total PCBs, and total RCRA Metals for any of the samples collected from the subsurface at the Building 03-60 UDP site.

- Arsenic concentrations were detected above the industrial PRG levels in several samples collected; however, these concentrations were below the maximum background concentrations detected for arsenic in Area 3 (DOE/NV, 1998). Based on the background concentrations, it is felt that arsenic is naturally occurring at these levels.

- Radiological field screening did not detect radiation greater than two times background levels associated with the soils at the site.

- The geologic, hydraulic, and geotechnical results revealed that the soil beneath the Building 03-60 UDP is comprised of a sand with discontinuous gravel lenses with a low migration potential.

- The only contaminant identified above preliminary action levels is TPH; corrective actions for addressing the TPH plume should be evaluated in the CADD.

A.6.0 References

AASHTO, see American Association of State Highway and Transportation Officials.

American Association of State Highway and Transportation Officials. 1995. *Standard Specifications for Transportation Materials and Methods of Sampling and Testing.* Washington, DC.

ASTM, see American Society for Testing Materials.

American Society for Testing Materials. 1996. *Annual Book of American Society for Testing and Materials (ASTM) Standards,* Section 4, "Construction," Volume 04.08, "Soil and Rock (1)," and Volume 04.09, "Soil and Rock (11)." Philadelphia, PA.

DOE, see U.S. Department of Energy.

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

EPA, see U.S. Environmental Protection Agency.

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

Federal Facility and Consent Order. 1996. Agreed to by the Nevada Division of Environmental Protection, the U.S. Department of Energy, and the U.S. Department of Defense.

IT, see IT Corporation.

IT Corporation. 1997. *Site-Specific Health and Safety Plan for Building 03-60 Underground Discharge Point (UDP), Tonopah Test Range.* Las Vegas, NV.

IT Corporation. 1998. *Bioassessment Report, Tonopah Test Range, Building 03-60 UDP.* Knoxville, TN.

Karanthanasis, A.D. and B.F. Hajek. 1982. "Quantitative Evaluation of Water Adsorption on Soil Clays." In *Soil Science Society of America Journal*, 46: 1321-1325.

NAC, see *Nevada Administrative Code*.

Nevada Administrative Code. 1996. NAC 445A.227, "Contamination of soil: Order by director of corrective action; factors to be considered in determining whether corrective action is required." Carson City, NV.

Soil Science Society of America. 1986. *Methods of Soil Analysis*, 2nd Edition, Part 1.

USACE, see U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers. 1970. "Laboratory Soils Testing." In *Engineer Manual* (EM) 1110-2-1906, Appendix II. Washington, DC.

U.S. Department of Energy, Nevada Operations Office. 1996a. *Corrective Action Unit Work Plan Tonopah Test Range.* Las Vegas, NV: IT Corporation.

U.S. Department of Energy, Nevada Operations Office. 1996b. *Industrial Sites Quality Assurance Project Plan, Nevada Test Site, Nevada,* Rev. 1. Las Vegas, NV: IT Corporation.

U.S. Department of Energy, Nevada Operations Office. 1997. *Corrective Action Investigation Plan for Corrective Action Unit No. 423: Building 03-60 Underground Discharge Point, Tonopah Test Range, Nevada,* DOE/NV--487, Rev. 0. Las Vegas, NV: IT Corporation.

U.S. Department of Energy, Nevada Operations Office. 1998. *Corrective Action Decision Document for the Area 3 Landfill Complex, Tonopah Test Range, CAU 424,* DOE/NV--496, Rev. 0. Las Vegas, NV: IT Corporation.

U.S. Environmental Protection Agency. 1987. *Data Quality Objectives for Remedial Response Activities*, EPA/540/G-87-003. Washington, DC.

U.S. Environmental Protection Agency. 1994a. *Guidance for the Data Quality Objectives Process*, EPA QA/G-4. Washington, DC.

U.S. Environmental Protection Agency. 1994b. *Contract Laboratory Program National Functional Guidelines for Organic Data Review*, EPA 540/R-94/012. Washington, DC.

U.S. Environmental Protection Agency. 1994c. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,* EPA 540/R-94/013. Washington, DC.

U.S. Environmental Protection Agency. 1996a. Memo from S. J. Smucker to PRG Table Mailing List regarding Region 9 Preliminary Remediation Goals (PRGs), 1 August. San Francisco, CA.

U.S. Environmental Protection Agency. 1996b. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* SW-846, CD ROM. Washington, DC.

Van Genuchten, M. 1980. "A Closed Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils." In *Soil Science Society of America Journal*, 44: 892-898.

Appendix B

Soil Boring Logs

SOIL BORING LOG	BORING NUMBER: B2	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-3 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/14/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/14/98	
HOLE SURFACE ELEVATION (feet): 5500.00	EASTING: 521466.10	
TOTAL DEPTH DRILLED (feet):70.00	NORTHING: 4182043.80	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird	
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.	
ELEVATION DATUM: Mean Sea Level		

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		SW	Fine to medium sand with gravel. Very loose, disturbed by air knife. Slightly moist, brownish yellow (10YR 6/6). Gravel subangular to angular, up to 2-in. <10% silt.			
	1.0						
5.0					4		
	2.0		GM	Sandy gravel. Very loose. Slightly moist, yellowish-brown (10YR 5/6). Gravel up to 3-in., subrounded., well graded sand.			
				Sandy gravel, increase in silt content. Slightly moist, yellowish-brown (10YR 5/4). Well graded sand, gravel to 4-in.			
10.0	3.0		GW	Sandy gravel, <5% silt. Moist, yellowish-brown (10YR 5/4). At 11 ft. two 4-in. subrounded cobbles. At 12.5-ft increase in silt.	3		
	4.0						
15.0				Sandy gravel, <5% silt. Moist, brown (7.5YR 5/4). Fine to medium sand. Gravel becoming larger to 2-in., and more angular. At 14-ft three cobbles to 5-in.	4		
	5.0			Well graded, fine to medium sand with silt. <5% gravel. Moist yellowish-brown (7.5YR 5/6). At 17.5 ft cobble to 6-in.			
			SM				
			GW	Sandy gravel, <5% silt. Moist, strong brown (7.5YR 5/6). Medium to coarse sand. Gravel is subrounded to 2-in.			
20.0	6.0				4		
	7.0		SW	Well graded gravelly sand. Fine to medium sand with fine gravel, some gravel to 1-in. Moist, strong brown (7.5YR 5/6). Soil becomes very dense, stays consolidated in bags as blocky chunks. A 4-in cobble at 23 ft and 26 ft.			
25.0					5		
	8.0			Gravelly sand. Subangular gravel is 1 to 3 inches, in a well graded sand. Moist, dark yellowish brown (10YR 4/6).			
				Gravelly sand. Well graded sand with fine gravel, <5% silt. Moist, yellowish brown (10YR 5/6). More consolidated towards 29 to 30 ft.			
	9.0				4		
30.0				Gravelly sand. Well graded sand with fine gravel, <5% silt. Moist, yellowish-brown (10YR 5/6). Gravel subangular to 1-inch.			TTR01119
	10.0		SM	Gravelly sand as above, increase in silt content to <10%. Moist, yellowish brown (10YR 5/4).			
			SW	Well graded sand with fine gravel, <5% silt. Loose. Moist, yellowish-brown (10YR 5/4).			
35.0					3		
	11.0			Well graded sand with fine gravel, <5% silt. Dense. Moist, yellowish brown (10YR 5/4). Gravel is subangular to subrounded.			
				Well graded sand with some fine gravel, <5% silt. Moist, yellowish brown (10YR 5/6). At 37.5 ft, approx. 1-in. lens of increased silt content to <10%.			
	12.0				4	10	

SOIL BORING LOG	BORING NUMBER: B2
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/14/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/14/98
HOLE SURFACE ELEVATION (feet): 5500.00	EASTING: 521466.10
TOTAL DEPTH DRILLED (feet):70.00	NORTHING: 4182043.80
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
				Fine to medium sand with some fine gravel, 5 to 10% silt. Moist, yellowish brown (10YR 5/4). Becoming more dense, with a slight increase in silt content towards 42.5. ft, but still <10%. 3-inch cobble at 42.5 ft.			
	13.0			Well graded sand with some gravel, <5% silt. Moist, yellowish brown (10YR 5/4). Subangular gravel to 1-inch.			
			SM	Fine to medium sand, <10% silt, moist, yellowish brown (10YR 5/4).	3	50	TTR01112
45.0			SW	Fine to medium sand with occasional fine gravel, <10%, moist, yellowish brown (10YR 5/8). Some subangular gravel to 1.5-inches. At 47 ft. subangular cobble to 5-in.			
	14.0			Fine to medium sand with occasional fine gravel, <10%, moist, yellowish brown (10YR 5/6). Some rounded gravel to 1-inch.			
				Sandy gravel, <5% silt, loose, moist, yellowish-brown (10YR 5/6).			
	15.0						TTR01113
50.0			GW	Silty sand. Fine sand, <15% silt. Rare (<5%), rounded gravel to 0.5-in. Moist, yellowish brown (10YR 5/4).	4	10	
			SM	Fine to medium sand. <5% fine, subangular, gravel. Moist, yellowish brown (10YR 5/4).			
			SP				
	16.0			Silty, fine to medium sand, <5% fine, subangular, gravel. More consolidated. Moist, yellowish brown (10YR 5/4).			
			SM	Fine to medium sand, <5% fine, subangular, gravel. More consolidated. Moist, yellowish brown (10YR 5/6).			
55.0			SP				
			GW	Sandy gravel, dry, yellowish brown (10YR 5/4). Well graded sandy gravel. Gravel is subrounded to 0.5-in.			
	17.0			Sandy gravel, more consolidated. Dry, yellowish brown (10YR 5/4). Well graded sandy gravel. Gravel is subrounded to 0.5-in.			
			GM				
			SW	Gravelly sand.			
	18.0			Gravelly sand with silt, moist, yellowish brown (10YR 5/6). More consolidated. Fine gravel.	3		TTR01114
60.0			SM				
			SW	Gravelly sand, moist, yellowish brown (10YR 5/6). Well graded sand with <10%, fine, subangular gravel.			
	19.0			Gravelly sand. Well graded sand, <5% silt, <15% gravel, moist, yellowish brown (10YR 5/6). Gravel subrounded to 1.5 inches.			
				Silty sand, moist, reddish yellow (7.5YR 7/6). Fine sand with silt. Low to medium plasticity.			
65.0				Gravelly sand, moist, yellowish brown (10YR 5/8). Well graded, coarse sand with fine, subangular, gravel (<15%) to 1-inch. <5% silt.			
	20.0			Sand, moist, yellowish brown (10YR 5/6). Well graded sand with fine gravel (<5%) to 0.5-in. Sand becoming more fine grained after 65 ft.			
				Fine to medium sand, slightly moist, yellowish brown (10YR 5/4). More consolidated.			
	21.0		SP	Well graded sand with fine gravel (<25%), moist, yellowish brown (10YR 5/6). Gravel subrounded to subangular. 70.0 ft is bottom of boring.			
			SW		3		TTR01115

SOIL BORING LOG	BORING NUMBER: B3
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/15/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/15/98
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521468.10
TOTAL DEPTH DRILLED (feet):5.30	NORTHING: 4182056.20
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		GP	Sandy gravel. Gravel to 1-inch, subangular. Disturbed by airknife that was used to check for utilities.			
			GM	Gravelly sand with silt. Fine grained sand with fine gravel (<10%) and silt (<15%). 3-in. rock at 2.5 ft.			
	1.0		GW	Sandy gravel. Gravel is fine, (<0.5-inches), subrounded, to 3 ft, becoming more coarse (1 to 2.5-in.), subangular towards 5 ft. Moist, brownish yellow (10YR 6/8).			
			UNKNO	Obstruction. Investigated with airknife. Appears to be concrete with a ring (possibly a cross-section of pipe). Stop drilling. Bottom of boring is 5.3 ft.	3		

SOIL BORING LOG	BORING NUMBER: B4	
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/15/98	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-6 of B-18
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/15/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521466.70	
TOTAL DEPTH DRILLED (feet):70.00	NORTHING: 4182054.70	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird	
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.	
ELEVATION DATUM: Mean Sea Level		

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		SW	Gravelly sand, very moist, yellowish brown (10YR 5/6). Well graded sand with <40% gravel, <5% silt. Gravel is subangular to subrounded, to 1.5-in. This zone disturbed by airknife while investigating for buried utilities.			
	1.0				3		
5.0			GP	Sandy gravel with <5% silt, moist, light yellowish brown (10YR 6/4). Subrounded gravel 0.6 to 1.5 in.			
	2.0		SP	Gravelly sand, <40% gravel, <5% silt, moist, brownish yellow (10YR 6/6).			
				Gravelly sand, <30% gravel, moist, light yellowish brown (10YR 6/4).			
10.0	3.0		SM	Sand with gravel, moist, yellowish brown (10YR 5/6). Fine to medium sand, gravel 1 to 2.5-in., <10% silt.	3		
			SW	Gravelly sand, moist, yellowish brown (10YR 5/6). Well graded sand with gravel to 2-in.			
			SM	Fine to medium sand, <3% gravel, <5% silt. Breaks into platy sections.			
	4.0		SW	Gravelly sand, moist, yellowish brown (10YR 5/4). Medium to coarse sand with fine gravel. Finer sand towards 15 ft.			
15.0					3		
	5.0		GM	Silty gravel, moist, yellowish brown (10YR 5/6). Some gravel to 1.5-in. angular. More consolidated.			
			GP	Sandy gravel, moist, yellowish brown (10YR 5/6). Fine gravel with poorly graded sand, gravel is angular, <0.5-in.			
			SP	Gravelly sand, moist, yellowish brown (10YR 5/4). Poorly graded sand, <5% silt, with fine, subangular gravel <0.5-in.			
20.0	6.0			Sand, moist, strong brown (7.5YR 5/6). Fine to medium sand with rare (<3%) gravel.	3		
			SW	Gravelly sand, moist, strong brown (7.5YR 5/6). Well graded sand with fine, subangular gravel generally <0.5-inch, max. to 1-inch.			
	7.0		SP	Poorly graded sand with gravel, to 1-in., dry, dark yellowish brown (10YR 4/6). A cobble to 5-in. at 23.5 ft.			
25.0				Sand with gravel, moist, dark yellowish brown (10YR 4/4). Sand is poorly graded, <5% silt, gravel <0.5-in.	3		
	8.0			Sand with gravel, moist, yellowish brown (10YR 5/6). Poorly graded sand with fine, angular to subangular gravel, <5% silt.			
				Sand with gravel, slightly moist, pinkish gray (7.5YR 6/2). Medium to coarse sand with gravel.			
30.0	9.0		SW	Sand with gravel, moist, becoming slightly moist to dry after 32.5 ft, yellowish brown (10YR 5/6). Fine to medium sand with (<10%) fine gravel to 0.5-in, <5% silt. More consolidated 31.5 to 32 ft.	3		
	10.0			Gravelly sand, moist, yellowish brown (10YR 5/6). Gravel <1-in.			
35.0					3		
	11.0		SM	Sand, fine to medium grained with silt, and some fine gravel, <0.25-in. Moist, brownish yellow (10YR 6/6).			
			SW	Gravelly sand, moist, brownish yellow (10YR 6/6). Well graded sand, with fine, subangular gravel.			
			GW	Sandy gravel, slightly moist, light yellowish brown (10YR 6/4). Coarse gravel (0.5 to 3-in) with medium to coarse sand matrix.			
	12.0				4		

SOIL BORING LOG	BORING NUMBER: B4
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/15/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/15/98
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521466.70
TOTAL DEPTH DRILLED (feet):70.00	NORTHING: 4182054.70
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
			SW	Well graded sand, moist, light yellowish brown (10YR 6/4).			
			SP	Fine to medium sand with fine, subrounded gravel, <5%. Moist, light yellowish brown (10YR 6/4).			
	13.0		SW	Fine to medium sand, moist, yellowish brown (10YR 5/8).			
45.0				Fine to medium sand, slightly moist, yellowish brown (10YR 5/6). More consolidated, some white calcite binding some grains. Breaks into blocks.	3		
	14.0		GW	Sandy gravel, sightly moist, yellowish brown (10YR 5/6). Sand is medium to coarse grained. Gravel is subrounded to subangular to 1.5-in.			
			SW	Fine to medium sand with <10% fine gravel to 0.5-in., <5% silt. Moist, yellowish brown (10YR 5/6). Decrease in gravel (<5%) towards 50.8 ft. One gravel to 2-in at 48.5 ft.			
	15.0						
50.0					3		
			SP	Fine to medium sand with fine gravel, moist, brown (10YR 4/3). Gravel is rounded, 0.25 to 1-in. 4-in. cobble at 51.5 ft.			
	16.0			Fine to medium sand, moist brown (10YR 4/3). Decrease in gravel to 5%.			
			SW	Gravelly sand, moist, brown (10YR 4/3). Fine to medium sand with gravel, <15%. Sand becoming more coarse after 54 ft.			
55.0			SP				
	17.0			Sand, moist, yellowish brown (10YR 5/6). Fine to medium clean sand, with <5%, fine, subrounded gravel, <0.5-in..			
				Gravelly sand, moist, yellowish brown (10YR 5/6). Fine to medium, clean sand with gravel 0.5 to 1.5-in.			
	18.0		SW	Gravelly sand, moist, yellowish brown (10YR 5/6). Well graded sand, (more coarse than above), gravel subangular, silt to <5%.	3		TTR01121
60.0				Well graded sand with some fine gravel, moist, yellowish brown (10YR 5/6).			TTR01120
			SP	Fine to medium sand with <15% gravel, moist, yellowish brown (10YR 5/4). Angular gravel <0.5-in. After 62-ft size of gravel increases to 0.5 to 1.0-in.			
	19.0		SC	Clayey-sand, slightly moist, brownish yellow (10YR 6/6).			
65.0			SW	Well graded sand with fine gravel, slightly moist, brownish yellow (10YR 6/6). Angular gravel to 0.5-in.			
	20.0		GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Gravel is subangular, 0.5 to 1-in. Subangular cobbles to 3-in from 69 to 70 ft.			
	21.0				3		TTR01122

SOIL BORING LOG	BORING NUMBER: B5
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/19/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/19/98
HOLE SURFACE ELEVATION (feet): 5503.00	EASTING: 521478.00
TOTAL DEPTH DRILLED (feet):70.00	NORTHING: 4182049.90
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		SW	Gravelly sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand, with <10% fine gravel. Gravel to 2.5-in., subangular. Distrubed with airknife to 3.5 ft.			
				Sandy gravel, dry, light yellowish brown (10YR 6/4). Subangular gravel to 1.5-in. Fine sand with <5% silt.			
	1.0		GW				
			SW	Gravelly sand, moist, yellowish brown (10YR 5/4). Fine to medium sand, <5% silt. Gravel, subangular, 0.25 to 1-in..	3		
5.0				Gravelly sand, moist, yellowish brown (10YR 5/4). Well graded sand with subrounded gravel 0.25 to 1-in..			
	2.0		GW	Sandy gravel, moist, yellowish brown (10YR 5/4). Sand is fine to medium grained, with predominately fine gravel from 0.5 to 1.5-in..			
			SW	Sandy gravel, moist, yellowish brown (10YR 5/4). Medium to coarse sand, with fine, subrounded gravel from 0.25 to 1.5-in.	4		
10.0	3.0			Well graded sand with gravel, <5% silt, moist, yellowish brown to brownish yellow (10YR 5/6 to 10YR 6/6). Subangular gravel generally 0.5 to 1.0-in. From 9 to 10-ft, rare gravel to 2.5-in. Thin silty lenses (10-15% silt) from 10 to 11-ft.			
	4.0			Gravelly sand, moist, yellowish brown (10YR 5/6). Well graded sand with fine gravel. Gravel generally 0.25 to 1.0-in., rare to 2.5-in. Thin silty lenses (10-15% silt) at approx. 14 ft.			
15.0				Gravelly sand, moist, strong brown (7.5YR 5/6). Well graded sand with fine gravel. Gravel, subrounded to subangular, 0.5 to 1.5-in.	3		
	5.0		GM	Gravelly sand with silt, moist, strong brown (7.5YR 5/6). Well graded sand with fine gravel, and 10 to 15% silt. Gravel subrounded to subangular, from 0.5 to 1.5-in.. Two subangular rocks to 2.5-in.			
			GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Well graded sand with fine gravel to 1.0-in.			
			SW	Gravelly sand, moist, yellowish brown (10YR 5/4). Well graded sand with some fine gravel, subrounded, 0.25 to 1-in.			
20.0	6.0		GW	Sandy gravel, slightly moist, yellowish brown (10YR 5/6). Well graded gravel, subrounded, to 3-in. Medium to coarse sand with <5% silt. Hard drilling at 20-ft.	3		
			SM	Silty sand, increase in silt to 15%, moist, yellowish brown (10YR 5/4).			
			SW	Well graded sand with some fine gravel, moist, yellowish brown (10YR 5/4).			
	7.0		SM	Silty sand, moist, yellowish brown (10YR 5/4). Sand fine to medium with subrounded gravel, 0.5 to 1-in, <15% silt.			
			SW	Gravelly sand, moist, yellowish brown (10YR 5/6). Well graded sand with gravel to 2-in.	3		
25.0							
	8.0			Well graded sand, moist, yellowish brown (10YR 5/6), <5% silt, and rare gravel to 2-in.			
				Gravelly sand, moist, yellowish brown (10YR 5/6). Medium to coarse sand with subangular gravel <1-in.			
	9.0			Sandy gravel, moist, yellowish brown (10YR 5/6). Medium to coarse sand, <5% silt, with subangular gravel, <0.5-in. Three angular cobbles to 3-in.	3		
30.0			GW	Sand, moist, yellowish brown (10YR 5/6). Fine to medium sand, <5% silt, and rare, fine gravel to 0.5-in.			
			SP	Silty sand, moist, yellowish brown (10YR 5/4). Fine sand with some coarser sand, 10-15% silt and occasional gravel to 0.75 in.			
			SM				
	10.0		SW	Fine to medium sand with gravel, slightly moist to dry, yellowish brown (10YR 5/4).			
				Well graded sand with fine gravel, dry, light gray (10YR 7/2). More consolidated, breaks into 1 to 3-in block fragments.	3		
35.0				Well graded sand with fine gravel to 0.5-in, moist, light yellowish brown (10YR 6/4).			
	11.0		SP	Sand, moist, brownish yellow (10YR 6/8). Fine to medium sand, <5% silt.			
			SW				
			GM	Well graded sand with gravel, slightly moist to dry, yellowish brown (10YR 6/8). More consolidated, breaks into blocky fragments. Calcite cement?			
	12.0			Silty-sandy gravel, slightly moist, yellowish brown (10YR 5/8). Silty sand with gravel, <10% silt. Not loose, breaks into blocky fragments, calcite cement?	3		

SOIL BORING LOG	BORING NUMBER: B5
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/19/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/19/98
HOLE SURFACE ELEVATION (feet): 5503.00	EASTING: 521478.00
TOTAL DEPTH DRILLED (feet):70.00	NORTHING: 4182049.90
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
			GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Medium to coarse sand with fine, subangular gravel to 1-in.			
	13.0		SM	Silty sand, slightly moist, brownish yellow (10YR 6/6). Fine to medium to sand, 5% silt.			
			SW				
			SP	Medium sand with fine gravel.			
45.0					3		
			GW	Fine to medium sand, <5% silt, rare gravel <0.5-in., moist.			TTR01124
	14.0			Sandy gravel, slightly moist. Well graded sand with fine, subangular gravel.			
			SP	Sand, moist, brown (10YR 5/3). Fine to medium sand, <5% silt, rare subrounded gravel to 1.5-in.			
	15.0			Fine to medium sand, moist, brownish yellow (10YR 5/3). Sand with 5-10% silt, and gravel to 1-in.			
50.0					3		
			SW	Sand, moist, yellowish brown (10YR 5/6). Fine to medium sand, with rare, subrounded gravel to 0.5 to 1-in, <5% silt. After 52.5 ft, fine gravel, 0.25 to 0.75-in., becoming more common, some to 1.5-in.			
	16.0			Gravelly sand. Well graded sand with common subangular gravel to 1.5-in, <5% silt.			
			SP	Sand, moist, yellowish brown (10YR 5/4). Fine to medium sand, <5% silt, rare, fine gravel to 0.5-in.			
55.0							
	17.0						
			SW	Gravelly sand, moist, brownish yellow (10YR 6/6). Well graded sand with common, subrounded gravel from 0.5 to 1-in.			
	18.0		GW	Sandy gravel, moist, pale brown (10YR 6/3). Gravel 1 to 3 inches; at 59 ft, two cobbles to 5.0 and 5.5-in., in well graded sand matrix, <5% silt.	3		TTR01125
60.0			SW				
				Sand, moist, brown (10YR 5/3). Medium sand with rare subrounded gravel, coarsening to coarse sand to fine gravel.			
	19.0						
				Gravelly sand, moist, brownish yellow (10YR 6/8). Fine to medium sand with fine gravel. Gravel is common, 0.5 to 1.5-in, <5% silt.			
65.0					3		
			SP				
	20.0		SW	Sand, moist, brownish yellow (10YR 6/6). Fine to medium sand with rare, subangular gravel, to 1-in.			
				Gravelly sand, moist, brownish yellow (10YR 6/6). Towards 69-ft. fine to medium sand becoming coarser, and subangular gravel becoming more common, <1-in.			
	21.0						
			GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Fine gravel from 0.25 to 3-in., in a fine to medium sand.			
					3		TTR01126

SOIL BORING LOG	BORING NUMBER: B6	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-10 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/19/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/21/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521469.00	
TOTAL DEPTH DRILLED (feet):90.00	NORTHING: 4182049.20	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird	
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.	
ELEVATION DATUM: Mean Sea Level		

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		SW	Gravelly sand, moist, yellowish brown (10YR 5/6). Fine sand and fine gravel, subangular, <5% silt. Some cobbles to 3-in.			
	1.0			Gravelly sand, dry, very pale brown (10YR 7/4). Well graded sand with subrounded gravel to 1.5-in.			
5.0			GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Well graded sand. Gravel is subrounded, from 0.25 to 1.5-in. At 6-ft a subrounded cobble to 5-in.	3	NA	
	2.0			Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand. Gravel is subrounded, from 0.25 to 1.5-in.			
			SW				
			GM	Sandy gravel with silt, moist, brownish yellow (10YR 6/6). Fine grained sand with 5 to 10% silt. Gravel is subrounded to subangular, 0.5 to 1.5-in. At 9 ft, cobble to 4-in.	2	NA	
10.0	3.0			Sandy gravel with silt, moist, light yellowish brown (10YR 6/4). Fine sand with 5-10% silt. Gravel is subrounded to subangular, 0.5 to 1.5-in.			
	4.0			Gravelly sand with silt, moist, brownish yellow (10YR 6/6). Fine sand with silt (5 to 10%) and fine, angular gravel <1-in. At 12.5 ft, a cobble to 5-in.			
			GW				
15.0			SW	Sandy gravel with silt, moist, brownish yellow (10YR 6/6). Gravel with coarse sand with silt (<10%). Gravel mostly to 0.5-in, but up to 3-in.	7	NA	
	5.0			Sandy gravel, moist, yellowish brown (10YR 5/6). Well graded gravel to 1-in, and well graded sand.			
				Well graded sand, moist, dark yellowish brown (10YR 4/4 estimated). Well graded sand with some gravel <1.0-in. Notice hydrocarbon odor at 15-ft. At 16-ft, cobble to 3-in. At 18-ft, two cobbles to 5-in.			
	6.0				336	1000	TTR01131
20.0			GW	Sandy gravel, slightly moist, brown (10YR 5/3). Well graded sand. Gravel, subrounded <0.75-in. At 20.5-ft some gravel to 2.5-in. Increase in gravel towards 22.5 ft.			
	7.0		SW	Well graded sand, moist, brown (10YR 5/3).			
				Well graded sand with fine gravel, moist, dark grayish brown to grayish brown (10YR 4/2 to 10YR 5/3). Gravel subrounded <1-in. Appears to have hydrocarbon staining at 23-ft.	526	500	
25.0							
	8.0		SM	Silty sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with <10% silt. Some fine gravel <0.5-in.			
			SW	Well graded sand, moist, yellowish brown (10YR 5/6). Rare fine gravel <1-in. <5% silt. At 28.3-ft, gravel to 2-in.			
				Well graded sand, moist, yellowish brown (10YR 5/4).			TTR01132
	9.0				499	1000	
30.0				Gravelly sand, moist, yellowish brown (10YR 5/4). Well graded sand. Gravel, subrounded, to 1-in. Notice clear "oil" on sampling gloves.			
			SP	Sand, moist, pale brown (10YR 6/3). Fine to medium sand, some coarse sand. Very rare gravel. More moist than 30 to 31-ft.			
	10.0		SW	Gravelly sand, moist, pale brown (10YR 6/3). Fine to medium sand, coarse sand is more common. Rare, fine, gravel to 0.75-in, subrounded.			
35.0			GW	Sandy gravel, moist, pale brown (10YR 6/3). Medium to coarse sand. Fine, subrounded gravel, <0.5-in. At 36.5-ft, 1-in dry layer. Sampling gloves still have slight clear "oil" sheen on them.	437	500	
	11.0		SW	Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand. Gravel generally <1-in, rare to 2-in. At 37.5 ft, 4-in cobble. At 38 ft 4.5-in cobble.			
			GW	Sandy gravel, moist, light brownish gray (10YR 6/2). Well graded sand, fine gravel to 2.5-in.			
	12.0		SW	Sand, moist, pale brown (10YR 6/3). Fine to medium sand with, 5% silt. Rare gravel to 1-in. More cohesive, breaks into blocky fragments.	450	500	

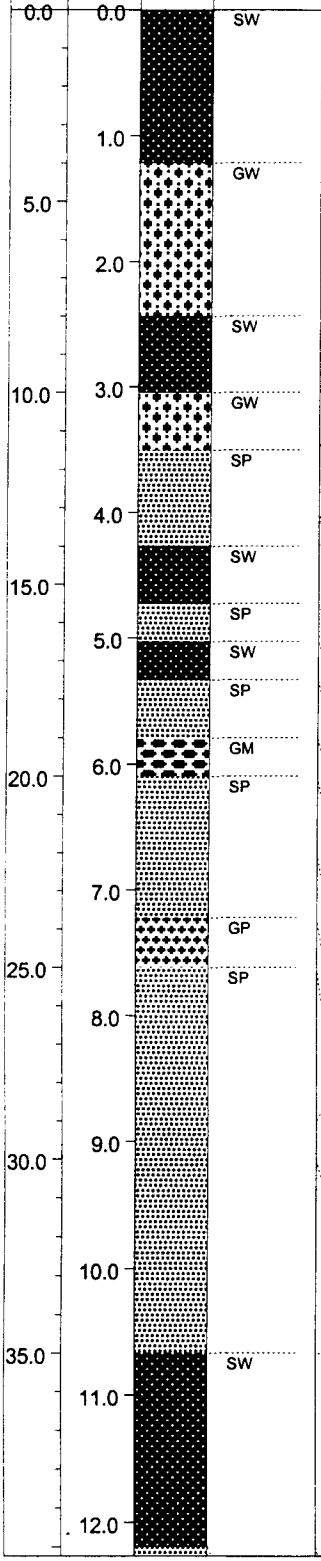
SOIL BORING LOG	BORING NUMBER: B6	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-11 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/19/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/21/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521469.00	
TOTAL DEPTH DRILLED (feet):90.00	NORTHING: 4182049.20	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
				Gravelly sand, moist, pale brown (10YR 6/3). Well graded sand with fine gravel. Some coarser gravel from 1.5 to 2.5-in.			
			SP				
	13.0		SW	Sand, moist, brownish yellow with gray motteling (10YR 6/6). Primarily fine sand, <5% silt, with some medium sand and rare coarse sand. Some fine gravel to 0.25-in.			
				Gravelly sand, moist, light yellowish brown with grayish-brown motteling (10YR 6/4).			
45.0				Well graded sand, <5% silt, moist, yellowish brown with grayish brown motteling (10YR 6/4).	383	1000	TTR01133
	14.0			Gravelly sand, moist, yellowish brown with grayish-brown motteling (10YR 6/4). Fine to medium sand with fine gravel to 0.5-in.			TTR01128
				Gravelly sand, moist, yellowish brown with grayish-brown motteling (10YR 6/4). Fine to medium sand with fine gravel to 1.0-in, <5% silt.			
			SP				
	15.0			Sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand some gravel to 1-in. At 49-ft, three rocks from 2.5 to 3.5 in.			
50.0					378	1000	
				Fine to medium sand, moist, brown (10YR 5/3). Rare gravel to 0.5-in.			
			SW	Gravelly sand, moist, grayish brown (10YR 5/2). Well graded sand, gravel is mostly <1-in, rare to 2-in, subangular .			
	16.0			Gravelly sand, moist, yellowish brown (10YR 5/6). Medium sand with gravel. Some gravel to 2.5-in.			
			SP				
			SW	Sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand with rare, fine gravel <0.5-in, <5% silt.			
55.0							
	17.0			Sand, moist, yellowish brown to brown (10YR 5/4 to 10YR 5/3). Fine to medium sand with fine gravel frm 0.5 to 1-in. Rare gravel to 2-in.			
			GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Well graded sand, and well graded gravel to 2-in. 4-in cobble at 59.5-ft.			
			SP				
	18.0						
60.0				Sand, moist, brown (10YR 5/3). Fine to medium sand. Gravel, rare to some, 0.25 to 0.75-in. <5% silt.	376	1000	TTR01134
			SW				TTR01129
				Gravelly sand, moist, dark brown (10YR 3/3). Well graded sand with fine gravel <0.5-in, <5% silt.			
	19.0						
			SP	Medium to coarse sand, dry to slightly moist, pale brown (10YR 6/3). More consolidted.			
				Fine sand with fine gravel, slightly moist, brownish yellow (10YR 6/6).			
65.0							
	20.0		SW	Sand, slightly moist, brownish yellow (10YR 6/6). Fine to medium sand with common fine gravel.			
			GW	Sandy gravel, moist, pale brown (10YR 6/3). Predominately fine gravel with gravel to 1.5 in. common. Some coarser gravel to 3-in.			
	21.0						
70.0				Sandy gravel, dry to slightly moist, light yellowish brown to brownish yellow (10YR 6/4 to 6/6). Sand is well graded. Gravel is up to 1.5-in, predominately fine grained (<0.5-in), becoming coarser towards 73-ft. 68.7 to 70 more cemented, holds together in 1-in blocks.	4	10	
	22.0						
			SP	Gravelly sand, dry to slightly moist, light gray to dark yellowish brown (10YR 7/2 to 10YR 4/4). Fine to medium sand with gravel to 1.5-in.			
75.0				Sandy gravel, slightly moist, olive yellow (2.5Y 6/6). Well graded sand, gravel angular to subangular to 1.5. A 6-in cobble at 75 ft.			
	23.0		GW				
			SP	Sand, slightly moist, light yellowish brown (10YR 6/4). Fine to medium sand, with some coarse sand. Rare fine gravel to 0.5-in, <5% silt.			
			SW	Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand with fine, subangular to subrounded gravel. Cobble to 3.5-in at 78 ft.			
	24.0		SP				
				Sand, moist, yellowish brown (10YR 5/4). Fine to medium sand with rare coarse sand, and some gravel to 2-in, <5% silt.	2	NA	TTR01135
80.0			SW				
				Well graded sand, moist, pale brown (10YR 6/3).			
	25.0		SP	Fine sand, moist, light brownish gray (10YR 6/2).			

SOIL BORING LOG	BORING NUMBER: B6	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-12 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/19/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/21/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521469.00	
TOTAL DEPTH DRILLED (feet):90.00	NORTHING: 4182049.20	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
85.0	26.0		SW	Sand, slightly moist, brown (10YR 5/3). Fine to medium sand with some fine gravel (<0.5-in). Two cobbles to 3-in.			
			SP	Sand, slightly moist, yellowish brown (10YR 5/4). Poorly graded sand.			
	27.0			Gravelly sand, slightly moist, light yellowish brown (10YR 6/4). Poorly graded sand with some gravel to 2.0-in.	2	NA	TTR01137

SOIL BORING LOG	BORING NUMBER: B7
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/21/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/22/98
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521471.90
TOTAL DEPTH DRILLED (feet):80.00	NORTHING: 4182052.80
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.
ELEVATION DATUM: Mean Sea Level	



Depth Feet	Depth Meters	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0	SW	Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand with 5-10% silt, gravel from 0.5 to 2.5-in. A cobble to 4.5-in at 3 ft.			
	1.0	GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Well graded sand and well graded gravel to 2-in.			
5.0				12	NA	
	2.0		Sandy gravel, slightly moist to dry, light yellowish brown (10YR 6/4). Well graded sand and subrounded gravel to 3-in.. At 6-ft a cobble to 4-in.			
		SW	Gravelly sand, moist, brownish yellow (10YR 6/6). Well graded sand with fine gravel to 1-in.			
10.0	3.0	GW	Sandy gravel, moist, brownish yellow (10YR 6/6). Well graded sand and gravel to 1-in.	12	NA	
		SP	Gravelly sand, moist, brownish yellow (10YR 6/6). Poorly graded sand with gravel 0.5 to 1-in., subrounded.			
	4.0		Fine sand, moist, brownish yellow (10YR 6/6). Poorly graded, fine sand with rare, subangular gravel to 0.5-in.			
		SW	Gravelly sand, moist, yellowish brown (10YR 5/4). Medium and coarse sand, with common, fine gravel from 0.5 to 0.75-in..			
15.0		SP	Gravelly sand, moist, yellowish brown (10YR 5/4). Well graded sand with fine, angular gravel from 0.25 to 1-in, some to 2.5-in.	12	NA	
	5.0	SW	Sand, moist, yellowish brown (10YR 5/6). Fine grained sand with some gravel to 0.5-in.			
		SP	Gravelly sand, moist, yellowish brown (10YR 5/6). Well graded sand with fine, angular gravel to 0.75-in.			
		GM	Sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with some coarse sand. Rare gravel, subrounded, 1 to 1.5-in.			
20.0	6.0	SP	Sandy gravel, moist, yellowish brown (10YR 5/6). Fine sand with 10-15% silt, and gravel, subrounded, 0.5 to 1-in.	11	NA	
			Sand, moist, yellowish brown (10YR 5/6). Well sorted medium sand, some coarse sand, with uncommon fine gravel to 0.75-in., <5% silt.			
	7.0	GP	Sand, moist, brownish yellow (10YR 6/6). Fine to medium sand, <5% silt, rare gravel to 1.5-in.			
25.0		SP		13	NA	
	8.0		Fine sandy gravel, slightly moist, light yellowish brown (10YR 6/4).			
			Sand, moist, brownish yellow (10YR 6/6). Fine to medium sand, <5% silt, rare subrounded gravel, <1-in.			
30.0	9.0		Sand, moist, pale brown to light yellowish brown (10YR 6/3 to 6/4). Fine to medium sand. Rare fine, subangular gravel, <0.5-in. Fine gravel more abundant towards 30-ft. More consolidated towards 30-ft.	13	NA	TTR01141
			Sand, moist, brownish yellow (10YR 6/6). Fine to medium sand, <5% silt, some fine, subrounded gravel <1-in.			
	10.0					
35.0		SW		15	NA	
	11.0		Sand, moist, brownish yellow (10YR 6/6). Well graded sand with some fine, subrounded gravel, <1-in, <5% silt. Slight decrease in gravel towards 40 ft.			
	12.0			8	NA	

SOIL BORING LOG	BORING NUMBER: B7	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-14 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/21/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/22/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521471.90	
TOTAL DEPTH DRILLED (feet):80.00	NORTHING: 4182052.80	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
			SP	Sand, moist, brownish yellow (10YR 6/6). Fine to medium sand with some gravel, subrounded, 0.5 to 1.5-in. Becoming more coarse sand towards 42.5 ft.			
	13.0			Sand, moist, light yellowish brown (10YR 6/4). Fine to medium grained sand, with rare gravel to 0.5-in, <5% silt			
45.0			SW	Gravelly sand, moist, yellowish brown (10YR 5/5). Medium to coarse grained sand with fine gravel to 0.3-in.	9		TTR01142
	14.0			Sand, moist, brown (10YR 5/3). Fine sand, with some, rounded gravel from 0.5 to 1.0-in.			
				Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand with fine gravel to 0.75-in., subrounded to rounded, <5% silt.			
				Silty sand with gravel, moist, brownish yellow (10YR 6/6). Sand with <15% silt, and gravel, subrounded to rounded, <1.5-in.			
	15.0		GM				
50.0			SM	Silty sand with gravel, moist light yellowish brown (10YR 6/4). Well graded sand with some gravel. Gravel is subrounded to rounded 0.5 to 2-in. Decrease in silt towards 52-ft. A subrounded cobble to 5-in at 50.5 ft.	8		
			SW	Sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand with some gravel, subrounded to rounded, 0.5 to 1.5-in.			
	16.0			Well graded sand with gravel, moist, light yellowish brown (10YR 6/4). Gravel is subrounded to 0.5-in, <5% silt. A 3-in. cobble at 56-ft.			
55.0				Fine sand, moist, pale brown (10YR 6/3). Well sorted, fine sand with rare, subrounded gravel to 0.75-in.			
	17.0			Well graded sand with gravel, moist, light yellowish brown (10YR 6/4). Fine, subangular gravel from 0.5 to 0.74-in.			
			SP				
			SW				
			GW	Sandy gravel, moist, light yellowish brown (10YR 6/4). Fine sand, <5% silt, and gravel to 2-in.			
	18.0		SP	Sandy gravel, moist, yellowish brown (10YR 5/4). Fine to medium sand with rounded gravel, <1-in.			
60.0			SW	Sand, moist, brown (10YR 5/3). Well sorted fine to medium sand.	7		
			COBBLE	Well graded sand with fine gravel, moist, brown (10YR 5/3). Common subrounded gravel to 0.5-in, <5% silt.			
			SP	Hard layer, rock?, well cemented. Dry, powdery, very pale brown (10YR 8/2). Some rounded fragments 0.5 to 2.0-in..			
	19.0		SM				
			SW	Gravelly sand, slightly moist, light yellowish brown (10YR 6/4). Well sorted sand with gravel, <1-in.			
				Silty sand, moist, brownish yellow (10YR 6/6). Rare, subrounded gravel, <0.5-in.			
65.0			GW				
	20.0			Gravelly sand, slightly moist, brownish yellow (10YR 6/6). Fine to medium sand with gravel from 0.5 to 1.0-in, subrounded, <5% silt.			
			SW	Sandy gravel, moist, pale brown (10YR 6/3). Well graded sand, with subangular gravel to 1.5-in.			
				Well graded sand with gravel, dry, powdery, to slightly moist, light brownish gray to pale brown (10YR 7/2 to 7/3). Medium to coarse sand with fine, angular gravel. Hard layer, up to 5-in cobbles of cemented medium to coarse sand.			
	21.0						TTR01143
70.0			GW	Well graded sand with gravel, moist, light yellowish brown (10YR 6/4). Subrounded gravel to 1-in.	8		
	22.0			Sandy gravel, moist, pale brown (10YR 6/3). Well graded sand. Well graded gravel generally 0.25 to 2-in., some to 3-in, subangular to subrounded, <5% silt.			
				Well graded sand, moist, pale brown (10YR 6/3). Rare subrounded gravel, to 0.5-in, <5% silt.			
75.0			SW				
	23.0			Sandy gravel, moist, pale brown (10YR 6/3). Well graded sand with gravel, subangular, to 1-in.			
			GW				
				Gravelly sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand, with gravel to 0.5-in, subrounded.			
			SW				
	24.0			Gravelly sand, moist, pale brown (10YR 6/3). Medium to coarse sand with gravel, 0.5 to 1-in, subangular to subrounded.	11		TTR01144

SOIL BORING LOG	BORING NUMBER: B8
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/22/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/22/98
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521466.00
TOTAL DEPTH DRILLED (feet):80.00	NORTHING: 4182049.00
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		SP	Prior to drilling, the first 3-ft were removed with airknife to investigate for buried utility lines.			
	1.0		GW	Sand, moist, brownish yellow, (10YR 6/6). Fine sand with uncommon gravel 0.25 to 1-in., subrounded, <5% silt. This interval disturbed by airkife.			
5.0					59	10	
	2.0			Sandy gravel, moist, light yellowish brown (10YR 6/4). Medium to coarse sand. Well graded, subangular gravel to 1.5-in., some gravel to 3-in. <5% silt.			
				Sandy gravel, moist, pale brown (10YR 6/3). Increase in medium to coarse sand from previous interval. Gravel well graded to 1.5 in, some to 3.5-in, subangular.			
10.0	3.0				3		
			GM	Sandy gravel, moist, brownish yellow (10YR 6/6). Sand is fine to medium grained, some coarse sand. Gravel is well graded 0.25 to 1-in, subrounded, max to 2.5-in.			
				Silty gravel, moist, yellowish brown (10YR 5/6). Silty fine sand with gravel. Gravel 0.5 to 2-in.			
	4.0		GW	Sandy gravel, moist, light yellowish brown to brownish yellow (10YR 6/4 to 6/5). Fine to medium sand,			
			SW	Gravelly sand, moist, light yellowish brown (10YR 6/4).			
15.0					4		
	5.0			Gravelly sand, moist, brownish yellow (10YR 6/6). Well graded sand, subrounded to subangular, <1-in, <5% silt. Cobble to 4.5 in at 16 ft.			
				Gravelly sand, moist, yellowish brown (10YR 5/6). Fine sand, <5% silt. Gravel 0.5 to 1.5-in, rare to 2.5-in.			
			SP	Sand, moist, brownish yellow (10YR 6/6). Medium sand, some coarse sand. Some fine gravel <0.5-in, subrounded. More cemented towards 20 ft.			
	6.0				4		
20.0			GW	Sandy gravel, moist, yellowish brown (10YR 5/8). Gravel 1 to 1.5-in, subangular. Sand fine to medium, <5% silt. At 21-ft, subrounded cobble to 4.75-in.			
				Sandy gravel, moist yellowish brown (10YR 5/4 to 5/5). Well graded gravel to 1.5-in, subangular. Well graded sand.			
	7.0		SW	Gravelly sand, moist, yellowish brown (10YR 5/4). Well graded sand, <5% silt. Gravel 0.5 to 1-in, subrounded. Some more silty zones, up to 10%.			
25.0				Well graded sand, moist, light yellowish brown (10YR 6/4). Some rounded gravel to 1-in.	4		
	8.0		SM	Sand, moist, brownish yellow (10YR 6/6). Fine sand, some medium sand, <10% silt. Rare 1-in gravel. Increase is silt towards 28 ft.			
			SW	Gravelly sand, slightly moist to dry, pale brown (10YR 6/3). Well graded sand. Common, subangular, gravel to 1.5-in.			
	9.0			Sand, moist, pale brown (10YR 6/3). Well graded sand, <5% silt. Rare subangular gravel <0.5-in.	147	500	
30.0			GP	Gravel, moist, light yellowish brown (10YR 6/4). Gravel is well sorted, 0.5-in diameter, (pea gravel), with medium sand.			
	10.0		SW	Sand, moist, light yellowish brown (10YR 6/4). Well graded sand with rare gravel 0.5 to 1.0-in, subangular to subrounded. Gravel more common towards 35 ft.			
					206	500	TTR01147
35.0				Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand. Well graded gravel to 1.5-in, subangular. <5% silt.			
	11.0			Sandy gravel, slightly moist, pale brown (10YR 6/3). Well graded sand, well graded gravel to 1.5-in, subangular. More consolidated after 39 ft.			
	12.0				327	500	

SOIL BORING LOG	BORING NUMBER: B8	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-16 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/22/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/22/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521466.00	
TOTAL DEPTH DRILLED (feet):80.00	NORTHING: 4182049.00	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
			SP	Sand, slightly moist, pale brown (10YR 6/3). Medium to coarse sand. Uncommon gravel, subangular, <.75-in.			
	13.0		SW	Sand, slightly moist, light yellowish brown (10YR 6/4). Well graded sand, some gravel <1-in, subrounded.			
			SM SW	Silty sand, moist, brownish yellow (10YR 6/6). Fine sand, <15% silt, rare gravel, <0.5-in.			
45.0			SP	Sand, slightly moist, light yellowish brown (10YR 6/4). Fine to medium sand. Rare subangular gravel <0.5-in. More consolidated, blocky.	6		TTR01148
	14.0		SW	Gravelly sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand, <5% silt. Gravel 0.25 to 1-in.			
				Gravelly sand, moist, light yellowish brown (10YR 6/4) . Medium to coarse sand. Subrounded gravel, 0.25 to 1.5-in. Increase in gravel towards 47.5 ft. to a sandy gravel.			
	15.0		SP	Gravelly sand, slightly moist, pale brown (10YR 6/3). Medium to coarse sand. Gravel is subrounded to angular, 0.5 to 1.5-in. Angular cobble to 4-in.	15	50	
50.0			GM	Gravelly sand, moist, light yellowish brown (10YR 6/4). Fine sand with some coarse sand, <5% silt.			
			SP	Silty fine sand with gravel, moist, brownish yellow (10YR 6/6). Gravel is rare to 0.5-in. Fine sand with <10% silt.			
	16.0		SM	Sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand with some gravel 0.5 to 1-in,			
			SW	Silty sand, moist, brownish yellow (10YR 6/6). Fine sand, <15% silt. Rare gravel to 1.5-in.			
55.0				Sand with gravel, moist, yellowish brown (10YR 5/6). Fine to medium sand with some subrounded gravel, 0.25 to 1.5-in. Starting at 55-ft to 60 ft, harder drilling, notice sweet/chemical odor. Odor stronger than in upper portion of boring.			
	17.0			Sand, slightly moist gray (10YR 5/1). Fine sand with some medium to coarse sand. Rare gravel to 0.5-in.			
				Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand with some rounded gravel to 0.75-in.			
	18.0		SP	Sand, slightly moist, pale brown (10YR 6/3). Medium sand with some coarse sand, <5% silt. Uncommon, subrounded gravel, to 0.6-in.	531	1000	TTR01149
60.0				Sand, moist, brownish yellow (10YR 6/6). Fine to medium sand, <5% silt. Rare gravel to 1-in.			
				Sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand with some gravel, subrounded to 0.5-in, rare to 1.5-in.			
	19.0		SW	Gravelly sand, moist, yellowish brown (10YR 5/4). Medium to coarse sand. 0.25 to 1-in subrounded			
			SM	Silty sand, moist, brownish yellow (10YR 6/6). Fine to medium sand with silt (<15%). Rare gravel to 0.5-in.	5		
65.0							
	20.0		SW	Silty sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with silt (<10%). Some coarse sand and subrounded gravel to 0.5-in.			TTR01146
			GW	Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand and well graded, subrounded gravel to 0.75-in.			
	21.0			Sandy gravel, moist, light yellowish brown (10YR 6/4). Well graded sand. Well graded, subangular to			
70.0			SW	Sandy gravel, moist, yellowish brown (10YR 5/4). Well graded, subangular, gravel to 3.5-in. Well graded sand, <5% silt.	5		TTR01150
				Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand. Very fine, subrounded, gravel.			
	22.0			Gravelly sand, moist, yellow (10YR 7/6). Medium sand. Gravel, subrounded, 0.25 to 1-in. Some gravel 1.5 to 3-in, subangular.			
75.0			GW	Sandy gravel, slightly moist, very pale brown (10YR 7/3). Well graded sand. Gravel well graded to 1-in., some to 1.5, rounded.			
	23.0			Sandy gravel, moist, pale brown (10YR 6/3). Well graded sand. Well graded gravel, subangular to subrounded, to 1-in. Rare gravel from 1.5 to 3-in. Cobble at 76 ft, 6-in diameter, 5-in long.			
	24.0				5		TTR01151

SOIL BORING LOG	BORING NUMBER: B9
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/23/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/23/98
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521462.90
TOTAL DEPTH DRILLED (feet):80.00	NORTHING: 4182049.60
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart. 6-in. diameter continuous core to total depth.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		SW	Gravelly sand, moist, light yellowish brown, (10YR 6/4). Fine to medium sand with <5% silt. Some subrounded gravel to 1-in, very rare to 2-in.			
	1.0			Sand, moist, brownish yellow (10YR 6/6), fine to medium sand, increase in silt towards 7.5 ft (<5%). Some gravel, subrounded to 1-in.	19		
5.0			GM				
	2.0			Sandy gravel, moist, light yellowish brown (10YR 6/4). Well graded gravel to 1.5-in., subangular, with well graded sand. A 4-in rounded cobble at 8-ft.			
			GW				
				Gravelly sand, moist, light yellowish brown (10YR 6/4). Well graded sand with subrounded gravel to 1.0-in, uncommon to 3-in.	5		
10.0	3.0		SW				
				Gravelly sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand, some coarse sand, with subangular gravel to 0.75-in.			
	4.0			Gravelly sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with subrounded gravel, 0.5 to 1.5-in.			
15.0			SM	Silty sand with gravel, moist, light yellowish brown (10YR 6/4). Medium sand with fine, subangular gravel, 0.25 to 0.5-in. Less silty towards 16.5 ft.	8		
	5.0		SP				
			SW	Sand, slightly moist, pale brown (10YR 6/3). Fine to medium sand with fine gravel, subrounded, <0.5-in.			
				Sand, moist, yellowish brown (10YR 5/6). Well graded sand with subrounded gravel 0.5 to 1-in. A 4.5-in. cobble at 19.5 ft.			
20.0	6.0		SM	Silty sand, moist, brownish yellow (10YR 6/6). Silty fine sand with some coarse sand and rare gravel <0.5-in. <15% silt.	7		
			SP				
				Gravelly sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with well graded, subangular gravel to 1.5-in.			
	7.0			Sand, slightly moist, yellowish brown (10YR 5/6). Fine to medium sand with rare, subrounded gravel <0.5-in. 22.5 to 25 ft becomes more cemented, drier, increase in silt to <5%.	6		
25.0			SW				
	8.0			Gravelly sand, moist, yellowish brown (10YR 5/6). Well graded sand, <5% silt. Fine, angular gravel from 0.3 to 1-in. At 26-ft and 27.5-ft, angular gravel to 3-in.			
				Gravelly sand, moist, yellowish brown (10YR 5/4). Well graded sand, no silt. Gravel subrounded, 0.5 to 1.5-in.			
	9.0			Silty fine to medium sand, moist, brownish yellow (10YR 6/6). Silt <10%. Some coarse sand, rare gravel to 0.5-in.	6		
30.0			SM				
				Well graded sand, moist, brownish yellow (10YR 6/6). Fine to medium sand with <5% silt, and some fine, rounded gravel to 5-in.			
			SW				
				Sand, moist, brown (10YR 5/3). Fine to medium sand with some, subrounded gravel to 0.75-in.			
	10.0		SP				
				Sandy gravel, moist, pale brown (10YR 6/3). Gravel is subrounded 0.5 to 0.75-in, with fine sand.			
35.0				Gravelly sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand with subrounded gravel, 0.25 to 1-in.	6		
	11.0			Gravelly sand, moist, brownish yellow (10YR 6/6). Fine to medium sand, subrounded gravel 0.25 to 0.75-in.			
				Sand, moist, yellowish brown (10YR 6/6). Fine sand, <5% silt, rare fine gravel, to 0.5-in.			
				Sand, slightly moist, brownish yellow (10YR 6/6). Fine to medium sand with subrounded gravel to 0.5-in. More cemented, breaks into blocks <2-in.			
	12.0				6		

SOIL BORING LOG	BORING NUMBER: B9	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-18 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/23/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/23/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521462.90	
TOTAL DEPTH DRILLED (feet):80.00	NORTHING: 4182049.60	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
			GW				
			SP	Sandy gravel, moist, light yellowish brown (10YR 6/4). Well graded gravel to 1.5-in. subangular to subrounded, and well graded sand.			
	13.0			Sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with some subrounded gravel 0.5 to 0.75-in. Sand becomes coarser towards 43.3 ft.			
				Sand, moist, pale brown (10YR 6/3). Fine to medium sand with some subangular gravel to 0.5-in.	4		
45.0			SW	Sand, moist, light yellowish brown (10YR 6/4). Well graded sand with some subrounded gravel to 0.5-in,			
	14.0			rare to 2.5-in.			
				Sand, moist, light yellowish brown (10YR 6/4). Well graded sand with <5% silt, and uncommon, subangular gravel to 0.5-in.			
	15.0		SP	Sand, moist, brownish yellow (10YR 6/6). Fine sand with <5% silt, and some coarse sand and subangular gravel to 0.75-in. Rare gravel to 2-in.	4		
50.0							
				Sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand with some coarse sand, <5% silt, and some subangular gravel from 0.25 to 0.5-in. 2 cobbles to 5-in at 53-ft.		
	16.0		SW	Gravelly sand, moist, brownish yellow (10YR 6/6). Well graded sand with subrounded gravel from 0.25 to 1.25-in.			
					4		
55.0			SP	Sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with rare gravel from 0.25 to 0.75-in.			
	17.0						
			SM	Silty sand, moist, reddish yellow (7.5YR 6/8). Fine sand with some medium sand, 5-10% silt. Uncommon subangular gravel to 0.5-in.			
			SP	Gravelly sand, moist, yellowish brown (10YR 5/4). Fine to medium sand, <5% silt, with common subrounded gravel to 0.5 in. Drusey quartz to 3.5-in.			
	18.0			Gravelly sand, moist, light yellowish brown (10YR 6/4). Fine to medium sand with subrounded gravel from	4		
60.0			SW	0.5 to 1-in, slight increase in silt.			
				Sand, moist, yellowish brown (10YR 5/6). Well graded sand, <5% silt, with uncommon, subangular gravel, 0.5 to 1-in. Decrease in gravel towards 62.5-ft.			
	19.0		SP	Gravelly sand, moist, yellowish brown (10YR 5/4). Fine to medium sand, <5% silt with subrounded gravel 0.3 to 1.5-in.			
				Sand, moist, yellowish brown (10YR 5/6). Fine to medium sand, <5% silt, with some subrounded gravel, 0.5 to 1-in.	3		
65.0			SW	Gravelly sand, moist, brown (10YR 5/3). Well graded sand, <5% silt, rare subrounded, gravel to 1.5-in.			
	20.0						
				Sandy gravel, moist, yellow (10YR 7/6). Subangular gravel, 0.5 to 1.5-in with well graded sand, <5% silt. A subrounded cobble to 3.5-in at 68-ft.			
			GW				
	21.0		SP	Sand, moist, yellowish brown (10YR 5/6). Fine to medium sand with some subrounded gravel 0.5 to 1-in.	4		TTR01153
70.0			SW	Sand, moist, brown (10YR 5/3). Well graded sand, <5% silt, with subrounded gravel <0.5-in. Rare gravel to 1.5-in.			
	22.0			Sand, moist, yellowish brown (10YR 5/4). Well graded sand, with some subrounded to subangular gravel to 0.75-in.			
				Silty sand, slightly moist, brownish yellow (10YR 6/6). Silty fine sand with white stringers of decomposing			
75.0			SM	Sand, moist, yellowish brown(10YR 5/6). Fine sand, <5% silt, with some subangular gravel to 0.25-in, rare			
	23.0		SP	subangular gravel to 1-in.			
				Sandy gravel, moist, brown (10YR 5/3). Well graded gravel with well graded sand. Gravel subangular to 2-in. Subangular cobbles to 5-in at 78-ft.			
			GW				
	24.0			Sandy gravel, moist, pale brown (10YR 6/3). Subrounded gravel to 1-in, with well graded sandy with <5% silt.	4		TTR01154

SOIL BORING LOG	BORING NUMBER: B1
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/12/98
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/13/98
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521471.10
TOTAL DEPTH DRILLED (feet):81.50	NORTHING: 4182049.30
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher
DRILLING METHOD: Sonic Drilling	QA CHECK: F. Baird
DRILLING CONTRACTOR: Boart Longyear	COMMENTS: Only values >0.0 are shown for the VOC and TPH field screening results. Soil color per Munsell Soil Color Chart 6-in. diameter continuous core to total depth.
ELEVATION DATUM: Mean Sea Level	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
0.0	0.0		OPEN	Bottom of the UDP is estimated to be at 20 ft below ground surface (bgs) and was open to surface. Drilling was conducted through a 10-in. surface casing set at 22.5 ft bgs. Casing was secured inside the UDP with a sand pack.			
	1.0						
5.0							
	2.0						
10.0	3.0						
	4.0						
15.0							
	5.0						
20.0	6.0		SLUDGE	Precise top of sludge/sludge and soil material is unknown but it was estimated to begin at approx. 20-ft bgs.			
	7.0		SLUDGE	Sludge/soil mixture, saturated, black. Very strong hydrocarbon odor.	NA	NA	
25.0	8.0		GM	Silty gravel with medium sand, moist, brown (10YR 5/3). Gravel is angular. Strong hydrocarbon odor. Soil, no sludge.			
				Silty sand with gravel, moist, brown (10YR 5/3). Angular gravel to 2-in.			
	9.0				866	1000	TTR01103
30.0				Silty fine sand with gravel, moist, brown (10YR 5/3). Angular to subangular gravel to 3.25-in.			
	10.0			Silty sand as above; becoming less silty, sand with gravel, moist, dark brown (10YR 4/4). Angular to subangular gravel.			
			SP	Silty sand as above; becoming less silty, gravelly sand, moist, brown (10YR 5/2). Gravel angular to 2-in.	894	1000	
35.0	11.0			Silty sand, moist, brown (10YR 5/2). No gravel.			
			SM				
			SP	Gravelly sand with less silt, moist, brown (10YR 5/2). Gravel angular to 2-in.			
	12.0				880	1000	

SOIL BORING LOG	BORING NUMBER: B1	CAU 423 CADD Appendix B Revision: 0 Date: 06/18/98 Page B-2 of B-18
PROJECT NAME: CAU423	DATE HOLE STARTED: 01/12/98	
PROJECT NUMBER: 772850.21020200	DATE HOLE COMPLETED: 01/13/98	
HOLE SURFACE ELEVATION (feet): 5499.00	EASTING: 521471.10	
TOTAL DEPTH DRILLED (feet):81.50	NORTHING: 4182049.30	
ENVIRONMENTAL CONTRACTOR: IT Corporation	GEOLOGIST: A.M. Welcher	

Depth Feet	Depth Meters	Legend	USCS	Classification (Description)	Headspace (ppm)	Field Screen TPH (mg/kg)	Sample ID
			GM	Medium sand with poorly sorted gravel, becoming less silty towards 43 ft., moist, brown (10YR 5/2). Gravel is angular to 1-in. Between 40 to 41 ft some subrounded gravel to 3-in.			
	13.0		SM	Fine to medium sand, moist, brown (10YR 5/2). Sand with silt, decrease in gravel.			
45.0					812	1000	TTR01104
	14.0			Fine sand with silt, moist, orangish-brown (10YR 5/4). Rare (two) 3-in. gravel observed.			
				Sand, moist, grayish-brown (10YR 3/1), becomes more coarse towards 50 ft., less silt.			
	15.0						
50.0			SW		675	1000	
				Sand, moist, brown (10YR 4/3). Fine grained sand coarsening to a medium sand (no fines) towards 54 ft. 5% gravel, angular to subangular.			
	16.0						
			SP	Sand, moist, yellowish-brown (10YR 4/3). Fine to medium sand with some gravel.			
55.0							
	17.0						
				Sand as above; fine to medium sand with some gravel. Moist, slight color change to grayish brown (10YR 4/2).			
	18.0			Sand, slightly moist. Medium sand with fine gravel. Soil is more consolidated, blocky. Some white calcite(?) stringers (approx. 1 mm thick) visible.	105	500	
60.0				Sand, medium to coarse sand, with gravel and <5% silt.			
	19.0		COBBLE	Cobble, grayish-white, blocky, tuff with mica and one 2-in. gravel of scoria.			
			SW	Sand, moist, yellowish-brown (10YR 5/4). Fine to medium sand, <5% gravel. Mostly loose, but dense in places, can crumble but can't penetrate with thumb.			
65.0							
	20.0		SP	Gravelly sand, moist, brown (10YR 5/3). Fine to medium sand with pebbles.			
			GM	Sandy gravel with silt. More cemented layer, white calcite(?) when break apart. Less moist than above.			
	21.0			Silt with a large cobble (5-in), moist, brown (10YR 5/2).	4		TTR01105
70.0			GP	Sandy gravel, moist, dark yellowish brown (10YR 4/4). Gravel is subrounded, up to 5-in. diameter, sand is medium grained with <5% silt.			
	22.0						
75.0							
	23.0			Sandy gravel, moist, yellowish brown (10YR 5/4). Sandy gravel with <5% silt, layer of increased silt content at 75 ft. Subrounded gravel up to 3-in.			
				Sandy gravel, yellowish brown (10YR 5/4). More cemented, blocky (not loose).			
	24.0		GW				
				Sandy gravel, moist, yellowish brown (10YR 5/4). Fine gravel with medium sand.	4		TTR01106
80.0			SW	Sand, moist yellowish-brown (10YR 5/4). Fine to medium sand with <5% gravel to 1-cm, <5% silt. Bottom of boring at 81.5 ft.			TTR01108

Appendix C

Cost Estimates

(As received from Bechtel Nevada [BN])

EST: CAU423,03-60 UDP	**BN ENVIRONMENTAL RESTORATION** **COST ESTIMATE SUMMARY**	**Prep Date:** 4/13/98 **Print Date:** 4/23/98

TO: JEFF SMITH - Environmental Restoration Task Manager **FROM:** ABDEL AGALLOUCH - ER Project Controls

SUBJECT: REMEDIAL ALTERNATIVES **TEC:** (see totals below)

WORK PKGE: CAU 423 - AREA 3 BUILDING 03-60 UDP **WBS:**

TAP: DRAIN AND SUMPS SOURCE GROUPING **LOCATION:** TTR

TYPE OF ESTIMATE				TYPE OF WORK	
X	ORDER OF MAGNITUDE		PRELIMINARY TITLE II		RI / FS
	PLANNING/STUDY		WORK ORDER	X	REMEDIATION
	CONCEPTUAL/BUDGET		COMPARATIVE	X	CONSTRUCTION
	TITLE I / PRELIMINARY		OTHER		OTHER

BN REMEDIATION PROJECT		WORK TO BE PERFORMED BY			
ESTIMATOR:	Abdel Agallouch 702-295-5275	X	DOE PRIME CONTRACTOR		NATIONAL LAB
TASK MGR:	Jeff Smith 702-295-7775		NTS GENERAL		SUBCONTRACT
PROGRM MGR:	Dave Cowser 702-295-1632		NTS MAINTENANCE		OTHER

STATEMENT OF WORK :

This estimate has been prepared at the request of DOE/NV to provide remedial alternative costs for the closure of Corrective Action Unit (CAU) 423, an environmental restoration site listed in the Federal Facilities and Consent Order (FFACO). CAU 423 is specifically described as the Area 3 Building 03-60 UDP located at the Tonopah Test Range (TTR). Assume one of following alternatives will be used for closure of the site: No Further Action; Administrative Controls; Partial Excavation, Disposal, and Administrative Controls. This estimate will be used to identify the most cost effective alternative for closure of the site while being protective of human health and the environment. Total Estimated Costs are intended for comparative analysis of remedial field work and field management only. Costs for Project Management, project support, or other overhead functions are not included. Assume additional documentation will be required for Clean Closure alternative including extended HASP, Construction Work Plan, and Area 3 Building 03-60 UDP Handling and Procedures Plan.

SCOPE

Provide site closure using one of the following alternatives:

- NO FURTHER ACTION:
  No actions; no associated costs. No administrative controls implied.
- ADMINISTRATIVE CONTROLS:
  Only costs associated with administrative activities, remove surface casing, and grout the remainder to the surface.
- *IN SITU* BIOREMEDIATION
- PARTIAL EXCAVATION, DISPOSAL, AND ADMINISTRATIVE CONTROLS

BASIS OF ESTIMATE

- The administrative closure alternative includes:
  1) Survey and engineering support required for as-built drawing preparation. Site inspection is not anticipated for engineering techs.
  2) Implement administrative controls (ie., digging restrictions)
  3) Remove surface casing and grout the remainder to the surface
- The approximate plume dimensions are 20 ft by 35 ft by 65 ft deep with 20 ft of clean soil above the shallowest contamination.

See following page/s for continuation and cost summary

Review / Concurrence:

Abdel Agallouch — 4/28/98
Estimator — Date

Jeff L. Smith — 4/28/98
Checked By — Date

EST: CAU423,03-60 UDP	**BN ENVIRONMENTAL RESTORATION** **COST ESTIMATE SUMMARY**	**Prep Date:** 4/13/98 **Print Date:** 4/23/98

BASIS OF ESTIMATE cont

- The bioremediation system will require the installation of 3, 6-inch diameter wells advanced to approximately 70 feet with 4-inch PVC casing from 0 to 20 ft with the bottom 50 ft comprised of 0.010 inch slotted PVC screen.
- The common cost components associated with the bioremediation process are: Mixing tank, structural slab, delivery system, pumps, piping, nutrients, pH adjustments, operations and maintenance (Assume 10 years).
- A pilot test will not be conducted for the bioremediation option, mainly because of the low permeability of the soil (10^{-3} cm/s) within the plume.
- The initial bioremediation rate constant (i.e., measure CO_2 respiration rates within all three wells) will determine whether there is a need for nutrients and PH adjustments.
- The completion of the bioremediation process will take 3 to 10 years (depending upon biodegradation rate).
- Post-Closure monitoring will be semiannual for 10 years.
- If encountered during the excavation operations, utilities (gas, phone, electric, and water lines) will be rerouted appropriately.
- Backfill material for the utilities will be compacted in 8" lifts, 4 passes using a tamper vibrator.
- A 25 ton rig/hydraulic jack will be used to pull out surface casing from boring B1. A 2 ft thick cement cap will be cover the UDP after removal.
- The wells will be fenced and signs will be installed to protect the wells.

GENERAL ASSUMPTIONS :

- The Bioremediation alternative cost is based on the standard technology cost with the BN adders.
- Stabilization of slope will be used by means of shoring method installed to a depth of 40 ft. Three 8 ft X 20 ft Steel trench boxes (approximate weight per box: 8500 lbs) will be needed.
- Slope stability and excavation will be studied by an independent geotechnical engineer (OSHA requirement for depths greater than 20 ft).
- The total volume of excavated TPH impacted soil is approximately 177 CY and will be disposed offsite.
- Offsite and transport disposal will be required for the UDP filled with sand, Surface casing and bentonite (500 lbs)
- The UDP and associated soils are assumed to be hazardous, but below LDRs.
- Survey and engineering support for as-built drawing preparation.
- Labor costs are based on a 10 hr day, 4 day week schedule. Personnel will be paid round trip mileage between NTS and TTR during construction activities.
- Equipment and personnel will be mobed/demobed to the TTR from the Nevada Test Site. One mobe/demobe activity is estimated for each CAU closure alternative.
- Assume lodging and meals are available for personnel at the TTR.
- Soil used for backfill at the excavation can be obtained from a borrow pit approximately 1 mile from the site.

ESCALATION:

Escalation is not included in this estimate. All costs are in FY98 dollars

(Except for post closure monitoring costs for 10 years: Assume 3% escalation)

CONTINGENCY:

Contingency costs are not included in this estimate.

COST SUMMARY - TOTAL ESTIMATED COST PER REMEDIAL ALTERNATIVE

• NO FURTHER ACTION:	**$0**
• ADMINISTRATIVE CONTROLS:	**$36,416**
• *IN SITU* BIOREMEDIATION:	**$213,221**
• PARTIAL EXCAVATION, DISPOSAL, AND ADMINISTRATIVE CONTROLS:	**$138,275**

Appendix D

Response to NDEP Comments

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

(Page 1 of 1)

1. Document Title/Number: CADD for CAU 423: Building 03-60 Underground Discharge Point, TTR, Nevada	2. Document Date: April 1998
3. Revision Number: Draft Rev. 0	4. Originator/Organization: IT Corporation
5. Responsible DOE/NV ERP Subproject Mgr.: Kevin Cabble	6. Date Comments Due: May 21, 1998
7. Review Criteria: Full	
8. Reviewer/Organization/Phone No.: Karen Beckley, NDEP	9. Reviewer's Signature:

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1	M	DOE/NV has proposed closure alternative 2, Closure in Place with Administrative Controls and discusses land-use restrictions in conjunction with this closure. As stated in previous correspondence, even if the CADD is found to be technically sound, NDEP will not approve this document for implementation without written Air Force concurrence of the proposed closure alternative and subsequent land-use restrictions.	The DOE/NV is discussing the issue with the Air Force	
2	M	On December 4, 1997, NDEP was notified that there was a transfer of TTR management responsibilities from DOE/NV to DOE/KAO. Even though DOE/NV is still responsible for the ER activities conducted on TTR, DOE/KAO need to provide acknowledgment of these actions as well.	Comment noted.	
3	M	DOE needs to ensure that this site is placed on the CAB agenda for NDEP to present. This should be done at the CAB meeting in line with submittal of the final CADD to NDEP. This will allow the CAB approximately 30 days to express any comments.	The CAB was notified of the approximate CADD submittal date at the June 3, 1998 meeting. Two copies of the final CADD will be transmitted to the CAB when the document is submitted to NDEP.	
4	M	On page 16, reference is made to a casing that was installed to allow drilling through the center of the UDP. How many of these were installed? What boring sample was taken from this location and what are the dimensions of the casing?	The first sentence was replaced with the following: "A 25-cm (10-in.) surface casing was installed to allow drilling of boring B1 through the center of the UDP (Figure A.2-2). This surface casing was left open pending corrective action decisions and will have to be addressed by either cutting the casing below ground surface and filling with a grout material or removing and grouting the hole."	

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

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

Distribution

*Provide copy on initial distribution of Rev. 0; remainder of list gets Rev. 0 if approved without changes, and entire list receives distribution of Rev. 1, if issued.

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