Nevada
Environmental
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Project

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Corrective Action Decision Document
for Corrective Action Unit 342:
Area 23 Mercury Fire Training Pit,
Nevada Test Site, Nevada

Controlled Copy No.: ____

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June 1999

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**CORRECTIVE ACTION DECISION DOCUMENT
FOR CORRECTIVE ACTION UNIT 342:
AREA 23 MERCURY FIRE TRAINING PIT,
NEVADA TEST SITE, NEVADA**

DOE Nevada Operations Office
Las Vegas, Nevada

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**CORRECTIVE ACTION DECISION DOCUMENT
FOR CORRECTIVE ACTION UNIT 342:
AREA 23 MERCURY FIRE TRAINING PIT,
NEVADA TEST SITE, NEVADA**

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List of Acronyms and Abbreviations

AST	Aboveground storage tank(s)
bgs	Below ground surface
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site(s)
CAU	Corrective Action Unit(s)
CFR	<i>Code of Federal Regulations</i>
CLP	Contract Laboratory Program
cm/sec	Centimeter(s) per second
COC	Contaminant(s) of concern
COPC	Contaminant(s) of potential concern
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DQO	Data Quality Objective(s)
EPA	U.S. Environmental Protection Agency
FFACO	<i>Federal Facility Agreement and Consent Order</i>
ft	Foot (feet)
ft ²	Square foot (feet)
FTP	Mercury Fire Training Pit
ICP	Inductively coupled plasma
in.	Inch(es)
LCS	Laboratory control sample(s)
mg/kg	Milligram(s) per kilogram
mg/L	Milligram(s) per liter
µg/kg	Microgram(s) per kilogram
mi	Mile(s)
MEK	Methylethyl ketone (2-butanone)
MIBK	Methyl isobutyl ketone

List of Acronyms and Abbreviations (Continued)

MS/MSD	Matrix spike/matrix spike duplicate
NAC	<i>Nevada Administrative Code</i>
NDEP	Nevada Division of Environmental Protection
NIST	National Institute of Standards and Technology
NRS	<i>Nevada Revised Statutes</i>
NTS	Nevada Test Site
PAL	Preliminary action level(s)
PCB	Polychlorinated biphenyl(s)
pCi/g	Picocurie(s) per gram
PE	Polyethylene
PID	Photoionization detector
PPE	Personal protective equipment
PRG	Preliminary remediation goal(s)
QA	Quality assurance
QA/QC	Quality assurance and quality control
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	<i>Resource Conservation and Recovery Act</i>
RPD	Relative percent difference
SDG	Sample delivery group
SVOC	Semivolatile organic compound(s)
TCLP	Toxicity characteristic leaching procedure
TPH	Total petroleum hydrocarbon(s)
VOC	Volatile organic compound(s)
%R	Percent recovery
µg/kg	Microgram(s) per kilogram

Executive Summary

This Corrective Action Decision Document has been prepared for the Nevada Test Site's Area 23 Mercury Fire Training Pit (Corrective Action Unit 342) in accordance with the *Federal Facility Agreement and Consent Order* (FFACO, 1996). Corrective Action Unit 342 is comprised of Corrective Action Site 23-56-01. 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 342.

The scope of this 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 corrective action alternatives in relation to corrective action objectives and screening criteria.
- Recommend and justify a preferred corrective action alternative for the Corrective Action Unit.

In May and June 1998, a corrective action investigation was performed as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 342: Area 23 Mercury Fire Training Pit, Nevada Test Site, Nevada* (DOE/NV, 1998). Unknown hydrocarbons were detected in the total petroleum hydrocarbon diesel analyses at concentrations ranging from nondetect to 10,000 milligrams per kilogram. These unknown hydrocarbons could be attributed to aromatic, halogenated and nonhalogenated volatile and semivolatile compounds and/or other petroleum hydrocarbons (i.e., nongasoline, nondiesel, and nonwaste oil) present in the samples. Total petroleum hydrocarbons were identified at concentrations above the 100 milligrams per kilogram action level specified in the *Nevada Administrative Code* (NAC, 1996a). These detections were primarily related to plumes associated with the aboveground storage tank storage area and the burn pit. The surface soil immediately downgradient of the burn pit and several stained areas also had concentrations exceeding the 100 milligrams per kilogram action level. The aboveground storage tank storage area subsurface plume is limited vertically to 50 feet. The lateral extent does

not exceed 130 by 80 feet. The burn pit plume is limited vertically to 30 feet and laterally to not more than a few feet beyond the dimensions of the surface berm (65 by 27 feet). The highest detected concentration of total petroleum hydrocarbon was 18,000 milligrams per kilogram as diesel in boring B-14 in the aboveground storage tank storage area at the 24 to 25 feet below ground surface sampling interval. Xylene was detected in one sample at a concentration exceeding the preliminary action level. This xylene detection, as well as those less than the preliminary action levels, were associated with the hydrocarbon detections and should therefore be limited to the extent of the hydrocarbon plume. The lateral extent of the hydrocarbon contamination is shown on [Figure A.3-1](#). Details of the investigation can be found in [Appendix A](#) of this document.

Based on the potential exposure pathways, the following corrective action objectives have been identified for Corrective Action Unit 342:

- Prevent or mitigate exposure to surface, near-surface, and subsurface soil containing contaminants of concern at concentrations exceeding preliminary action levels (DOE/NV, 1998).
- Prevent adverse impacts to groundwater quality.

Upon review of existing data, future use, and current operations at the Nevada Test Site, the following alternatives were developed for consideration at Corrective Action Unit 342:

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

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 342 is Alternative 4, Partial Excavation, Disposal, and Monitoring.

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, all applicable state and federal regulations for closure of the site, and will reduce potential future exposure pathways to the contaminated soil at the Mercury Fire Training Pit.

This alternative will present minor risks to site workers during corrective action implementation. Therefore, appropriate health and safety procedures will be developed and implemented.

1.0 Introduction

This Corrective Action Decision Document (CADD) has been prepared for Corrective Action Unit (CAU) 342, Area 23 Mercury Fire Training Pit (FTP) in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) 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), 23-56-01, within CAU 342.

Corrective Action Unit 342 is located at the Nevada Test Site (NTS) in Area 23. The NTS is approximately 65 miles (mi) northwest of Las Vegas, Nevada ([Figure 1-1](#)). The FTP is an area approximately 350 by 450 feet (ft) located west of Mercury, Nevada, which was used between approximately 1965 and 1990 to train fire-fighting personnel ([Figure 1-2](#)) (REECo, 1991; Jacobson, 1991).

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 the investigative activities conducted in accordance with the *Corrective Action Investigation Plan for Corrective Action Unit 342: Area 23 Mercury Fire Training Pit, Nevada Test Site, Nevada* (DOE/NV, 1998). The CAU is the same as described in the Corrective Action Investigation Plan (CAIP) except for surface features that were removed.

1.2 Scope

The scope of this CADD consists of the following:

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

Figure 1-1
Nevada Test Site

26-MAY-1999 h:\firetraining\p1final_cadd\p1location.dgn

Figure 1-2
Area 23 Mercury Fire Training Pit, Nevada Test Site

- 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 Corrective Action Unit 342: Area 23 Mercury Fire Training Pit, Nevada Test Site*

[Appendix B](#): Soil Boring Logs

[Appendix C](#): Geotechnical Sample Results

[Appendix D](#): Cost Estimates

[Appendix E](#): Bioassessment Report, Nevada Test Site, CAU 342 (Area 23 Mercury Fire Training Pit)

[Appendix F](#): Nevada Environmental Restoration Project Documentation Review Sheets

All work was performed in accordance with the following documents:

- *Corrective Action Investigation Plan for Corrective Action Unit 342: Area 23 Mercury Fire Training Pit, Nevada Test Site, Nevada* (DOE/NV, 1998)
- *Industrial Sites Quality Assurance Project Plan* (DOE/NV, 1996b)
- 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 342. Detailed investigation results and minor deviations from the CAIP are presented in [Appendix A](#).

2.1 Investigation Activities

In May and June 1998, corrective action investigation activities were performed as set forth in the CAIP (DOE/NV, 1998). The purpose of the investigation was to:

- Identify the presence and nature of contaminants of potential concern (COPCs) at the FTP.
- Determine the vertical and lateral extent of COPCs at the FTP.
- Provide sufficient information and data to develop and evaluate appropriate corrective action for the CAU.

The investigation activities are summarized below:

- Conducted a biological resources survey prior to sample collection. No endangered species were identified on the site.
- Collected surface/near-surface soil samples for laboratory analysis from 31 random and biased locations using a direct-push sampling method and from three biased locations using hand tools ([Figure A.2-2](#) shows these locations).
- Drilled 17 soil borings in and around each of the point source areas using a rotary sonic drilling method. The borings ranged in depth from 15 to 70 ft.
- Collected subsurface soil samples from each of the borings for field screening and laboratory analysis ([Figure A.2-3](#) shows boring locations).
- Field-screened soil samples for volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), and alpha/beta emitters.
- Analyzed environmental samples (soil and quality control [QC] samples) from the investigation for one or all of the following: total and leachable VOCs; total semivolatile organic compounds (SVOCs); total and leachable *Resource Conservation and Recovery Act* (RCRA) metals and zinc; TPH; dioxans/furans; polychlorinated biphenyls (PCBs); and

radionuclides using gamma spectroscopy. The results of these analyses were compared to preliminary action levels (PALs) as established in Section 3.3 of the CAIP (DOE/NV, 1998).

- 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 at concentrations above the 100 milligrams per kilogram (mg/kg) action level specified in the *Nevada Administrative Code* (NAC) (NAC, 1996a). Unknown hydrocarbons were detected in the TPH diesel analyses at concentrations ranging from nondetect to 10,000 mg/kg. These unknown hydrocarbons could be attributed to aromatic, halogenated and nonhalogenated volatile and semivolatile compounds and/or other petroleum hydrocarbons (i.e., nongasoline, nondiesel, and nonwaste oil) present in the samples. These detections were primarily related to plumes associated with the aboveground storage tank (AST) storage area and the burn pit. The surface soil immediately downgradient of the burn pit and several stained areas also had concentrations exceeding the 100 mg/kg action level. The AST area subsurface plume lobes appear to have had three different point sources. The northernmost and largest of the three lobes is limited vertically to 50 ft. The smaller two lobes are limited vertically to 30 ft and 20 ft. Their combined lateral extent does not exceed 130 by 80 ft. The burn pit plume is limited vertically to 30 ft and laterally to not more than a few feet beyond the dimensions of the surface berm (65 by 27 ft) ([Figures A.3-1 through A.3-4](#) show plume locations). The highest detected hydrocarbon concentration was 18,000 mg/kg as diesel in boring B14 in the AST storage area at the 24 to 25 ft sampling interval.
- For VOCs, only xylene was detected above its PAL. All other VOCs were below the PALs. A single detection of xylene was identified in boring B14 above the PAL. This detection corresponds with the highest TPH detection. All other xylene detections were below the PAL. A single sample was analyzed for leachable VOCs to support waste management. No constituents were identified above RCRA regulatory levels in this sample.
- No toxicity characteristic leaching procedure (TCLP) VOCs were detected above minimum reporting limits.

- Total SVOCs were either not present above the minimum reporting limits, or if present, were below PALs. Detected SVOCs were identified within the TPH contaminated areas and are probably associated with the TPH constituents and degradation products.
- Only arsenic was detected in the total RCRA metals and zinc analyses above PALs. The arsenic concentrations ranged from 2.5 mg/kg to 10.8 mg/kg. These concentrations are not unusual for the state of Nevada (Shacklette and Boerngen, 1984). No other total metals were detected above PALs. Analysis for leachable metals was conducted on two samples from the burn pit (sample selection criteria is discussed in Section A.3.6). Cadmium was detected above the regulatory limit of 1 milligrams per liter (mg/L) (CFR, 1998) in both samples. Subsequently, additional samples were analyzed for leachable RCRA metals. No cadmium or other RCRA metals were detected in these samples. Matrix interference from high diesel concentrations may have masked the cadmium contamination in the totals analysis for the samples or a laboratory anomaly may have occurred in the analysis of these samples.
- No dioxins or furans were detected above minimum reporting limits.
- No PCBs were detected above minimum reporting limits.
- Radionuclides in the FTP soil samples were not distinguishable from soil samples taken from background locations and no man-made radionuclides were identified.
- Bioassessment samples indicated that viable microbial populations exist at the FTP and that soil conditions are suitable for bioremediation (natural or enhanced).
- Geotechnical results indicate the soils at the FTP are gravelly sand and sandy gravels with significant silt and clay. Isolated caliche layers are also present. Permeability tended to decrease with increasing depth.

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 contaminants of concern (COCs) for CAU 342. Total petroleum hydrocarbons were detected above the 100 mg/kg action level (NAC 445A) (NAC, 1996b) in samples taken from soil below and around the AST storage area, the burn pit, and several isolated stained areas. Xylene was detected in one sample at 480,000 micrograms per kilogram ($\mu\text{g/kg}$) which exceeded the PAL (320,000 $\mu\text{g/kg}$). No other COCs were identified above PALs 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 and related xylene contamination in accordance with NAC 445A (NAC, 1996b).

3.0 Evaluation of Alternatives

The purpose of this section is to present the corrective action objectives for CAU 342, describe the general standards and decision factors used to screen the corrective action alternatives, and develop and evaluate a set of corrective action alternatives that could be used to meet the corrective action objectives.

3.1 Corrective Action Objectives

The corrective action objectives are media-specific goals for protecting human health and the environment. Based on the potential exposure pathways (see [Section 3.1.2](#)), the following corrective action objectives have been identified for CAU 342:

- Prevent or mitigate exposure to surface, near-surface, and subsurface soil containing COCs at concentrations exceeding PALs (DOE/NV, 1998).
- Prevent adverse impacts to groundwater quality.

3.1.1 Contaminants of Concern

Contaminants of potential concern were determined in the Data Quality Objective (DQO) process as listed in the CAIP (DOE/NV, 1998). Analytical results obtained from the corrective action investigation were evaluated to determine if COPCs were detected above PALs, and would therefore be COCs for CAU 342 that must be addressed by corrective action. Based on the results of this evaluation, elevated levels of petroleum hydrocarbons and xylene (associated with the petroleum hydrocarbons) identified them as COCs. No other COCs were identified.

3.1.2 Potential Exposure Pathways

Based on the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996a) and the *Record of Decision: Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996c), the future use of the FTP area may include support for short-term nondefense research, testing, experimentation, and training. These potential future uses would likely require limited excavation of the contaminated soil by site workers. Groundwater at the site is estimated to be greater than 800 ft

below ground surface (bgs) and the environmental conditions at the site (i.e., arid climate, low permeabilities) are not conducive to downward migration (Winograd and Thordarson, 1975). Therefore, groundwater exposure to COCs is not considered to be a pathway (refer to [Section 3.3](#) for a detailed [a-k] evaluation).

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's (EPA) *Guidance on Resource Conservation and Recovery Act (RCRA) Corrective Action Decision Documents* (EPA, 1991) and the *Final RCRA Corrective Action Plan* (EPA, 1994).

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

The general corrective action standards are:

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

The remedy selection decision factors are:

- 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 state and federal regulations (445A.2272 [NAC, 1996b]). This regulation prescribes an appropriate 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 PALs. The PALs were established during the DQO process and are presented in the CAIP.

Control the Source(s) of the Release

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

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

During implementation of any corrective action alternative, all waste management activities must be conducted in accordance with applicable state and federal regulations (e.g., *Nevada Revised Statutes* [NRS] 459.400 - 459.600 [NRS, 1995]; RCRA 40 CFR 260 - 282, "RCRA Regulations" [CFR, 1998]; NAC 444, "Solid Waste Disposal" [NAC, 1996a]; and NAC 459.9974, "Disposal and Evaluation of Contaminated Soil" [NAC, 1996c]). The requirements for management of the waste, if any, derived from the corrective action will be determined based on applicable state and federal regulations, field observations, process knowledge, characterization data, and data collected and

analyzed during corrective action implementation. Administrative controls (e.g., decontamination procedures and corrective action strategies) will minimize waste generated during site corrective action activities. Decontamination activities will be performed in accordance with approved procedures and will be designated according to the COCs present at the site.

3.2.2 Remedy Selection Decision Factors

The following paragraphs 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 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 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, necessary 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 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 D](#).

3.3 Development of Corrective Action Alternatives

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

future use, and current operations at the NTS, the following alternatives have been developed for consideration at CAU 342:

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

Other alternatives such as complete removal of COCs and administrative controls were considered. However, complete removal was considered unnecessary due to limited nature and extent of COCs and administrative controls alone were deemed not to be protective due to the presence of surface contamination and potential future uses of the site.

The following evaluation of NAC 445A.227 (2) (a-k) (NAC, 1996b) supports the protection of groundwater from CAU 342 COCs:

- a. The depth to groundwater is approximately 800 to 1,100 ft below land surface in Mercury Valley (Winograd and Thordarson, 1975; Robie et al., 1995). Field screening and analytical data indicate that COCs at the FTP extend less than 50 ft bgs.
- b. The distance to the nearest water-supply well Army Well #1, is approximately 5 mi southwest of the FTP (La Camera and Westenberg, 1994). Army Well #1 is a back-up drinking water supply for Mercury, Nevada. The groundwater flow direction is generally to the southwest (Laczniak et al., 1996).
- c. Soils at the FTP are gravelly sands and sandy gravels with lenses of sands and gravels with significant silt and clay. Caliche layers between a few inches and a few feet thick correlate with underlying zones of lower TPH field screening. Geotechnical samples demonstrate that permeability generally decreases with increasing depth. Permeability values decreased from a high of 3.20×10^{-4} centimeters per second (cm/sec) measured at 5 ft bgs to a low of 3.59×10^{-6} cm/sec measured at 50 ft bgs. The caliche layers and decreasing permeability with greater depth limit downward migration of COCs.
- d. Average annual precipitation for valleys in the South-Central Great Basin range from 3 to 6 inches (in.) (Winograd and Thordarson, 1975). Precipitation events are ephemeral and highly variable in the arid environment. Annual evaporation is roughly 5 to 25 times the

annual precipitation (Winograd and Thordarson, 1975). The high evaporation low precipitation rates create a negative water balance for the area; therefore, there is no sufficient driving force at the FTP that would aid in mobilizing COCs beyond current depths.

- e. The COCs released are hydrocarbon compounds including diesel, waste oil, gasoline, unknown hydrocarbons, and xylene (associated with the petroleum hydrocarbons).
- f. The vertical extent of contamination based on field screening and analytical data indicate that COCs are confined to within 50 ft of the land surface. Surface contamination includes areas of 16,300 square feet (ft²) and 5,830 ft² and three areas with much less vertical and lateral extent.
- g. Presently the CAU is located in a government-controlled facility and future land use will likely remain the same. The NTS is a restricted area guarded continuously throughout the year. Access is limited to authorized personnel. Fire suppression training at the FTP ended in 1992 and the facility is currently inactive. Future use of the FTP area may include support for short-term nondefense research, testing, experimentation, and training.
- h. Preferred routes of migration are limited since the point sources of the COCs have been removed. Vertical migration of the COCs is unlikely because of a lack of driving forces and generally decreasing permeability with increasing depth. Limited downward migration of COCs driven by ponding of precipitation within the burn pit is possible. The burn pit is surrounded by a low berm ranging from 2 in. to 10 in. high, and enclosing a 1,755 ft² area. Standing water is unlikely for the remainder of the FTP because the site is well drained by adjacent stream drainages. Lateral migration of COCs could be produced by precipitation runoff from the FTP surface contamination areas. Contact with surface contamination or contact with subsurface contamination due to inadvertent intrusion are the pathways from the contamination to potential receptors.
- i. Surface structures and debris were removed prior to investigation activities.
- j. The potential hazards related to fire, vapor, or explosion are very low because the highest TPH concentrations are located below the land surface.
- k. The ASTs have been removed mitigating additional contaminants from being released into the subsurface. 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 surface and subsurface contamination. This alternative will not be compared to the other alternatives using the selection decision factors.

3.3.2 Alternative 2 - Closure in Place with Partial Excavation, Disposal, and Administrative Controls

This alternative consists of removing portions of the TPH contaminated soil from the source areas and areas where surface contamination has been identified (see [Figure 3-1](#)). The contaminated soil will then be disposed of in an appropriate disposal facility. Soil analyses indicate that soil within the burn pit may be hazardous (exceed the maximum concentration for the toxicity characteristic for cadmium).

The point source areas will be excavated to an approximate depth of 5 ft. The surrounding and downgradient contaminated surface soils will be excavated to an approximate depth of 1 ft. These areas are indicated in [Figure 3-1](#). The remaining voids will be backfilled with clean borrow soil. The site will then be graded and compacted to ambient conditions to minimize inadvertent intrusion, by burrowing animals, prevent ponding, and promote surface drainage.

The areas with TPH contamination greater than 10,000 mg/kg will be excavated using a 8 1/2 ft diameter auger. Proposed auger locations are shown in [Figure 3-2](#). Each auger location will be advanced to 5 ft below the depth where TPH concentrations exceeded 10,000 mg/kg. Verification samples will be collected from the bottom of each auger location to determine remaining TPH concentrations. Step-out locations may be augered if verification samples indicate that TPH concentrations greater than 10,000 mg/kg remain. The remaining voids will be backfilled with clean borrow soil.

Administrative controls will also be implemented under this alternative to prevent inadvertent contact with subsurface contaminated media. These controls would consist of use restrictions to prevent unauthorized intrusive activities. The future use of the area 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). Natural

Figure 3-2
Potential Auger Locations, Area 23 Mercury Fire Training Pit,
Nevada Test Site

biological activity will result in reduced concentrations of hydrocarbons with time. The bioassessment report is in [Appendix E](#).

Administrative controls are commonly used and can effectively eliminate potential exposure pathways. Administrative controls are effective because the NTS 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, 1996b) requirements is presented in [Section 3.3](#). This evaluation provides support that the conditions at the CAU will not adversely impact the groundwater beneath the CAU or any nearby drinking water wells.

3.3.3 *Alternative 3 - Partial Excavation, Disposal, In Situ Bioremediation and Administrative Controls*

Alternative 3 consists of removing portions of the TPH contaminated soil from the source areas and areas where surface contamination has been identified. The point source areas will be excavated to an approximate depth of 5 ft. The surrounding and downgradient contaminated surface soils will be excavated to an approximate depth of 1 ft. These areas are indicated in [Figure 1-1](#). The remaining voids will be backfilled with clean borrow soil. The site will then be graded and compacted to ambient conditions to minimize inadvertent intrusion, by burrowing animals, prevent ponding, and promote surface drainage.

Remaining source plume subsurface TPH concentrations will be reduced via *in situ* bioremediation. The analysis of microbial parameters at the site indicated favorable conditions for bioremediation with minimal need for added components ([Appendix E](#)). Because of the relatively small plume sizes, a simplified system could be employed to provide oxygen to the contaminated zone to stimulate biological activity. This system would consist of approximately five wells. Both the burn pit plume and the AST storage area plumes would have two or three vadose zone wells; at least one of the vadose zone wells would be an extraction well with 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 in the plume and serve as a monitoring port. Fencing would be installed to protect the bioremediation well system and prevent inadvertent contact with contaminated subsurface soil until

concentrations could be adequately reduced. 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 wells. 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. A respiration test would be necessary to more accurately estimate the length of time and number of wells necessary for adequate effectiveness. After remediation, the wells would be closed in accordance with State of Nevada requirements.

Administrative controls will also be implemented under this alternative to prevent inadvertent contact with subsurface contaminated media. These controls would consist of use restrictions to prevent unauthorized intrusive activities. The future use of the area 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.

3.3.4 Alternative 4 - Partial Excavation, Disposal, Monitoring, and Administrative Controls

Alternative 4 consists of removing surface and shallow, subsurface contamination and monitoring the natural attenuation of the remaining source plume subsurface TPH concentrations. The analysis of microbial parameters at the site indicated favorable conditions for bioremediation with minimal need for added components.

This alternative consists of removing portions of the TPH contaminated soil from the source areas and areas where surface contamination has been identified. The point source areas will be excavated to an approximate depth of 5 ft. The surrounding and downgradient contaminated surface soils will be excavated to an approximate depth of 1 ft. These areas are indicated in [Figure 1-1](#). The remaining voids will be backfilled with clean borrow soil. The site will then be graded and compacted to ambient conditions to minimize inadvertent intrusion, by burrowing animals, prevent ponding, and promote surface drainage.

A gas sampling system will be installed. Soil gas samples will be collected at one location to determine ambient conditions and degradation rate. The approximate location for the gas sample well

is shown on [Figure 3-3](#). The actual well location will be determined by site conditions at the time of installation. Samples will be field screened for oxygen, carbon dioxide, methane, and VOCs. Gas samples will be collected for laboratory analysis for total VOCs and total SVOCs. Biannual sampling will be conducted for three sampling events or a total of six years. The data will be evaluated at the end of the six-year monitoring period to determine what additional actions are required at the site. If the natural degradation rate is determined to be sufficient to reduce the concentrations of COCs below 100 mg/kg in 30 years no bioremediation system will be installed.

Verification of *in situ* biodegradation will be based on the following techniques:

- Metabolic by-products. The production of, or an increase in the concentrations of known by-products of microbial activity, such as carbon dioxide, will be used as a biodegradation indicator (NRC, 1993).
- Intermediary metabolites. The presence of metabolic intermediaries, simpler but incompletely degraded forms of the contaminants, will be used as a biodegradation indicator (NRC, 1993).
- Growth-stimulating materials. A depletion of the concentration of growth-stimulating materials, such as oxygen or other electron acceptors, will be used as a biodegradation indicator (NRC, 1993).
- Ratio of nondegradable to degradable compounds. An increase in the the ratio of compounds that are difficult to degrade to those that are easily degradable will be used as a biodegradation indicator (NRC, 1993).

Administrative controls will also be implemented under this alternative to prevent inadvertent contact with subsurface contaminated media. These controls would consist of use restrictions to prevent unauthorized intrusive activities. The future use of the area 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). Natural biological activity will result in reduced concentrations of hydrocarbons with time. The bioassessment report is in [Appendix E](#).

Administrative controls are commonly used and can effectively eliminate potential exposure pathways. Administrative controls are effective because the NTS is a restricted access facility. The

Figure 3-3
Potential Soil Gas Sampling Well Location

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, 1996b) requirements is presented in [Section 3.3](#). This evaluation provides support that the conditions at the CAU will not adversely impact the groundwater beneath the CAU or any nearby drinking water wells.

3.4 *Evaluation and Comparison of Alternatives*

The general corrective action standards and remedy selection decision factors described in [Section 3.2](#) were used to conduct detailed and comparative analyses of each corrective action alternative. The advantages and disadvantages of each alternative were assessed to select a preferred alternative for CAU 342. [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 the costs for the alternatives is provided in [Appendix D](#)

Table 3-1
Detailed Evaluation of Alternatives
(Page 1 of 6)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Partial Excavation, Disposal, and Administrative Controls	Alternative 3 Partial Excavation, Disposal, <i>In Situ</i> Bioremediation, and Administrative Controls	Alternative 4 Partial Excavation, Disposal, Monitoring, and Administrative Controls
Closure Standards				
Protection of Human Health and the Environment	<ul style="list-style-type: none"> Does not meet corrective action objective of preventing exposure to the contaminated soil zone. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. No worker exposure associated with implementation. 	<ul style="list-style-type: none"> Meets corrective action objectives. Prevents inadvertent intrusion into the contaminated soil zone, thereby limiting exposures. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. Natural attenuation of COCs results in lower concentrations over time. Greater worker risk associated with excavation of contaminated subsurface soils and operation of heavy equipment. Appropriate level of personal protective equipment (PPE) will be used during excavation. Low risk to public because of remote location and controlled access to the NTS. Highest concentrations removed. 	<ul style="list-style-type: none"> Meets corrective action objectives. Prevents inadvertent intrusion into the contaminated soil zone, thereby limiting exposures. Bioremediation over time may result in concentrations at or below the PAL. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. Limited worker risk associated with excavation of contaminated surface and limited subsurface soils, operation of heavy equipment, and installation and operation of bioremediation system. Appropriate level of PPE will be used during excavation. Low risk to public because of remote location and controlled access to the NTS. 	<ul style="list-style-type: none"> Meets corrective action objectives. Prevents inadvertent intrusion into the contaminated soil zone, thereby limiting exposures. Natural attenuation over time may result in concentrations at or below the PAL. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. Limited worker risk associated with excavation of contaminated surface and limited subsurface soils, operation of heavy equipment, and installation and operation of monitoring system. Appropriate level of PPE will be used during excavation. Low risk to public because of remote location and controlled access to the NTS.

Table 3-1
Detailed Evaluation of Alternatives
(Page 2 of 6)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Partial Excavation, Disposal, and Administrative Controls	Alternative 3 Partial Excavation, Disposal, <i>In Situ</i> Bioremediation, and Administrative Controls	Alternative 4 Partial Excavation, Disposal, Monitoring, and Administrative Controls
Closure Standards				
Compliance with Media Cleanup Standards	<ul style="list-style-type: none"> Does not comply with media cleanup standards because COCs remain at levels above PALs, and no corrective action is taken to prevent exposure through inadvertent intrusion. No action implemented to close the FTP. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. 	<ul style="list-style-type: none"> Complies with media cleanup standards by removing contaminated surface and subsurface soils and eliminating exposure pathways. Natural attenuation of COC results in lower concentrations over time. Exposure to the contaminated soil through intrusive activities is controlled. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. 	<ul style="list-style-type: none"> Complies with media cleanup standards by removing contaminated surface soils and eliminating exposure pathways. Concentrations may be reduced to PAL level over time by the bioremediation. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. 	<ul style="list-style-type: none"> Complies with media cleanup standards by removing contaminated surface soils and eliminating exposure pathways. Concentrations may be reduced to PAL level over time by natural attenuation. Contaminants not impacting groundwater as shown by NAC 445A.227 (2) (a-k) analysis. A monitoring system will be installed to verify natural attenuation.
Control the Source(s) of Release	<ul style="list-style-type: none"> Training exercises are no longer conducted at the FTP. The site elements (e.g., tanks, bus, and structures) have been removed. The source(s) for release of COCs to the environment are no longer viable. 	<ul style="list-style-type: none"> Training exercises are no longer conducted at the FTP. The site elements (e.g., tanks, bus, and structures) have been removed. The source(s) for release of COCs to the environment are no longer viable. Contaminated surface and the most highly contaminated subsurface soils will be removed to limit migration of COCs to uncontaminated areas. 	<ul style="list-style-type: none"> Training exercises are no longer conducted at the FTP. The site elements (e.g., tanks, bus, and structures) have been removed. The source(s) for release of COCs to the environment are no longer viable. Contaminated surface and limited subsurface soils will be removed to limit migration of COCs to uncontaminated areas. 	<ul style="list-style-type: none"> Training exercises are no longer conducted at the FTP. The site elements (e.g., tanks, bus, and structures) have been removed. The source(s) for release of COCs to the environment are no longer viable. Contaminated surface and limited subsurface soils will be removed to limit migration of COCs to uncontaminated areas.

Table 3-1
Detailed Evaluation of Alternatives
(Page 3 of 6)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Partial Excavation, Disposal, and Administrative Controls	Alternative 3 Partial Excavation, Disposal, <i>In Situ</i> Bioremediation, and Administrative Controls	Alternative 4 Partial Excavation, Disposal, Monitoring, and Administrative Controls
Closure Standards				
Comply with Applicable Federal, State, and Local Standards for Waste Management	No waste generated	<ul style="list-style-type: none"> Potentially characteristic hazardous waste associated with leachable cadmium contamination at the burn pit will be handled and disposed of in compliance with applicable regulations. Other wastes, such as hydrocarbon contaminated soil, will be disposed according to applicable regulations in an appropriate disposal facility. 	<ul style="list-style-type: none"> Potentially characteristic hazardous waste associated with leachable cadmium contamination at the burn pit will be handled and disposed of in compliance with applicable regulations. Other wastes, such as hydrocarbon contaminated soil, will be disposed according to applicable regulations in an appropriate disposal facility. 	<ul style="list-style-type: none"> Potentially characteristic hazardous waste associated with leachable cadmium contamination at the burn pit will be handled and disposed of in compliance with applicable regulations. Other wastes, such as hydrocarbon contaminated soil, will be disposed according to applicable regulations in an appropriate disposal facility.

Table 3-1
Detailed Evaluation of Alternatives
(Page 4 of 6)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Partial Excavation, Disposal, and Administrative Controls	Alternative 3 Partial Excavation, Disposal, <i>In Situ</i> Bioremediation, and Administrative Controls	Alternative 4 Partial Excavation, Disposal, Monitoring, and Administrative Controls
Closure Standards				
Remedy Selection Decision Factors				
Short-Term Reliability and Effectiveness	Not evaluated	<ul style="list-style-type: none"> Limited worker risk associated with excavation and disposal of contaminated surface and subsurface soils through exposure to COCs and operation of heavy equipment. Appropriate level of PPE will be used during excavation. Limited environmental impact during alternative implementation because removal areas are previously disturbed and sparsely vegetated. Public protected by remote location and NTS site access controls. Risks associated with transportation minimized by disposing of excavated nonhazardous contaminated soil at an appropriate site on the NTS. 	<ul style="list-style-type: none"> Limited worker risk associated with excavation and disposal of contaminated surface soils through exposure to COCs, operation of heavy equipment, and installation and operation of bioremediation system. Appropriate level of PPE will be used during excavation. Limited environmental impact during alternative implementation because removal areas are previously disturbed and sparsely vegetated. Emissions from the bioremediation system would be limited through design. Public protected by remote location and NTS site access controls. Risks associated with transportation minimized by disposing of excavated nonhazardous contaminated soil at an appropriate site on the NTS. 	<ul style="list-style-type: none"> Limited worker risk associated with excavation and disposal of contaminated surface soils through exposure to COCs, operation of heavy equipment, and installation and operation of monitoring system. Appropriate level of PPE will be used during excavation. Limited environmental impact during alternative implementation because removal areas are previously disturbed and sparsely vegetated. Public protected by remote location and NTS site access controls. Risks associated with transportation minimized by disposing of excavated nonhazardous contaminated soil at an appropriate site on the NTS. The site will be monitored to verify natural attenuation and to determine rate.

Table 3-1
Detailed Evaluation of Alternatives
(Page 5 of 6)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Partial Excavation, Disposal, and Administrative Controls	Alternative 3 Partial Excavation, Disposal, <i>In Situ</i> Bioremediation, and Administrative Controls	Alternative 4 Partial Excavation, Disposal, Monitoring, and Administrative Controls
Closure Standards				
Reduction of Toxicity, Mobility, and/or Volume	Not evaluated	<ul style="list-style-type: none"> Removal of contaminated surface soil would result in reduction of mobility and volume at the site; proper disposal would result in reduced mobility at the disposal location. Removal of higher concentrations of contaminated soil will result in lower toxicity. Natural attenuation will likely result in a decrease in toxicity, mobility, and volume of the remaining contaminated soil with time. 	<ul style="list-style-type: none"> Removal of contaminated surface soil would result in reduction of mobility and volume at the site; proper disposal would result in reduced mobility at the disposal location. Bioremediation will result in reduction of toxicity, mobility, and volume of the remaining contaminated soil with time. 	<ul style="list-style-type: none"> Removal of contaminated surface soil would result in reduction of mobility and volume at the site; proper disposal would result in reduced mobility at the disposal location. Natural attenuation will result in reduction of toxicity, mobility, and volume of the remaining contaminated soil with time.
Long-Term Reliability and Effectiveness	Not evaluated	<ul style="list-style-type: none"> Controls inadvertent intrusion. Administrative controls required. Natural attenuation of COC concentrations will result in lower risk with time. 	<ul style="list-style-type: none"> Controls inadvertent intrusion. Administrative controls required. Bioremediation of COC concentrations, potentially to PALs, will result in lower risk with time. Maintenance and system monitoring required. 	<ul style="list-style-type: none"> Controls inadvertent intrusion. Administrative controls required. Natural attenuation of COC concentrations, potentially to PALs, will result in lower risk with time. Maintenance and system monitoring required.

Table 3-1
Detailed Evaluation of Alternatives
(Page 6 of 6)

Evaluation Criteria	Alternative 1 No Further Action	Alternative 2 Closure in Place with Partial Excavation, Disposal, and Administrative Controls	Alternative 3 Partial Excavation, Disposal, <i>In Situ</i> Bioremediation, and Administrative Controls	Alternative 4 Partial Excavation, Disposal, Monitoring, and Administrative Controls
Closure Standards				
Feasibility	Not evaluated	<ul style="list-style-type: none"> • Easily implementable. • No buildings, utilities, or other interferences at the site. • Coordination of all entities is necessary to ensure compliance to prevent intrusion into contaminated soil zones. 	<ul style="list-style-type: none"> • Implementable at the site; however, testing would be required to facilitate proper design. • No buildings, utilities, or other interferences at the site. • Coordination of all entities is necessary to ensure compliance to prevent intrusion into contaminated soil zones. 	<ul style="list-style-type: none"> • Easily implementable. • No buildings, utilities, or other interferences at the site. • Coordination of all entities is necessary to ensure compliance to prevent intrusion into contaminated soil zones.
Cost	\$0	\$216,011	\$710,115	\$180,195

Table 3-2
Comparative Evaluation of Alternatives

Evaluation Criteria	Comparative Evaluation
Closure Standards	
Protection of Human Health and the Environment	Alternatives 2, 3, and 4 meet corrective action objectives; Alternative 1 does not. No worker exposure to risks associated with Alternative 1. Highest risks are associated with Alternative 2 due to increase in exposures to higher concentrations of COCs and greater volumes. Slightly lower risks are associated with Alternatives 3 and 4. NAC 445A.227 (2) (a-k) analysis shows the contaminants are not impacting groundwater.
Compliance with Media Cleanup Standards	Alternative 1 does not comply with media cleanup standards. Alternatives 2, 3, and 4 meet media cleanup standards by limiting exposure pathways through administrative controls and by removing contaminated surface and subsurface soils. Bioremediation under Alternative 3 may reduce COC concentrations to PALs. Natural attenuation in Alternatives 1, 2, and 4 may result in reduced concentrations over time.
Control the Source(s) of the Release	The source(s) to the FTP are no longer viable. Under Alternatives 2, 3, and 4, removal of contaminated surface soils will prevent spread of contaminants to uncontaminated areas.
Comply with Applicable Federal, State, and Local Standards for Waste Management	All generated wastes will be handled in accordance with applicable regulations and requirements.
Remedy Selection Decision Factors	
Short-Term Reliability and Effectiveness	Limited risks to workers are associated with Alternatives 2, 3, and 4. The general public is not exposed to risk from the COCs under any of the alternatives.
Reduction of Toxicity, Mobility, and/or Volume	Alternatives 2, 3, and 4 result in a reduction of mobility and volume through removal of the contaminated surface soils. For Alternatives 2 and 4, natural attenuation will likely reduce these characteristics for the remaining contaminated soils with time. Alternative 3 reduces these characteristics through <i>in situ</i> bioremediation.
Long-Term Reliability and Effectiveness	Residual risk is low for both Alternatives 2, 3, and 4. All three will require administrative measures to control intrusive activities. Alternatives 3 and 4 require long-term monitoring and maintenance associated with the bioremediation or monitoring system.
Feasibility	Alternatives 2, 3, and 4 are feasible; however, Alternative 3 requires testing prior to the bioremediation system design. All three require heavy equipment, operating personnel, and disposal of wastes. Alternative 2 would be the easiest to implement.
Cost	The cost for Alternative 1 is \$0. The estimated cost for Alternative 2 is \$216,011 for partial excavation, disposal, and administrative controls. Alternative 3 is estimated to cost \$710,115 for partial excavation, disposal, and <i>in situ</i> bioremediation. Alternative 4 is estimated to cost \$180,195 for partial excavation, disposal, and natural attenuation monitoring.

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 342 is Alternative 4, Partial Excavation, Disposal, Monitoring, and Administrative Controls. Alternative 4 was chosen because it:

- Minimizes health risks by preventing public access and controlling worker access to the contaminated soil through removal of surface soils and administrative controls.
- Complies with waste management standards because all waste will be managed in accordance with applicable federal, state, and local requirements.
- Minimizes long-term risks through removal of contaminated surface and limited subsurface soils, administrative controls, and natural attenuation of the COCs.
- Utilizes standard construction equipment for removal of contaminated soil for ease of implementation; administrative controls are easily implemented because the site has controlled access.
- Monitoring provides evidence of natural attenuation.
- Provides 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. 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 eliminate potential future exposure pathways to the contaminated soil at the FTP.

This alternative will present minor risks to site workers during corrective action implementation. Therefore, appropriate health and safety procedures will be developed and implemented.

5.0 References

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Appendix A

Corrective Action Investigation Report for Corrective Action Unit 342: Area 23 Mercury Fire Training Pit, Nevada Test Site

A.1.0 Introduction

The report contained in this appendix presents the investigation activities and analytical results from the corrective action investigation conducted at CAU 342, Area 23 Mercury Fire Training Pit, which consists of CAS 23-56-01. The corrective action investigation was conducted in accordance with the requirements set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 342: Area 23 Mercury Fire Training Pit Nevada Test Site, Nevada* (DOE/NV, 1998) as developed under the FFACO (1996).

The FTP is located in Area 23 of the NTS on the west side of the Mercury Bypass Road and was used between approximately 1965 and 1990 to train fire-fighting personnel. Additional information relating to the site history, planning, and scope of the investigation is presented in the CAIP (DOE/NV, 1998) and is not repeated in this report.

A.1.1 Project Objectives

The primary objectives for this project were to:

- Identify the presence and nature of COPCs at the FTP.
- Determine the vertical and lateral extent of COPCs at the FTP.
- Provide sufficient information and data to develop and evaluate appropriate corrective action for the CAU.

A conceptual site model was developed to support the DQO process (DOE/NV, 1998) and used to guide the investigation. The soil at the FTP was investigated by various techniques. A passive soil gas survey was conducted to qualitatively assess the presence of VOCs and TPH (DOE/NV, 1998). Surface and near-surface samples were collected for laboratory analysis at both random and biased sampling points using direct push as well as manual collection techniques. Subsurface soil at the FTP was investigated by drilling and collecting soil samples for field screening and laboratory analysis. Drilling locations were selected based on the conceptual site model.

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 methods.
- [Section A.3.0](#) summarizes the results of the laboratory analysis from the investigation.
- [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 Mercury FTP corrective action investigation.
- [Section A.6.0](#) cites the references.

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.

A.2.0 Field Investigation and Sampling Activities

Field investigation and sampling activities were divided into three phases. The first phase involved the characterization and removal of the surface features from the FTP (September 1997 - April 1998). This included sampling and disposal of the telephone poles and liquid waste contained in the ASTs; and removal of the four ASTs, burn tank, two wooden sheds, and various debris (Figure A.2-1). The second phase was the passive soil gas survey (December 1997). Details of these two phases are discussed in the CAIP (DOE/NV, 1998) and are not documented in this report. The third phase was the investigation of possible soil contamination at the site (May - June 1998). This was divided into two tasks: collection of surface and near-surface soil samples and collection of subsurface soil samples. Prior to sample collection, a biological resources survey was conducted. No endangered species were identified in the investigation area.

The soil sampling phase of the investigation was managed in accordance with the requirements set forth in the CAIP (DOE/NV, 1998). The field activities were performed in accordance with an approved Site-Specific Health and Safety Plan (IT, 1998b). 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, 1998). 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, 1996) 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 site investigation included an area approximately 350 by 450 ft (DOE/NV, 1998). There are no buildings or utilities within the CAS. Remaining surface features include the burn pit; small pieces of debris and scrap from historic site activities; and hydrocarbon and ash stains. The burn pit is approximately 65 by 27 ft and is defined by a low berm 2 in. to 10 in. high (Figure A.2-1).

Figure A.2-1
Aerial View of the Mercury Fire Training Pit

A.2.2 Surface and Near-Surface Investigation

Surface and near-surface samples were taken at 31 locations by a direct-push method (GeoProbe®). Samples were collected at both random and biased locations. Biased samples were collected at each of the potentially contaminated site elements and noticeably stained soil locations. Random samples were collected from the approximate center of each grid cell (DOE/NV, 1998) which did not contain a biased sample location or a borehole.

Samples were collected by hand at three locations at the FTP. These samples were not discussed in the CAIP and were taken at the discretion of the Site Supervisor. Two of these sample locations were rock and soil piles located in the northwest corner of the site. There was no historical or site evidence that indicated contamination at these locations. The third sample location was an oil stain in the AST area.

The locations of surface and near-surface samples collected with the direct-push method and the surface samples collected by hand are presented on [Figure A.2-2](#).

A.2.2.1 Direct-Push Operation

The direct-push equipment works by mechanically pushing and/or hammering a core barrel into the soil to the desired depth. The core barrel used at the FTP was 48 in. long with an outside diameter of 2 in. The core barrel was lined with five 6-in. and one 4-in. long stainless steel sleeves. To obtain good soil recovery, the exact drive depth of the core barrel varied from 4.5 to 5.5 ft bgs.

A.2.2.2 Sample Collection

Sample collection followed the procedures specified in the CAIP (DOE/NV, 1998). The core barrel was removed from the direct-push equipment and brought to the sample collection area. The core barrel was split open and screened for alpha and beta contamination. The breathing zone was also screened for VOCs. Sample sleeves were identified for collection. Teflon tape was placed over each end of the sleeve, the sleeve was capped, labeled, sealed with custody tape, and placed in an iced cooler with a trip blank. Each sample was made up of at least two sleeves. A third sleeve was submitted in some cases due to poor recovery in one of the sleeves designated for sample collection. Samples were collected at the locations identified in [Table A.2-1](#).

Figure A.2-2
Direct-Push and Manual Sample Collection Locations for Mercury Fire Training Pit

All samples were analyzed for total VOCs, total SVOCs, total RCRA metals, TPH, and PCBs. Samples collected from locations where physical evidence or site history indicated burning (e.g., cable racks, charcoal stains, and burn sheds) were analyzed for dioxins and furans. Surface samples were collected by hand for analyses using gamma spectroscopy at 18 of the 34 sample locations. [Table A.2-1](#) summarize the analyses performed on each sample.

Table A.2-1
Direct-Push and Surface Sample Locations and Analyses for
Mercury Fire Training Pit
(Page 1 of 4)

Sample Location ^a	Site Element ^b	Sample Number	Start Depth (ft)	End Depth (ft) ^c	Sample Type	Analyses & Comments ^d
NA	NA	FTP00001	NA	NA	Trip Blank	VOCs only
NA	NA	FTP00002	NA	NA	Rinsate Blank	Dioxins/Furans
NA	NA	FTP00003	NA	NA	Trip Blank	VOCs only
GP-F5	Random	FTP00004	0	1	Soil	-- ^d
		FTP00005	3	4		-- ^d
GP-F4	Random (Drainage ^e)	FTP00006	0	1	Soil	-- ^d
		FTP00007	3	4		-- ^d
GP-F3	Cable Racks	FTP00008	0	1	Soil	Dioxins/Furans, Gamma
		FTP00009	3	4		MS/MSD Dioxins/Furans
		FTP00010	0	1		Duplicate of FTP00008 Dioxins/Furans, Gamma
GP-F2	Cable Racks	FTP00011	0	1	Soil	Dioxins/Furans
		FTP00012	3	4		Dioxins/Furans
GP-F1	Random	FTP00013	0	1	Soil	-- ^d
		FTO00014 ^f	3	4		-- ^d
NA	NA	FTP00015	NA	NA	Trip Blank	VOCs only
NA	NA	FTP00016	NA	NA	Field Blank	Dioxins/Furans
NA	NA	FTP00017	NA	NA	Trip Blank	VOCs only
GP-E1	Random	FTP00018	0	1	Soil	-- ^d
		FTP00019	3	4		-- ^d
GP-E2a	Telephone poles	FTP00020	0	1	Soil	Gamma
		FTP00021	3	4		-- ^d
GP-E2b	Burn shed	FTP00022	0	1	Soil	Gamma
		FTP00023	3	4		-- ^d

Table A.2-1
Direct-Push and Surface Sample Locations and Analyses for
Mercury Fire Training Pit
(Page 2 of 4)

Sample Location ^a	Site Element ^b	Sample Number	Start Depth (ft)	End Depth (ft) ^c	Sample Type	Analyses & Comments ^d
GP-E3	Random	FTP00024	0	1	Soil	-- ^d
		FTP00025	3	4		-- ^d
GP-E4	Drainage ^e	FTP00026	0	1	Soil	-- ^d
		FTP00027	3	4		-- ^d
GP-E5	Random	FTP00028	0	1	Soil	Gamma
		FTP00029	3	4		-- ^d
NA	NA	FTP00030	NA	NA	Rinsate blank	Dioxins/Furans
NA	NA	FTP00031	NA	NA	Trip blank	VOCs only
GP-D5	Random	FTP00032	0	1	Soil	-- ^d
		FTP00033	3	4		-- ^d
GP-D4	Soil stains	FTP00034	0	1	Soil	Dioxins/Furans, Gamma
		FTP00035	3	4		MS/MSD Dioxins/Furans
		FTP00036	0	1		Duplicate of FTP00034 Dioxins/Furans, Gamma
GP-D3	Random	FTP00037	0	1	Soil	-- ^d
		FTP00038	3	4		-- ^d
GP-D2	Burn shed	FTP00039	0	1	Soil	Gamma
		FTP00040	3	4		-- ^d
GP-D1	Random	FTP00041	0	1	Soil	-- ^d
		FTP00042	3	4		-- ^d
NA	NA	FTP00043	NA	NA	Trip blank	VOCs only
C1	NA ^g	NA	NA	NA	NA	NA
GP-C2	Burned pallets	FTP00044	0	1	Soil	Gamma
		FTP00045	3	4		-- ^d
GP-C3	Soil stains	FTP00046	0	1	Soil	-- ^d
		FTP00047	3	4		-- ^d
GP-C4	Soil stains	FTP00048	0	1	Soil	Gamma
		FTP00049	3	4		-- ^d
GP-C5	Random	FTP00050	0	1	Soil	-- ^d
		FTP00051	3	4		-- ^d
NA	NA	FTP00052	NA	NA	Trip blank	VOCs only

Table A.2-1
Direct-Push and Surface Sample Locations and Analyses for
Mercury Fire Training Pit
(Page 3 of 4)

Sample Location ^a	Site Element ^b	Sample Number	Start Depth (ft)	End Depth (ft) ^c	Sample Type	Analyses & Comments ^d
GP-B5	Random (sample taken in wash)	FTP00053	0	1	Soil	-- ^d
		FTP00054	3	4		-- ^d
GP-B3b	Soil stain (small AST)	FTP00055	0	1	Soil	Gamma, TCLP Metals
		FTP00056	3	4		-- ^d
GP-B3a	Soil stain (large AST)	FTP00057	0	1	Soil	Gamma, TCLP Metals
		FTP00058	3	4		MS/MSD
		FTP00059	0	1		Duplicate of FTP00057 Gamma
NA	NA	FTP00060	NA	NA	Field blank	Dioxins/Furans
NA	NA	FTP00061	NA	NA	Trip blank	VOCs only
GP-B2	Bus	FTP00062	0	1	Soil	Gamma
		FTP00063	3	4		-- ^d
GP-B1	Random	FTP00064	0	1	Soil	Dioxins/Furans, Gamma
		FTP00065	3	4		Dioxins/Furans
NA	NA	FTP00066	NA	NA	Trip blank	VOCs only
GP-A1	Random	FTP00067	0	1	Soil	Dioxins/Furans, Gamma
		FTP00068	3	4		Dioxins/Furans
GP-A2	Random	FTP00069	0	1	Soil	-- ^d
		FTP00070	3	4		-- ^d
GP-A3a	Soil stain (burn area)	FTP00071	0	1	Soil	Dioxins/Furans, Gamma
		FTP00072	3	4		Dioxins/Furans
GP-A3b	Soil stain (tire burn area)	FTP00073	0	1	Soil	Dioxins/Furans, Gamma
		FTP00074	3	4		Dioxins/Furans
GP-A4	Random	FTP00075	0	1	Soil	-- ^d
		FTP00076	3	4		-- ^d
GP-A5	Random	FTP00077	0	1	Soil	-- ^d
		FTP00078	3	4		-- ^d
NA	NA	FTP00079	NA	NA	Field blank	Dioxins/Furans
NA	NA	FTP00080	NA	NA	Trip blank	VOCs only
NA	NA	FTP00081	NA	NA	Rinsate blank	Dioxins/Furans
NA	NA	FTP00082	NA	NA	Trip blank	VOCs only
SS-A2	Soil pile	FTP00083	0.5	1.5	Soil	-- ^d

Table A.2-1
Direct-Push and Surface Sample Locations and Analyses for
Mercury Fire Training Pit
(Page 4 of 4)

Sample Location ^a	Site Element ^b	Sample Number	Start Depth (ft)	End Depth (ft) ^c	Sample Type	Analyses & Comments ^d
SS-B1	Soil pile	FTP00084	0.5	1.5	Soil	-- ^d
		FTP00085	0.5	1.5		Duplicate of FTP00084
SS-B4	Soil stain	FTP00086	0	1	Soil	MS/MSD TCLP Metals
NA	NA	FTP00087	NA	NA	Trip blank	VOCs only
NA	NA	FTP00088	NA	NA	Rinsate blank	Dioxins/Furans

^aThe prefix for the sample locations indicate the method of sample collection (i.e., GP - Direct-Push [GeoProbe[®]] and SS - Surface Sample collected by hand). See [Figure A.2-2](#) for actual locations.

^bSite elements, except for soil stains, have been removed. The soil at the former locations of these elements was sampled.

^cThe start and end depths listed are approximate.

^dAll samples were analyzed for the following unless otherwise noted: total VOCs; total SVOCs; total RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver) and zinc; TPH; and PCBs. Additional parameters are specified.

^eThis sample was collected in a natural drainage that originates from the "burn pit."

^fSample "FTO00014" is correct. The "P" was replaced by the "O" due to a typo introduced into the database.

^gSurface and near-surface samples were not collected using direct-push equipment because borehole B-2 was planned for this location ([Table A.2-2](#)).

NA = Not applicable

MS/MSD = Matrix spike/matrix spike duplicate

A.2.3 Subsurface Investigation

Seventeen vertical boreholes were drilled at the FTP to investigate the subsurface soils. The rotary sonic ("sonic") drilling method was used to extract continuous cores from vertical borings. Recovery of continuous core allowed for detailed 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 15 to 70 ft bgs. Field-screening for TPH (Hanby method) and VOCs (headspace screening) was used to guide the lateral and vertical extent 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. Borehole locations are shown on [Figure A.2-3](#).

Figure A.2-3
Borehole Locations for Mercury Fire Training Pit

A.2.3.1 Drilling Operations

The sonic drilling method uses vibration and rotation of the drill string to advance a core barrel and an outer casing. The casing is used to stabilize the hole and also minimizes potential cross contamination produced by soil from shallower depths falling down the hole (sloughing) as the core barrel is removed for core extrusion. After the bit at the end of the core barrel reaches the specified depth, the core barrel is withdrawn from the borehole and the contents are extruded into polyethylene (PE) bags. This investigation utilized 6-in. diameter core barrels with a 8-in. diameter casing. The casing was removed and the boreholes were filled with grout to complete each boring.

The sonic drilling method produced some heat from friction. On occasion, sample intervals were adjusted and samples were collected from a cooler section of the core. The temperature of the soil varied according to the difficulty of drilling (e.g., the soil was hotter when the ground was harder) due to the additional friction generated by driving the core barrel into harder and/or deeper conditions.

A.2.3.2 Field Screening

Field screening levels were established to guide the advancement of each borehole and selection of samples for laboratory analyses. The screening levels established were as follows:

- Total Petroleum Hydrocarbons - 100 mg/kg in accordance with the NDEP screening levels for TPH (NAC, 1996)
- Volatile Organic Compounds - 20 parts per million or 2.5 times background, whichever is higher (DOE/NV, 1998)
- Radioactivity - two times background levels (DOE/NV, 1998)

Field screening was performed at 5-ft intervals to total depth or to 50 ft. Below 50 ft, field screening was performed at 10-ft intervals. The field screening methods included:

- Total Petroleum Hydrocarbons - Hanby field testing kit manufactured by Hanby Environmental Laboratory Procedures, Inc.
- Volatile Organic Compounds - Headspace screening using a photoionization detector (PID) in conjunction with a warm water bath at a constant temperature.
- Radioactivity (alpha and beta) - Electra™ instrument

At the discretion of the Site Supervisor, TPH field screening was not conducted at all specified locations to reduce use of TPH field screening reagents and minimize associated hazardous waste. The presence of odor and/or soil staining, VOC field screening results, and TPH field screening results in adjacent sample locations were used to select which locations would not be field screened. Supplementary field screening was conducted at the discretion of the Site Supervisor.

A.2.3.3 Sample Collection

Sample collection followed the procedures specified in the CAIP (DOE/NV, 1998) with the exception of the samples collected at varying depths due to heat in the soil core as explained in [Section A.2.3.1](#). Soil cores were removed from the boreholes and transferred to the sampling area in approximately 2.5 ft lengths contained in PE bags. The bags were split open and screened for alpha and beta emitting radionuclides. The soil and breathing zone were monitored for VOCs before sample collection using a PID. Samples were collected in appropriate containers with temporary sample labels. Samples to be analyzed for volatile parameters (total VOCs, TPH gasoline, TPH field screening, headspace field screening, and TCLP VOCs as appropriate) were collected directly from the soil cuttings immediately after required radiation field screening and VOC monitoring was performed. The remainder of the samples (TPH oil and diesel, SVOCs, total RCRA metals, PCBs, Dioxins and Furans, Gamma Spectroscopy, and TCLP metals as appropriate) were collected from soil representative of the sampling interval after homogenization in a stainless steel bowl. Samples were obtained at the locations specified in [Table A.2-2](#).

After laboratory samples were identified, temporary labels were removed and the jars were labeled for shipment to the laboratory. 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. Samples not submitted to the laboratory were containerized with other soil cores from the same boring upon removing or defacing temporary sample labels and removing sample jar lids.

Samples were analyzed for the parameters identified in [Table A.2-2](#).

Table A.2-2
Samples Collected During Subsurface Investigation at the Mercury Fire Training Pit
(Page 1 of 3)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Sample Type	Analyses & Comments ^a
NA	FTP00090	NA	NA	Trip Blank	VOCs only
NA	FTP00092	NA	NA	Field Blank	Dioxins/Furans
B-1	FTP00089	0	1	Soil	Gamma, TCLP Metals, TCLP VOCs, Dioxins/Furans
	FTP00091	4	5	Soil	TCLP Metals, TCLP VOCs, Dioxins/Furans
	FTP00094	19	20	Soil	Dioxins/Furans, TCLP Metals
	FTP00095	29	30	Soil	Dioxins/Furans
	FTP00093	30	31.5	Soil	Geotechnical & Microbial parameters only
	FTP00096	34	35	Soil	Dioxins/Furans
	FTP00097	34	35	Soil	Dioxins/Furans Duplicate of FTP00096
NA	FTP00098	NA	NA	Trip Blank	VOCs only
B-2	FTP00099	0	5	Soil	MS/MSD
	FTP00100	9	10	Soil	-- ^a
	FTP00101	14	15	Soil	-- ^a
B-3	FTP00103	4	5	Soil	Dioxins/Furans
	FTP00104	14	15	Soil	Dioxins/Furans
	FTP00105	19	20	Soil	Dioxins/Furans
	FTP00102	20	21.5	Soil	Geotechnical & Microbial parameters only
NA	FTP00106	NA	NA	Trip Blank	VOCs only
B-4	FTP00107	4	5	Soil	TCLP VOCs
	FTP00108	14	15	Soil	-- ^a
	FTP00109	19	20	Soil	-- ^a
B-5	FTP00111	4	5	Soil	Dioxins/Furans, TCLP Metals
	FTP00110	5	6.5	Soil	Geotechnical & Microbial parameters only
	FTP00112	9	10	Soil	Dioxins/Furans, TCLP Metals
	B5-14-15M	16	17.5	Soil	Microbial parameters only
	FTP00113	24	25	Soil	Dioxins/Furans
	FTP00114	29	30	Soil	Dioxins/Furans
NA	FTP00115	NA	NA	Trip Blank	VOCs only
NA	FTP00116	NA	NA	Field Blank	Dioxins/Furans
NA	FTP00117	NA	NA	Trip Blank	VOCs only
NA	FTP00119	NA	NA	Rinsate Blank	Dioxins/Furans

Table A.2-2
Samples Collected During Subsurface Investigation at the Mercury Fire Training Pit
(Page 2 of 3)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Sample Type	Analyses & Comments ^a
B-6	FTP00120	4	5	Soil	Dioxins/Furans
	FTP00121	14	15	Soil	Dioxins/Furans
	FTP00118	16	17.5	Soil	Geotechnical parameters only
	FTP00122	19	20	Soil	Dioxins/Furans
B-7	FTP00123	4	5	Soil	Dioxins/Furans
	FTP00124	14	15	Soil	Dioxins/Furans
	FTP00125	19	20	Soil	Dioxins/Furans
NA	FTP00126	NA	NA	Trip Blank	VOCs only
B-8	FTP00128	9	10	Soil	TCLP Metals
	B8-14-15M	14	15	Soil	Microbial parameters only
	FTP00129	34	35	Soil	-- ^a
	FTP00130	49	50	Soil	-- ^a
	FTP00131	59	60	Soil	-- ^a
	FTP00132	69	70	Soil	-- ^a
NA	FTP00127	NA	NA	Trip Blank	VOCs only
B-9	FTP00133	9	10	Soil	TCLP Metals
	FTP00134	19	20	Soil	-- ^a
	FTP00135	24	25	Soil	-- ^a
B-10	FTP00136	14	15	Soil	-- ^a
	FTP00137	29	30	Soil	MS/MSD
	FTP00138	34	35	Soil	-- ^a
	FTP00139	34	35	Soil	Duplicate of FTP00138
	FTP00140	39	40	Soil	-- ^a
NA	FTP00141	NA	NA	Trip Blank	VOCs only
NA	FTP00142	NA	NA	Rinsate Blank	Dioxins/Furans
NA	FTP00143	NA	NA	Trip Blank	VOCs only
NA	FTP00144	NA	NA	Field Blank	Dioxins/Furans
B-11	FTP00145	19	20	Soil	-- ^a
	FTP00146	39	40	Soil	-- ^a
	FTP00147	44	45	Soil	-- ^a
B-12	FTP00149	19	20	Soil	-- ^a
	FTP00148	35	36.5	Soil	Geotechnical & Microbial parameters only
	FTP00150	49	50	Soil	-- ^a
	FTP00151	69	70	Soil	-- ^a
NA	FTP00152	NA	NA	Trip Blank	VOCs only
B-13	FTP00153	39	40	Soil	-- ^a

Table A.2-2
Samples Collected During Subsurface Investigation at the Mercury Fire Training Pit
(Page 3 of 3)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Sample Type	Analyses & Comments ^a
B-14	FTP00154	24	25	Soil	TCLP Metals
	B14-29-30M	29	30	Soil	Microbial parameters only
	FTP00155	39	40	Soil	-- ^a
	FTP00156	68	69	Soil	-- ^a
B-15	FTP00157	26	27	Soil	-- ^a
B-16	FTP00160	18.5	19	Soil	-- ^a
	FTP00161	33	34	Soil	-- ^a
	FTP00158	40	41.5	Soil	Geotechnical parameters only
	FTP00159	50	51.5	Soil	Geotechnical & Microbial parameters only
	FTP00162	54	55	Soil	-- ^a
B-17	FTP00163	29	30	Soil	-- ^a
	FTP00164	51.5	52.5	Soil	-- ^a

^aAll soil samples were analyzed for the following unless otherwise noted: total VOCs; total SVOCs; total RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver); TPH; and PCBs. Additional parameters are specified.

NA = Not applicable

MS/MSD = Matrix spike/matrix spike duplicate

A.2.4 Waste Management

Investigation derived waste was segregated into the following waste streams:

- Personal protective equipment and disposable sampling equipment
- Decontamination rinsate
- Soil and debris (plastic sheeting, sample jars, PE bags) incidental to sample collection
- Plastic used under drill rig and to line decontamination sumps
- Personal protective equipment, sampling debris, spent solvent, soil, and rinsate generated from the use of the Hanby field screening kit

Potentially hazardous waste generated during the investigation was placed in 55-gallon drums, labeled as "Hazardous Waste - Pending Analysis," and placed in a 90-day Hazardous Waste

Accumulation Area. The amount, type, and source of waste placed into each drum was recorded in a waste management log.

A total of 89 55-gallon drums of waste were generated during the investigation. The waste in 13 drums was characterized as hazardous and turned over to the NTS prime contractor for shipment to an off-site treatment, storage, and disposal facility. Waste was characterized as hazardous due to elevated lead (Sample FTP00011) or cadmium (Samples FTP00089 and FTP00091) concentrations, or because it was associated with TPH field testing kits which utilize carbon tetrachloride as a solvent. The remaining waste was characterized as sanitary and turned over to the NTS prime contractor for disposal in an on-site sanitary waste disposal unit.

A.2.5 Geology

The FTP is located on an alluvial slope. The surface slopes toward the southwest from Red Mountain (carbonate rock) toward Mercury Valley and consists of detrital material composed of silty sands, gravels, and cobbles. Localized caliche is present to 55-ft bgs. Some cobbles up to 6-in. in diameter were noted.

Field descriptions performed by the field geologist for each boring were recorded on a Visual Classification of Soil Log, and indicate that the stratigraphy is dominated by moderate to poorly sorted gravelly sand, with occasional silty gravelly sand. Small lenses of silt and clay are also present, along with isolated caliche layers. The caliche was noted as follows:

- B-10 Approximately 3-in. thick caliche layer noted at 11 to 12 ft bgs and 24 to 25 ft bgs.
- B-12 Caliche layers noted at 12 to 13 ft bgs, 42 to 42.5 ft bgs, 53 ft bgs, and 57.5 to 60 ft bgs.
- B-13 Approximately 3-in. thick caliche layer noted at 25 ft bgs.
- B-17 Approximately 2-in. thick caliche layer noted at 51.5 ft bgs.

The caliche layers in boreholes B-10, B-12, B-13, and B-17 correspond with either decreased or below detection level TPH field screening readings, indicating that the caliche is acting as an impediment to contaminant migration. See [Appendix B](#) for the complete soil boring logs.

A.2.6 Hydrology

Average annual precipitation for valleys in the South-Central Great Basin range from 3 to 6 in. (Winograd and Thordarson, 1975). Precipitation events are ephemeral and highly variable in the arid environment. Ponding of precipitation within the burn pit is possible. The burn pit is surrounded by a low berm ranging from 2-in. to 10-in. high, and enclosing a 2,400 ft² area. Standing water is unlikely for the remainder of the FTP because the site is well drained by adjacent stream drainages on the east and west. The elevation at the site is approximately 3,740 ft above sea level (USGS; 1983a and b). At Mercury Valley the depth to groundwater ranges from 800 to 1,100 ft bgs (Winograd and Thordarson, 1975; Robie et al., 1995).

A.3.0 Investigation Results

The analytical results of samples collected from the FTP 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 in the project files.

During the investigation activities, 167 samples (133 soil and 34 liquid samples) were collected and submitted for laboratory analysis. Eight soil samples were submitted for bioassessment analysis. Seven were submitted for geotechnical analysis. Six field duplicates were collected and submitted for laboratory analysis. Nine samples were resubmitted for additional analysis (TCLP metals) based on review of initial results. The recollection of one sample for PCB analysis was required after initial results were rejected during validation.

The analytical parameters and laboratory analytical methods requested for this investigation are presented in [Table A.3-1](#). The analytical parameters were selected through the application of site knowledge using the EPA'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 IX 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, 1998). Sampling activities were designed to detect contaminants of potential concern and conducted to either prove or disprove the assumptions made in the DQO process.

Samples collected from the FTP were analyzed by Quanterra Environmental Services in Earth City, Missouri. Additional analyses (TCLP and totals metals) for several samples were performed at DataChem Laboratories Inc., in Salt Lake City, Utah. Geotechnical samples were analyzed by Converse Consulting in Las Vegas, Nevada. The bioassessment was performed by IT Corporation in Knoxville, Tennessee. Third-party data validation was performed by Lockheed-Martin Environmental Services in Las Vegas, Nevada.

Table A.3-1
Laboratory Analytical Methods
Used for the Mercury Fire Training Pit Investigation Soil Samples

Chemical and Radiological Parameter	Analytical Method
Total petroleum hydrocarbons (diesel/oil & gasoline)	EPA 8015B (modified) ^a
Total RCRA metals (arsenic, barium, cadmium, chromium, lead, selenium, silver, and mercury) and zinc	EPA 6010B/7470A/7471A ^a
TCLP metals	EPA1311/7470A/7471A ^a
	EPA 1311/6010B ^a
Total volatile organic compounds	EPA 8260B ^a
TCLP volatile organic compounds	EPA 1311/8260B ^a
Total semivolatile organic compounds	EPA 8270C ^a
Dioxins and Furans	EPA 8280 ^a
Total polychlorinated biphenyls	EPA 8082 ^a
Gamma-Emitting Radionuclides	HASL 300, 4.5.2.3 ^b
Geotechnical and Hydraulic Parameters	Method
Initial moisture content	ASTM D 2216 ^c
Dry bulk density	EM-1110-2-1906 ^d
Calculated porosity	EM-1110-2-1906 ^d
Saturated hydraulic conductivity	ASTM D 5084 ^c
Unsaturated hydraulic conductivity	Not analyzed ^e
Particle-size distribution	ASTM D 422 ^c
Water-release (moisture retention) curve	ASTM D 3152 ^c
Bioassessment Parameters	Method
Soil pH and moisture	Laboratory specific ^f
Background nutrient concentrations	
Microbial enumerations	
Microbial stimulation test	

^aEPA *Test Methods for Evaluating Solid Waste*, 3rd Edition, Parts 1-4, SW-846 (EPA, 1996b)

^b*Environmental Measurements Laboratory Procedures Manual*, HASL-300, U. S. Department of Energy (DOE, 1992)

^c*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

^dU.S. Army Corps of Engineers (USACE), *Engineer Manual* (EM) 1110-2-1906, "Laboratory Soils Testing," Appendix II, 1970

^eTest requested but not performed by laboratory due to soil characteristics

^fTechniques described in *Bioassessment Report Nevada Test Site CAU 342; Area 23 Mercury Fire Training Pit*, IT Corporation, 1998a

A.3.1 Total Petroleum Hydrocarbon Analytical Results

The TPH compounds detected above minimum reporting limits (DOE/NV, 1998) are provided in [Table A.3-2](#). Concentrations exceeding the action level of 100 mg/kg are shaded. Diesel, waste oil, gasoline, and unknown hydrocarbons were detected in the soil samples. The unknown hydrocarbons were detected in the diesel and waste oil analyses of the soil samples but did not match either the diesel or the waste oil peak patterns. These unknown hydrocarbons could be attributed to aromatic, halogenated and nonhalogenated volatile, and semivolatile compounds, and/or other petroleum hydrocarbons (i.e., nondiesel, nongasoline, and nonwaste oil) present in the samples.

Table A.3-2
Soil Sample Results for Total Petroleum Hydrocarbons Detected Above Minimum Reporting Limits, Mercury Fire Training Pit, Nevada Test Site
(Page 1 of 2)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/kg)			
				Diesel	Waste Oil	Gasoline	Unknown Hydrocarbon
GP-E2a	FTP00020	0	1	--	--	--	440
GP-E2a	FTP00021	3	4	--	--	--	420
GP-E2b	FTP00022	0	1	--	--	--	130
GP-E3	FTP00024	0	1	--	--	--	45
GP-E3	FTP00025	3	4	--	--	--	100
GP-E4	FTP00026	0	1	--	--	--	230
GP-E4	FTP00027	3	4	--	--	--	420
GP-E5	FTP00028	0	1	--	--	--	180
GP-E5	FTP00029	3	4	--	--	--	370
GP-D4	FTP00034	0	1	--	--	--	210
GP-D4	FTP00035	3	4	--	--	--	590
GP-D4	FTP00036	0	1	--	--	--	760
GP-C4	FTP00048	0	1	250	--	--	--
GP-C4	FTP00049	3	4	--	--	--	3,000
GP-B3b	FTP00055	0	1	--	--	--	4,000
GP-B3b	FTP00056	3	4	2,800	--	--	--
GP-B3a	FTP00057	0	1	--	--	--	410
GP-B3a	FTP00058	3	4	2,500	--	--	--
GP-B3a	FTP00059	0	1	--	--	--	130
GP-B2	FTP00062	0	1	--	1,400	--	--
SS-B4	FTP00086	0	1	--	--	--	4,000
B-1	FTP00089	0	1	4,100 (J)	--	4.8 (Y)	--
B-1	FTP00091	4	5	3,400 (J)	--	5.2 (Y)	--
B-1	FTP00094	19	20	10,000 (J)	--	1.7 (Y)	--
B-3	FTP00103	4	5	--	--	--	37

Table A.3-2
Soil Sample Results for Total Petroleum Hydrocarbons Detected Above Minimum
Reporting Limits, Mercury Fire Training Pit, Nevada Test Site
(Page 2 of 2)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/kg)			
				Diesel	Waste Oil	Gasoline	Unknown Hydrocarbon
B-3	FTP00104	14	15	--	--	--	46
B-4	FTP00107	4	5	--	--	--	27
B-4	FTP00108	14	15	--	230	--	--
B-4	FTP00109	19	20	140	--	--	--
B-5	FTP00111	4	5	--	--	--	3,300
B-5	FTP00112	9	10	--	--	--	10,000
B-7	FTP00124	14	15	--	--	--	61
B-8	FTP00128	9	10	16,000 (J)	--	530 (Y)	--
B-8	FTP00129	34	35	--	--	1.6 (Y)	--
B-9	FTP00133	9	10	13,000 (J)	--	4.6 (Y)	--
B-10	FTP00136	14	15	7,600 (J)	--	9.3 (Y)	--
B-10	FTP00139	34	35	--	--	--	32
B-11	FTP00145	19	20	3,000 (J)	--	58 (Y)	--
B-12	FTP00149	19	20	7,500 (J)	--	54 (Y)	--
B-14	FTP00154	24	25	18,000 (J)	--	3,000 (J)	--
B-14	FTP00155	39	40	57	--	11 (J)	--
B-16	FTP00160	18.5	19	5,400 (J)	--	320 (J)	--
B-16	FTP00161	33	34	--	--	2.5 (J)	43
B-16	FTP00162	54	55	--	--	13 (J)	--
B-17	FTP00163	29	30	--	--	1.2 (J)	--

-- = Not detected above minimum reporting limits

J = Estimated value

Y = The chromatogram patterns do not match the peak patterns

Shaded area = Analytical result exceeds the 100 mg/kg NDEP established action level

The majority of the petroleum hydrocarbon contamination is confined to two general areas of the FTP: the burn pit and the fuel storage area (location of ASTs). These areas are depicted in the contaminant distribution diagram shown in [Figure A.3-1](#). Contamination associated with site elements discussed in Table 3-1 of the CAIP (DOE/NV, 1998), as well as additional locations, is described in the following subsection.

A.3.1.1 Aboveground Storage Tanks Area

Diesel, gasoline, and unknown hydrocarbons were detected in the AST area. The contamination appears to have had at least three point sources: one at the former location of the rail car AST as

evidenced by a surface soil stain and the other two are from the former locations of the small ASTs also evidenced by surface soil stains. No surface stain was evident in the former location of the “green tanker” AST. Each stain appears to be the result of leakage from the ASTs. Each of these sources appear to have contributed to a subsurface plume of contamination.

The source of the largest lobe of the plume appears to have been one or both of the large ASTs (rail car and green tanker [Figure A.2-1]) that were used at the FTP. A surface stain approximately 1 ft in diameter was evident at the former location of the rail car. Samples were collected from the location of the stain by both direct-push equipment (GP-B3a) and subsurface drilling (B-8). Subsequent stepout borings (B-11, B-12, B-14, B-15, B16, And B-17) were drilled to asses the lateral and vertical extent of the plume. The maximum depth of this lobe of the plume is approximately 50-ft bgs as shown in the interpretive cross sections shown in Figure A.3-2 and Figure A.3-3.

The sources of the two smaller lobes of the plume appear to have been the two small ASTs that were stored on site. Small surface stains were evident at the former location of each of the small ASTs. The easternmost of these stains was sampled by direct-push equipment (GP-B3b) and subsurface drilling (B-9). The westernmost stain was sampled by subsurface drilling (B-10). The maximum depth of the contamination is no greater than 20-ft bgs from the easternmost stain and no more than 30-ft bgs from the westernmost stain. The horizontal extent of these lobes of the plume is not well defined but is thought to have a radius no greater then the total depth of the contamination in this part of the plume. A single stepout boring (B-13) was drilled between B-9 and B-10. No TPH was detected in borehole B-13. This suggests that there are two or three plumes, not one continuous plume (Figure A.3-2 and Figure A.3-3). However, due to the proximity of the surrounding detections of TPH, the plumes are assumed to be contiguous for the purposes of modeling the lateral extent of the TPH contamination (Figure A.3-1).

As shown in Figure A.3-1, the combined lobes of the AST plume have a maximum length and width of approximately 130 by 80 ft.

A.3.1.2 Burn Area Near Bus

Four samples were obtained by direct-push equipment (GP-B1 and GP-A1) within the historical burn area near the bus. No petroleum hydrocarbons were detected above minimum reporting limits.

Figure A.3-2
Cross Section of AST Subsurface Plume (West/East)

Figure A.3-3
Cross Section of AST Subsurface Plume (North/South)

Borehole B-2 was drilled just south of this area in a spot identified by the passive soil gas survey as likely hydrocarbon contamination area (DOE/NV, 1998). No hydrocarbons were identified in samples collected from borehole B-2.

A.3.1.3 Burn Pit

Diesel, gasoline, and unknown hydrocarbons were detected in this area. The surface area inside the berm is heavily stained. Two boreholes (B-1 and B-5) were drilled inside the berm. Step-out boreholes were drilled on the south side berm (B-7), approximately 15 ft from the southeast corner of the burn pit (B-3), and approximately 10 ft from middle of the north side of the burn pit (B-6), as shown in [Figure A.2-3](#). The contamination extends from the surface of the burn pit to a depth of approximately 30-ft bgs as shown in the interpretive cross section ([Figure A.3-4](#)). There was no TPH contamination detected above 100 mg/kg in the boreholes outside the berm. The plume is assumed to have the same approximate dimensions as the berm defining the burn pit. Therefore, the burn pit plume has a length (east - west) of approximately 65 ft and a width (north - south) of approximately 27 ft. Surface contamination extends downgradient of the burn pit ([Figure A.3-1](#)) as discussed in [Section A.3.1.8](#).

A.3.1.4 Bus

Two samples were obtained by direct-push (GP-B2) from a soil stain at the approximate former location of the bus. Waste oil was detected above the PALs in the sample collected at the 0 to 1 ft bgs interval at this location. No petroleum hydrocarbons were detected above the minimum reporting limits in the sample collected from the 3- to 4-ft bgs interval.

A.3.1.5 Cable Racks

Four samples were obtained by direct-push (GP-F3 and GP-F2) from the former location of the cable racks. No petroleum hydrocarbons were detected above minimum reporting limits.

A.3.1.6 Pallets and Wood Debris

Two samples were obtained by direct-push (GP-C2) at the former location of the pallets and wood debris. No petroleum hydrocarbons were detected above minimum reporting limits.

B-3, B-5, and B-7 Projected Onto Plane

Explanation	Notes
(D) = Diesel	1. Analytical Lab Results on Right Side of Borehole in mg/kg
(G) = Gasoline	2. Hanby Field Test Results on Left Side of Borehole in mg/kg
(U) = Unknown	3. Contour Lines Drawn Based on a Combination of Analytical and Hanby Results
• = Lab Sample	
▲ = Microbial Sample	

Scale

Figure A.3-4
Cross Section of Burn Pit Plume

A.3.1.7 Sheds

Two samples were collected by direct-push (GP-E2b and GP-D2) from the former locations of the burn sheds. An unknown hydrocarbon was detected above the PAL in the sample collected at the 0- to 1-ft bgs interval at the GP-E2b location (southernmost shed). No petroleum hydrocarbons were detected above minimum reporting limits in the sample collected at the 3- to 4-ft bgs interval of the GP-E2b location or at either interval of the GP-D2 location (northernmost shed).

A.3.1.8 Stained Soil Areas

Several areas of surface staining not specifically covered under another heading were sampled. Two main areas of surface stains were sampled by direct-push: the area downgradient of the burn pit, and the area downgradient of the AST area. A small surface stain near the AST area was also sampled.

A total of 16 samples were obtained by direct-push in the area downgradient of the burn pit. Surface staining is evident in this area and is believed to have originated from overflow and surface runoff from the burn pit (Figure A.2-1). An unknown hydrocarbon was detected in both the 0- to 1-ft bgs and the 3- to 4-ft bgs intervals in direct-push locations GP-E5, GP-E4, GP-E3, and GP-D4 closest to the burn pit (Figure A.3-1). Sample location GP-E4 was located in the middle of a shallow natural drainage originating from the southwest corner of the burn pit (Figure A.2-1). No petroleum hydrocarbons were detected above minimum reporting limits at sample location GP-F4 which is further downgradient in the same natural drainage. No petroleum hydrocarbons were detected above minimum reporting limits in sample locations GP-F5, GP-F4, and GP-F2 which are also further downgradient (Figure A.3-1).

Four samples were obtained by direct-push in the area downgradient of the AST area. Surface staining is evident in this area and is believed to have originated from leaking hoses transferring fuel from the AST area to the burn pit and from surface runoff from the AST area (Figure A.2-1). Diesel was detected in the 0- to 1-ft bgs interval and an unknown hydrocarbon was detected in the 3- to 4-ft bgs interval at sample location GP-C4 (Figure A.3-1). No petroleum hydrocarbons were detected above minimum reporting limits at sample location GP-C3.

One sample was collected using hand collection methods from a surface stain to the east of the former locations of the small ASTs. The stain has a diameter of approximately 2 ft and appears to be the

result of a localized spill of oil or other heavy hydrocarbon. An unknown hydrocarbon was detected in the sample collected at this location (SS-B4).

The vertical extent of the contamination associated with these stains has not been defined; however, it is expected to be limited due to release mechanisms, surface grade, and low precipitation rates.

A.3.1.9 Telephone Poles

Two samples were obtained by direct-push (GP-E2a) at the former location of the telephone poles. Unknown hydrocarbons were detected above the PAL at the both the 0- to 1-ft and 3- to 4-ft bgs intervals at this location. Staining is evident in this area; however, it appears to be associated with debris from the telephone poles and not hydrocarbon staining.

A.3.1.10 Tire Burn Area

Two areas containing burned tire and other debris were sampled by direct-push (GP-A3a and GP-A3b). No petroleum hydrocarbons were detected above minimum reporting limits.

A.3.1.11 Borehole B-4

Borehole B-4 was drilled at the center of the area identified in the CAIP as a possible chlorinated hydrocarbon plume based on the soil gas survey (DOE/NV, 1998). Waste oil was detected above the PAL in the sample collected from the 14- to 15-ft bgs interval and diesel was detected above the PAL in the sample collected from the 19- to 20-ft bgs interval. No samples were collected from lower depths because field screening results were negative (nondetects). No chlorinated hydrocarbons were identified in samples collected from this borehole.

A.3.2 Total Volatile Organic Compound Analytical Results

The total VOC analytical results above the minimum reporting limits (DOE/NV, 1998), along with the associated PALs, are presented in [Table A.3-3](#). Data indicate that constituents were either not present above the minimum reporting limits or, if present, were below the PALs, except for one sample in which xylene was detected above the PAL.

Table A.3-3
Soil Sample Results for Total Volatile Organic Compounds Detected Above the Minimum Reporting Limit,
Mercury Fire Training Pit, Nevada Test Site
(Page 1 of 3)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (µg/kg)												
				Methylene Chloride	Chloromethane	1,1,2-Trichloroethane	2-Hexanone	MIBK	1,1,1-Trichloroethane	Acetone	Tetrachloroethene	MEK	Toluene	Xylene (total)	Bromomethane	EthylBenzene
Preliminary Action Levels ^a				18,000	2,600	1,500	NI	2,800,000	3,000,000	8,800,000	17,000	27,000,000	880,000	320,000	23,000	230,000
GP-F2	FTP00011	0	1	42 (B)	--	--	--	--	--	--	--	--	--	--	--	--
GP-E2a	FTP00020	0	1	39 (B)	--	--	--	--	--	--	--	--	--	--	--	--
GP-E2b	FTP00022	0	1	34 (B)	6 (J)	--	--	--	--	--	--	--	--	--	--	--
GP-E3	FTP00024	0	1	39 (B)	--	--	--	--	--	--	--	--	--	--	--	--
GP-E4	FTP00026	0	1	46 (B)	--	--	--	--	--	--	--	--	--	--	--	--
GP-E5	FTP00028	0	1	43 (B)	--	--	--	--	--	--	--	--	--	--	--	--
GP-D5	FTP00032	0	1	--	--	--	7 (J)	6 (J)	--	--	--	--	--	--	--	--
GP-D5	FTP00033	3	4	--	--	--	--	--	--	--	--	--	--	--	--	--
GP-D3	FTP00037	0	1	40 (B)	--	--	--	--	--	--	--	--	--	--	--	--
GP-C3	FTP00047	3	4	41 (J)	--	--	--	--	--	76 (J)	--	--	--	--	--	--
GP-C4	FTP00048	0	1	--	--	--	--	--	7	--	--	--	--	--	--	--
GP-C4	FTP00049	3	4	--	--	--	--	--	51	--	8	--	--	--	--	--
GP-C5	FTP00051	3	4	31 (J)	--	--	--	--	--	--	--	--	--	--	--	--
GP-B3b	FTP00055	0	1	--	--	--	--	--	12	--	20 (J)	--	--	--	--	--
GP-B3b	FTP00056	3	4	--	--	--	--	--	34	--	100 (J)	--	--	--	--	--
GP-B3a	FTP00058	3	4	--	--	--	--	--	--	--	6 (J)	--	--	--	--	--
GP-A3b	FTP00074	3	4	6 (B)	--	--	--	--	--	32 (B)	--	14 (BJ)	--	--	--	--
SS-B4	FTP00086	0	1	--	--	--	--	8 (J)	13	120 (J)	34 (J)	--	--	--	--	--

Table A.3-3
Soil Sample Results for Total Volatile Organic Compounds Detected Above the Minimum Reporting Limit,
Mercury Fire Training Pit, Nevada Test Site
(Page 2 of 3)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (µg/kg)												
				Methylene Chloride	Chloromethane	1,1,2-Trichloroethane	2-Hexanone	MIBK	1,1,1-Trichloroethane	Acetone	Tetrachloroethene	MEK	Toluene	Xylene (total)	Bromomethane	EthylBenzene
Preliminary Action Levels ^a				18,000	2,600	1,500	NI	2,800,000	3,000,000	8,800,000	17,000	27,000,000	880,000	320,000	23,000	230,000
B-1	FTP00089	0	1	8 (J)	--	--	--	--	--	350 (J)	--	68 (J)	--	--	--	--
B-1	FTP00091	4	5	28	--	--	--	--	38	190 (J)	--	67 (J)	6 (J)	--	--	--
B-1	FTP00094	19	20	13 (J)	--	98	--	--	9 (J)	--	--	--	--	--	--	--
B-1	FTP00095	29	30	--	--	40	--	--	--	--	--	--	--	--	--	--
B-1	FTP00096	34	35	--	--	10 (J)	--	--	--	--	--	--	--	--	--	--
B-2	FTP00099	0	5	8	--	--	--	--	--	--	--	--	--	--	--	--
B-2	FTP00100	9	10	7	--	--	--	--	--	--	--	--	--	--	--	--
B-2	FTP00101	14	15	--	--	--	--	--	--	--	--	--	--	--	34 (J)	--
B-3	FTP00103	4	5	--	--	--	--	--	--	--	--	--	--	--	39 (J)	--
B-4	FTP00109	19	20	--	--	--	--	--	--	--	--	--	--	--	16 (J)	--
B-5	FTP00112	9	10	--	--	9 (J)	--	--	--	--	--	--	--	--	--	--
B-5	FTP00114	29	30	--	--	6	--	--	--	--	--	--	--	--	--	--
B-6	FTP00120	4	5	--	--	--	--	--	--	--	--	--	--	--	--	--
B-8	FTP00128	9	10	3,000 (BJ)	--	--	--	--	--	43,000 (J)	--	--	--	25,000 (J)	--	--
B-8	FTP00129	34	35	--	--	--	--	--	--	--	--	--	--	--	--	--
B-10	FTP00137	29	30	--	--	--	--	--	--	--	--	--	--	53	--	--
B-12	FTP00150	49	50	--	--	--	--	--	--	--	--	--	--	1,800 (J)	--	--
B-14	FTP00154	24	25	--	--	--	--	--	--	--	--	--	47,000 (J)	480,000 (J)	--	58,000 (J)

Table A.3-3
Soil Sample Results for Total Volatile Organic Compounds Detected Above the Minimum Reporting Limit,
Mercury Fire Training Pit, Nevada Test Site
(Page 3 of 3)

Sample Location		Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (µg/kg)												
					Methylene Chloride	Chloromethane	1,1,2-Trichloroethane	2-Hexanone	MIBK	1,1,1-Trichloroethane	Acetone	Tetrachloroethene	MEK	Toluene	Xylene (total)	Bromomethane	EthylBenzene
Preliminary Action Levels ^a					18,000	2,600	1,500	NI	2,800,000	3,000,000	8,800,000	17,000	27,000,000	880,000	320,000	23,000	230,000
B-15	FTP00157	26	27	--	--	--	--	--	--	--	--	--	--	7 (J)	--	--	
B-16	FTP00160	18.5	19	--	15 (J)	--	--	--	--	--	--	4,900 (J)	44,000 (J)	--	--	6,900 (J)	
B-16	FTP00161	33	34	--	--	--	--	--	--	--	--	--	120	--	--	--	
B-16	FTP00162	54	55	--	--	--	--	--	16 (J)	--	--	--	--	--	--	--	
B-17	FTP00163	29	30	--	--	--	--	--	10 (J)	--	--	--	56	--	--	--	
B-17	FTP00164	51.5	52.5	--	--	--	--	--	31 (J)	--	--	--	--	--	--	--	

^aEnvironmental Protection Agency Region IX, Industrial PRG (EPA, 1996a)

NI = Not identified

BJ = Analyte found in associated blank; estimated value

J = Estimated value

B = Analyte found in associated blank

-- = Not detected above minimum reporting limit

Darker shaded area = Analytical result exceeds the preliminary action level

Xylene was detected in boreholes B-8, B-10, B-12, B-14, B-15, B-16, and B-17. The highest detections (>10,000 micrograms per kilogram [$\mu\text{g/kg}$]) were recorded within the center of the large lobe of the AST area hydrocarbon plume. The lone sample in which xylene (B-14, 24- to 25-ft bgs) was detected above the PAL corresponds with the highest TPH detection suggesting that the xylene is limited to only the highest hydrocarbon contaminated zones of the AST plume.

Ethylbenzene and toluene were detected in boreholes B-14 and B-16 also corresponding to the area of highest petroleum hydrocarbon contamination in the AST plume.

Acetone, methylene chloride, and methylethyl ketone (MEK) were detected at very low levels indicative of laboratory contamination. With the exception of detections of acetone and methylene chloride in elevated levels in one sample (FTP00128) from the 9- to 10-ft bgs interval in borehole B-8, the detections of these three compounds do not correspond to any other elevated constituents detected during this investigation. One detection of toluene (B-1, 4- to 5-ft bgs) also falls into this description.

Other VOCs detected during the investigation are limited to methylene chloride; chloromethane; 1,1,2-trichloroethane; 2-hexanone; methyl isobutyl ketone (MIBK); 1,1,1-trichloroethane; acetone; tetrachloroethane; and bromomethane. In most cases, the detections correspond to samples in which hydrocarbons were detected.

In all cases except for the one xylene detection described above, the levels detected were below the PALs.

A.3.3 TCLP Volatile Organic Compounds Analytical Results

Three samples (FTP00089, FTP00091, and FTP00107) were analyzed for TCLP VOCs to support waste management decisions. Sample FTP00107 was collected at a location (B-4, 4- to 5-ft bgs) identified in the CAIP (DOE/NV, 1998) as a likely place for chlorinated hydrocarbon contamination. Samples FTP00089 and FTP00091 were collected from B-1 at 0- to 1-ft bgs and 4- to 5-ft bgs, respectively. No constituents were identified above RCRA regulatory levels in any of these samples. No VOCs were identified in this sample, or in other samples from borehole B-4 or borehole B-1, above PALs.

A.3.4 Total Semivolatile Organic Compound Analytical Results

The total SVOC analytical results above minimum reporting limits (DOE/NV, 1998), along with the associated PALs, 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 present below the PALs.

Detected SVOCs were identified within the TPH contaminated areas described in [Section A.3.1](#) and probably represent chemicals associated with TPH constituents and degradation products.

A.3.5 Total RCRA Metals and Zinc Analytical Results

The total RCRA metals and zinc detected above the minimum reporting limits are presented in [Table A.3-5](#). Arsenic was detected above the PAL of 2.4 mg/kg in all of the samples analyzed. The arsenic concentrations for the samples analyzed ranged from 2.5 mg/kg to 5.9 mg/kg with two exceptions; samples FTP00021 and FTP00054 had the highest arsenic concentrations of 10.8 mg/kg and 7.0 mg/kg, respectively. Although these concentrations exceed the PAL for arsenic, these concentrations are not unusual for the State of Nevada (Shacklette and Boerngen, 1984) and are considered representative of ambient conditions.

A.3.6 TCLP Metals Analytical Results

The TCLP metals detected above the minimum reporting limits are presented in [Table A.3-6](#). These samples were taken to support waste characterization decisions. Originally, only two samples (FTP00089 and FTP00091), collected at the top of borehole B-1, were analyzed for TCLP metals. This was considered to be the most likely location to find RCRA metals above the maximum toxicity characteristic limits based on sample results of the residue that was found inside the burn tank (DOE/NV, 1998). Cadmium was detected above the regulatory limit of 1 mg/L (CFR, 1998) in both samples. Cadmium was not detected above the minimum reporting limits for total metals analysis in either of these samples.

Additional samples from within the burn pit (FTP00094, FTP00111, and FTP00112) as well as other samples containing high diesel concentrations were analyzed for TCLP metals. No cadmium or other RCRA metals were detected in these samples above the toxicity characteristic limits. This suggests one of the following conclusions: matrix interference (high diesel concentration) masked the

Table A.3-4
Soil Sample Results for Total Semivolatile Organic Compounds Detected Above Minimum Reporting Limits,
Mercury Fire Training Pit, Nevada Test Site

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (µg/kg)							
				bis(2-Ethylhexyl)Phthalate	Fluoranthene	Phenanthrene	Pyrene	Di-N-Butylphthalate	2-Methylnaphthalene	Naphthalene	n-Nitrosodiphenylamine
Preliminary Action Levels ^a				140,000	27,000,000	NI	100,000	68,000,000	NI	240,000	390,000
GP-F2	FTP00011	0	1	720	--	--	--	--	--	--	--
GP-E2a	FTP00020	0	1	--	2,100	2,100	1,400	--	--	--	--
GP-E4	FTP00026	0	1	1,700	--	--	--	--	--	--	--
GP-C4	FTP00048	0	1	--	--	--	--	220 (J)	--	--	--
GP-B3a	FTP00057	0	1	--	--	--	--	230 (J)	--	--	--
GP-B3a	FTP00059	0	1	--	--	--	--	--	--	--	--
GP-B2	FTP00062	0	1	--	--	--	--	230 (J)	--	--	--
B-8	FTP00128	9	10	--	--	4,600 (J)	--	--	1,4000 (J)	7,800 (J)	4,700 (J)
B-8	FTP00132	69	70	--	--	--	--	150 (J)	--	--	--
B-9	FTP00133	9	10	1,200 (J)	--	4,000	--	--	9,800	2,900 (J)	--
B-10	FTP00136	14	15	--	--	1,800 (J)	--	--	--	--	--
B-11	FTP00145	19	20	--	--	--	--	--	7,900	4,100	--
B-12	FTP00149	19	20	--	--	--	--	--	--	3,500	--
B-14	FTP00154	24	25	--	--	--	--	--	35,000 (J)	19,000 (J)	--
B-16	FTP00160	18.5	19	--	--	--	--	--	11,000 (J)	5,500 (J)	--
B-16	FTP00160	18.5	19	--	--	--	--	--	3,800 (E)	4,200 (E)	--

^aU.S. Environmental Protection Agency Region IX, Industrial PRGs (EPA, 1996a)

E = Compound concentration exceeds calibration range

J = Estimated value

-- = Not detected above minimum reporting limit

NI = Not identified

µg/kg = Microgram per kilogram

Table A.3-5
Soil Sample Results for Total RCRA Metals and Zinc Detected Above Minimum
Reporting Limits, Mercury Fire Training Pit, Nevada Test Site
(Page 1 of 5)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/kg)					
				Arsenic	Barium	Chromium	Lead	Mercury	Zinc
Preliminary Action Levels ^a				2.4	100,000	450	1,000	510	100,000
GP-F5	FTP00004	0	1	4.7 (J)	103	9.4 (J)	8.5 (J)	--	39.6
GP-F5	FTP00005	3	4	4.4 (J)	67.5	5.1(J)	3.5(J)	--	12.2
GP-F4	FTP00006	0	1	4.4 (J)	103	6.7 (J)	7.8 (J)	--	20.4
GP-F4	FTP00007	3	4	5.4 (J)	46.7	4.0 (J)	6.6 (J)	--	6.5
GP-F3	FTP00008	0	1	3.9 (J)	90.9	7.1 (J)	5.6 (J)	--	18.0
GP-F3	FTP00009	3	4	3.6 (J)	40.1	3.7 (J)	2.8 (J)	--	6.6
GP-F3	FTP00010	0	1	4.4 (J)	101	9.2 (J)	21.3 (J)	--	28.0
GP-F2	FTP00011	0	1	5.3 (J)	328	15.1 (J)	318 (J)	--	88.0 (J)
GP-F2	FTP00012	3	4	5.3 (J)	34.9	7.2 (J)	2.8 (J)	--	5.9
GP-F1	FTP00013	0	1	4.3 (J)	73.2	6.2 (J)	3.8 (J)	--	13.7
GP-F1	FTO00014	3	4	5.1 (J)	61.8	3.4 (J)	2.2 (J)	--	6.5
GP-E1	FTP00018	0	1	3.6 (J)	74.5	5.1 (J)	3.6 (J)	--	12.6
GP-E1	FTP00019	3	4	4.6 (J)	64.0	4.6 (J)	3.1 (J)	--	10.5
GP-E2a	FTP00020	0	1	5.4 (J)	107	10.1 (J)	13.6 (J)	--	48.3
GP-E2a	FTP00021	3	4	10.8 (J)	54.3	4.5 (J)	2.4 (J)	--	6.4
GP-E2b	FTP00022	0	1	4.6 (J)	102	8.0 (J)	7.7 (J)	--	28.6
GP-E2b	FTP00023	3	4	3.1 (J)	28.6	2.8 (J)	1.7 (J)	--	4.1
GP-E3	FTP00024	0	1	5.5 (J)	93.5	8.3 (J)	8.3 (J)	--	23.7
GP-E3	FTP00025	3	4	3.0 (J)	32.4	2.6 (J)	1.8 (J)	--	2.6 (J)
GP-E4	FTP00026	0	1	5.9 (J)	88.8	10.3 (J)	9.6 (J)	--	32.9
GP-E4	FTP00027	3	4	4.1 (J)	45.5	3.1 (J)	3.7 (J)	--	4.5
GP-E5	FTP00028	0	1	4.4 (J)	107	11.2 (J)	7.1 (J)	--	28.1
GP-E5	FTP00029	3	4	2.9 (J)	46.7	3.8 (J)	2.3 (J)	--	11.2
GP-D5	FTP00032	0	1	4.9 (J)	97.1	9.3 (J)	6.9 (J)	--	27.9
GP-D5	FTP00033	3	4	3.9 (J)	46.4	3.4 (J)	2.4 (J)	--	6.1
GP-D4	FTP00034	0	1	3.0 (J)	65.1	6.7 (J)	3.0 (J)	--	14.7
GP-D4	FTP00035	3	4	4.6 (J)	62.6	7.0 (J)	3.3 (J)	--	11.9
GP-D4	FTP00036	0	1	3.5 (J)	72.3	4.7 (J)	3.5 (J)	--	16.7

Table A.3-5
Soil Sample Results for Total RCRA Metals and Zinc Detected Above Minimum
Reporting Limits, Mercury Fire Training Pit, Nevada Test Site
(Page 2 of 5)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/kg)					
				Arsenic	Barium	Chromium	Lead	Mercury	Zinc
Preliminary Action Levels ^a				2.4	100,000	450	1,000	510	100,000
GP-D3	FTP00037	0	1	5.3 (J)	99.7	11.3 (J)	7.7 (J)	--	30.6
GP-D3	FTP00038	3	4	3.9 (J)	39.4	3.1 (J)	3.1 (J)	--	5.6
GP-D2	FTP00039	0	1	5.1 (J)	94.5	7.8 (J)	86.4 (J)	--	89.1
GP-D2	FTP00040	3	4	4.6 (J)	52.5	3.9 (J)	2.5 (J)	--	12.7
GP-D1	FTP00041	0	1	3.9 (J)	92.4	6.2 (J)	5.5 (J)	--	22.2
GP-D1	FTP00042	3	4	4.7 (J)	48.9	3.8 (J)	2.3 (J)	--	6.3
GP-C2	FTP00044	0	1	5.6	101	11.2	13.1	0.19	29.7
GP-C2	FTP00045	3	4	5.3	44.5	3.7	2.7	--	5.7
GP-C3	FTP00046	0	1	3.1	43.1	2.8	2.1	--	3.8
GP-C3	FTP00047	3	4	4.3	72.0	5.1	3.5	--	12.4
GP-C4	FTP00048	0	1	3.5	74.6	6.5	2.9	--	9.1
GP-C4	FTP00049	3	4	4.0	48.3	3.5	3.3	--	7.5
GP-C5	FTP00050	0	1	5.4	108	10.3	7.6	--	31.3
GP-C5	FTP00051	3	4	3.9	59.4	4.2	2.8	--	8.0
GP-B5	FTP00053	0	1	3.9	58.9	4.9	4.4	--	10.9
GP-B5	FTP00054	3	4	7.0	53.3	4.5	2.9	--	8.6
GP-B3b	FTP00055	0	1	3.5	60.8	6.0	5.6	--	4.7
GP-B3b	FTP00056	3	4	4.5	52.6	5.2	2.6	--	7.9
GP-B3a	FTP00057	0	1	3.7	54.1	4.6	4.6	--	70.5
GP-B3a	FTP00058	3	4	4.5	52.1	3.9	3.2	--	6.9
GP-B3a	FTP00059	0	1	2.6	42.3	4.2	7.0	--	145
GP-B2	FTP00062	0	1	3.4	71.2	5.6	4.4	--	17.0
GP-B2	FTP00063	3	4	3.4	43.6	3.2	2.1	--	5.1
GP-B1	FTP00064	0	1	3.8	96.7	9.3	5.1	--	18.6
GP-B1	FTP00065	3	4	2.8	48.9	2.6	2.2	--	5.7
BP-A1	FTP00067	0	1	4.7	104	10.8	20.9	--	54.9
GP-A1	FTP00068	3	4	5.2	47.6	4.1	3.1	--	8.8
GP-A2	FTP00069	0	1	3.4	58.2	3.9	2.9	--	9.6

Table A.3-5
Soil Sample Results for Total RCRA Metals and Zinc Detected Above Minimum
Reporting Limits, Mercury Fire Training Pit, Nevada Test Site
(Page 3 of 5)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/kg)					
				Arsenic	Barium	Chromium	Lead	Mercury	Zinc
Preliminary Action Levels ^a				2.4	100,000	450	1,000	510	100,000
GP-A2	FTP00070	3	4	3.5	36.6	3.5	2.1	--	5.8
GP-A3a	FTP00071	0	1	5.2	116	12.2	52.8	--	119
GP-A3a	FTP00072	3	4	3.3	51.7	3.5	2.3	--	5.9
GP-A3b	FTP00073	0	1	4.1	77.2	5.1	3.3	--	12.1
GP-A3b	FTP00074	3	4	3.9	25.8	2.1	2.0	--	2.5
GP-A4	FTP00075	0	1	4.1	99.0	7.3	6.9	--	22.7
GP-A4	FTP00076	3	4	3.1	37.5	2.9	2.0	--	4.7
GP-A5	FTP00077	0	1	4.6	54.8	3.2	6.0	--	6.2
GP-A5	FTP00078	3	4	2.9	33.5	2.5	1.8	--	3.7
SS-A2	FTP00083	0.5	1.5	4.3	61.7	4.2	25.1	--	88.6
SS-B1	FTP00084	0.5	1.5	4.0	59.1	3.6	7.6	0.45	26.1
SS-B1	FTP00085	0.5	1.5	3.9	65.9	4.3	7.7	0.47	25.9
SS-B4	FTP00086	0	1	3.9	81.1	7.7	6.2	--	21.3
B-1	FTP00089	0	1	2.5	43.1	2.8 (J)	4.4	--	NA
B-1	FTP00091	4	5	3.3	30.7	1.8 (J)	2.0	--	NA
B-1	FTP00094	19	20	5.4	44.6	4.6 (J)	3.2	--	NA
B-1	FTP00094A ^b	19	20	-- ^c	46.0	4.2	5.6(B)	NA	NA
B-1	FTP00095	29	30	5.1	46.2	3.1 (J)	3.9	--	NA
B-1	FTP00096	34	35	4.1	52.1	2.8 (J)	4.2	--	NA
B-1	FTP00097	34	35	4.3	47.7	2.8 (J)	3.5	--	NA
B-2	FTP00099	0	5	3.5	80.4	4.6 (J)	5.2	--	NA
B-2	FTP00100	9	10	4.6	32.8	2.3 (J)	2.0	--	NA
B-2	FTP00101	14	15	3.7	31.6	2.1 (J)	1.8	--	NA
B-3	FTP00103	4	5	3.0	40.2	2.0 (J)	1.8	--	NA
B-3	FTP00104	14	15	5.9	45.6	2.6 (J)	2.9	--	NA
B-3	FTP00105	19	20	4.5	42.6	2.5 (J)	2.3	--	NA
B-4	FTP00107	4	5	3.6	60.6	2.8	2.3	--	NA
B-4	FTP00108	14	15	4.8	51.3	2.8	2.6	--	NA

Table A.3-5
Soil Sample Results for Total RCRA Metals and Zinc Detected Above Minimum
Reporting Limits, Mercury Fire Training Pit, Nevada Test Site
(Page 4 of 5)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/kg)					
				Arsenic	Barium	Chromium	Lead	Mercury	Zinc
Preliminary Action Levels ^a				2.4	100,000	450	1,000	510	100,000
B-4	FTP00109	19	20	3.1	32.6	2.0	2.2	--	NA
B-5	FTP00111	4	5	3.5	40.7	2.2	2.1	--	NA
B-5	FTP00112	9	10	3.7	62.1	4.4	3.2	--	NA
B-5	FTP00113	24	25	4.3	51.7	2.3	3.1	--	NA
B-5	FTP00114	29	30	3.7	47.1	2.7	3.0	--	NA
B-6	FTP00120	4	5	3.4	43.5	2.4	1.8	--	NA
B-6	FTP00121	14	15	3.9	56.1	2.7	2.7	--	NA
B-6	FTP00122	19	20	3.6	32.5	2.7	1.8	--	NA
B-7	FTP00123	4	5	3.2	35.6	2.6	2.4	--	NA
B-7	FTP00124	14	15	2.7	44.5	1.8	2.0	--	NA
B-7	FTP00125	19	20	3.5	35.7	2.8	2.5	--	NA
B-8	FTP00128	9	10	3.5	45.2	2.2	2.7	--	NA
B-8	FTP00129	34	35	3.4	57.4	3.3	3.5	--	NA
B-8	FTP00130	49	50	3.5	43.8	3.3	3.8	--	NA
B-8	FTP00131	59	60	3.7	36.2	2.3	2.6	--	NA
B-8	FTP00132	69	70	3.9	132	3.2	3.3	--	NA
B-9	FTP00133	9	10	4.9	67.3	3.1	2.4	--	NA
B-9	FTP00134	19	20	3.5	60.1	2.8	2.8	--	NA
B-9	FTP00135	24	25	4.0	48.0	3.3	3.7	--	NA
B-10	FTP00136	14	15	3.3	24.0	2.4	1.4	--	NA
B-10	FTP00137	29	30	4.3	44.6	3.0	3.4	--	NA
B-10	FTP00138	34	35	3.7	43.0	2.8	2.3	--	NA
B-10	FTP00139	34	35	3.9	41.7	3.1	2.3	--	NA
B-10	FTP00140	39	40	3.5	36.7	3.1	2.3	--	NA
B-11	FTP00145	19	20	3.9 (J)	38.5	3.0 (J)	2.9 (J)	--	NA
B-11	FTP00146	39	40	3.9 (J)	41.1	3.0 (J)	2.2 (J)	--	NA
B-11	FTP00147	44	45	3.1 (J)	35.6	2.7 (J)	2.0 (J)	--	NA
B-12	FTP00149	19	20	3.6 (J)	28.7	2.6 (J)	2.8 (J)	--	NA
B-12	FTP00150	49	50	3.1 (J)	35.4	3.4 (J)	2.0 (J)	--	NA

Table A.3-5
Soil Sample Results for Total RCRA Metals and Zinc Detected Above Minimum
Reporting Limits, Mercury Fire Training Pit, Nevada Test Site
(Page 5 of 5)

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/kg)					
				Arsenic	Barium	Chromium	Lead	Mercury	Zinc
Preliminary Action Levels ^a				2.4	100,000	450	1,000	510	100,000
B-12	FTP00151	69	70	4.5 (J)	55.9	4.0 (J)	3.6 (J)	--	NA
B-13	FTP00153	39	40	3.8	45.9	3.1	2.2	--	NA
B-14	FTP00154	24	25	4.4	55.4	3.5	3.8	--	NA
B-14	FTP00155	39	40	3.8	33.9	4.6	2.3	--	NA
B-14	FTP00156	68	69	4.4	104	3.3	4.1	--	NA
B-15	FTP00157	26	27	3.8	39.8	2.8	2.7	--	NA
B-16	FTP00160	18.5	19	2.9	25.0	1.9	1.5	--	NA
B-16	FTP00161	33	34	3.4	41.1	3.2	3.2	--	NA
B-16	FTP00162	54	55	3.2	40.7	3.2	2.6	--	NA
B-17	FTP00163	29	30	4.3	38.8	3.2	3.3	--	NA
B-17	FTP00164	51.5	52.5	3.6	47.0	3.3	2.7	--	NA

^aU.S. Environmental Protection Agency Region IX, Industrial PRGs (EPA, 1996a)

^bSample FTP00094 was reanalyzed for total RCRA metals by DataChem Laboratories, Inc., as sample FTP00094A

^cThe method detection limit for arsenic was 6.0 mg/kg for sample FTP00094A

J = Estimated value

B = Analyte found in associated blank

NA = Not analyzed

-- = Not detected above minimum reporting limits

cadmium contamination in the totals analysis of samples FTP00089 and FTP00091 and the cadmium contamination is confined to an isolated area of the burn pit; or laboratory anomaly occurred in the TCLP analysis of samples FTP00089 and FTP00091.

A.3.7 Dioxins and Furans Analytical Results

No dioxins or furans were detected above the minimum reporting limits (DOE/NV, 1998).

A.3.8 Polychlorinated Biphenyls Analytical Results

No PCBs were detected above the minimum reporting limits (DOE/NV, 1998).

Table A.3-6
Soil Sample Results for TCLP Metals Detected Above Minimum Reporting Limits,
Mercury Fire Training Pit, Nevada Test Site

Sample Location	Sample Number ^a	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (mg/L)		
				Barium	Cadmium	Chromium
Maximum Concentration for the Toxicity Characteristic ^b				100.0	1.0	5.0
GP-B3b	FTP00055A	0	1	0.69	--	--
GP-B3a	FTP00057A	0	1	0.57	--	--
SS-B4	FTP0086A	0	1	0.68	--	--
B-1	FTP00089	0	1	0.5(B)	10.4	--
B-1	FTP00091	4	5	0.42(B)	1.6	--
B-1	FTP00094A	19	20	0.74	--	--
B-5	FTP00111A	4	5	0.5	--	--
B-5	FTP00112A	9	10	0.73	--	--
B-8	FTP00128A	9	10	0.44	--	--
B-9	FTP00133A	9	10	0.96	--	0.045
B-14	FTP00154A	24	25	0.47	--	--

^aThe "A" after a sample number signifies additional analysis not originally requested. These samples were analyzed by DATACHEM Laboratories.

^b40 CFR 261.24, "Identification and Listing of Hazardous Waste" (CFR, 1998)

-- = Not detected above minimum reporting limits

B = Analyte found in associated blank

A.3.9 Gamma Spectroscopy Results

Radionuclides detected above minimum reporting limits (DOE/NV, 1998), along with the associated background concentrations, are presented in [Table A.3-7](#). Radionuclide concentrations in soil samples obtained at the FTP were compared to concentrations in soil samples taken from background locations (Atlan-Tech, 1992; McArthur and Miller, 1989). No man-made radionuclides associated with nuclear testing were detected. Both the concentrations of the detected radionuclides and their distribution support the conclusion that the radionuclides in the FTP soil samples are not distinguishable from soil samples taken from background locations.

One sample (FTP00073) had a detectable result for Potassium-40 (⁴⁰K) greater than the typical background concentration. Potassium-40 is a natural primordial radionuclide. The concentration of ⁴⁰K in background locations is highly variable. The baseline and preoperations surface soil samples

Table A.3-7
Soil Sample Results for Detected Radioactive Isotopes,
Mercury Fire Training Pit, Nevada Test Site

Sample Location	Sample Number	Start Depth (ft)	End Depth (ft)	Contaminant of Potential Concern (pCi/g)						
				Bismuth-214	Lead-210	Lead-212	Lead-214	Potassium-40	Thallium-208	Cesium-137
Background Concentrations				0.21-3.21 ^a	0.21-3.21 ^a	0.18-2.4 ^a	0.21-3.21 ^a	2.7-34.2 ^a	0.2-3.4 ^b	0.04-7.0 ^a
GP-F3	FTP00008	0	1	0.94 ± 0.29	--	0.79 ± 0.20	0.79 ± 0.20	11.7 ± 3.1	0.46 ± 0.14	--
GP-F3	FTP00010	0	1	--	--	0.80 ± 0.18	0.84 ± 0.19	4.53 ± 2.91	--	0.89 ± 0.19
GP-E2a	FTP00020	0	1	--	--	0.79 ± 0.23	0.89 ± 0.24	13.4± 3.68	--	0.72 ± 0.19
GP-E2b	FTP00022	0	1	--	--	0.85 ± 0.19	0.63 ± 0.18	9.48 ± 3.36	--	--
GP-E5	FTP00028	0	1	1.27 ± 0.36	--	1.14 ± 0.22	1.04 ± 0.25	12.4 ± 4.3	--	--
GP-D4	FTP00034	0	1	--	2.46 ± 1.11	0.66 ± 0.19	0.81 ± 0.22	8.38 ± 3.23	--	--
GP-D4	FTP00036	0	1	--	--	0.85 ± 0.21	0.83 ± 0.21	10.1 ± 5.6	--	--
GP-D2	FTP00039	0	1	1.30 ± 0.34	--	0.72 ± 0.24	0.78 ± 0.21	12.1 ± 6.8	--	--
GP-C2	FTP00044	0	1	--	--	0.99 ± 0.2	0.95 ± 0.21	13.9 ± 3.48	--	--
GP-C4	FTP00048	0	1	--	--	0.87 ± 0.22	0.76 ± 0.24	--	--	--
GP-B3b	FTP00055	0	1	--	--	1.21 ± 0.3	--	10.7 ± 6.1	--	--
GP-B3a	FTP00057	0	1	--	--	0.92 ± 0.29	1.01 ± 0.3	16.9 ± 9.2	0.46 ± 0.18	--
GP-B3a	FTP00059	0	1	1.10 ± 0.29	--	1.08 ± 0.23	1.05± 0.21	7.69 ± 2.97	0.46 ± 0.13	0.39 ± 0.17
GP-B2	FTP00062	0	1	--	--	0.64 ± 0.16	0.83 ± 0.19	9.47 ± 3.14	--	--
GP-B1	FTP00064	0	1	1.13 ± 0.31	--	1.21 ± 0.25	1.23 ± 0.27	23.8 ± 5.6	0.55 ± 0.15	--
GP-A1	FTP00067	0	1	--	--	0.91 ± 0.26	--	11.8 ± 6.9	--	--
GP-A3a	FTP00071	0	1	--	--	1.24 ± 0.29	0.70 ± 0.27	10.2 ± 6.09	--	--
GP-A3b	FTP00073	0	1	--	--	0.72 ± 0.24	0.83 ± 0.24	65.2 ± 7.4	--	0.46 ± 0.23
B-1	FTP00089	0	1	--	--	0.34 ± 0.10	--	--	--	--

^aBackground concentration listed or derived in *Off-Site Radiation Exposure Review Project, Phase II Soils Program* (McArthur and Miller, 1989)

^bBackground concentration listed in *Environmental Monitoring Report for the Proposed Ward Valley California Low-Level Radioactive Waste (LLRW) Facility* (Atlan-Tech, 1992)

Note: All concentrations are assigned "J" (estimated) qualifiers.

-- = Not detected above contract required detection limit.

pCi/g = Picocuries per gram

taken from Ward Valley, CA had ⁴⁰K concentrations ranging from 26 picocuries per gram (pCi/g) to a maximum of 97.7 pCi/g (Atlan-Tech, 1992). It ranges from 2.7 to 34.2 pCi/g in surface sample taken from background locations in the states of Nevada, Utah, and Arizona (McArthur and Miller, 1989).

Section 4.2 of the CAIP states that 25 percent of the surface samples will be analyzed using gamma spectroscopy. Eighteen of 34 surface samples were analyzed and one sample from the 0- to 1-ft bgs interval of B-1. Section 4.3.2 of the CAIP states that 25 percent of the drilling samples will be analyzed using gamma spectroscopy (DOE/NV, 1998). Subsurface samples were not analyzed using

gamma spectroscopy because process knowledge, lack of driving forces, site monitoring did not indicate that radiological contamination should be present in subsurface soil.

It is concluded that no man-made radionuclides have been added to the FTP.

A.3.10 Bioassessment and Geotechnical Results

Eight bioassessment and seven geotechnical samples were collected (see [Table A.2-1](#) and [Table A.2-2](#) for sample locations). All geotechnical and the majority of the bioassessment samples (samples FTP00093, FTP00105, FTP00111, FTP00118, FTP00148, FTP00158, and FTP00159) were collected in brass sleeves using a California modified split-spoon sampler. In each case, the soil from the uppermost sleeve was transferred to a sample jar, labeled, sealed with custody tape, and submitted to the IT Technology Center for analyses. The remaining two sleeves were capped, labeled, sealed with custody tape, and submitted to Converse Consulting for analysis. Additional bioassessment samples (samples B5-14-15M, B8-14 15M, and B14-29-30M) were collected using the methods described in [Section A.2.3.3](#).

The data were collected to provide input for the evaluation of corrective actions. The findings are summarized in this document, and both data reports are maintained in the contractors files.

A.3.10.1 Bioassessment Results

A bioassessment was performed on eight soil samples to investigate the feasibility of using bioremediation at the FTP ([Appendix E](#)). 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. Based on the results of the bioassessment, soil conditions are suitable for bioremediation of contaminated soil at the FTP. The results of the bioassessment are summarized below:

- Viable microbial populations exist at the site and appear to be well adapted to site conditions.
- Heterotrophic populations and hydrocarbon degraders responded favorably to oxygenation but the benefits of oxygenation and nutrient addition were only significant in sample

B8-14-15M. Nutrient addition to the vadose zone is not recommended until *in situ* respiration rates decline.

- The optimal pH for microbial activity is between 6 and 8. The pH values for all of the FTP samples were above 8. Although the pH values fall outside of the typical range for successful biodegradation, microbes adapted to alkaline desert soils appear capable of sustaining aerobic biodegradation.
- Phosphate levels are moderate and ammonia levels are less than the detection limit of 4 mg/kg for six out of eight of the samples.
- Moisture levels were generally low and may limit biodegradation.

A.3.10.2 Geotechnical Results

The results of the geotechnical observations suggest that the stratigraphy is dominated by moderate to poorly sorted gravelly sand, with occasional silty gravelly sand. Small lenses of silt and clay are also present, along with isolated caliche layers. See [Appendix B](#) for complete soil boring logs. The results of the laboratory analysis of the geotechnical samples are presented in [Appendix C](#).

A.4.0 Quality Assurance

The results of the QA/QC activities for the Mercury FTP corrective action investigation sampling events are summarized in the following text. Detailed information regarding the QA program is contained in the Industrial Sites QAPP (DOE/NV, 1996).

Quality control results are typically judged in terms of precision, accuracy, representativeness, completeness, and comparability and are 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 for inorganic analysis by collecting and analyzing duplicate field samples and comparing the results with the original sample. Precision is also assessed for inorganic analysis by preparing, analyzing, and comparing laboratory duplicates from one or more field samples. Precision is assessed for organic analysis by preparing, analyzing, and comparing matrix spike and matrix spike 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.

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 the 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 its 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 correctly labeled containers 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 laboratories 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 specified number of samples (DOE/NV, 1998) and by analyzing them by the approved analytical methods shown in [Table A.3-1](#).

A.4.4 Completeness

Completeness is defined as a 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, 1996).

The specified sampling locations were utilized as planned. All samples were collected as specified in the CAIP (DOE/NV, 1998), and all sample containers reached the laboratory intact and properly preserved (when applicable). Sample temperatures were maintained during shipment to the laboratory, and sample chain of custody was maintained during sample storage and/or shipment.

The analyses of the 117 soil samples and 6 duplicates collected from the FTP (CAU 342) were submitted to the laboratories produced 15,340 results. During data evaluation, 50 results were rejected. Thus, a completion level of over 99 percent was achieved.

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 FTP field and sampling activities were performed and documented in accordance with approved procedures, and all samples were

collected in accordance with the CAIP (DOE/NV, 1998), except where noted in [Section A.4.8](#).

Approved standardized methods and procedures were also used to analyze and report the data (e.g., Contract Laboratory Program [CLP] and/or CLP-like data packages). This approach ensures that the data from this project can be compared to other data sets. Based on the minimum comparability requirements specified in the Industrial Sites QAPP (DOE/NV, 1996), all requirements were met.

Field (i.e., 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 sections. Documentation of the data qualifications resulting from these reviews is retained in project files as both hard copy and electronic media.

A.4.6 Tier I and Tier II Data Evaluations

All laboratory data from samples collected at the FTP have been evaluated for data quality according to the EPA Functional Guidelines (EPA, 1994b and c). These guidelines are implemented in a tiered process and are presented in the following text. No data rejected during the data evaluation process were used to draw the conclusions presented in the CADD. Only valid data, whether estimated (i.e., J-qualified) or not, were used.

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

A.4.6.1 Tier I Evaluation

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

- Sample count/type consistent with chain of custody
- Analysis count/type consistent with chain of custody
- Correct sample matrix
- Significant problems stated in cover letter or case narrative
- Completeness of certificates of analysis
- 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
- Electronic data transfer 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 Evaluation

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

Chemical:

- 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
- MS/MSD percent recoveries (%R) and RPDs evaluated and applied to laboratory results/qualifiers
- Field duplicate RPDs evaluated using professional judgement and applied to laboratory results/qualifiers
- Laboratory duplicate RPDs evaluated and applied to laboratory results/qualifiers
- Surrogate %R evaluated and applied to laboratory results/qualifiers
- Laboratory control sample %R evaluated and applied to laboratory results/qualifiers
- Initial and continuing calibration evaluated and applied to laboratory results/qualifiers
- Internal standard evaluated and applied to laboratory results/qualifiers
- Recalculation of 10 percent of laboratory results from raw data

Radioanalytical:

- Blank contamination evaluated and applied to sample results/qualifiers
- Certificate of Analysis consistent with data package documentation
- QC sample results (duplicates, laboratory control samples) evaluated and applied to laboratory result qualifiers
- Sample results, error, and minimum detectable activity evaluated and applied to laboratory result qualifiers
- Detector system calibrated to National Institute for Standards and Technology (NIST) traceable sources
- Calibration sources preparation documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations
- Detector system response to daily, weekly, and monthly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency
- NIST-traceable tracers, appropriate for the analysis performed, and recoveries that met QC requirements
- Documentation of all QC sample preparation complete and properly performed
- Spectra lines, emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration
- QC sample results (e.g., calibration source concentration, percent recovery, and RPD) verified
- Radionuclides and their concentration appropriate considering their decay schemes, half-lives, and process knowledge and history of the facility and site
- Each identified line in spectra verified against emission libraries and calibration results

A.4.6.3 Tier III Evaluation

Data quality considerations that are included in EPA data review functional guidelines (EPA, 1994b and c) as a Tier III review include, but are not limited to, the additional evaluations:

Chemical:

- 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

Radioanalytical:

- QC sample results (e.g., calibration source concentration, percent recovery, and RPD) verified
- Radionuclides and their concentration appropriate considering their decay schemes, half-lives, and process knowledge and history of the facility and site
- Each identified line in spectra verified against emission libraries and calibration results
- Independent identification of spectra lines, area under the peaks, and quantification of radionuclide concentration in a random number of sample results

Tier III review of at least five percent of the sample analytical data was performed by Lockheed-Martin Environmental Services in Las Vegas, Nevada. Changes to the data resulting from this review have been documented in project files.

A.4.7 Quality Control Samples

Twenty-two trip blanks, six field blanks, six equipment rinsate blanks, six MS/MSDS, and six field duplicates were collected and submitted for laboratory analysis as shown in [Tables A.2-1](#) and [A.2-2](#). The samples and duplicates were assigned individual sample numbers and sent to the laboratory “blind.” Additional samples were selected by the laboratory to be analyzed as laboratory duplicates. The field blanks were taken by placing distilled water into appropriate sample bottles and preserving them according to the requirements specified in the Industrial Sites QAPP (DOE/NV, 1996). The equipment rinsate blanks were obtained by collecting the final rinse solution (i.e., distilled water), which was poured over the decontaminated sampling equipment into the appropriate sample bottles and preserved as applicable. The trip blanks, which were received sealed and preserved from the laboratory, were placed in each cooler containing samples for VOC analysis. The results of the QC samples are discussed in the following sections.

A.4.7.1 Field Quality Control Samples

Review of the field-collected blank analytical data for the investigation sampling indicates that cross-contamination from field methods did not occur during sample collection. Field and equipment rinsate blanks were analyzed for the parameters listed in [Tables A.2-1](#) and [A.2-2](#), and trip blanks were analyzed for VOCs only. None of the results for these field-collected blanks exceeded the minimum laboratory reporting limits (DOE/NV, 1998).

During the sampling event, six field duplicate soil samples were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in [Tables A.2-1](#) and [A.2-2](#). For these samples, the duplicate results precision (i.e., RPDs between the environmental sample results and their corresponding field duplicate sample results) were evaluated against the guidelines set forth in EPA Functional Guidelines (EPA, 1994b and c). The EPA Functional Guidelines state that there are no required review criteria for field duplicate analyses comparability, but allow the data reviewer to exercise professional judgement. The RPD between the environmental sample results and their corresponding field duplicate sample results exceeded the 20 percent criteria stated in the Industrial Sites QAPP (DOE/NV, 1996) for some target analytes (acetone, chromium, lead, and zinc). The variability in the results between the environmental samples and their corresponding field duplicate samples could be attributed to nonhomogeneous samples and the difficulties associated with collecting identical field samples. It is expected that soil field duplicate results will have a greater variance than water matrices.

The laboratory duplicate samples were compared to the criteria set forth in the EPA Functional Guidelines (EPA, 1994c) and the associated sample results were qualified accordingly. Both detections and nondetections have been qualified as estimated (J and UJ, respectively) if the relative percent difference between an environmental sample and its laboratory field duplicate fell outside established criteria.

Six field samples were selected for use as MS/MSD samples. The percent recoveries of these samples (a measure of accuracy) and the relative percent differences in these sample results (a measure of precision) were compared to EPA Functional Guideline criteria (EPA, 1994b and c). 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 judgement in considering these results in conjunction with the results of laboratory control samples (LCSs) and other QC criteria in applying qualifications to the data.

The inorganic data review in EPA Functional Guidelines allows professional judgement to be applied in evaluating the results of both matrix spikes. Generally, if the spike recovery is greater than the upper acceptance limits, nondetections are not qualified. If the spike recovery is greater than the upper acceptance limits or less than the lower acceptance limit, positive results are qualified as estimated (J) and nondetections are qualified as estimated (UJ), respectively. If the spike recovery is less than 30 percent (grossly low), positive results are not qualified and nondetections are qualified unusable (R).

A.4.7.2 Laboratory Quality Control Samples

Analysis of method QC blanks and surrogate spikes for organic analyses, method blanks, preparation blanks, initial and continuing calibration blanks for total metals and TCLP metals, and LCS were performed for each SDG by Quanterra Environmental Services laboratory. The results of these analyses were used to qualify associated environmental sample results according to EPA Functional Guidelines (EPA, 1994b and c).

The EPA Functional Guidelines (EPA, 1994b and c) state that 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 described in the “The 5X/10X Rule.”

For most VOCs and SVOCs, if an analyte is detected in the sample and was also detected in an associated blank the result is qualified as undetected (U) if the sample concentration is less than five times (5X) the blank concentration.

For the common laboratory contaminants (e.g., methylene chloride, acetone, MEK, and phthalate esters [especially bis(2-ethylhexyl)phthalate]), the factor is raised to ten times (10X) the blank

concentration. The sample result is elevated to the quantitation limit if it is less than the quantitation limit or remains unaltered if the sample result is greater than or equal to the quantitation limit.

For inorganics (i.e., 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 metallic common laboratory contaminants, so there is no “10X Rule” for metals, and the sample result is never altered. When applying the 5X criteria to soil sample data or calibration blank data, the raw data results are used to evaluate and qualify the reported results on the Certificates of Analysis.

Surrogate spikes, or system monitoring compounds, are added to the environmental samples analyzed by chromatographic techniques for VOCs, SVOCs, gasoline, and diesel. Surrogate compounds are analytes that are not expected to be present in associated environmental samples, but behave the same as similar target compounds chromatographically. Known amounts of each surrogate are added prior to sample preparation and are carried throughout the preparation/analysis procedure. The percent recoveries of these surrogate compounds give some measure of the anticipated recoveries of the target compounds whose chromatographic behavior they mimic.

If any surrogate percent recoveries are out of the acceptable range (which differs for each surrogate in each method), laboratory protocol calls for the sample to be reprepared and/or reanalyzed. When the surrogate recoveries are acceptable on the second run, only the second analysis results are reported. When both analyses yield the same unacceptable range, the results of both analyses are reported.

The evaluation of surrogate spike percent recovery results is not straightforward. The functional guidelines suggest several optional approaches, but require the data reviewer to exercise professional judgement in reviewing surrogate data and qualifying associated data as estimated (J or UJ, for detections or nondetections, respectively) or unusable (R). Documentation of data qualifications resulting from the application of these guidelines is retained in the project files as both hard copy and electronic media.

One laboratory duplicate analysis for metals was performed for each SDG. The duplicate results are compared to the results of the original sample to give a measure of analytical laboratory precision. If the results from a duplicate analysis for a particular analyte fall outside the control limits, the EPA Functional Guidelines for Inorganic Data Review (EPA, 1994c) call for all results for that analyte in

all associated samples of the same matrix to be qualified as estimated (J). Documentation of data qualifications resulting from the application of these guidelines is retained in the project files as both hard copy and electronic media.

Laboratory control samples, also known as blank spikes, consist of known quantities of target compounds added to purified sand or deionized, distilled water and analyzed along with the environmental samples in the sample delivery group. The percent recoveries of the compounds in the LCS give a measure of laboratory accuracy. The functional guidelines call for the data reviewer to use professional judgement to qualify associated data according to established criteria. Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

A.4.8 *Field Nonconformances*

During the corrective action investigation, one QA surveillance was conducted by IT Corporation to verify that sampling activities were performed in accordance with applicable requirements. The results of the surveillance indicated no findings, deficiencies, or nonconformances with sampling activities as they met the requirements of the plans and procedures governing the activities at the site. Documentation of these results is retained in project files.

A.4.9 *Laboratory Nonconformances*

Laboratory nonconformances are generally due to inconsistencies in analytical instrumentation operation, sample preparations, extractions, and fluctuations in internal standard and calibration results. Several laboratory nonconformances were documented for this project. These nonconformances have been accounted for in the data qualification process. Data were rejected as a result of these nonconformances. One additional sample was collected for PCB analysis to compensate for rejected data. Documentation of these results is retained in project files.

A.5.0 Summary

Analysis of the data generated from corrective action investigation activities conducted at the FTP indicates the following:

- A subsurface plume or plumes of TPH greater than 100 mg/kg TPH is associated with the AST area. The combined lateral extent does not exceed approximately 130 by 80 ft. The plume(s) originated from at least three surface sources (ASTs which have been removed) and extends vertically to an approximate depth of 50 ft bgs.
- A subsurface plume of TPH greater than 100 mg/kg TPH is associated with the burn pit. The plume has approximate lateral dimensions of 65 by 27 ft. The plume originates from excess fuel not burned in the burn pit and has an approximate depth of 30 ft bgs.
- Surface contamination is evident in contiguous areas downgradient from both the AST area and burn pit. Total surface contamination includes 16,300 ft² and 5,830 ft² areas and three areas with much less vertical and lateral extent. This surface contamination is believed to have originated from runoff from surface contamination in both the AST area and burn pit. The depth of this contamination is not well defined.
- Surface contamination was evident at the telephone poles, one burn shed (southernmost), and the bus.
- Arsenic concentrations were above the PAL of 2.4 mg/kg and ranged from 2.5 mg/kg to 5.9 mg/kg with two exceptions, samples FTP00021 and FTP00054 had the highest arsenic concentrations of 10.8 mg/kg and 7.0 mg/kg respectively. These arsenic concentrations are not unusual for the State of Nevada and represent naturally occurring (background) concentrations.
- Xylene was detected above the PAL in one sample collected from the area of highest TPH contamination in the AST subsurface plume.
- No other chemical constituents were detected above the PALs.
- Other VOCs and SVOCs detected appear to be associated with the areas of TPH contamination.
- Radiological analytical results were not distinguishable from background concentrations (PALs) (DOE/NV, 1998).

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Appendix B

Soil Boring Logs

ELEVATION DATUM: Mean Sea Level

COMMENTS:

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Depth		Legend	USCS	Classification (Description)	TPH (ppm) Log Scale	TPH Comments	VOC (ppm) Log Scale	VOC Comments	Remarks	Sample No
(feet)	(meters)				0	5000	0	5000		
0.0	0.0		SW	Gravelly Sand, medium brown (10 YR 5/4), 80% sand, fine to medium grain, angular to subangular, consolidated; 40% gravel, medium grain, subround, gravels to 10 cm. Soil is moist from 0 to 1 ft.					8/2/98 Start 0958, Stop 1002, no noticeable odor	
1.0										
2.0										
3.0										
4.0	1.0			Gravelly Sand, brown (10 YR 6/4), 60% sand, 40% gravel up to 12.5 cm, slightly moist.		3-16 #2 FUEL OIL		D.C.	Start 1012, Stop 1017, no odor	FTP00103
5.0										
6.0										
7.0										
8.0	2.0			Gravelly Sand, same as above, brown (10 YR 6/4), gravel to 7 cm, somewhat moist.		ND		4.0	Start 1021, Stop 1025, no odor	
9.0										
10.0	3.0									
11.0										
12.0								3.0	Start 1031, Stop 1041	
13.0										
14.0										
15.0										
16.0	5.0							3.0		FTP00105
17.0										
18.0										
19.0										
20.0	6.0							3.0		FTP00102
21.0										

ELEVATION DATUM: Mean Sea Level

COMMENTS:

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FTP00109

SOIL BORING LOG		BORING NUMBER: B-5	CAU 342 CADD Appendix B Revision: 1 Date: 05/27/99 Page B-5 of B-17
PROJECT NAME: FIRE TRAINING PIT		DATE HOLE STARTED: 06/02/98	
PROJECT NUMBER: 774729.03020200		DATE HOLE COMPLETED: 06/02/98	
UTM EASTING: 589148.00		GEOLOGIST: M. England	
UTM NORTHING: 4057801.00		QA CHECK: F. Baird	
ENVIRONMENTAL CONTRACTOR: IT CORP		TOTAL DEPTH OF HOLE: 30.00	
DRILLING METHOD: RotoSonic		SURFACE ELEVATION: 1140.00	
DRILLING CONTRACTOR: Boart Longyear		COMMENTS:	
ELEVATION DATUM: Mean Sea Level			

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Depth (feet) (meters)		USCS	Classification (Description)	TPH (ppm) Log Scale	TPH Comments	VOC (ppm) Log Scale	VOC Comments	Remarks	Sample No	
0.0	0.0	SW	Gravelly Sand, dark reddish brown (10 YR 5/4), 70 % sand, medium grain, subround to angular grains, 30% gravel, medium to fine grain, round to subangular to 11 cm, unconsolidated, moist, staining noted at 5 to 7.5 ft interval	0	5000	0	5000	6/2/98. Start 1640 Stop 1642. Start 1654 Stop 1656. solvent odor lessening at 10 ft		
1.0										
2.0										
3.0										
4.0	1.0									
5.0										
6.0										
7.0	2.0									
8.0										
9.0										
10.0	3.0	GM	Gravelly Sand, same as above, increase in gravel size up to 15 cm from 10 to 12.5 ft, moist.	500-1000 #2 FUEL		27.0		Start 1700. Stop 1704 no odor or staining noted	FTP00111	
11.0										FTP00110
12.0										
13.0	4.0									
14.0										
15.0										
16.0	5.0									
17.0										
18.0										
19.0										
20.0	6.0	SW	Silty Sandy Gravel, brown (10 YR 6/4), soil becomes consolidated bound by intermittent clay matrix from 15 to 18 ft, forming small brittle conglomerates of angular gravel, clay present, 50% gravel to 11 cm, 30% silt, 15% cla	10-50 #2 FUEL OIL		22.0		Start 1708. Stop 1716 no odor		
21.0										
22.0										
23.0	7.0									
24.0										
25.0										
26.0	8.0									
27.0										
28.0										
29.0										
30.0	9.0		Gravelly Sand, brown (10 YR 6/4), 70% sand, round to subangular, medium grain, 30% gravel, medium to fine grain, round to subangular to 13 cm, slightly moist, unconsolidated, at 25 ft soil becomes moist, somewhat consolidate	10 #2 FUEL OIL		9.0		Start 1720. Stop. 1725. Start 1735. Stop 1745. no odor or staining noted	FTP00113	
31.0										
32.0										
33.0										
34.0										
35.0										
36.0										
37.0										
38.0										
39.0										
40.0				ND		7.0			FTP00114	
41.0										
42.0										
43.0										
44.0										
45.0										
46.0										
47.0										
48.0										
49.0										

SOIL BORING LOG		BORING NUMBER: B-7	CAU 342 CADD Appendix B Revision: 1 Date: 05/27/99 Page B-7 of B-17
PROJECT NAME: FIRE TRAINING PIT		DATE HOLE STARTED: 06/03/98	
PROJECT NUMBER: 774729.03020200		DATE HOLE COMPLETED: 06/03/98	
UTM EASTING: 589147.00		GEOLOGIST: M. England	
UTM NORTHING: 4057792.00		QA CHECK: F. Baird	
ENVIRONMENTAL CONTRACTOR: IT CORP		TOTAL DEPTH OF HOLE: 20.00	
DRILLING METHOD: RotoSonic		SURFACE ELEVATION: 1140.00	
DRILLING CONTRACTOR: Boart Longyear		COMMENTS:	
ELEVATION DATUM: Mean Sea Level			

COMMENTS:

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[illegible]

[illegible]

SOIL BORING LOG	BORING NUMBER: B-9	CAU 342 CADD Appendix B Revision: 1 Date: 05/27/99 Page B-9 of B-17
PROJECT NAME: FIRE TRAINING PIT	DATE HOLE STARTED: 06/04/98	
PROJECT NUMBER: 774729.03020200	DATE HOLE COMPLETED: 06/04/98	
UTM EASTING: 589167.00	GEOLOGIST: M. England	
UTM NORTHING: 4057823.00	QA CHECK: F. Baird	
ENVIRONMENTAL CONTRACTOR: IT CORP	TOTAL DEPTH OF HOLE: 30.00	
DRILLING METHOD: RotoSonic	SURFACE ELEVATION: 1141.50	
DRILLING CONTRACTOR: Boart Longyear	COMMENTS:	
ELEVATION DATUM: Mean Sea Level		

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[illegible]

SOIL BORING LOG		BORING NUMBER: B-11	CAU 342 CADD Appendix B Revision: 1 Date: 05/27/99 Page B-11 of B-17
PROJECT NAME: FIRE TRAINING PIT		DATE HOLE STARTED: 06/08/98	
PROJECT NUMBER: 774729.03020200		DATE HOLE COMPLETED: 06/08/98	
UTM EASTING: 589170.00		GEOLOGIST: M. England	
UTM NORTHING: 4057841.00		QA CHECK: F. Baird	
ENVIRONMENTAL CONTRACTOR: IT CORP		TOTAL DEPTH OF HOLE: 45.00	
DRILLING METHOD: RotoSonic		SURFACE ELEVATION: 1142.00	
DRILLING CONTRACTOR: Boart Longyear		COMMENTS:	
ELEVATION DATUM: Mean Sea Level			

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[illegible]

SOIL BORING LOG		BORING NUMBER: B-13	CAU 342 CADD Appendix B Revision: 1 Date: 05/27/99 Page B-13 of B-17
PROJECT NAME: FIRE TRAINING PIT		DATE HOLE STARTED: 06/09/98	
PROJECT NUMBER: 774729.03020200		DATE HOLE COMPLETED: 06/09/98	
UTM EASTING: 589165.00		GEOLOGIST: M. England	
UTM NORTHING: 4057826.00		QA CHECK: F. Baird	
ENVIRONMENTAL CONTRACTOR: IT CORP		TOTAL DEPTH OF HOLE: 40.00	
DRILLING METHOD: RotoSonic		SURFACE ELEVATION: 1141.00	
DRILLING CONTRACTOR: Boart Longyear		COMMENTS:	
ELEVATION DATUM: Mean Sea Level			

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Depth		Legend	USCS	Classification (Description)	TPH (ppm) Log Scale	TPH Comments	VOC (ppm) Log Scale	VOC Comments	Remarks	Sample No.
(feet)	(meters)				0 5000		0 5000			
0.0	0.0		SW	Gravelly Sand, light tan (10 YR 7/3), 80% sand, fine to medium grain; 20% gravel, subangular, poorly sorted.					6/9/98 Start 1408. Stop 1411 no odor	
1.0										
2.0										
3.0	1.0			Gravelly Sand, same as above, reddish brown (10 YR 6/4), moist, cohesive, consolidated, visible staining at 3.5 ft.						
4.0										
5.0										
6.0	2.0			Gravelly Sand, same as above, light tan (10 YR 7/3); gravel to 5 cm, sand coarsening toward 10 ft. no visible staining		ND		2.0	Start 1419, Stop 1424 no odor	
7.0										
8.0										
9.0										
10.0	3.0			Gravelly Sand, same as above, reddish brown (10 YR 6/4), somewhat cohesive, consolidated, moist.				2.0	Start 1509; Stop 1520, no odor or staining, bag very hot	
11.0										
12.0				Gravelly Sand, same as above, light tan (10 YR 8/2), very dry, unconsolidated, gravel to 6 cm						
13.0	4.0									
14.0										
15.0										
16.0	5.0			Gravelly Sand, same as above, medium tan (10 YR 7/3), subangular gravel, sand coarsening toward 17 ft.		NOT RUN		4.0	Start 1530; Stop 1536 no odor	
17.0										
18.0			SM	Silty Gravelly Sand with more fines; bedding noted: 17 to 18 ft showed well-sorted; 18 to 18.5 ft showed poorly sorted. 18.5 to 20 ft showed moderately sorted.						
19.0										
20.0	6.0		SW	Gravelly Sand, medium brown (10 YR 6/4), hard consolidated layer of "caliche" noted at 25 ft				1.0	Start 1550, Stop 1558, no odor or staining	
21.0										
22.0										
23.0	7.0									
24.0			CL	Caliche layer				4.0		
25.0										
26.0	8.0		SW	Gravelly Sand, reddish brown (10 YR 5/6), somewhat moist and cohesive, gravel to 5 cm.					Start 1604, Stop 1610, no odor	
27.0										
28.0										
29.0	9.0									
30.0				Gravelly Sand, same as above, bedding noted: 27.5 to 28.5 ft showed poorly sorted; 28 to 29 ft showed well sorted; 29 to 30 ft showed poorly sorted.				0.0	Start 1612; Stop 1619; Start 1622; Stop 1626, no odor or staining, bags slightly warm	
31.0										
32.0										
33.0	10.0									
34.0										
35.0							ND		1.0	
36.0	11.0									
37.0										
38.0										
39.0	12.0									

SOIL BORING LOG		BORING NUMBER: B-15	CAU 342 CADD Appendix B Revision: 1 Date: 05/27/99 Page B-15 of B-17
PROJECT NAME: FIRE TRAINING PIT		DATE HOLE STARTED: 06/10/98	
PROJECT NUMBER: 774729.03020200		DATE HOLE COMPLETED: 06/10/98	
UTM EASTING: 589173.00		GEOLOGIST: M. England	
UTM NORTHING: 4057835.00		QA CHECK: F. Baird	
ENVIRONMENTAL CONTRACTOR: IT CORP		TOTAL DEPTH OF HOLE: 30.00	
DRILLING METHOD: RotoSonic		SURFACE ELEVATION: 1141.50	
DRILLING CONTRACTOR: Boart Longyear		COMMENTS:	
ELEVATION DATUM: Mean Sea Level			

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Depth		Legend	USCS	Classification (Description)	TPH (ppm) Log Scale	TPH Comments	VOC (ppm) Log Scale	VOC Comments	Remarks	Sample No.
0.0	0.0		SW	Gravelly Sand, medium brown (10 YR 6/3), 70% sand, medium grain; 30% gravel, semi-round to 5 cm, soil was damp and slightly cohesive, with slight staining noted at 4-5 ft.	0	5000	0	5000	8/10/98 Start 1320 Stop 1339 no odor, bag warm	
1.0										
2.0										
3.0	1.0									
4.0										
5.0				Gravelly Sand same as above medium brown (10 YR 6/3), dry, bedding noted		ND	0	0	Start 1346; Stop 1350, no odor	
6.0										
7.0	2.0									
8.0				Gravelly Sand, same as above, light tan, (10 YR 7/3), dry, more fine sand, semi-angular gravel to 4 cm, no odor.						
9.0										
10.0	3.0			Gravelly Sand, same as above, (10 YR 6/4), numerous large cobbles to 15 cm, loose, bedding noted moderate sorting at 12.5-13 ft, well sorted at 13-14 ft, moderate sorting at 14-15 ft			0	0	Start 1353; Stop 1403, no odor	
11.0										
12.0										
13.0	4.0									
14.0										
15.0				Gravelly Sand, same as above, light tan (10 YR 7/3), unconsolidated, very dry, 15 to 17.5 ft shows sorting and increased gravel		NOT RUN	0	0	Start 1419; Stop 1428	
16.0										
17.0	5.0									
18.0			SM	Silty Gravelly Sand, light tan (10 YR 7/3), 65% sand; 20% gravel, subround, 15% fine silt,			0	0	Bag was very hot at 20 ft	
19.0										
20.0	6.0			Silty Gravelly Sand , same as above, medium tan (10 YR 7/3), 40% semiround gravel.					Start 1437; Stop 1439	
21.0										
22.0				Silty Gravelly Sand , same as above, very light tan (10 YR 8/2), fine silt, one large cobble of 12 cm noted at 24 ft.						
23.0	7.0					ND	0	0		
24.0										
25.0				Silty Gravelly Sand , same as above, light tan, (10 YR 8/2), fine silt, gravel to 5 cm					Start 1509; Stop 1512, bag was hot at 30 ft	
26.0	8.0									
27.0								0		
28.0										
29.0										
9.0										

FTP00157

FTP00157

ELEVATION DATUM: Mean Sea Level												
Depth (feet)		Depth (meters)		USCS	Classification (Description)	TPH (ppm) Log Scale		VOC (ppm) Log Scale		Remarks	Sample No.	
						0	5000	0	5000			
0.0	0.0			SM	Silty Gravelly Sand, light brown (10 YR 7/3), dry, unconsolidated, 60% sand, 30% gravel to 5 cm, 10% silt. Soil was black (10 YR 4/4) and moist at 0 to .5 ft.					6/10/98 Start 1546 Stop 1554 strong odor		
1.0												
2.0												
3.0												
4.0	1.0											
5.0				SW	Gravelly Sand, light brown (10 YR 7/4), visible dark staining (10 YR 5/6) & odor at 6-7 ft, grading noted at 5-7 ft.			442.0		Start 1556 Stop 1559 moderate odor		
6.0												
7.0	2.0											
8.0												
9.0												
10.0	3.0					Gravelly Sand, same as above, medium brown (10 YR 6/4), moist, loose gravel-sand mixture, no fines.	10 PPM DIESEL		295.0		Start 1605 Stop 1607 slight odor	
11.0												
12.0						Gravelly Sand, same as above, medium brown (10 YR 7/4), bedding noted throughout bag.					Start 1610 Stop 1616 strong odor	
13.0	4.0											
14.0												
15.0					Gravelly Sand, same as above (10 YR 6/4).	400 PPM DIESEL		2000.0		Start 1620 Stop 1629 strong odor		
16.0	5.0											
17.0					Gravelly Sand, very dry, fine sand, bedding noted at 20 ft, coarsening to 22.5 ft, more fines.					Start 1631 Stop 1636 strong odor high PID reading	FTP00160	
18.0						NOT RUN		2000.0				
19.0	6.0											
20.0												
21.0												
22.0												
23.0	7.0											
24.0												
25.0					Gravelly Sand, same as above, light tan (10 YR 8/2), dry, gravel to 4.5 cm, some silt content in 32-35 ft bag.	1000 PPM DIESEL		2000.0		Start 1645 Stop 1712 Start 1716 Stop 1720 strong odor, high PID reading, bag hot at 35 ft.		
26.0	8.0											
27.0												
28.0												
29.0												
30.0	9.0											
31.0						400 PPM DIESEL		2000.0				
32.0												
33.0												
34.0	10.0											
35.0					Gravelly Sand, same as above, tan, (10 YR 7/3), some fines.	50 PPM		1087.0		Start 1725 Stop 1745 Start 1749 Stop 1755 bag warm at 40 ft	FTP00161	
36.0	11.0											
37.0												
38.0												
39.0												
40.0	12.0			SM	Silty Gravelly Sand, tan (10 YR 7/3), grading noted as follows: 41.5 to 42 ft shows well sorted fine gravel; small layer of poorly sorted large gravel; 42-42.5 ft is moderately sorted medium gravel.	1-15 PPM DIESEL		45.0		6/11/98 Start 0742 Stop 0751, no odor or visible staining	FTP00158	
41.0												
42.0												
43.0	13.0					Silty Gravelly Sand, same as above, with gravel coarsening to 45 ft, 10% silt content, subangular gravel to 5 cm.						
44.0												
45.0						Silty Gravelly Sand, tan (10 YR 7/4), 60% sand, 30% fine grain gravel, 10% silt throughout both bags, uniform grading noted throughout entire sample.	NOT RUN		19.0		Start 0755 Stop 0800 slight odor	
46.0	14.0											
47.0												
48.0												
49.0	15.0											
50.0					Silty Gravelly Sand, same as above, medium tan (10 YR 7/3), dry, loose, unconsolidated, subround to subangular gravel.			12.0		Start 0804 Stop 0835 slight odor	FTP00159	
51.0												
52.0	16.0											
53.0												
54.0											FTP00162	

SOIL BORING LOG

BORING NUMBER: B-17

PROJECT NAME: FIRE TRAINING PIT

DATE HOLE STARTED: 06/11/98

CAU 342 CADD

PROJECT NUMBER: 774729.03020200

DATE HOLE COMPLETED: 06/11/98

Appendix B

UTM EASTING: 589159.00

GEOLOGIST: M. England

Revision: 1

UTM NORTHING: 4057835.00

QA CHECK: F. Baird

Date: 05/27/99

ENVIRONMENTAL CONTRACTOR: IT CORP

TOTAL DEPTH OF HOLE: 53.00

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DRILLING METHOD: RotoSonic

SURFACE ELEVATION: 1141.00

DRILLING CONTRACTOR: Boart Longyear

COMMENTS:

ELEVATION DATUM: Mean Sea Level

Depth (feet)	Depth (meters)	Legend	USCS	Classification (Description)	TPH (ppm) Log Scale	TPH Comments	VOC (ppm) Log Scale	VOC Comments	Remarks	Sample No
0.0	0.0		SW		10	5000	0	5000		
1.0				Gravelly Sand, red-brown (10 YR 7/3), 60% sand; 40% gravel, subangular to round, red-brown stain (10 YR 6/6) visible at 0-1 ft, loose unconsolidated, dry.					6/11/98 Start 0920 Stop 0925, slight odor	
2.0										
3.0	1.0									
4.0										
5.0						NOT RUN		64.0	Start 0931, Stop 0937 slight odor	
6.0	2.0			Gravelly Sand, (10 YR 6/4), visible dark red stain (10 YR 5/6) noted at 5 to 5.5 ft, some fine silt noted at 7 to 10 ft.						
7.0										
8.0										
9.0										
10.0	3.0			Gravelly Sand, same as above, reddish brown (10 YR 6/4), moist, cohesive, unconsolidated, large cobbles to 13 cm, medium to fine grain sand		ND		6.0	Start 0945, Stop 0949 no noticeable odor or visible staining	
11.0										
12.0										
13.0	4.0									
14.0										
15.0						NOT RUN		7.0	Start 0952, Stop 0956 no odor	
16.0	5.0			Gravelly Sand, same as above, light brown (10 YR 7/3), 80% sand, medium to coarse grain, well sorted; 20% gravel, subround to 8 cm, moist, cohesive, loose, possible staining at 18 ft noted (10 YR 5/6).						
17.0										
18.0										
19.0	6.0			Gravelly Sand, same as above, reddish brown (10 YR 6/4), cohesive fine sand and gravel with very few fines				0.0	Start 1002, Stop 1030, no odor	
20.0										
21.0										
22.0	7.0									
23.0										
24.0										
25.0	8.0			Gravelly Sand, same as above, light tan (10 YR 7/4), dry, loose, unconsolidated, some fine silt noted from 27.5 to 30 ft, increasing gravel to 4 cm from 30-32.5 ft, increased fine silt content toward 35 ft.		1-10 PPM		233.0	Start 1033, Stop 1040 Start 1050, Stop 1054 no odor	
26.0										
27.0										
28.0										
29.0	9.0									FTP00163
30.0								350.0		
31.0										
32.0										
33.0	10.0									
34.0										
35.0										
36.0	11.0			Gravelly Sand, same as above, very light tan (10 YR 8/2), increased silt at 37.5 to 40 ft.		1 PPM		153.0	Start 1059, Stop 1107, Start 1110, Stop 1151, bag slightly warm, no odor	
37.0										
38.0										
39.0	12.0									
40.0						NOT RUN		25.0		
41.0										
42.0										
43.0	13.0									
44.0										
45.0	14.0	GM		Silty Sandy Gravel, very light tan (10 YR 8/2), 40% fine silt; 20% fine grain sand; 40% gravel. Original sample was lost down hole, and sample that was finally retrieved was pulverized into very fine rock flour.		NOT COLLECTE		0.0	Start 1159, Stop 1229, original sample was lost down-hole, and sample that was recovered was pulverized to rock flour consistency, no rocks were discernable.	
46.0										
47.0										
48.0										
49.0	15.0									
50.0			CL	Caliche layer					Same as above	FTP00164
51.0										
52.0		GM		Silty Sandy Gravel, same as above, light tan (10 YR 7/4), sand, silt and gravel, dry, loose, unconsolidated, a hard consolidated layer of "caliche"						

Appendix C

Geotechnical Sample Results

CONVERSE CONSULTANTS

REPORT OF AGGREGATE AND SOIL TEST RESULTS

CAU 342 CADD
Appendix C
Revision: 1
Date: 05/27/99
Page C-1 of C-23

Project : CAU 342 Mercury FTP

Page : 1 of 2

Report to : International Technology Corporation

Date of Report : 9-24-98

Attention : Mr. Ken Beach

Project No. : 774729.0302030

Sample Identification : _____

Reported By: Nancy E. Reid

Reviewed By: Kurt Tolivasia, P.E.

Director of Field Services

Sample Location	FTP	FTP	FTP	FTP	FTP
Sample Number	00093	00102	00110	00118	00148
Gradation (ASTM C117 & C136)					
Sieve Size	Percent Passing Each Sieve				
2"					100
1 1/2"		100	100		90.8
1"	100	97.1	90.0	100	90.8
3/4"	99.0	90.1	83.6	94.4	87.8
1/2"	97.3	86.3	75.3	89.0	79.5
3/8"	95.9	81.4	65.8	84.7	71.9
No. 4	84.2	65.1	50.5	69.0	51.3
No. 8	71.6	48.0	37.6	50.7	38.8
No. 10	68.7	45.0	35.4	47.6	36.7
No. 16	61.7	35.5	28.2	38.6	31.5
No. 30	55.7	26.7	22.9	31.9	26.9
No. 40	52.4	22.3	20.4	29.8	25.3
No. 50	50.6	20.6	18.7	26.6	22.7
No. 100	44.1	16.1	13.6	19.3	16.8
No. 200	38.9	12.2	9.0	12.7	12.2
Initial Moisture/Density, % / pcf	4.0 / 121.6	3.7 / 119.2	2.8 / 128.9	5.8 / 122.4	1.6 / 132.1
Apparent Specific Gravity	2.72	2.70	2.72	2.68	2.72
Calculated Porosity	0.28	0.29	0.24	0.27	0.16
Calculated Void Ratio	0.40	0.41	0.32	0.37	0.20

Comments: Hydrometer Analysis (ASTM D422) Not Performed on Sample 00110.

Sampled Contaminated with Drillers Foam.

CONVERSE CONSULTANTS

REPORT OF AGGREGATE AND SOIL TEST RESULTS

CAU 342 CADD
Appendix C
Revision: 1
Date: 05/27/99
Page C-2 of C-23

Project : CAU 342 Mercury FTP

Page : 2 of 2

Report to : International Technology Corporation

Date of Report : 9-24-98

Attention : Mr. Ken Beach

Project No. : 774729.0302030

Sample Identification :

Reported By: Nancy E. Reid

Reviewed By: Kurt Tolivasia, P.E.
Director of Field Services

Sample Location	FTP	FTP			
Sample Number	00158	00159			
Gradation (ASTM C117 & C136)					
Sieve Size	Percent Passing Each Sieve				
2"					
1 1/2"	100				
1"	95.6	100			
3/4"	91.9	93.4			
1/2"	80.8	88.1			
3/8"	74.9	84.8			
No. 4	58.8	71.0			
No. 8	48.1	54.9			
No. 10	45.7	51.1			
No. 16	41.0	43.9			
No. 30	36.4	37.0			
No. 40	35.5	34.4			
No. 50	32.6	32.0			
No. 100	26.9	26.2			
No. 200	21.2	21.2			
Initial Moisture/Density, % / pcf	1.9 / 130.3	1.7 / 128.2			
Apparent Specific Gravity	2.72	2.73			
Calculated porosity	0.23	0.25			
Calculated Void ratio	0.30	0.33			

Comments:

GRAIN SIZE DISTRIBUTION GRAPH

HYDROMETER TEST SUMMARY

% GRAVEL =	15.79%	$D_{85} = 5.0$	$D_{15} =$
% SAND =	45.34%	$D_{60} = 1.0$	$D_{10} =$
% SILT & CLAY =	38.87%	$D_{50} = 0.3$	$C_U =$
		$D_{30} =$	$C_C =$

Project No.: 774729.03020300
Client: International Technology Corporation
Project Name: CAU 342 Mercury FTP
Sample No.: FTP00093
Material Description: Clayey Sand with Gravel

GRAIN SIZE DISTRIBUTION TEST REPORT with HYDROMETER

CONVERSE CONSULTANTS, INC.

Drawing No.

GRAIN SIZE DISTRIBUTION GRAPH

GRAIN SIZE DISTRIBUTION GRAPH

TEST SUMMARY

% GRAVEL =	49.48%	$D_{85} = 20.3$	$D_{15} = 0.2$
% SAND =	41.50%	$D_{60} = 7.3$	$D_{10} = 0.1$
% SILT & CLAY =	9.03%	$D_{50} = 4.6$	$C_U = 84.1$
		$D_{30} = 1.4$	$C_C = 2.9$

Project No.: 774729.03020300

Project Name: International Technology Corporation

Date: 23-Sep-98

Sample No.: FTP00110

Material Description: Well Graded Gravel with Silt & Sand

GRAIN SIZE DISTRIBUTION TEST REPORT

CONVERSE CONSULTANTS SOUTHWEST

Drawing No.

GRAIN SIZE DISTRIBUTION GRAPH

HYDROMETER TEST SUMMARY

% GRAVEL =	31.03%	$D_{85} = 9.7$	$D_{15} = 0.1$
% SAND =	56.27%	$D_{60} = 3.4$	$D_{10} =$
% SILT & CLAY =	12.70%	$D_{50} = 2.3$	$C_u =$
		$D_{30} = 0.5$	$C_c =$

Project No.: 774729.03020300

Client: International Technology Corporation

Project Name: CAU 342 Mercury FTP

Sample No.: FTP00118

Material Description: Silty Sand with Gravel

GRAIN SIZE DISTRIBUTION TEST REPORT with HYDROMETER

CONVERSE CONSULTANTS, INC.

Drawing No.

GRAIN SIZE DISTRIBUTION GRAPH

HYDROMETER TEST SUMMARY

% GRAVEL =	48.67%	$D_{85} = 16.6$	$D_{15} = 0.1$
% SAND =	39.17%	$D_{60} = 6.4$	$D_{10} =$
% SILT & CLAY =	12.16%	$D_{50} = 4.4$	$C_u =$
		$D_{30} = 0.9$	$C_c =$

Project No.: 774729.03020300
Client: International Technology Corporation
Project Name: CAU 342 Mercury FTP
Sample No.: FTP00148
Material Description: Silty Gravel with Sand

GRAIN SIZE DISTRIBUTION TEST REPORT with HYDROMETER

CONVERSE CONSULTANTS, INC.

Drawing No.

GRAIN SIZE DISTRIBUTION GRAPH

HYDROMETER TEST SUMMARY

% GRAVEL =	41.16%	D ₈₅ = 14.8	D ₁₅ =
% SAND =	37.67%	D ₆₀ = 5.0	D ₁₀ =
% SILT & CLAY =	21.17%	D ₅₀ = 2.7	C _u =
		D ₃₀ = 0.2	C _c =

Project No.: 774729.03020300
Client: International Technology Corporation
Project Name: CAU 342 Mercury FTP
Sample No.: FTP00158
Material Description: Clayey Gravel with Sand

GRAIN SIZE DISTRIBUTION TEST REPORT with HYDROMETER

CONVERSE CONSULTANTS, INC.

Drawing No.

GRAIN SIZE DISTRIBUTION GRAPH

HYDROMETER TEST SUMMARY

% GRAVEL =	29.01%	$D_{85} = 9.7$	$D_{15} =$
% SAND =	49.81%	$D_{60} = 2.9$	$D_{10} =$
% SILT & CLAY =	21.17%	$D_{50} = 1.7$	$C_u =$
		$D_{30} = 0.2$	$C_c =$

Project No.: 774729.03020300
Client: International Technology Corporation
Project Name: CAU 342 Mercury FTP
Sample No.: FTP00159
Material Description: Clayey Sand with Gravel

GRAIN SIZE DISTRIBUTION TEST REPORT with HYDROMETER

CONVERSE CONSULTANTS, INC.

Drawing No.

Capillary-Moisture Relations for Soils

ASTM D 2325

Project Name: CAU 342 Mercury FTP

Tested By: SY Date: 09/03/98

Project No.: 774729.03020300

Checked By: AP Date: 09/11/98

Boring No.:

Sample No.: FTP00093 Depth N/A ft

Soil Type: Pale Brn Clayey Sand

Initial Moisture Content (%): 5.1

Initial Dry Weight (pcf): 115.2

Sample Diameter (in): 2.05

Sample Height (in): 0.4

Tension (bars)	0	0.1	0.3	0.5	1	2.5	5	10	15
Tension (feet of water)	0	3.4	11.04	17	33.9	84.8	169.5	339	508
Wt of Wet Soil + Ring (gm)	52.37	51.19	48.68	48	47.58	47.29	47.03	46.9	46.85
Wt of Dry Soil + Ring (gm)	42.83	42.83	42.83	42.83	42.83	42.83	42.83	42.83	42.83
Wt of Ring (gm)	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45
Moisture Content by Wt (%)	24.86	21.78	15.24	13.47	12.38	11.62	10.94	10.60	10.47
Cor. Dry Unit Wt of Soil (pcf)	115.20	115.20	115.20	115.20	115.20	115.20	115.20	115.20	115.20
Moisture Content by Vol (%)	45.87	40.19	28.13	24.86	22.84	21.44	20.19	19.57	19.33

Wilting Point: 19.3 %

Field Capacity: 27.6 %

Capillary-Moisture Relations for Soils

ASTM D 2325

Project Name: CAU 342 Mercury FTP

Tested By: SY Date: 09/03/98

Project No.: 774729.03020300

Checked By: AP Date: 09/11/98

Boring No.:

Sample No.: FTP00102 Depth N/A ft

Soil Type: Pale Brn Clayey Sand

Initial Moisture Content (%): 5.6

Initial Dry Weight (pcf): 117.2

Sample Diameter (in): 2.05

Sample Height (in): 0.4

Tension (bars)	0	0.1	0.3	0.5	1	2.5	5	10	15
Tension (feet of water)	0	3.4	11.04	17	33.9	84.8	169.5	339	508
Wt of Wet Soil + Ring (gm)	54.31	52.47	49.97	49.34	48.85	48.55	48.23	48.08	48.01
Wt of Dry Soil + Ring (gm)	43.68	43.68	43.68	43.68	43.68	43.68	43.68	43.68	43.68
Wt of Ring (gm)	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14
Moisture Content by Wt (%)	26.88	22.23	15.91	14.31	13.08	12.32	11.51	11.13	10.95
Cor. Dry Unit Wt of Soil (pcf)	110.40	110.40	110.40	110.40	110.40	110.40	110.40	110.40	110.40
Moisture Content by Vol(%)	47.54	39.31	28.13	25.31	23.12	21.78	20.35	19.68	19.37

Wilting Point: 19.4 %

Field Capacity: 27.7 %

Capillary-Moisture Relations for Soils

ASTM D 2325

Project Name: CAU 342 Mercury FTP

Tested By: SY Date: 09/03/98

Project No.: 774729.03020300

Checked By: AP Date: 09/11/98

Boring No.:

Sample No.: FTP00110 Depth N/A ft

Soil Type: Pale Brn Clayey Sand

Initial Moisture Content (%): 5.1

Initial Dry Weight (pcf): 108.7

Sample Diameter (in): 2.05

Sample Height (in): 0.4

Tension (bars)	0	0.1	0.3	0.5	1	2.5	5	10	15
Tension (feet of water)	0	3.4	11.04	17	33.9	84.8	169.5	339	508
Wt of Wet Soil + Ring (gm)	48.42	45.51	45.02	44.89	44.53	44.18	44.02	43.98	43.94
Wt of Dry Soil + Ring (gm)	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5	39.5
Wt of Ring (gm)	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36	4.36
Moisture Content by Wt (%)	25.38	17.10	15.71	15.34	14.31	13.32	12.86	12.75	12.64
Cor. Dry Unit Wt of Soil (pcf)	108.66	108.66	108.66	108.66	108.66	108.66	108.66	108.66	108.66
Moisture Content by Vol(%)	44.18	29.77	27.34	26.70	24.91	23.18	22.39	22.19	21.99

Wilting Point: 22.0 %

Field Capacity: 27.2 %

Capillary-Moisture Relations for Soils

ASTM D 2325

Project Name: CAU 342 Mercury FTP

Tested By: SY Date: 09/03/98

Project No.: 774729.03020300

Checked By: AP Date: 09/11/98

Boring No.: _____

Sample No.: FTP00118 Depth N/A ft

Soil Type: Pale Brn Clayey Sand

Initial Moisture Content (%): 7.2

Initial Dry Weight (pcf): 116.2

Sample Diameter (in): 2.05

Sample Height (in): 0.4

Tension (bars)	0	0.1	0.3	0.5	1	2.5	5	10	15
Tension (feet of water)	0	3.4	11.04	17	33.9	84.8	169.5	339	508
Wt of Wet Soil + Ring (gm)	51.24	50.06	47.6	47.17	46.96	46.66	46.44	46.38	46.33
Wt of Dry Soil + Ring (gm)	42.75	42.75	42.75	42.75	42.75	42.75	42.75	42.75	42.75
Wt of Ring (gm)	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Moisture Content by Wt (%)	22.14	19.06	12.65	11.53	10.98	10.20	9.62	9.47	9.34
Cor. Dry Unit Wt of Soil (pcf)	116.18	116.18	116.18	116.18	116.18	116.18	116.18	116.18	116.18
Moisture Content by Vol(%)	41.20	35.47	23.53	21.45	20.43	18.97	17.91	17.61	17.37

Wilting Point: 17.4 %

Field Capacity: 23.2 %

Capillary-Moisture Relations for Soils

ASTM D 2325

Project Name: CAU 342 Mercury FTP Tested By: SY Date: 09/03/98
Project No.: 774729.03020300 Checked By: AP Date: 09/11/98
Boring No.: _____
Sample No.: FTP00148 Depth N/A ft
Soil Type: Pale Brn Clayey Sand

Initial Moisture Content (%): 2.8 Initial Dry Weight (pcf): 131.9
Sample Diameter (in): 2.05 Sample Height (in): 0.4

Tension (bars)	0	0.1	0.3	0.5	1	2.5	5	10	15
Tension (feet of water)	0	3.4	11.04	17	33.9	84.8	169.5	339	508
Wt of Wet Soil + Ring (gm)	59.15	57.46	55.91	55.83	54.91	54.48	54.11	53.98	53.9
Wt of Dry Soil + Ring (gm)	49.33	49.33	49.33	49.33	49.33	49.33	49.33	49.33	49.33
Wt of Ring (gm)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Moisture Content by Wt (%)	21.90	18.14	14.68	14.50	12.45	11.49	10.66	10.37	10.19
Cor. Dry Unit Wt of Soil (pcf)	131.86	131.86	131.86	131.86	131.86	131.86	131.86	131.86	131.86
Moisture Content by Vol(%)	46.27	38.30	31.00	30.62	26.29	24.26	22.52	21.91	21.53

Wilting Point: 21.5 % Field Capacity: 30.9 %

Capillary-Moisture Relations for Soils

ASTM D 2325

Project Name: CAU 342 Mercury FTP

Tested By: SY Date: 09/03/98

Project No.: 774729.03020300

Checked By: AP Date: 09/11/98

Boring No.:

Sample No.: FTP00158 Depth N/A ft

Soil Type: Pale Brn Clayey Sand

Initial Moisture Content (%): 1.7

Initial Dry Weight (pcf): 119.9

Sample Diameter (in): 2.05

Sample Height (in): 0.4

Tension (bars)	0	0.1	0.3	0.5	1	2.5	5	10	15
Tension (feet of water)	0	3.4	11.04	17	33.9	84.8	169.5	339	508
Wt of Wet Soil + Ring (gm)	54.84	52.34	50.87	50.71	50.26	49.37	49.05	48.95	48.89
Wt of Dry Soil + Ring (gm)	46.95	46.95	46.95	46.95	46.95	46.95	46.95	46.95	46.95
Wt of Ring (gm)	4.27	4.27	4.27	4.27	4.27	4.27	4.27	4.27	4.27
Moisture Content by Wt (%)	18.49	12.63	9.18	8.81	7.76	5.67	4.92	4.69	4.55
Cor. Dry Unit Wt of Soil (pcf)	119.93	119.93	119.93	119.93	119.93	119.93	119.93	119.93	119.93
Moisture Content by Vol(%)	35.51	24.26	17.64	16.92	14.90	10.89	9.45	9.00	8.73

Wilting Point: 8.7 %

Field Capacity: 17.5 %

Capillary-Moisture Relations for Soils

ASTM D 2325

Project Name: CAU 342 Mercury FTP
Project No.: 774729.03020300
Boring No.:
Sample No.: FTP00159 Depth N/A ft
Soil Type: Pale Brn Sandy Silt

Tested By: SY Date: 09/03/98
Checked By: AP Date: 09/11/98

Initial Moisture Content (%): 4.0
Sample Diameter (in): 2.05

Initial Dry Weight (pcf): 108.1
Sample Height (in): 0.4

Tension (bars)	0	0.1	0.3	0.5	1	2.5	5	10	15
Tension (feet of water)	0	3.4	11.04	17	33.9	84.8	169.5	339	508
Wt of Wet Soil + Ring (gm)	51.2	50.88	48.94	47.8	47.32	46.83	46.47	46.22	46.14
Wt of Dry Soil + Ring (gm)	41.22	41.22	41.22	41.22	41.22	41.22	41.22	41.22	41.22
Wt of Ring (gm)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Moisture Content by Wt (%)	27.18	26.31	21.02	17.92	16.61	15.28	14.30	13.62	13.40
Cor. Dry Unit Wt of Soil (pcf)	108.11	108.11	108.11	108.11	108.11	108.11	108.11	108.11	108.11
Moisture Content by Vol(%)	47.06	45.55	36.41	31.03	28.77	26.46	24.76	23.58	23.20

Wilting Point: 23.2 %

Field Capacity: 35.6 %

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST ASTM D5084

Project Name: CAU 342 Mercury FTP
Project No.: 774729.03020300
Boring No.:
Sample No.: FTP00093 Depth: N/A feet
Soil Description: Pale Brn Clayey Sand
Test Condition: Brass Tube
Confining Pressure = 5 PSI

Tested by KK
Calculated by SY
Checked by AP

Date 09/08/98
Date 09/10/98
Date 09/11/98

INITIAL CONDITION OF SPECIMEN

Diameter (d) 2.415 in
Sample Area (A) 4.58 in²
Length (L) 2.30 in
Weight Before 344.5 g
Wet Density 124.5 pcf
Dry Density 118.4 pcf

	Before	After
Container No.		
Wt. Wet Soil+Container(gms)	214.41	415.67
Wt. Dry Soil+Container(gms)	211.02	369.54
Wt. Container (gms)	145.17	48.85
Moisture, (%)	5.1	14.4

TEST RESULTS

Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	0.2	0.486	0.0	3.0	36.1	0.000000
1	4.3	0.486	2.0	3.0	36.1	0.033210
3	13.2	0.486	6.3	3.0	36.1	0.036045
4	18.1	0.486	8.7	3.0	36.1	0.039690
5	23.0	0.486	11.1	3.0	36.1	0.039690
5.5	25.2	0.486	12.2	3.0	36.1	0.035640

Hydraulic Conductivity (cm/sec): 3.59E-05

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST ASTM D5084

Project Name: CAU 342 Mercury FTP
Project No.: 774729.03020300
Boring No.:
Sample No.: FTP00102 Depth: N/A feet
Soil Description: Pale Brown Clayey Sand
Test Condition: Brass Tube
Confining Pressure = 5 PSI

Tested by KK
Calculated by SY
Checked by AP

Date 09/07/98
Date 09/10/98
Date 09/11/98

INITIAL CONDITION OF SPECIMEN

Diameter (d) 2.415 in
Sample Area (A) 4.58 in²
Length (L) 2.20 in
Weight Before 308.82 g
Wet Density 116.7 pcf
Dry Density 110.4 pcf

	Before	After
Container No.		
Wt. Wet Soil+Container(gms)	634.26	385.86
Wt. Dry Soil+Container(gms)	628.28	339.82
Wt. Container (gms)	522.21	50.18
Moisture, (%)	5.6	15.9

TEST RESULTS

Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	48.0	1	0.0	3.0	37.8	0.000000
1	42.0	1	6.0	3.0	37.8	0.100000
2	36.8	1	11.2	3.0	37.8	0.086667
3	31.8	1	16.2	3.0	37.8	0.083333
4	27.4	1	20.6	3.0	37.8	0.073333
5	22.6	1	25.4	3.0	37.8	0.080000

Hydraulic Conductivity (cm/sec): 7.07E-05

**FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST
ASTM D5084**

Project Name: CAU 342 Mercury FTP
 Project No.: 774729.03020300
 Boring No.: _____
 Sample No.: FTP00110 Depth: N/A feet
 Soil Description: Pale Brown Silty Sand w/ gravel
 Test Condition: Brass Tube
 Confining Pressure = 5 PSI

Tested by KK
 Calculated by SY
 Checked by AP

Date 09/07/98
 Date 09/10/98
 Date 09/11/98

INITIAL CONDITION OF SPECIMEN

Diameter (d) 2.415 in
 Sample Area (A) 4.58 in²
 Length (L) 3.60 in
 Weight Before 513.19 g
 Wet Density 118.5 pcf
 Dry Density 112.8 pcf

Container No. _____

	Before	After
Wt. Wet Soil+Container(gms)	689.22	591.30
Wt. Dry Soil+Container(gms)	684.84	508.69
Wt. Container (gms)	598.48	32.98
Moisture, (%)	5.1	17.4

TEST RESULTS

Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	45.5	1	0.0	1.0	7.69	0.000000
1	38.4	1	7.1	1.0	7.69	0.118333
2	33.0	1	12.5	1.0	7.69	0.090000
3	28.0	1	17.5	1.0	7.69	0.083333
5	19.5	1	26.0	1.0	7.69	0.070833
8	8.0	1	37.5	1.0	7.69	0.063889

Hydraulic Conductivity (cm/sec): 3.20E-04

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST ASTM D5084

Project Name: CAU 342 Mercury FTP
Project No.: 774729.03020300
Boring No.:
Sample No.: FTP00118 Depth: N/A feet
Soil Description: Pale Brown Silty Sand w/ gravel
Test Condition: Brass Tube
Confining Pressure = 5 PSI

Tested by KK
Calculated by SY
Checked by AP

Date 09/07/98
Date 09/10/98
Date 09/11/98

INITIAL CONDITION OF SPECIMEN

Diameter (d) 2.415 in
Sample Area (A) 4.58 in²
Length (L) 3.10 in
Weight Before 457.09 g
Wet Density 122.6 pcf
Dry Density 114.3 pcf

	Before	After
Container No.		
Wt. Wet Soil+Container(gms)	618.1	542.53
Wt. Dry Soil+Container(gms)	611.88	475.39
Wt. Container (gms)	525.18	52.27
Moisture, (%)	7.2	15.9

TEST RESULTS

Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	2.0	0.474	0.0	1.0	8.93	0.000000
0.5	17.2	0.474	7.2	1.0	8.93	0.240160
0.75	23.4	0.474	10.1	1.0	8.93	0.195920
1	30.9	0.474	13.7	1.0	8.93	0.237000
1.25	38.0	0.474	17.1	1.0	8.93	0.224360
1.5	44.6	0.474	20.2	1.0	8.93	0.208560

Hydraulic Conductivity (cm/sec): 8.46E-04

AP Engineering and Testing, Inc.

GEOTECHNICAL TESTING LABORATORY

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST ASTM D5084

Project Name: CAU 342 Mercury FTP
Project No.: 774729.03020300
Boring No.:
Sample No.: FTP00148 Depth: N/A feet
Soil Description: Pale Brown Clayey Sand
Test Condition: Brass Tube
Confining Pressure = 5 PSI

Tested by KK
Calculated by SY
Checked by AP

Date 09/07/98
Date 09/10/98
Date 09/11/98

INITIAL CONDITION OF SPECIMEN

Diameter (d) 2.415 in
Sample Area (A) 4.58 in²
Length (L) 1.80 in
Weight Before 288.42 g
Wet Density 133.2 pcf
Dry Density 129.5 pcf

	Before	After
Container No.		
Wt. Wet Soil+Container(gms)	267.73	348.15
Wt. Dry Soil+Container(gms)	264.37	320.51
Wt. Container (gms)	145.17	52.85
Moisture, (%)	2.8	10.3

TEST RESULTS

Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	4.7	2.449	0.0	3.0	46.2	0.000000
6	8.5	2.449	9.3	3.0	46.2	0.025851
14	12.5	2.449	19.1	3.0	46.2	0.020408
21	16.0	2.449	27.7	3.0	46.2	0.020408
30	20.2	2.449	38.0	3.0	46.2	0.019048
44	26.5	2.449	53.4	3.0	46.2	0.018368

Hydraulic Conductivity (cm/sec): 1.41E-05

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST ASTM D5084

Project Name: CAU 342 Mercury FTP
Project No.: 774729.03020300
Boring No.:
Sample No.: FTP00158 Depth: N/A feet
Soil Description: Pale Brown Silty Sand
Test Condition: Brass Tube
Confining Pressure = 5 PSI

Tested by KK
Calculated by SY
Checked by AP

Date 09/08/98
Date 09/10/98
Date 09/11/98

INITIAL CONDITION OF SPECIMEN

Diameter (d) 2.415 in
Sample Area (A) 4.58 in²
Length (L) 3.20 in
Weight Before 466.14 g
Wet Density 121.1 pcf
Dry Density 119.1 pcf

	Before	After
Container No.		
Wt. Wet Soil+Container(gms)	280.4	560.12
Wt. Dry Soil+Container(gms)	278.18	513.39
Wt. Container (gms)	145.17	56.82
Moisture, (%)	1.7	10.2

TEST RESULTS

Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	4.7	2.388	0.0	3.0	26	0.000000
11	7.1	2.388	5.7	3.0	26	0.008684
34	12.4	2.388	18.4	3.0	26	0.009171
49	15.5	2.388	25.8	3.0	26	0.008225
57	17.2	2.388	29.9	3.0	26	0.008458
73	20.4	2.388	37.5	3.0	26	0.007960
87	23.3	2.388	44.4	3.0	26	0.008244

Hydraulic Conductivity (cm/sec): 1.07E-05

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST ASTM D5084

Project Name:	CAU 342 Mercury FTP	Tested by	KK	Date	09/08/98
Project No.:	774729.03020300	Calculated by	SY	Date	09/10/98
Boring No.:		Checked by	AP	Date	09/11/98
Sample No.:	FTP00159	Depth:	N/A	feet	
Soil Description:	Pale Brown Sandy Silt				
Test Condition:	Brass Tube				
	Confining Pressure = 5 PSI				

INITIAL CONDITION OF SPECIMEN

Diameter (d)	2.415	in		
Sample Area (A)	4.58	in ²		
Length (L)	1.80	in		
Weight Before	257.77	g		
Wet Density	119.0	pcf		
Dry Density	114.4	pcf		

Container No.	Before	After
Wt. Wet Soil+Container(gms)	598.85	310.16
Wt. Dry Soil+Container(gms)	595.87	276.28
Wt. Container (gms)	522.18	27.34
Moisture, (%)	4.0	13.6

TEST RESULTS

Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	42.0	1	0.0	3.0	46.2	0.000000
13	36.8	1	5.2	3.0	46.2	0.006667
28	31.7	1	10.3	3.0	46.2	0.005667
81	15.6	1	26.4	3.0	46.2	0.005063
89	13.0	1	29.0	3.0	46.2	0.005417
104	9.2	1	32.8	3.0	46.2	0.004222
119	5.0	1	37.0	3.0	46.2	0.004667

Hydraulic Conductivity (cm/sec): 3.59E-06

Appendix D

Cost Estimates

EST: CAU342 CADD Rev 1	BN ENVIRONMENTAL RESTORATION COST ESTIMATE SUMMARY	Prep Date: 4/19/99 Print Date: 5/13/99
TO: SHANNON PARSONS-DEPRY - Environmental Restoration Task Manager FROM: ABDEL AGALLOUCH - ER Project Controls		
SUBJECT: REMEDIAL ALTERNATIVES: REV 1 TEC: (see totals below)		
WORK PKGE: CAU 342-Fire Training Pit WBS: 1040102130903		
TAP: SPILL SITES SOURCE GROUPING LOCATION: NTS		
TYPE OF ESTIMATE X ORDER OF MAGNITUDE PRELIMINARY TITLE II PLANNING/STUDY WORK ORDER CONCEPTUAL/BUDGET COMPARATIVE TITLE I / PRELIMINARY OTHER		TYPE OF WORK RI / FS X REMEDIATION X CONSTRUCTION OTHER
BN REMEDIATION PROJECT ESTIMATOR: Abdel Agallouch 702-295-5275 TASK MGR: Shannon Parsons Depry 702-295-0645 PROJ MGR: Steve Nacht 702-295-7234		WORK TO BE PERFORMED BY X DOE PRIME CONTRACTOR NATIONAL LAB NTS GENERAL SUBCONTRACT NTS MAINTENANCE OTHER
<p><u>STATEMENT OF WORK:</u></p> <p>This estimate has been prepared to provide remedial alternative costs for the closure of Corrective Action Unit (CAU) 342, an environmental restoration site listed in the Federal Facilities and Consent Order (FFACO). CAU 342 is specifically described as the Area 23 Fire Training Pit. Four alternatives will be evaluated for closure of the site: I) No Further action no associated costs or administrative controls, II) Closure by administrative controls, partial excavation and drilling, III) Closure by bioremediation and partial excavation, and IV) Closure by gas vapor monitoring and partial excavation. 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, plan preparation, project support, or other overhead functions are not included.</p> <p><u>SCOPE</u></p> <p>Provide site closure using one of the following alternatives:</p> <p>I) NO FURTHER ACTION -NO ASSOCIATED COSTS OR ADMINISTRATIVE CONTROLS</p> <p>II) PARTIAL EXCAVATION AND DRILLING</p> <p>III) BIOREMEDIATION AND PARTIAL EXCAVATION</p> <p>IV) PARTIAL EXCAVATION AND GAS VAPOR MONITORING</p> <p><u>BASIS OF ESTIMATE AND ASSUMPTIONS</u></p> <p><u>Alternative II: Partial excavation and drilling</u></p> <ul style="list-style-type: none"> • The total volume of excavation is approximately 2100 CY, including a 20% expansion factor and will be disposed of at the Area 6 TPH landfill. Assume clean fill material will be used from the stockpile of material at decon pond in area 6. • Process and transport of 150CY of pea gravel from batch plant to the site • The excavation depths will range from 1 ft to 5 ft • Assume 6 loads/day @ 20CY/load for a total of 120 CY/day, will be excavated, disposed of and backfilled. • Assume excavation will require 17 days • Backfill material for excavated areas will be compacted using a backhoe/loader. • Fence line survey for use restriction document will be required. • Labor costs are based on a 10 hr day, 4 day week schedule. • Assume no hazardous material will be encountered during the excavation operations. • 3 20 feet deep wells will be drilled at different locations for a total of 60 linear feet. Assume drilling of the wells will require 2 days for move and demove, 4 days of drilling. • The majority of soil with TPH concentrations greater than 10,000 mg/Kg will be excavated using an 8 1/2 ft diameter auger. • Assume 20 samples will be collected and analyzed for TPH 		
Review / Concurrence: <div style="display: flex; justify-content: space-between; align-items: flex-end; margin-top: 10px;"> <div style="text-align: center;"> Abdel Agallouch Estimator </div> <div style="text-align: center;"> 5/13/99 Date </div> <div style="text-align: center;"> Checked By </div> <div style="text-align: center;"> 5/13/99 Date </div> </div>		

BN ENVIRONMENTAL RESTORATION

Prep Date: 4/19/99

EST: CAU342 CADD Rev 1

COST ESTIMATE SUMMARY

Print Date: 5/13/99

Alternative III: Bioremediation and partial excavation

a) Bioremediation

- The Bioremediation alternative cost is based on the standard technology cost with the BN adders.
- The bioremediation system will consist of in-situ passive bioventing system comprised of 5 wells; three, 6 3/4 inch and two, 6 3/4 inch diameter boreholes, advanced to approximately 50 feet and 30 feet, respectively, all with 4 inch PVC screening from 5 ft to total depth. Casing will be comprised of 0.010 inch slotted PVC screen with graded sand pack.
- The initial bioremediation rate constant (i.e., measure CO₂ respiration rates within all five wells) will determine whether there is a need for supplemental nutrients.
- The completion of the bioremediation process will take 3 to 10 years (depending upon biodegradation rate).
- The wells will be fenced and signs will be installed to protect the wells.
- Post-Closure monitoring will be for a total of ten years; quarterly for the first five years and semiannual for the next 5 years.
- Soil gas sampling will be conducted for TPH, O₂, N₂ and CO₂ (2 samples per well)

b) Partial excavation

- The total volume of excavation is approximately 1950 CY, including a 20% expansion factor and will be disposed of the TPH landfill
- The excavation depths will range from 1 ft to 5 ft
- Assume 6 loads/day @ 20CY/load for a total of 120 CY/day, will be excavated, disposed of and backfilled
- Backfill material for excavated areas will be compacted using a backhoe/loader
- Fence line survey for use restriction document will be required.
- Labor costs are based on a 10 hr day, 4 day week schedule.
- Assume no hazardous material will be encountered during the excavation operations.
- Assume backfill material can be obtained from a borrow pit located at the area 6.

Alternative IV: Partial Excavation and Gas Vapor Monitoring

- The Gas Vapor Monitoring will consist of drilling 1 4 1/4 inch diameter wells to 20 feet. Assume Schedule 40 PVC pipe with surface cap and surface manhole will be used.
- Assume drilling and installing of the well will take 2 days
- The monitoring and maintenance will consist of 3 sampling events: gas sampling for VOCs and SVOCs and field screening for O₂, CO₂, Methane, and (VOCs). Assume the monitoring will be done for 6 years every 2 years.
- The partial excavation alternative will be identical to the one listed under the bioremediation alternative (b)
- To protect the well, fencing and signs will be installed around the well.

ESCALATION:

Escalation is not included in this estimate. All costs are in FY99 dollars

(Except for bioremediation 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 -NO ASSOCIATED COSTS OR ADMINISTRATIVE CONTROLS	\$0
• PARTIAL EXCAVATION AND DRILLING	\$216,359
• BIOREMEDIATION AND PARTIAL EXCAVATION	\$717,917
• PARTIAL EXCAVATION AND GAS VAPOR MONITORING	\$181,530

Appendix E

**Bioassessment Report, Nevada Test Site,
CAU 342 (Area 23 Mercury Fire Training Pit)**

**BIOASSESSMENT REPORT
NEVADA TEST SITE
CAU 342 (AREA 23 MERCURY FIRE TRAINING PIT)**

Prepared for:

**IT CORPORATION
LAS VEGAS, NEVADA**

Prepared by:

**IT CORPORATION
312 DIRECTORS DRIVE
KNOXVILLE, TENNESSEE 37923**

IT PROJECT NO. 774729

**MAY 1999
REVISION 1**

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1.0 Introduction

IT Corporation was contracted to conduct a site bioassessment on samples collected from the Nevada Test Site, Corrective Action Unit 342 (Area 23 Mercury Fire Training Pit). The Biotechnology Applications Center received eight soil samples on June 26, 1998. The samples were collected June 1998. In order to investigate the feasibility of bioremediation at the Fire Training Pit (FTP), a bioassessment was performed on eight site soil samples.

Bioremediation is an environmental remediation tool that uses bacteria to oxidize a wide variety of wastes. Bacteria can transform most natural and man-made organic compounds given appropriate environmental conditions and an adequate acclimation period. The biological conversion of organic compounds into biomass, carbon dioxide, and water makes bioremediation an attractive remedial alternative.

The FTP was used from the early 1960s through the early 1990s for fire suppression training exercises. Fires were ignited using off-specification or rust-contaminated fuels; various fire-suppressant chemicals were used to extinguish the fires. The chemicals of potential concern (COPCs) consist mainly of hydrocarbons and possibly other volatile organic compounds, semivolatile organic compounds, metals, and polychlorinated biphenyls. In addition to regular training exercises, special burns were occasionally conducted to test cables or other materials. These special burns may have resulted in the release of other contaminants such as dioxins and furans.

The surface and subsurface soils in the FTP have likely been impacted by hydrocarbons and other COPCs associated with burn activities and training exercises in the area. The COPCs may have been redistributed across the surface of the FTP through regarding activities and previous cleanup activities. Subsurface COPCs would be a result of direct release of hydrocarbon fuels to the soil and subsequent vertical migration through natural processes or the application of water used during fire fighting exercises. Subsurface contamination in the burn pit area reached 20 feet below ground surface (bgs) and reached approximately 40-50 feet bgs in the Aboveground Storage Tanks area. Groundwater impact is unlikely because depth to groundwater is greater than 800 feet and the environmental conditions at the site (i.e., arid climate, high evapotranspiration rate, low subsurface permeabilities) are not conducive to downward migration.

Bioventing is a common method of bioremediation which may be applicable for impacted vadose zone soils found on site. Bioventing is the in situ biological treatment of contaminated vadose zone soil. During bioventing, remediation is promoted by supplying oxygen to the subsurface using blowers or vacuum pumps. Bioventing can effectively treat any biodegradable compound, if bacteria are present in the soil with the metabolic capability to biodegrade the target compounds. In the case of petroleum products such as gasoline, jet fuel, diesel, and heating oils, bacteria are nearly always present but they may not be very active due to lack of oxygen, extreme pH, lack of nutrients, lack of moisture, or cold temperature.

2.0 Bioassessment Test Results

This bioassessment is a series of tests designed to evaluate the physical, chemical, and microbiological characteristics of a site. The bioassessment consists of nutrient determinations, pH, microbial population density, and the ability of the microbial populations to grow under enhanced environmental conditions. Understanding and controlling these parameters is critical for designing and executing a successful soil treatment system.

2.1 pH and Soil Moisture

The optimal pH for effective bioremediation is in the range of 6 to 8. A pH outside of this range may negatively affect microbial metabolism and contaminant biodegradation. Results of the laboratory pH measurements are reported in Table 1. The pH of the soil samples range from 8.1 to 9.3. If this pH range is a result of natural alkaline soil conditions common in deserts, biodegradation may proceed with little impact from the high pH. If the pH has been raised from neutral by man-made changes, microbiological activity may be impaired. Petroleum degradation often results in the formation of organic acids that depress pH. Thus, the slightly alkaline pH is not expected to have long term detrimental effects on treatment.

The moisture content of the soil samples ranged from 4 to 12 percent (weight to weight). The samples were characterized as fine soil containing rocks.

2.2 *Background Nutrient Concentrations*

Nutrients essential for bioremediation are nitrogen, as ammonium, and phosphorous, as ortho-phosphate. The existing nutrient concentrations in all samples were defined to determine the need for nutrient additions. Results of the analyses for these inorganic nutrients are shown in Table 1. The ammonium concentrations in the eight soil samples were below the detection limit (4.0 mg/K) in all but two of the samples. Sample B5-14-15M had a high ammonium concentration of 25 mg/Kg and sample FTP00093 had a low ammonium value of 5.4 mg/K. This suggests that the lack of ammonium in most of these soil samples may limit the rate and effectiveness of remediation. Phosphate concentrations in the soil samples range from 33 to 210 mg/Kg. Phosphate frequently combines with naturally occurring cations to form insoluble minerals. This means that even if phosphate levels are high, biological availability can still be low. In the FTP samples the phosphate content of the soil is low to moderate. Nutrient additions (particularly fixed nitrogen) may be required to avoid nutrient limited biodegradation during bioremediation.

2.3 *Microbial Enumerations*

In situ treatment requires the presence of hydrocarbon-degrading bacteria. To determine if appropriate bacteria are present, bacteria are quantified according to two categories. The first category includes heterotrophic bacteria, defined as those bacteria capable of growing on dilute, solidified nutrient medium. Heterotrophs represent a very general class of bacteria that are typically abundant in soil and groundwater. Quantification of this category provides a measure of the overall size and vigor of the bacterial population.

The second category includes hydrocarbon-degrading bacteria. These bacteria are quantified after growing in an environment where petroleum hydrocarbons are the only available carbon (or food) source. In this study the petroleum hydrocarbon used as the carbon source was diesel. This test determines if the bacterial population has adapted to the contaminant present in the soil samples.

The heterotrophic population ranged from less than 10 colony -forming units per gram of dry soil (CFU/g) to 630,000 CFU/g after 10 days of incubation. Hydrocarbon-degrading microbial population size ranged from less than 10 CFU/g to 60,000 CFU/g over the same length of time.

The results indicate that a viable microbial population exists on site. Native population sizes are listed on Table 2.

2.4 *Microbial Stimulation Test*

A microbial stimulation test was performed to determine if enhanced in situ conditions will stimulate growth of indigenous bacteria. This test involves introducing oxygen or oxygen plus nutrients to soil slurries created from the soil samples. The results determine if oxygen will stimulate activity, and if nutrients provide an additional benefit. A positive response is indicated by a five-fold or greater change in microbial density.

In almost all samples bacterial densities for the heterotrophic population in the FTP soil samples increased by 53-fold to 152-fold after oxygenation. The exceptions were samples B14-29-30M, FTP00159, and FTP00102 which exhibited no increase upon oxygenation. Oxygenation with nutrient addition caused an additional increase in only two samples; B8-14-15M by 2441-fold and FTP00110 by 200-fold (Table 3). The hydrocarbon degraders increased by 2-fold to 570-fold with oxygenation and 38-fold to 3,673-fold with oxygenation and nutrient addition. Sample B14-29-30M did not respond to oxygenation nor oxygenation with nutrient addition. Samples FTP00159 and FTP00102 which only showed a slight increase upon oxygenation, showed no appreciable increase upon oxygenation with nutrient addition.

The heterotrophic population that increased with oxygenation showed additional increases upon oxygenation with nutrient addition in only one sample, B8-14-15M. The hydrocarbon degrading population showed increases with oxygenation; however, oxygenation with nutrient addition resulted in a significant population increase in only one sample, B8-14-15M. This indicates that, in general, nutrients provided little additional benefit suggesting that residual nutrients were able to sustain microbial activity during the short duration of this test. Nutrient additions maybe required if the available level of residual nutrients fails to sustain biodegradation throughout the treatment process. The initial pH of the soil seemed to have no relationship to the response of the various samples in this test, suggesting that pH will not be detrimental to field scale biological treatment.

3. Summary and Conclusion

The results of the bioassessment indicate that bioremediation is a feasible remedial option for the petroleum impacted soils through the use of bioventing. The results of the bioassessment are summarized below:

- Viable microbial populations exist at the site and appear to be well adapted to site conditions
- Heterotrophic populations and hydrocarbon degraders responded favorably to oxygenation but the benefits of oxygenation and nutrient addition were only significant in sample B8-14-15M. Nutrient addition to the vadose zone is not recommended until in situ respiration rates decline.
- The optimal pH for microbial activity is between 6 and 8. The pH values for all of the site samples were above 8. Although the pH values fall outside of the typical range for successful biodegradation, microbes adapted to alkaline desert soils appear capable of sustaining aerobic biodegradation.
- Phosphate levels are moderate and ammonia levels are less than the detection limit of 4 mg/Kg for almost all of the samples.
- Moisture levels were generally low and may limit biodegradation.

Bioventing is the in situ aeration of unsaturated (vadose zone) soil to stimulate aerobic biodegradation of organic contaminants. Bioventing is attractive for sites where soil cannot be excavated due to contaminant depth, volume of soil, or the presence of surface structures. Bioventing can be operated in remote areas where there is no supplied electricity through the use of wind powered turbines or solar powered blowers.

Bioventing systems are aerated by injecting or extracting air from the treatment area. Bioventing wells are located throughout the contaminated soil and are slotted through the entire thickness of the contamination to effectively aerate the contaminated soil. Unlike soil vapor extraction, the

introduction of air into the soil provides oxygen with very little volatilization of contaminants. For air injection systems, volatile emissions are almost never observed at the ground surface. The amount of air required for biological activity is far less than that required for conventional Soil Vapor Extraction systems so the cost for equipment and energy is usually less and the requirement for air pollution control can be minimized or eliminated.

The soil at the FTP site is fairly dry. This could inhibit microbial activity. It is recommended that moisture be added at this site prior to and during bioventing. There are several mechanisms for the addition of water to the site soil, options include; irrigation and infiltration, injection of humidified air through the bioventing system, or pumping water into the soil through multiple small direct push points. Prior to bioventing an in situ respiration test should be performed to verify microbial activity at the site.

The parameters which are typically monitored quarterly or semiannually for bioventing are soil moisture content, inorganic nutrients, pH, and microbial activity. Microbial activity must be maintained and can be monitored through in situ respiration testing. The soil being treated must be aerated on a regular basis in order to sustain microbial activity and biodegradation. Nutrients may limit biodegradation eventually; however, bioventing should proceed without nutrient addition until evidence of low microbial respiration is observed. At that time nutrients can be added using IT's patented vapor phase nutrient delivery system or by injection of liquid nutrient solutions.

Table 1
Nevada Test Site
Fire Training Pit
Nutrient Content, and pH, of Site Samples
IT Project No. 774729

SAMPLE NO.	MATRIX	AMMONIUM (ppm)*	ORTHO- PHOSPHATE (ppm)	% SOIL MOISTURE	pH
B8-14-15M	Fine Soil Rocky	4.0U^b	210	5.6	8.1
B14-29-30M	Fine Soil Rocky	4.0U	210	4.8	9.3
B5-14-15M	Fine Soil Rocky	25	88	12	8.2
FTP00148	Fine Soil Rocky	4.0U	120	5.3	9.1
FTP00159	Fine Soil Rocky	4.0U	84	3.9	9.3
FTP00093	Fine Soil Rocky	5.4	33	5.2	8.7
FTP00102	Fine Soil Rocky	4.0U	110	5.5	8.4
FTP00110	Fine Soil Rocky	4.0U	87	6.4	9.3

*ppm is mg/KG for soil

^bU = concentration below the detection limit

Table 2
Nevada Test Site
Fire Training Pit
Enumeration of the Microbial Population Density of Site Samples
IT Project No: 774729

SAMPLE NO.	MATRIX	TOTAL HETEROTROPHS^a (CFU/g)^c	HYDROCARBON DEGRADERS^b (CFU/g)
B8-14-15M	Fine Soil Rocky	1.4 x 10³	3.4 x 10²
B14-29-30M	Fine Soil Rocky	1.2 x 10²	1.5 x 10²
B5-14-15M	Fine Soil Rocky	5.2 x 10⁴	1.0 x 10⁴
FTP00148	Fine Soil Rocky	8.3 x 10²	5.7 x 10²
FTP00159	Fine Soil Rocky	<1.0 x 10¹	<1.0 x 10¹
FTP00093	Fine Soil Rocky	1.9 x 10³	3.2 x 10¹
FTP00102	Fine Soil Rocky	2.4 x 10³	8.5 x 10²
FTP00110	Fine Soil Rocky	6.3 x 10⁵	6.0 x 10⁴

^a10 Day Incubation time before enumerations

^b21 Day Incubation time before enumerations

^cCFU/g, colony forming units per gram dry soil

Table 3
Nevada Test Site Fire Training Pit
Stimulation of the Growth of Site Microbes by
Enhanced Oxygenation and Nutrient Augmentation
IT Project No. 774729

SAMPLE NO.	Heterotrophs (CFU/g)			Hydrocarbon Degraders (CFU/g)		
	INITIAL	OXYGEN ^a	OXYGEN AND NUTRIENTS ^b	INITIAL	OXYGEN	OXYGEN AND NUTRIENTS
B8-14-15M	4.3 X 10 ⁴	2.3 X 10 ⁶	1.1 X 10 ⁸	4.6 X 10 ⁴	7.6 X 10 ⁶	1.7 X 10 ⁸
B14-29-30M	1.6 X 10 ³	1.0 X 10 ²	1.2 X 10 ³	1.4 X 10 ³	1.7 X 10 ⁶	4.9 X 10 ⁶
B5-14-15M	3.6 X 10 ⁵	1.4 X 10 ⁷	1.2 X 10 ⁷	8.4 X 10 ⁴	1.7 X 10 ⁶	4.9 X 10 ⁶
FTP00148	2.6 X 10 ³	1.4 X 10 ⁵	8.2 X 10 ⁴	1.3 X 10 ³	8.5 X 10 ⁴	5.0 X 10 ⁴
FTP00159	<1.0 X 10 ²	<1.0 X 10 ²	<1.0 X 10 ²	<1.0 X 10 ²	2.0 X 10 ²	<1.0 X 10 ²
FTP00093	2.3 X 10 ³	2.2 X 10 ⁵	8.8 X 10 ⁴	2 X 10 ²	1.1 X 10 ⁵	7.0 X 10 ⁴
FTP00102	1.4 X 10 ³	1.4 X 10 ³	7.0 X 10 ²	<1.0 X 10 ²	8.0 X 10 ²	1.0 X 10 ²
FTP00110	6.8 X 10 ⁵	9.0 X 10 ⁷	1.4 X 10 ⁶	2.0 X 10 ⁵	4.0 X 10 ⁷	1.5 X 10 ⁷

^aThe oxygenated treatment was vigorously shaken to provide oxygen to the microbes but no nutrients were added in addition to those present in the sample material.

^bOxygen and nutrient treatments are oxygenated and nutrient augmented with 100 ppm of the microbial nutrient formulation Restore 375.

Appendix F

Nevada Environmental Restoration Project Document Review Sheet

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

(Page 1 of 3)

1. Document Title/Number: Corrective Action Decision Document for Corrective Action Unit 342: Area 23, Mercury Fire Training Pit, Nevada Test Site, Nevada			2. Document Date: February 1999	
3. Revision Number: 0			4. Originator/Organization: IT Corporation	
5. Responsible DOE/NV ERP Subproject Mgr.: Janet Appenzeller-Wing			6. Date Comments Due:	
7. Review Criteria: Full				
8. Reviewer/Organization/Phone No.: Paul Liebendorfer, NDEP, (775) 687-4670			9. Reviewer's Signature:	
10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1) Appendix A, Page A-33, Paragraph A.3.3	M	<p>“...One sample (FTP00107) was analyzed for TCLP VOCs...”</p> <p>According to Table A.2-2, Page A-14, samples FTP 00089 and FTP 00091 (Borehole 1) should also have been analyzed for TCLP VOCs. Based on TPH results (Table A.3-2), Borehole 1 would have been more likely than Borehole 4 to produce TCLP VOC results. Based on the high concentrations of diesel and gasoline at depths of 30 feet or more, additional sampling in the areas of highest contamination is required. This sampling should be conducted at the Aboveground Storage Tank (AST) area (Borehole B-14) as well as the Burn Pit area (Borehole B-1). These samples should be analyzed for TCLP VOCs at depths which represent the highest concentrations.</p>	<p>The text was changed to read: Three samples (FTP00089, FTP00091, and FTP00107) were analyzed for TCLP VOCs to support waste management decisions. Sample FTP00107 was collected at a location (B-4, 4- to 5-ft bgs) identified in the CAIP (DOE/NV, 1998) as a likely place for chlorinated hydrocarbon contamination. Samples FTP00089 and FTP00091 were collected from B-1 at 0- to 1-ft bgs and 4- to 5-ft bgs. No constituents were identified above RCRA regulatory levels in any of these samples. No VOCs were identified in this sample, or in other samples from borehole B-4 or borehole B-1, above PALs.</p>	Yes
2) Section 4.0, Recommended Alternative	M	<p>Based on the high concentrations of diesel and gasoline remaining in the soil at this site, along with the potential for other COCs, NDEP does not concur with Alternative 2, Closure in Place with Partial Excavation, Disposal, and Administrative Controls. Once additional data are required, NDEP will evaluate proposed alternatives including the need for active remediation activities.</p>	<p>Alternative 4 was added and selected as the recommended Alternative.</p>	Yes

^a Comment Types: M = Mandatory, S = Suggested.

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

(Page 2 of 3)

1. Document Title/Number: Draft Corrective Action Decision Document CAU 342: Area 23, Mercury Fire Training Pit, Nevada Test Site, Nevada			2. Document Date: December 1998	
3. Revision Number: Draft and Revision 0			4. Originator/Organization: IT Corporation	
5. Responsible DOE/NV ERP Subproject Mgr.: Janet Appenzeller-Wing			6. Date Comments Due:	
7. Review Criteria: Full				
8. Reviewer/Organization/Phone No.: Michael D. McKinnon, NDEP			9. Reviewer's Signature:	

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
1) Page 6, Section 2.1, 2 nd Paragraph, 3 rd Bullet		“...ranged in depth from 15 ft to 21 m 70 ft...” Change to “...ranged in depth from 15 ft to 70 ft (21 m)...”	Deleted “21 m”	Yes
2) Page 16, Section 3.3 and Page A-43, Section A.3.10.1		These sections indicate that existing conditions are favorable for natural biological degradation. Will natural biological degradation effectively reduce long-chain hydrocarbons (such as diesel fuel)? If not, biodegradation is not a feasible alternative at this site.	Yes. Aerobic biodegradability half-life for diesel fuel components ranges from approximately one week to one year for both vadose and saturated zones.	No
3) Page 16, Section 3.3.2, 3 rd Paragraph		In addition to administrative controls restricting personnel access to this site, controls to prevent access to burrowing animals and desert tortoises is appropriate (fencing).	Fencing will not prevent access by burrowing animals. The backfill material will be compacted to ambient conditions or greater to limit burrowing.	No
4) Page A-8, Table A.2-1		Sample location C-1 is not indicated on Figure A.2-2.	A Geoprobe® sample was not collected in Cell C-1. The table will be revised to reflect that no analysis was done.	No

NEVADA ENVIRONMENTAL RESTORATION PROJECT

DOCUMENT REVIEW SHEET

(Page 3 of 3)

10. Comment Number/ Location	11. Type*	12. Comment	13. Comment Response	14. Accept
5) Page A-20/2, Table A.3-2		From this table, it appears there is minimal contamination in the 0-5 foot region, while contamination increases with depth down to approximately 20-30 feet. By removing the top 5 feet of soil in the areas of the Burn Pit and the Above-ground Storage Tanks, the potential for personnel contacting more heavily contaminated soil increases. The proposal to remove the top 5 feet of soil in these areas should be revisited and further justified.	The areas to be excavated had results exceeding the action level. Removal of the contaminated material will lessen future dispersion. The excavations will be backfilled with clean borrow material to limit future contact. The health and safety of the workers involved with the excavation will be controlled during the investigation.	No

^a Comment Types: M = Mandatory, S = Suggested.

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

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