FINAL SWMU K03F DECISION DOCUMENT

Solid Waste Management Unit (SWMU K03F) Building 94
Former Underground Storage Tank Site

June 2012
Version 01

Hawthorne Army Depot
Hawthorne, Nevada

U.S. Army Corps of Engineers - Sacramento District
Contract W91238-06-D-0019
Task Order 0004

FINAL

DECISION DOCUMENT
SWMU K03F: Building 94
Hawthorne Army Depot, Nevada

Contract No. W91238-06-D-0019

June 2012

Prepared for:

US Army Environmental Command

Hawthorne Army Depot
Hawthorne, Nevada

Prepared by:

US Army Corps of Engineers
Sacramento District

and

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St. Paul, Minnesota
55103

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 Site Name and Location 1-1
1.2 Statement of Basis and Purpose 1-1
1.3 Description of Selected Remedy 1-1
1.4 Regulatory Setting 1-1
1.5 Authorizing signatures 1-2
2.0 DECISION SUMMARY 2-1
2.1 Site Name, Location, and Description 2-1
2.2 Physical Setting 2-1
2.3 Investigation History 2-1
2.4 Nature and Extent of Contamination 2-1
2.4.1 Summary of Existing Data 2-1
2.4.2 Migration Modeling Data 2-4
2.4.3 Tier II SSTL for TPH-Diesel 2-4
2.5 Decommissioning Activities 2-5
3.0 CONCLUSIONS 3-1
4.0 REFERENCES 4-1

List of Tables

Table 2-1 Summary of Previous Actions at SWMU K03F 2-2
Table 3-1 Site Evaluation for SWMU K03F 3-1

List of Figures

Figure 1 Installation Location
Figure 2 SWMU K03F Site Location
Figure 3 SWMU K03F Site Features

List of Attachments

Attachment 1 Supporting Documentation

- NDEP Tank 1 and Tank 3 Closure Approval Letter
- 2011 Boring and Analytical Results Figure
- 2011 Boring Logs
- 2011 Analytical Data
- SWMU K03F Tier II SSTL for TPH-D

ACRONYMS

API ..... American Petroleum Institute
Bay West..... Bay West, Inc.
bgs ..... below ground surface
Bramco..... Bramco Construction Corporation
DZHC ..... Day & Zimmermann Hawthorne Corporation
EPA..... Environmental Protection Agency
GBL..... Great Basin Laboratories
HWAD ..... Hawthorne Army Depot
mg/kg ..... milligrams per kilogram
NAC ..... Nevada Administrative Code
NDEP ..... Nevada Division of Environmental Protection
NFA..... No Further Action
PCBs..... Polychlorinated Biphenyls
ppm ..... Parts per Million
RBCA ..... Risk Based Corrective Action
RCRA..... Resource Conservation & Recovery Act
SSTL ..... Site Specific Target Level
SWMU..... Solid Waste Management Unit
TPH-d..... Total Petroleum Hydrocarbons and Diesel
USAEHA ..... U.S. Army Environmental Hygiene Agency
USEPA..... U.S. Environmental Protection Agency
UST..... Underground Storage Tank
VOC ..... Volatile Organic Compound
WP ..... Work Plan

1.0 INTRODUCTION

1.1 Site Name and Location

Facility Name: Hawthorne Army Depot

Site Location: Hawthorne, Nevada

Operable Unit/Site: Solid Waste Management Unit (SWMU) K03F

1.2 Statement of Basis and Purpose

This Decision Document describes the rationale for the selected remedy of No Further Action (NFA), industrial scenario, at SWMU K03F at Hawthorne Army Depot (HWAD) Hawthorne, Nevada, (hereafter referred to as SWMU K03F) (**Figure 1**).

Remedial investigations of hazardous substances, pollutants, or contaminants at SWMU K03F have demonstrated that:

- Total Petroleum Hydrocarbons as Diesel (TPH-d) was detected at a concentration above State Corrective Action Level of 100 milligrams per kilogram (mg/kg); and
- Fate and Transport Modeling of residual TPH-d contamination indicates petroleum does not pose a significant risk to human health or the environment.

1.3 Description of Selected Remedy

It has been determined that no remedial action, with the implementation of an administrative industrial land use restriction, is necessary at SWMU K03F. Based on investigative results, the Army, with concurrence from the Nevada Division of the Environment (NDEP), has determined that no significant risks or threats to human health or the environment exist at this time.

1.4 Regulatory Setting

The U.S. Environmental Protection Agency (USEPA) provides regulatory oversight of contamination assessment and corrective measures at Resource Conservation and Recovery Act (RCRA) SWMUs under Section 3004 (u) of the 1984 Hazardous and Solid Waste Amendments to RCRA. Corrective action for releases of hazardous wastes or constituents is required under 40 CFR Part 264.101 (a), (b), and (c).

The HWAD also maintains RCRA Permit No. NEV HW0017 (renewed in August 2005), which requires corrective actions for any hazardous waste or hazardous constituents released from any SWMUs at the facility. Authority and responsibility for the implementation of RCRA has been delegated by the USEPA to the State of Nevada, making the NDEP the lead regulatory agency for all RCRA investigations and corrective actions at HWAD.

1.5 Authorizing signatures

This signature sheet documents the Army approval and NDEP concurrence of the remedy selected in the Decision Document for SWMU K03F in HWAD.

This remedy decision may be reviewed and modified in the future if information becomes available that indicates the presence of contamination may cause unacceptable risk to human health or the environment.

Kirk L. Bausman Deputy to the Commander Hawthorne Army Depot	20120611 Date
Greg Lovato Chief, Bureau of Corrective Actions Nevada Division of Environmental Protection	6/26/12 Date

2.0 DECISION SUMMARY

The Decision Summary identifies the selected remedy, explains how the remedy fulfills statutory and regulatory requirements, and provides a substantive summary of the Administrative Record file that supports the remedy selection decision.

2.1 Site Name, Location, and Description

SWMU K03F, Building 94, is located approximately three miles east of the main gate to HWAD, and adjacent to the security post (Post 5) entering the central magazine (**Figure 2**). SWMU K03F is composed of three former Underground Storage Tanks (USTs): HWAP-38 (Tank 1, also referred to as 94-1), HWAP-39 (Tank 2), and HWAP-40 (Tank 3, also referred to as 94-3) (**Figure 3**). Tank 1 (94-1) and Tank 3 (94-3) have been filled and abandoned in place. Per a NDEP letter dated 31 March 1992, Tank 1 (94-1), and Tank 3 (94-3) have been granted closure (**Attachment 1**). Tank 2 was removed in 1991.

2.2 Physical Setting

HWAD is located in Mineral County, Nevada, approximately 140 miles southeast of Reno, Nevada. The depot is approximately 150,000 acres in size and encloses three sides of the town of Hawthorne (**Figure 1**).

2.3 Investigation History

As discussed above, Tank 1 and Tank 3 have been abandoned/closed in place and Tank 2 was removed in 1991. A limited site investigation and soil removal was completed in the vicinity of the former tank 2 UST basin in 1992 and 1993, respectively. In addition, a limited site investigation was completed in 2011. **Table 2-1** provides a brief summary of these activities.

2.4 Nature and Extent of Contamination

2.4.1 Summary of Existing Data

Based on data collected during the limited site investigation at SWMU K03F, TPH-d contamination beneath the former Tank 2 UST basin is limited vertically to a depth of approximately 20 feet below ground surface (bgs), and horizontally to a width of approximately 15 to 20 feet. Groundwater is estimated to be approximately 80-90 feet bgs. Analytical results, soil boring logs, and site figures have been included in **Attachment 1.**

Table 2-1 Summary of Previous Actions at SWMU K03F

Date	Area and Purpose of Investigation	Company	Area Assessed	Major Findings	Recommendations
1991	Removal of Tank 2	Bramco Construction Corporation (Bramco)	Removed 300-gallon steel UST (Tank 2) containing diesel fuel. Collected two soil samples from beneath the UST and one composite soil sample from beneath the UST lines. The exact depths of the soil samples are unknown. Soil samples were analyzed for Volatile Organic Compounds (VOCs), TPH-d, organochlorine pesticides, polychlorinated biphenyls (PCBs), and RCRA metals.	The soil samples collected beneath the UST contained TPH-d at concentrations ranging from 1,900 to 2,800 mg/kg.	TPH-d was identified as the Contaminant of Potential Concern at K03F.
1992	Limited Investigation of former Tank 2 UST basin	U.S. Army Environmental Hygiene Agency (USAEHA)	Completed one soil boring (E-1) in the former UST basin to a depth of 35 feet bgs. Soil samples were collected from 10, 15, 30, and 35 feet bgs and analyzed for TPH-d (USAEHA, 1992).	Samples collected at 10 and 15 feet bgs contained TPH-d at concentrations of 9,800 mg/kg and 260 mg/kg, respectively (USAEHA, 1992).	Removal of impacted soil in former Tank 2 UST basin.
1993	Excavation of impacted soils from the former Tank 2 UST basin	Unknown	A letter, dated 21 May 1993, from Jerry Lamason, Day & Zimmermann Hawthorne Corporation (DZHC), to the Administrative contracting officer at HWAD specified that contaminated soil from beneath the former Tank 2 UST basin had been excavated (Bay West, 2012). This letter could not be located. A report to Bramco from Great Basin Laboratories (GBL) dated 23 March 1994 indicated that soil sample collected from 17 feet bgs had a TPH-d concentration of 25,930 parts per million (ppm) (Woodward-Clyde, 1994). This report is no longer available.	TPH-d contamination extended further than the final excavation depth of 17 feet bgs (Bay West, 2012).	

Date	Area and Purpose of Investigation	Company	Area Assessed	Major Findings	Recommendations
1994	Work Plan Development	Woodward-Clyde	Developed a Work Plan that included advancement of up to six soil borings, conversion of two soil borings into soil vapor extraction points, collection of up to four groundwater samples, and initiation of passive bio-venting. In addition to the investigation, the work plan outlined a sampling and removal plan of a soil stockpile, assumed to be the soil generated in 1993 (Bay West, 2012).	Research of available documentation could not confirm if the work described in the Work Plan was completed. Site conditions in 2011 indicated that the soil stockpile had been removed.	Evaluate the nature and extent of VOCs and TPH-d in the former Tank 2 UST basin.
2011	Additional Investigation of former Tank 2 UST basin	Bay West, Inc. (Bay West)	Completed five soil borings to 30-33 feet bgs, adjacent to the former Tank 2 UST basin to define the current magnitude and extent of VOC and TPH-d impacts to soil.	Samples collected between 7.5 and 16 feet bgs in two borings contained TPH-d at concentrations ranging from 270 to 8,200 mg/kg.	TPH-d beneath former Tank 2 UST basin is limited vertically to a depth of approximately 20 feet bgs and horizontally to a width of approximately 15 to 20 feet.

2.4.2 Migration Modeling Data

The contaminate pathway at K03F is through dissolution of residual TPH-d in the soil by infiltration of water. Due to low rainfall in the Hawthorne area (<5 inches per year) and the approximate depth of groundwater (80 to 90 feet bgs), it is unlikely that consequential amounts of water might move through the soil and leach contamination to groundwater. Additionally, contaminant Fate and Transportation modeling completed at similar sites with similar soils and contamination (SWMU I07 and SWMU I08) supports TPH-d's limited migration potential (Bay West, 2012).

2.4.3 Tier II SSTL Summary for TPH-d

A Tier II Site Specific Target Level (SSTL) for TPH-d at SWMU K03F was developed to assist in evaluating the potential risk posed by petroleum contaminated soils present at the site. NAC 445A.22705, allows for the application of the ASTM Standard E-1739-95 Risk Based Corrective Action (RBCA) to develop Tier II SSTLs in setting site-specific risk criteria. Because diesel contains relatively little of the more mobile and more toxic volatile organic compounds, the primary concern is on the prevention of free product on groundwater. NAC 445A.22735 requires that free product be reduced to less than 0.5 inch. Therefore the TPH-d SSTL was developed based on the prevention of free product migration to groundwater.

2.4.3.1 Tier II SSTL background

Soil has the ability to retain non-mobile liquids in smaller and discontinuous pore spaces. The amount that a soil can hold is called its residual saturation. Once residual saturation has been exceeded, the liquid can migrate. Diesel exists as a light non-aqueous phased liquid (LNAPL) and is held in retention along with water. The American Petroleum Institute (API) published a summary of empirical models and compared the results with experimentally measured residual saturated values. The results of these comparisons were then used to develop screening level criteria for specific soils and products.

The API utilizes three empirical models in developing a method for conservative screening levels. These included 1) a zero water method; 2) a field moisture capacity method (both developed by Hoag and Marley, 1986); and 3) a method developed by Zytner (1993). The Hoag and Marley methods are both based on average soil particle diameter and that residual retention is related to available surface area. In the zero water method, all the pore spaces are available for the LNAPL. In the field moisture capacity method some of the available pore space is occupied by water. Therefore, field conditions would be expected to range somewhere between the zero water and field moisture methods. The Zytner method is based on observed relationships of residual saturation and the ratio of product density over soil bulk density. A more detailed discussion of the SSTL is presented in **Attachment 1**.

2.4.3.2 Tier II SSTL Conclusion

Results of the empirical models, for SWMU K03F, indicated a petroleum residual saturated value of between 32,000 and 174,000 mg/kg. The average of the three methods is higher than the median American Petroleum Institute (API) value. Therefore, applying the 90% confidence value of 11,000 mg/kg would provide an acceptable conservative margin. Groundwater contacting fine- to medium-grained soils with a TPH-d concentration less than 11,000 mg/kg would not likely result in free product (Bay West, 2012).

Only one soil sample at SWMU K03F was found to exceed the 90% confidence level at a TPH-d concentration of 25,930 mg/kg but it was far below the median value for residual saturation of 40,000 mg/kg. The sample was collected in 1993 from a depth of 17 feet bgs and groundwater is at a depth of approximately 80-90 feet bgs. Furthermore, in 2011 the highest TPH-d

concentration detected was 8,200 mg/kg at 7.5-9.5 feet bgs, which is below the 90% confidence level. Given the depth of the soil sample above groundwater, if mobile product exists at this depth, the concentration would continue to decrease with vertical migration until it was immobilized (Bay West, 2012).

2.5 Decommissioning Activities

Subsequent to soil sample collection, soil borings were abandoned in accordance with Nevada Administrative Code (NAC) 534.4371.

Groundwater was not generated or encountered during the advancement of soil borings at SWMU K03F. Decontamination water was containerized in two 55-gallon drums and stored next to Building 94. The analytical results of the decontamination water sample did not exceed the USEPA Maximum Contaminant Levels, and the decontamination water was dispersed at the site (Bay West, 2012).

3.0 CONCLUSIONS

Soil samples collected within, or adjacent to, the former Tank 2 UST Basin at SWMU K03F between 1991 and 2011 contained TPH-d concentrations exceeding the State of Nevada Screening Level of 100 mg/kg. The additional investigation completed in 2011 determined that TPH-d beneath former Tank 2 UST basin is limited vertically to a depth of approximately 20 feet bgs and horizontally to a width of approximately 15 to 20 feet. Tank 2 has been removed and a contaminant source is no longer present at the site (Bay West, 2012).

Sampling, analysis and modeling indicate that no present or future receptors are likely to be adversely impacted by site contamination at SWMU K03F. Closure is requested following NAC 445A.227 guidelines, under which the following issues were addressed (**Table 3-1**):

Table 3-1 Site Evaluation for SWMU K03F

Assessment Criteria		Response
A	Depth of any groundwater	Approximately 80 to 90 feet bgs
B	Distance to irrigation or drinking water wells	The nearest irrigation or drinking water well (HWAD Production Well #7) is located 2,100 feet northwest of SWMU K03F
C	The type of soil that is contaminated	Primarily sand with varying amounts of silt and a few clay stringers. Volcanic clasts were encountered between 30 and 31 feet bgs in K03F-01.
D	The annual precipitation	Annual precipitation in Hawthorne, Nevada is 4.6 inches
E	The type of waste or substance released	The release is TPH in the form of diesel
F	The extent of the contamination	TPH-d beneath former Tank 2 UST basin is limited vertically to a depth of approximately 20 feet bgs and horizontally to a width of approximately 15 to 20 feet.
G	The present and potential use for the land	The site is presently used for industrial purposes. Future land use is also expected to be industrial.
H	The preferred routes of migration	Vertically, due to gravity
I	The location of structures and impediments	There are no known subsurface structures or physical impediments to horizontal migration of contaminants
J	The potential for a hazard related to fire, vapor, or explosion	There are no apparent hazards related to fire, vapor, or explosions
K	Other site-specific factors	No other site-specific factors have been noted

4.0 REFERENCES

Bay West, 2012. *SWMU K03F Technical Memorandum, Hawthorne Army Ammunition Plan, Hawthorne, Neveda*. April.

USAEHA 1992. *Geohydrologic Study No. 38-26-KP66-92, Former Underground Storage Tank Sites, Hawthorne Army Ammunition Plant, Hawthorne, Nevada.* August.

Woodward-Clyde 1994. *Final Work Plan for DERA Funded Underground Storage Tanks, Hawthorne Army Ammunition Plant, Hawthorne, Nevada.* September.

Figures

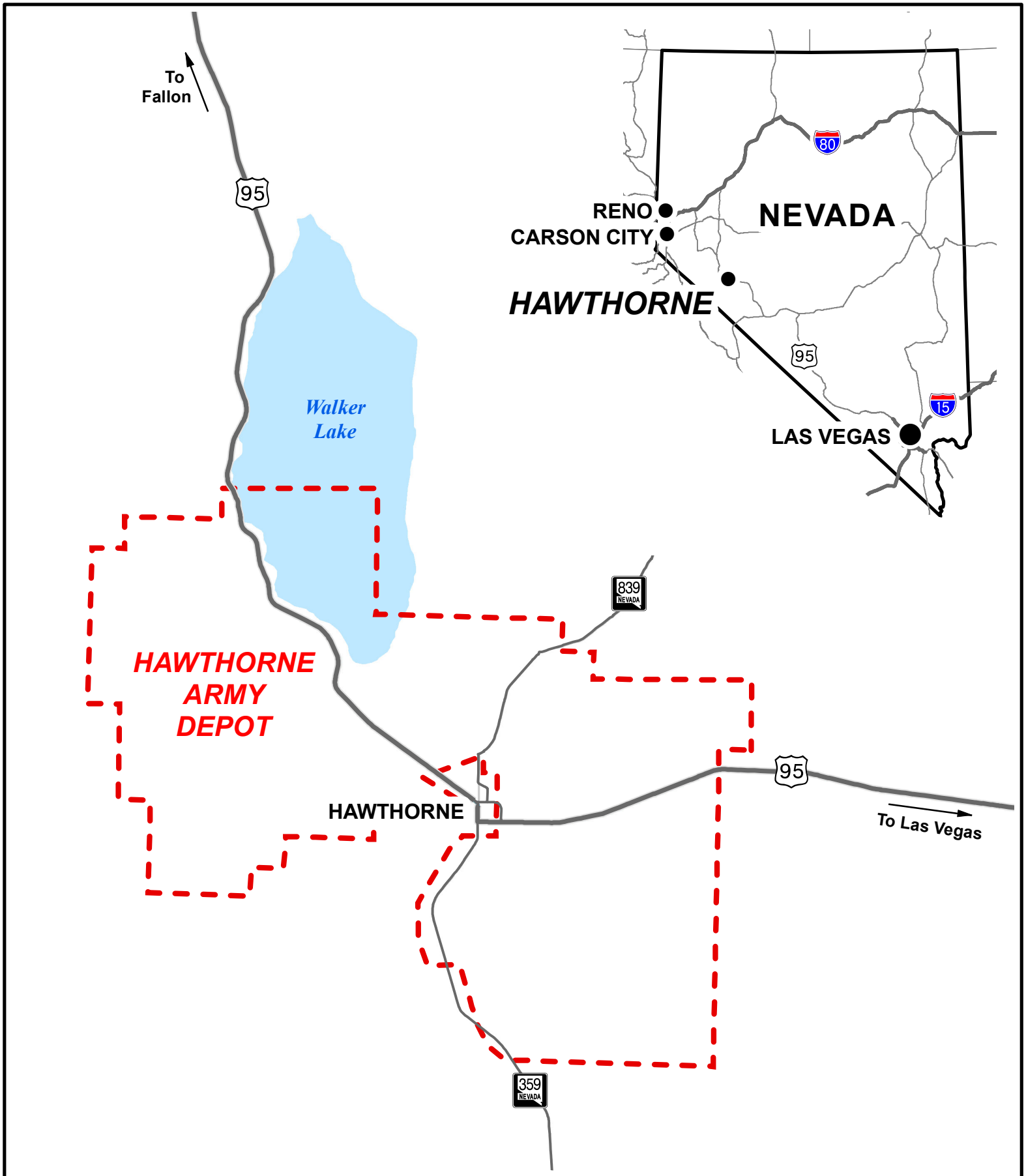


Figure 1

Hawthorne Army Depot

Bay West

Customer-Focused Environmental & Industrial Solutions

N

0 3 6 Miles

0 4 8 Kilometers

Legend

Installation Boundary

Data is Projected in the NAD83 UTM Zone 11N
Aerial Photo: ArcGIS Online Map server
Figure Create Using ArcMap 9.3.1

Y:\Clients\US_ARMY_CORP_OF_ENGINEERS_SACRAMENTO\Hawthorne_AAP\090499\MapDocs\I07\I07 Regional Map.mxd

Figure 2

Site Location Map

Bay West

Customer-Focused Environmental & Industrial Solutions

N

0 0.125 0.25 Miles

0 0.25 0.5 Kilometers

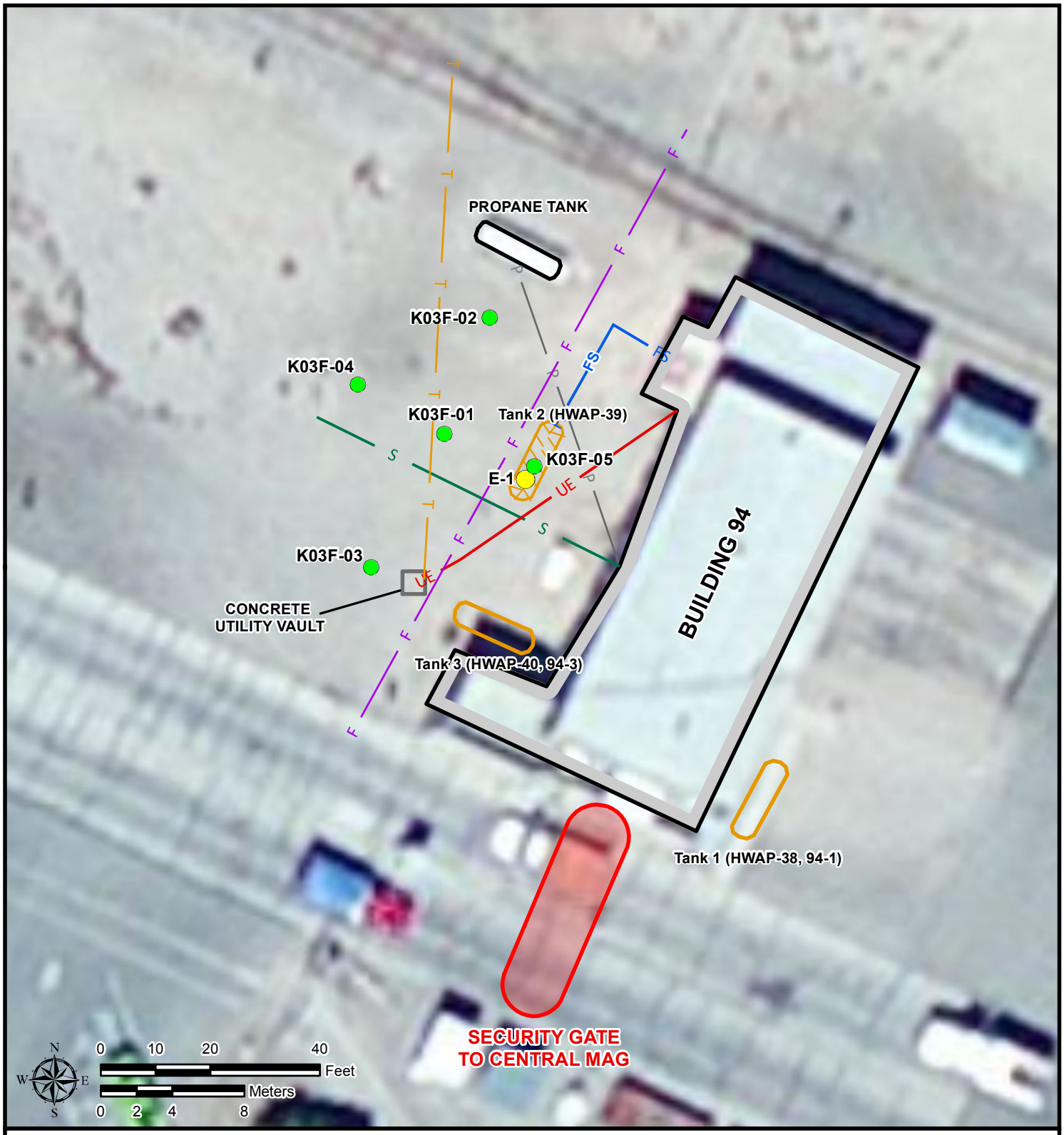
Legend

Sampling Location

Data is Projected in the NAD83 UTM Zone 11N
Aerial Photo: Bing Image Server
Figure Create Using ArcMap 9.3.1

NEVADA

Hawthorne Army Depot



Map Projection: NAD 1983 UTM Zone 11 North - Meters
Bing World Imagery Basemap

Drawn By: M.B. Date Drawn: 4/16/2012 Project No. J090499

- Boring Locations
- Previous Sample Location (E-1)
- UE — Underground Electric Line (25" Depth)
- F — Fiber Optic Line
- FS — Fuel Supply Line
- P — Propane Line (19" Depth)
- S — Sewer Line
- T — Telephone Line (33" Depth)
- UST Abandoned in Place
- UST Removed

Figure 3

K03F Boring Locations

Hawthorne Army Depot
Hawthorne, Nevada

Bay West
Customer-Focused Environmental & Industrial Solutions

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Attachment 1

NDEP Tank 1 and Tank 3 Closure Approval Letter
2011 Boring and Analytical Results Figure
2011 Boring Logs
2011 Analytical Data
SWMU K03F Tier II SSTL for TPH-D

Hawthorne Army

STATE OF NEVADA
BOB MILLER
Governor

PETER G. MORROS
Director

L. H. DODGION
Administrator

Administration	**(702) 687-4670**
Air Quality	**687-5065**
Mining Regulation and Reclamation	**687-4670**
Waste Management	**687-5872**
Federal Facilities	**687-3880**

Wastewater Treatment Services	**687-5870**
Water Permits and Compliance	**687-4670**
Water Quality Planning	**687-4670**
FAX	**886-0868**

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL PROTECTION

123 W. Nye Lane

Carson City, Nevada 89710

March 31, 1992

Mr. F.L. Justus
Department of the Army
Hawthorne Army Ammunition Plant
Hawthorne, Nevada 89415-5000

Dear Mr. Justus:

I am in receipt of your request for closure in place for underground storage tanks at Hawthorne AAP. Attached to this request was analytical results from assessments for each of the USTs.

Closure in place is granted for each of the USTs referenced (13-11, 94-3, 94-1, 150, 101-51, 35, 36, 103-37). All tanks except for 67-2 indicated a total petroleum concentration below the state criteria of 100 mg/kg TPH. Tank 67-2 had a TPH concentration of 230 mg/kg in sample number one. Further investigation and remediation is required before this UST can be closed.

Please provide this office with a schedule for the further assessment and remediation of 67-2 by May 1, 1992.

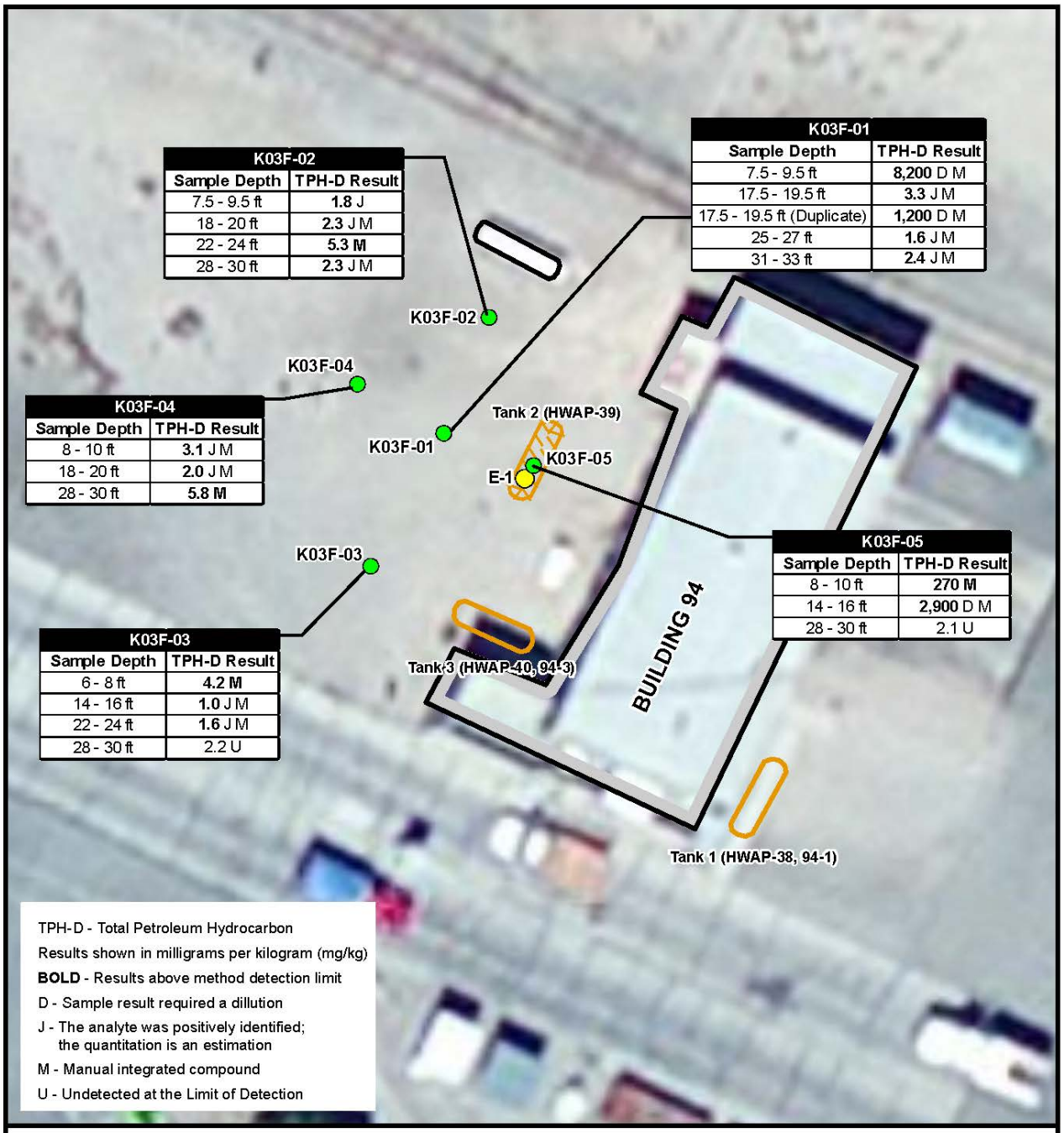
If questions or comments arise, please feel free to contact me.

Sincerely,

Allen Biaggi
Supervisor, UST Branch
Bureau of Waste Management

AJB:klh/HAAP

cc: Verne Rosse
Nevin Kane



K03F-01	
Sample Depth	TPH-D Result
7.5 - 9.5 ft	**8,200** D M
17.5 - 19.5 ft	**3.3** J M
17.5 - 19.5 ft (Duplicate)	**1,200** D M
25 - 27 ft	**1.6** J M
31 - 33 ft	**2.4** J M

K03F-02	
Sample Depth	TPH-D Result
7.5 - 9.5 ft	**1.8** J
18 - 20 ft	**2.3** J M
22 - 24 ft	**5.3 M**
28 - 30 ft	**2.3** J M

K03F-04	
Sample Depth	TPH-D Result
8 - 10 ft	**3.1** J M
18 - 20 ft	**2.0** J M
28 - 30 ft	**5.8 M**

K03F-05	
Sample Depth	TPH-D Result
8 - 10 ft	**270 M**
14 - 16 ft	**2,900** D M
28 - 30 ft	2.1 U

K03F-03	
Sample Depth	TPH-D Result
6 - 8 ft	**4.2 M**
14 - 16 ft	**1.0** J M
22 - 24 ft	**1.6** J M
28 - 30 ft	2.2 U

TPH-D - Total Petroleum Hydrocarbon
Results shown in milligrams per kilogram (mg/kg)
BOLD - Results above method detection limit
D - Sample result required a dillution
J - The analyte was positively identified; the quantitation is an estimation
M - Manual integrated compound
U - Undetected at the Limit of Detection

Map Projection: NAD 1983 UTM Zone 11 North - Meters
Bing World Imagery Basemap

Boring Locations
Previous Sample Location (E-1)
UST Abandoned in Place
UST Removed

N W E S

0 10 20 40 Feet
0 2 4 8 Meters

Figure 4-1

K03F Analytical Results

Hawthorne Army Depot
Hawthorne, Nevada

Bay West
Customer-Focused Environmental & Industrial Solutions

Drawn By: M.B. Date Drawn: 5/18/2012 Project No. J090499

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Project Name: K03F-HWAD
Project Number: J090499
Driller: Dennis Mitchell
Geologist: Shawn Lyman

Soil Boring No.: K03F-01
Well No.:
Total Depth: 33 Ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 Ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
0	0-7.5ft Hand Augered to clear high concentration of utilities							
1	on site, no samples or geologic description taken.							
2								
3								
4								
5								
6								
7	7.5-9.5 ft, 20" recovery, SP and SM, First 9", lt brwn-grey, fine grained silty Sand, Next 5", lt brwn, coarse grained Sand.				■ K03F-01-S-7.5-9.5 @ 6:38	20"	6,7,7,6	5.62
8	Remaining, 6", fine grained silty Sand.							
9								
10	10-12 ft, 24" recovery, SM and SW First 18", lt grey fine-~~coarse~~ grained silty Sand w/ 1-2 inch Clay Stringer.					24"	4,6,9,15	57.81
11	Remaining 6", lt brwn, fine-coarse grained Sand.							
12	12.5-14.5, 19" Recovery SP and SW First 6", lt brwn-grey coarse					19"	7,8,10,14	15.4
13	grained Sand w/ 2" stringer of color change to dk black/brwn. Remaining 13", lt brwn-grey							
14	fine-coarse grained Sand.							
15								

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Project Name: K03F-HWAD
Project Number: J090499
Driller: Dennis Mitchell
Geologist: Shawn Lyman

Soil Boring No.: K03F-01
Well No.:
Total Depth: 33 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
15' 15	15-17, 22" recovery SW and SM First 4" lt brown-grey fine-coarse grained sand w/ large black					22"	11,13 10,12	10.81
16	Volcanic rock fragments, Remaining 18", lt brown, fine grained silty sand w/ occasional coarse grained sand grains.							
17	17.5-19.5, 22" recovery, SM and SP First 6", md brown, fine-md grained silty sand, moist. Next 16", ~~md~~ SC lt brown, md-coarse grained sand.			94 Duplicate taken	K03F-01-S-17.5-19.5 @ 0838	22"	12,21 24,37	337.0
18								
19								
20' 20	20-22, 23" recovery, SP + SM First 5", lt grey md-coarse grained sand, 3" fine grained sand stringer, 5" lt brown					23"	17,26 24,27	5.37
21	coarse grained sand, 2" of fine grained sand, 4" coarse grained sand. Remaining 8" lt brown, fine grained silty sand							
22	22.5-24.5, 24" recovery SM First 14", lt tan, very fine-fine					24"	10,19 22,21	5.19
23	grained silty sand. Remaining 10" fine-coarse grained silty sand.							
24								
25' 25	25-27 ft, 22" recovery SM + SC First 10", md brown, fine grained silty sand.				K03F-01-S-25-27 @ 0850	22"	8,15 21,30	7.75
26	Next 8", md brown, fine grained clayey sand remaining 4", lt grey, fine-md grained silty sand							
27	27-29 ft, 20" recovery SM, SP, + CL First 5" md brown, fine-md grained silty clayey sand.					20"	8,23 46,45	4.67
28	Next 8", lt grey md-coarse grained sand 3" lt brown clay, 4" lt brown fine grained silty sand w/ red oxidized							
29	garnets.					16"	4,6 11,15	5.31
30' 30								

Bay West
Customer-Focused Environmental & Industrial Solutions

Project Name: K03F - HWAD
Project Number: J090499
Driller: Dennis Mitchell
Geologist: Shawn Lyman

Soil Boring No.: K03F-01
Well No.:
Total Depth: 33 ft
Drilling Method: 2" Hollow stem Auger
Sampling Method: 2 ft split spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
30	29-31 ft; 16" recovery CL + SP First 10", md brown, fine grained sandy clay Remaining 6", md grey; md-coarse grained			See 2nd Page for values				
31	Sand w/ dk black stringer of large angular volcanic clasts.				★ K03F-01-S-31'-33' @ 0914	14"	24, 42 50, 5	8.02
32	31-33 ft 14" recovery, SW lt grey gravelly coarse sand w/silt							
33	large 2" clasts (sub-rounded)							
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Bay West

Customer-Focused Environmental & Industrial Solutions

Project Name: K03F-HWAD
Project Number: J090499
Driller: Jeff Cothron
Geologist: Shawn Lyman

Soil Boring No.: K03F-02
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft split spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
0	0-7.5 ft, Hand Augered to verify Clearance of utilities onsite,							
1	no samples or geologic description taken.							
2								
3								
4								
5								
6								
7	7.5 - 9.5 ft, 24" recovery, SM First 6", ltgry-brwn, fine-coarse				K03F-02-7.5-9.5 @ 0840	24"	11, 10 11 11	6.34
8	grained silty sand, Remaining 18" ltgrey fine grained silty sand.							
9								
10	10-12 ft, 24" Recovery SM First 10", ltgrey, fine-md grained silty sand, Remaining 14" md brwn					24"	9, 10 13, 12	3.74
11	fine grained silty sand.							
12	12-14 ft, 24" Recovery, SP ltgrey, md-coarse grained sand w/ gravel clasts (< 10%).					24"	10, 31 35, 35	5.95
13								
14						15"	2, 10 34, 28	7.42
15								

Bay West

Customer-Focused Environmental & Industrial Solutions

Project Name: K03F-HWAD
Project Number: 5090499
Driller: Jeff Cothron
Geologist: Shawn Lyman

Soil Boring No.: K03F-02
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
15	14-16 ft, 15" recovery, SM, SC, SP First 2", md brown, moist, fine-md grained silty clayey sand. Next 8" lt grey		See First Page For Results →					
16	fine-coarse grained silty sand, Remaining 5", lt tan, fine-md grained sand w/ gravel debris.					21"	2, 6 10, 19	08.25
17	16-18 ft, 21" recovery SM + SC First 5", md brown, fine grained silty sand Remaining 16", md brown, fine grained silty clayey sand.							
18	18-20 ft 19" recovery SM-SC, SP First 4", lt brown, fine grained clayey silty sand Remaining 15", lt brown, md-coarse grained sand				★K03F-02 @ 0917	19"	2, 25 43, 34	10.43
19	w/ < 10% gravel clasts.							
20	20-22 ft, 24" recovery, SP lt brown, fine-coarse grained, subrounded sand.				K03F-02-S-18'-20'	24"	27, 39 38, 50, 5	08.46
21								
22	22-24 ft, 24" recovery, SM First 6", lt brown, fine-md grained, silty sand, 18", lt brown-tan				★K03F-02 @ 0931	24"	33, 34 33, 30	12.98
23	fine grained silty sand							
24	24-26 ft, 24" recovery, SM lt brown, fine-coarse grained silty sand (fine > coarse), dry.				K03F-02-S-22'-24'	24"	1, 13 33, 27	05.85
25								
26	26-28 ft, 24" recovery SC, SM, + CL First 4", md brown sandy clay Next 10", lt brown, fine-coarse grained					24"	10, 15 14, 19	07.43
27	silty sand (fine > coarse) Remaining 10", md brown, clay							
28	28-30, 20" recovery, SC, SC-SM First 3", md brown, sandy clay				★K03F-02 @ 0959	20"	6, 13 19, 23	09.47
29	Remaining 17", lt brown-grey, clayey silty sand, dry				K03F-02-S-28'-30'			
30								

Bay West
Customer-Focused Environmental & Industrial Solutions

Project Name: K03F-HWAD
Project Number: J090499
Driller: Dennis Mitchell
Geologist: Shawn Lyman

Soil Boring No.: K03F-03
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
0	0'-6', Hand Augered to verify clearance of Utilities on site							
1	no samples or geologic description taken.							
2								
3								
4								
5								
6	6-8 ft, 20" recovery SM + SP First 4", lt brwn, fine-coarse grained silty sand next 10", lt grey, med-coarse grained Sand				#K03F-03-S-6'-8' @ 1005	20"	3, 6, 6, 7	5.97
7	Remaining 6", lt grey fine-coarse grained ~~sand~~ silty sand (SL)							
8	8-10 ft, 21" recovery, SM lt grey, fine-coarse grained silty sand w/ the last 2" limited to fine grained range.					21"	6, 10 11, 12	3.27
9								
10	10-12 ft, 24" recovery, SM, SM-SC, SP First 10", lt grey-brwn, fine-coarse grained silty sand next 9", lt grey-brwn, silty clayey sand (fine grained)					24"	5, 10 17, 21	2.32
11	w/ a gravel stringer Remaining 5", lt grey, med-coarse grained sand.							
12	12-14 ft, 23" Recovery, SP, SM, SC First 5", lt gry-brwn, fine-coarse grained sand, Next 8", lt brwn, fine-grained silty sand.					23"	6, 8 10, 19	4.81
13	Remaining 10", med brwn, Sandy Clay							
14	14-16 ft, 22" recovery, SW lt grey is a brwn, fine-coarse grained sand				#K03F-03-S-14'-16' @ 1032	22"	7, 13 21, 20	5.41
15								

Bay West

Customer-Focused Environmental & Industrial Solutions

Project Name: K03F- HWAD
Project Number: 5090499
Driller: Dennis Mitchell
Geologist: Shawn Lyman

Soil Boring No.: K03F-03
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
15			See Page One For Results →					
16	16-18 ft, 22" recovery, SW First 4", fine-med grained Sand Next 12", lt grey Coarse grained Sand					22"	5,14 26,33	3.41
17	remaining 6", lt grey-tan gravelly Sand.							
18	18-20 ft, 24" recovery, SP lt tan, med-coarse grained sand w/ abundant gravel frags.					24"	13,33 32,29	3.60
19								
20	20-22 ft, 23" recovery, SW + SM First 10", lt brown fine-coarse grained Sand Remaining 13", lt brown, very fine - fine grained					23"	16,23 25,32	4.07
21	Silty Sand 22-24 ft, 24" recovery, SM. First 18", lt tan, fine grained silty Sand. Remaining 6", lt tan fine-coarse grained silty Sand.							
22	24-26 ft, 24" recovery SW, SM, SC First 12", lt tan, fine-coarse grained sand Next 7", lt brown, fine grained silty Sand				*K03F-03-S-20-24 @ 1057	24"	8,22 33,46	7.63
23	Remaining 5", med brown, Sandy Clay							
24						24"	13,16 15,8	4.90
25								
26	26-28 ft, 24" recovery, SM + SW First 12", lt brown, fine-med grained silty Sand Remaining 12", lt grey, fine-coarse grained Sand					24"	7,33 37,15	6.42
27	W/ minor gravel frags.						7,4 (SV)	
28	28-30 ft, 23" Recovery, SM-SC, SC, SM First 9", lt grey-brown, fine-coarse grained clayey silty Sand (fine 7 coarse)				*K03F-03-S-28-30 @ 1116	23"	7,9 12,42	4.65
29	Next 11", lt brown, fine grained Sandy Clay Remaining 3", lt gray-brown, fine grained silty Sand.							
30								

Bay West
Customer-Focused Environmental & Industrial Solutions

Project Name: K03F-HWAD
Project Number: J090499
Driller:
Geologist: Shawn Lyman

Soil Boring No.: K03F-04
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
0	0'-8' ft, Hand Augered to verify clearance of Utilities							
1	On site, no samples or geologic description taken							
2								
3								
4								
5								
6								
7								
8	8-10 ft, 24" recovery, SM + SW First 18", lt gry-brown, fine-coarse grained silty sand (fine > coarse). Remaining 6"				★K03F-04-S-8-10 @ 1034	24"	7,11 26,22	2.26
9	lt grey, gravelly sand w/ minor silt.							
10	10-12 ft, 22" recovery, SM + SC + SP 3" fine grained silty sand (lt grey). Next 10", lt grey-brown gravelly silty sand					22"	12,7 4,10	3.53
11	w/ large gravel fragments. Next 5", lt greyish brown, clayey sand Remaining 4", lt tan, med-coarse grained sand.							
12	12-14 ft, 18" recovery, CL + SW First 3", lt brown clay stringer					18"	3,6 17,19	3.65
13	Remaining 15", lt grey, fine-coarse grained sand.							
14	14-16, 23" recovery, SM, SW, CL First 2", med grey-brown, fine-coarse grained silty sand (fine > coarse)					23"	16,20 37,39	5.39
15	Next 14", lt grey, fine-coarse sand w/ small zone of color change to reddish tan							

2" clay stringer
Remaining 5", lt grey-brown gravelly sand

Bay West
Customer-Focused Environmental & Industrial Solutions

Project Name: K03F-HWAD
Project Number: J090499
Driller: Jeff
Geologist: Shawn Lyman

Soil Boring No.: K03F-04
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
15			See First Page for Results →					
16	16-18ft, 24" recovery, SC, SP, SC-SP, First 4", md brown Sandy Clay Next 2", lt tan, md-course grained Sand					24"	17,13 27,48	4.50
17	Next 8", md brown, fine grained Sandy Clay Remaining 10", lt tan, md grained, well sorted Sand							
18	18-20ft, 24" recovery, SM + SP First 3", lt grey, fine-course silty Sand Remaining 21", lt tan, md-course grained Sand				★ K03F-04-S-18-20 @ 1104	24"	18,28 39,39	7.45
19								
20	20-22ft, 24" recovery, SM + SP 4" lt grey-brown, fine grained silty Sand 12" lt tan, md-course grained Sand					24"	15,20 21,32	5.56
21	8" fine-md grained, well laminated (thinly) layers of Sand (tan to orange beds)							
22	22-24ft, 24" recovery, SP @ SM lt tan-grey, fine grained silty Sand					24"	16,25 30,31	4.38
23								
24	24-26ft, 24" recovery, SM, SM-SC, SP First 3", lt brown-grey, fine grained silty Sand Next 2", lt brown-grey, fine grained silty clayey Sand				24" → SC	~~16,23~~ 25	16,23 25,14	3.91
25	Next 5", lt tan, course grained, well sorted Sand 14", lt grey, fine grained, well sorted, silty Sand.							
26	26-28ft, 23" recovery, SM + SP 4", lt brown, fine grained silty Sand Next 10", lt grey, fine-md grained Sand					23"	20,31 30,25	3.12
27	Remaining 10", lt grey, md-course grained Sand							
28	28-30, 19" recovery, SM, SM-SC First 4", lt grey-brown, fine-course grained silty Sand. Next 5", lt grey, fine grained silty Sand				★ K03F-04-S-28-30 @ 1140	19"	13,8 9,10	4.56
29	Remaining 10", lt grey-brown, silty clayey Sand							
30								

Bay West
Customer-Focused Environmental & Industrial Solutions

Project Name: K03F - HWAD
Project Number: J090499
Driller: Jeff Cothron
Geologist: Shawn Lyman

Soil Boring No.: K03F-05
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft Split Spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
0	0-8 ft, Hand Augered to verify clearance of utilities on site, no sample or geologic description taken.							
1								
2								
3								
4								
5								
6								
7								
8	8-10 ft, 20" recovery, SM + SW First 16", md brown, fine-coarse grained silty sand				* K03F-05-S-8-10 @ 1225	20"	3,1 2,2	3.86
9	Remaining 4", lt grey, fine-md grained sand							
10	10-12 ft, 24" Recovery, SM, SW, SP 6" md brown, fine-coarse grained silty sand 4" fine-coarse grained sand (lt grey).					24"	6,3 4,7	4.43
11	14", very fine-fine grained sand (lt grey).						~~4,7~~ ~~8,8~~	(SL)
12	12-14 ft, 20" recovery, SM, SC 12" lt grey, fine-coarse grained silty sand (Fine 7 coarse) 4" lt brown, sandy clay					20"	4,7 6,18	4.18
13	4" lt brown, fine grained silty sand							
14	14-16), 24" Recovery, SM, SW First 4", lt brown, fine grained silty sand			@ 1240	* K03F-05-S-14-16	24"	10,16 18,15	6.39
15	Next 20" lt brown, fine-coarse grained sand w/ gravel frags.							

Bay West
Customer-Focused Environmental & Industrial Solutions

Project Name: K03F - HWAD
Project Number: J090499
Driller: Jeff
Geologist: Shawn Lyman

Soil Boring No.: K03F-05
Well No.:
Total Depth: 30 ft
Drilling Method: 2" Hollow Stem Auger
Sampling Method: 2 ft split spoon
Grade Elevation:
Date Started/Completed: 4/14/11 / 4/14/11

Depth (ft bgs)	Description - Remarks	Graphic Section	Munsell Color	USCS Class.	Analytical Sample	REC (in.)	Blows	Headspace FID (ppm)
15			See First Page for results →					
16	16-18 ft, 24" recovery, SM First 4", lt grey, fine-coarse, silty sand ~~w/ minor clay content~~ (SL)					24"	10,13 16,16	5.67
17	Next 20", lt tan-brown, v. fine - fine grained silty sand w/ minor clay content.							
18	18-20 ft, 24" recovery SM, SW First 14", lt grey-brown, thinly laminated, very fine-fine grained silty sand w/ few orange streaks.					24"	11,15 20,30	5.18
19	Next 10", lt grey-brown, fine-coarse grained gravelly sand.							
20	20-22 ft, 20" recovery, SW lt brown-tan, fine-coarse grained gravelly sand w/ silt, 3" gravel stringer					20"	15,13 21,22	6.78
21	(dk grey angular clasts, fractures easily → also contains ~~the~~ shades of black + Red).							
22	22-24 ft, 24" recovery SW + SM First 3", lt grey-brown gravelly sand w/ silt					24"	20,22 25,40	6.36
23	Next 21", lt grey-brown, thinly laminated tan bands of fine grained silty sand, (2" zone w/ md-coarse grain size range)							
24	24-26 ft, 19" recovery, SM lt tan, fine-md grained, well sorted silty sand (Beach Sand)					19"	4,21 18,19	6.06
25								
26	26-28 ft, 20" recovery, SW, SC, SP First 14", lt brown-tan, fine-coarse grained					20"	21,15 16,16	6.67
27	sand w/ silt, few orange bands. 5", md brown sandy clay 1", lt grey, md grained, well sorted sand.							
28	28-30 ft, 24" recovery SC, SM First 7", md brown sandy clay				☆ K03F-05-S-28-30	24"	10,28 38,35	6.91
29	Next 17", lt grey-brown, fine-md grained silty sand.			@ 1317				
30								

Table 4-1 SWMU K03F Analytical Results

Analyte	CAS Number	Method	Units	EPA RSLs (2011) Industrial	K03F-01										K03F-02							
					K03F-01-S-7.5-9.5		K03F-01-S-17.5-19.5		K03F-01-S-17.5-19.5-Z		K03F-01-S-25-27		K03F-01-S-31-33		K03F-02-S-7.5-9.5		K03F-02-S-18-20		K03F-02-S-22-24		K03F-02-S-28-30	
					4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011	
					7.5-9.5 ft bgs		17.5-19.5 ft bgs		Duplicate		25-27 ft bgs		31-33 ft bgs		7.5-9.5 ft bgs		18-20 ft bgs		22-24 ft bgs		28-30 ft bgs	
					Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America	
					Result	MDL	Result	MDL	Result	MDL		MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Diesel Range Organics [C10-C28]																						
Diesel Range Organics [C10-C28]	N/A	8015B	mg/Kg	100(1)	**8,200 D M**	18	**3.3 J M**	0.69	**1,200 D M**	6.7	**1.6 J M**	0.69	**2.4 J M**	0.65	**1.8 J**	0.68	**2.3 J M**	0.66	**5.3 M**	0.7	**2.3 J M**	0.71
Volatile Organic Compounds																						
2-Butanone (MEK)	78-93-3	8260C	ug/Kg	200,000,000	360 U	330	11 U	2.1	360 U	330	10 U	1.9	10 U	1.9	11 U	2	11 U	2	11 U	2	11 U	2
Benzene	71-43-2	8260C	ug/Kg	5,400	56 U	50	1.1 U	0.54	56 U	50	1.0 U	0.49	1.0 U	0.49	1.1 U	0.52	1.1 U	0.51	1.1 U	0.52	1.1 U	0.52
Ethylbenzene	100-41-4	8260C	ug/Kg	27,000	56 U Q	38	1.1 U	0.77	56 U Q	38	1.0 U	0.69	1.0 U	0.69	1.1 U	0.74	1.1 U	0.73	1.1 U	0.74	1.1 U	0.75
Toluene	108-88-3	8260C	ug/Kg	45,000,000	67 U	43	1.1 U	0.79	67 U	44	1.0 U	0.71	1.0 U	0.71	1.1 U	0.76	1.1 U	0.75	1.1 U	0.77	1.1 U	0.77
Xylenes, Total	1330-20-7	8260C	ug/Kg	2,700,000	110 U	39	1.1 U	1.1	110 U	39	1.0 U	1	1.0 U	1	1.1 U	1.1	1.1 U	1.1	1.1 U	1.1	1.1 U	1.1

Analyte	CAS Number	Method	Units	EPA RSLs (2011) Industrial	K03F-03								K03F-04							
					K03F-03-S-6-8		K03F-03-S-14-16		K03F-03-S-22-24		K03F-03-S-28-30		K03F-04-S-8-10		K03F-04-S-18-20		K03F-04-S-28-30		K03F-04-S-28-30-Z	
					4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011	
					6-8 ft bgs		14-16 ft bgs		22-24 ft bgs		28-30 ft bgs		8-10 ft bgs		18-20 ft bgs		28-30 ft bgs		Duplicate	
					Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America	
					Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Diesel Range Organics [C10-C28]																				
Diesel Range Organics [C10-C28]	N/A	8015B	mg/Kg	100(1)	**4.2 M**	0.68	**1.0 J M**	0.66	**1.6 J M**	0.66	2.2 U	0.76	**3.1 J M**	0.7	**2.0 J M**	0.66	**5.8 M**	0.75	**9.8 M**	0.73
Volatile Organic Compounds																				
2-Butanone (MEK)	78-93-3	8260C	ug/Kg	200,000,000	9.5 U	1.7	11 U	2	**3.7 J**	2	12 U	2.1	13 U	2.3	**2.3 J**	2	13 U	2.3	12 U	2.3
Benzene	71-43-2	8260C	ug/Kg	5,400	0.95 U	0.45	1.1 U	0.51	1.1 U	0.53	1.2 U	0.55	1.3 U	0.6	1.1 U	0.51	1.3 U	0.6	1.2 U	0.58
Ethylbenzene	100-41-4	8260C	ug/Kg	27,000	0.95 U	0.64	1.1 U	0.72	1.1 U	0.75	1.2 U	0.78	1.3 U	0.86	1.1 U	0.73	1.3 U	0.86	1.2 U	0.83
Toluene	108-88-3	8260C	ug/Kg	45,000,000	0.95 U	0.66	1.1 U	0.74	1.1 U	0.77	1.2 U	0.81	1.3 U	0.88	1.1 U	0.75	1.3 U	0.88	1.2 U	0.85
Xylenes, Total	1330-20-7	8260C	ug/Kg	2,700,000	0.95 U	0.95	1.1 U	1.1	1.1 U	1.1	1.2 U	1.2	1.3 U	1.3	1.1 U	1.1	1.3 U	1.3	1.2 U	1.2

Analyte	CAS Number	Method	Units	EPA RSLs (2011) Industrial	K03F-05					
					K03F-05-S-8-10		K03F-05-S-14-16		K03F-05-S-28-30	
					4/14/2011		4/14/2011		4/14/2011	
					8-10 ft bgs		14-16 ft bgs		28-30 ft bgs	
					Test America		Test America		Test America	
					Result	MDL	Result	MDL	Result	MDL
Diesel Range Organics [C10-C28]										
Diesel Range Organics [C10-C28]	N/A	8015B	mg/Kg	100(1)	**270 M**	0.71	**2,900 D M**	3.4	2.1 U	0.7
Volatile Organic Compounds										
2-Butanone (MEK)	78-93-3	8260C	ug/Kg	200,000,000	10 U	1.9	**2.6 J**	1.8	11 U	2
Benzene	71-43-2	8260C	ug/Kg	5,400	1.0 U	0.48	0.99 U	0.47	1.1 U	0.52
Ethylbenzene	100-41-4	8260C	ug/Kg	27,000	1.0 U	0.69	0.99 U	0.66	1.1 U	0.74
Toluene	108-88-3	8260C	ug/Kg	45,000,000	1.0 U	0.71	0.99 U	0.68	1.1 U	0.77
Xylenes, Total	1330-20-7	8260C	ug/Kg	2,700,000	1.0 U	1	0.99 U	0.99	1.1 U	1.1

Notes:
RSLs - Regional Screening Levels
HWAD - Hawthorne Army Depot
MDL - Method Detection Limit
BGS - Below Ground Surface
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
N/A- Not Applicable or Not Established
Bold - results above method detection limit
(1) - DRO level is a State of Nevada Screening Level

Laboratory Qualifiers
J - Estimated: The analyte was positively identified; the quantitation is an estimation
D - Sample result required a dilution
Q - One or more quality control criteria failed.
U - Undetected at the Limit of Detection.
M - Manual integrated compound.

TABLE E-2
ALL SOILSAMPLE RESULTS
SWMU KO3F
HAWTHORNE ARMY DEPOT, NEVADA

				K03F-01										K03F-02								K03F-03							
				K03F-01-S-7.5-9.5		K03F-01-S-17.5-19.5		K03F-01-S-17.5-19.5-Z		K03F-01-S-25-27		K03F-01-S-31-33		K03F-02-S-7.5-9.5		K03F-02-S-18-20		K03F-02-S-22-24		K03F-02-S-28-30		K03F-03-S-6-8		K03F-03-S-14-16		K03F-03-S-22-24		K03F-03-S-28-30	
				4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011	
				7.5-9.5 ft bgs		17.5-19.5 ft bgs		Duplicate		25-27 ft bgs		31-33 ft bgs		7.5-9.5 ft bgs		18-20 ft bgs		22-24 ft bgs		28-30 ft bgs		6-8 ft bgs		14-16 ft bgs		22-24 ft bgs		28-30 ft bgs	
				Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America		Test America	
Analyte	CAS Number	Method	Units	Result	MDL	Result	MDL	Result	MDL		MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Diesel Range Organics [C10-C28]																													
Diesel Range Organics [C10-C28]	N/A	8015B	mg/Kg	**8,200** D M	18	**3.3** J M	0.69	**1,200** D M	6.7	**1.6** J M	0.69	**2.4** J M	0.65	**1.8** J	0.68	**2.3** J M	0.66	**5.3 M**	0.7	**2.3** J M	0.71	**4.2 M**	0.68	**1.0** J M	0.66	**1.6** J M	0.66	2.2 U	0.76
Volatile Organic Compounds																													
1,1,1,2-Tetrachloroethane	630-20-6	8260C	ug/Kg	56 U Q	23	1.1 U	0.64	56 U Q	23	1.0 U	0.58	1.0 U	0.58	1.1 U	0.62	1.1 U	0.61	1.1 U	0.62	1.1 U	0.62	0.95 U	0.53	1.1 U	0.6	1.1 U	0.63	1.2 U	0.65
1,1,1-Trichloroethane	71-55-6	8260C	ug/Kg	56 U	22	1.1 U	0.6	56 U	22	1.0 U	0.54	1.0 U	0.54	1.1 U	0.58	1.1 U	0.57	1.1 U	0.58	1.1 U	0.58	0.95 U	0.49	1.1 U	0.56	1.1 U	0.58	1.2 U	0.61
1,1,2,2-Tetrachloroethane	79-34-5	8260C	ug/Kg	56 U	32	1.1 U	0.7	56 U	32	1.0 U	0.63	1.0 U	0.63	1.1 U	0.68	1.1 U	0.67	1.1 U	0.68	1.1 U	0.68	0.95 U	0.58	1.1 U	0.66	1.1 U	0.68	1.2 U	0.71
1,1,2-Trichloroethane	79-00-5	8260C	ug/Kg	56 U	30	1.1 U	1	56 U	30	1.0 U	0.91	1.0 U	0.91	1.1 U	0.98	1.1 U	0.96	1.1 U	0.98	1.1 U	0.98	0.95 U	0.84	1.1 U	0.95	1.1 U	0.98	1.2 U	1
1,1-Dichloroethane	75-34-3	8260C	ug/Kg	67 U	56	1.1 U	0.24	67 U	56	1.0 U	0.22	1.0 U	0.22	1.1 U	0.23	1.1 U	0.23	1.1 U	0.23	1.1 U	0.23	0.95 U	0.2	1.1 U	0.23	1.1 U	0.23	1.2 U	0.25
1,1-Dichloroethene	75-35-4	8260C	ug/Kg	67 U	56	1.1 U	0.68	67 U	56	1.0 U	0.61	1.0 U	0.61	1.1 U	0.65	1.1 U	0.64	1.1 U	0.66	1.1 U	0.66	0.95 U	0.56	1.1 U	0.64	1.1 U	0.66	1.2 U	0.69
1,2,3-Trichlorobenzene	87-61-6	8260C	ug/Kg	56 U	39	1.1 U	0.86	56 U	39	1.0 U	0.77	1.0 U	0.78	1.1 U	0.83	1.1 U	0.82	1.1 U	0.83	1.1 U	0.84	0.95 U	0.71	1.1 U	0.81	1.1 U	0.84	1.2 U	0.88
1,2,3-Trichloropropane	96-18-4	8260C	ug/Kg	110 U	52	1.1 U	0.93	110 U	52	1.0 U	0.84	1.0 U	0.84	1.1 U	0.9	1.1 U	0.88	1.1 U	0.9	1.1 U	0.9	0.95 U	0.77	1.1 U	0.87	1.1 U	0.91	1.2 U	0.95
1,2,4-Trichlorobenzene	120-82-1	8260C	ug/Kg	67 U	52	1.1 U	0.84	67 U	52	1.0 U	0.75	1.0 U	0.76	1.1 U	0.81	1.1 U	0.8	1.1 U	0.81	1.1 U	0.81	0.95 U	0.69	1.1 U	0.79	1.1 U	0.82	1.2 U	0.85
1,2,4-Trimethylbenzene	95-63-6	8260C	ug/Kg	56 U	34	1.1 U	0.67	56 U	35	1.0 U	0.6	1.0 U	0.6	1.1 U	0.64	1.1 U	0.63	1.1 U	0.64	1.1 U	0.65	0.95 U	0.55	1.1 U	0.63	1.1 U	0.65	1.2 U	0.68
1,2-Dibromo-3-Chloropropane	96-12-8	8260C	ug/Kg	220 U	96	1.1 U	0.69	220 U	96	1.0 U	0.62	1.0 U	0.62	1.1 U	0.67	1.1 U	0.66	1.1 U	0.67	1.1 U	0.67	0.95 U	0.57	1.1 U	0.65	1.1 U	0.67	1.2 U	0.7
1,2-Dichlorobenzene	95-50-1	8260C	ug/Kg	56 U	100	1.1 U	0.52	56 U	100	1.0 U	0.46	1.0 U	0.47	1.1 U	0.5	1.1 U	0.49	1.1 U	0.5	1.1 U	0.5	0.95 U	0.43	1.1 U	0.49	1.1 U	0.5	1.2 U	0.53
1,2-Dichloroethane	107-06-2	8260C	ug/Kg	180 U	28	1.1 U	0.8	180 U	28	1.0 U	0.72	1.0 U	0.73	1.1 U	0.78	1.1 U	0.76	1.1 U	0.78	1.1 U	0.78	0.95 U	0.67	1.1 U	0.75	1.1 U	0.78	1.2 U	0.82
1,2-Dichloropropane	78-87-5	8260C	ug/Kg	56 U	51	1.1 U	0.63	56 U	52	1.0 U	0.57	1.0 U	0.57	1.1 U	0.61	1.1 U	0.6	1.1 U	0.61	1.1 U	0.61	0.95 U	0.52	1.1 U	0.59	1.1 U	0.61	1.2 U	0.64
1,3,5-Trimethylbenzene	108-67-8	8260C	ug/Kg	67 U	43	1.1 U	0.66	67 U	44	1.0 U	0.59	1.0 U	0.59	1.1 U	0.63	1.1 U	0.62	1.1 U	0.63	1.1 U	0.63	0.95 U	0.54	1.1 U	0.61	1.1 U	0.64	1.2 U	0.67
1,3-Dichloropropane	142-28-9	8260C	ug/Kg	67 U Q	31	1.1 U	0.59	67 U Q	31	1.0 U	0.53	1.0 U	0.53	1.1 U	0.57	1.1 U	0.56	1.1 U	0.57	1.1 U	0.57	0.95 U	0.49	1.1 U	0.55	1.1 U	0.57	1.2 U	0.6
1,4-Dichlorobenzene	106-46-7	8260C	ug/Kg	56 U	28	1.1 U	0.9	56 U	28	1.0 U	0.81	1.0 U	0.81	1.1 U	0.86	1.1 U	0.85	1.1 U	0.87	1.1 U	0.87	0.95 U	0.74	1.1 U	0.84	1.1 U	0.87	1.2 U	0.91
1,4-Dioxane	123-91-1	8260C	ug/Kg	8900 U	2800	92 U	64	8900 U	2800	83 U	58	83 U	58	89 U	62	87 U	61	89 U	62	89 U	62	76 U	53	86 U	60	89 U	63	94 U	66
2-Butanone (MEK)	78-93-3	8260C	ug/Kg	360 U	330	11 U	2.1	360 U	330	10 U	1.9	10 U	1.9	11 U	2	11 U	2	11 U	2	11 U	2	9.5 U	1.7	11 U	2	**3.7** J	2	12 U	2.1
2-Chloro-1,3-butadiene	126-99-8	8260C	ug/Kg	89 U	52	0.92 U	0.6	89 U	52	0.83 U	0.54	0.83 U	0.54	0.89 U	0.58	0.87 U	0.57	0.89 U	0.58	0.89 U	0.58	0.76 U	0.49	0.86 U	0.56	0.89 U	0.58	0.94 U	0.61
2-Chlorotoluene	95-49-8	8260C	ug/Kg	56 U	29	1.1 U	0.59	56 U	29	1.0 U	0.53	1.0 U	0.53	1.1 U	0.57	1.1 U	0.56	1.1 U	0.57	1.1 U	0.57	0.95 U	0.49	1.1 U	0.55	1.1 U	0.57	1.2 U	0.6
2-Hexanone	591-78-6	8260C	ug/Kg	360 U	240	11 U	5.6	360 U	240	10 U	5.1	10 U	5.1	11 U	5.4	11 U	5.3	11 U	5.4	11 U	5.4	9.5 U	4.7	11 U	5.3	11 U	5.5	12 U	5.7
4-Chlorotoluene	106-43-4	8260C	ug/Kg	56 U	26	1.1 U	0.9	56 U	26	1.0 U	0.81	1.0 U	0.81	1.1 U	0.86	1.1 U	0.85	1.1 U	0.87	1.1 U	0.87	0.95 U	0.74	1.1 U	0.84	1.1 U	0.87	1.2 U	0.91
Acetone	67-64-1	8260C	ug/Kg	710 U Q	440	11 U	6.2	710 U Q	450	10 U	5.6	10 U	5.6	11 U	6	8.9 J	5.9	6.6 J	6	11 U	6	9.5 U	5.1	11 U	5.8	6.2 J	6	12 U	6.3
Acetonitrile	75-05-8	8260C	ug/Kg	890 U	730	37 U	3.2	890 U	740	33 U	2.8	33 U	2.8	35 U	3	35 U	3	36 U	3.1	36 U	3.1	30 U	2.6	34 U	3	36 U	3.1	37 U	3.2
Acrolein	107-02-8	8260C	ug/Kg	890 U	510	9.2 U	8	890 U	510	8.3 U	7.2	8.3 U	7.3	8.9 U	7.8	8.7 U	7.6	8.9 U	7.8	8.9 U	7.8	7.6 U	6.7	8.6 U	7.5	8.9 U	7.8	9.4 U	8.2
Acrylonitrile	107-13-1	8260C	ug/Kg	440 U	290	9.2 U	5.5	450 U	290	8.3 U	5	8.3 U	5	8.9 U	5.3	8.7 U	5.3	8.9 U	5.4	8.9 U	5.4	7.6 U	4.6	8.6 U	5.2	8.9 U	5.4	9.4 U	5.6
Benzene	71-43-2	8260C	ug/Kg	56 U	50	1.1 U	0.54	56 U	50	1.0 U	0.49	1.0 U	0.49	1.1 U	0.52	1.1 U	0.51	1.1 U	0.52	1.1 U	0.52	0.95 U	0.45	1.1 U	0.51	1.1 U	0.53	1.2 U	0.55
Bromobenzene	108-86-1	8260C	ug/Kg	56 U	21	1.1 U	0.56	56 U	21	1.0 U	0.51	1.0 U	0.51	1.1 U	0.54	1.1 U	0.54	1.1 U	0.54	1.1 U	0.55	0.95 U	0.47	1.1 U	0.53	1.1 U	0.55	1.2 U	0.57
Bromoform	75-25-2	8260C	ug/Kg	110 U Q	32	1.1 U	0.26	110 U Q	32	1.0 U	0.24	1.0 U	0.24	1.1 U	0.25	1.1 U	0.25	1.1 U	0.26	1.1 U	0.26	0.95 U	0.22	1.1 U	0.25	1.1 U	0.26	1.2 U	0.27
Bromomethane	74-83-9	8260C	ug/Kg	89 U	49	1.1 U	0.57	89 U	49	1.0 U	0.52	1.0 U	0.52	1.1 U	0.55	1.1 U	0.55	1.1 U	0.56	1.1 U	0.56	0.95 U	0.48	1.1 U	0.54	1.1 U	0.56	1.2 U	0.58
Carbon disulfide	75-15-0	8260C	ug/Kg	67 U	71	1.1 U	0.48	67 U	71	1.0 U Q	0.43	1.0 U Q	0.44	1.1 U	0.47	1.1 U	0.46	1.1 U	0.47	1.1 U	0.47	0.95 U	0.4	1.1 U	0.45	1.1 U	0.47	1.2 U	0.49
Carbon tetrachloride	56-23-5	8260C	ug/Kg	67 U	19	1.1 U	0.72	67 U	19	1.0 U	0.65	1.0 U	0.65	1.1 U	0.7	1.1 U	0.69	1.1 U	0.7	1.1 U	0.7	0.95 U	0.6	1.1 U	0.68	1.1 U	0.7	1.2 U	0.74
Chlorobenzene	108-90-7	8260C	ug/Kg	89 U Q	33	1.1 U	0.62	89 U Q	34	1.0 U	0.56	1.0 U	0.56	1.1 U	0.6	1.1 U	0.59	1.1 U	0.6	1.1 U	0.6	0.95 U	0.51	1.1 U	0.58	1.1 U	0.6	1.2 U	0.63
Chlorobromomethane	74-97-5	8260C	ug/Kg	67 U	52	1.1 U	0.34	67 U	53	1.0 U	0.31	1.0 U	0.31	1.1 U	0.33	1.1 U	0.33	1.1 U	0.33	1.1 U	0.33	0.95 U	0.29	1.1 U	0.32	1.1 U	0.34	1.2 U	0.35
Chloroform	67-66-3	8260C	ug/Kg	67 U	51	1.1 U	0.33	67 U	51	1.0 U	0.3	1.0 U	0.3	1.1 U	0.32	1.1 U	0.32	1.1 U	0.32	1.1 U	0.32	0.95 U	0.28	1.1 U	0.31	1.1 U	0.32	1.2 U	0.34
Chloromethane	74-87-3	8260C	ug/Kg	89 U	56	1.1 U	0.88	89 U	56	1.0 U	0.8	1.0 U	0.8	1.1 U	0.85	1.1 U	0.84	1.1 U	0.86	1.1 U	0.86	0.95 U	0.73	1.1 U	0.83	1.1 U	0.86	1.2 U	0.9
cis-1,2-Dichloroethene	156-59-2	8260C	ug/Kg	67 U	24	1.1 U	0.64	67 U	25	1.0 U	0.58	1.0 U	0.58	1.1 U	0.62	1.1 U	0.61	1.1 U	0.62	1.1 U	0.62	0.95 U	0.53	1.1 U	0.6	1.1 U	0.63	1.2 U	0.65
cis-1,3-Dichloropropene	10061-01-5	8260C	ug/Kg	67 U	30	2.3 U	1.5	67 U	30	2.1 U	1.3	2.1 U	1.3	2.2 U	1.4	2.2 U	1.4	2.2 U	1.4	2.2 U	1.4	1.9 U	1.2	2.2 U	1.4	2.2 U	1.4	2.3 U	1.5
cis-1,4-Dichloro-2-butene	1476-11-5	8260C	ug/Kg	180 U	70	3.7 U	1.2	180 U	70	3.3 U	1.1	3.3 U	1.1	3.5 U	1.2	3.5 U	1.1	3.6 U	1.2	3.6 U	1.2	3.0 U	1	3.4 U	1.1	3.6 U	1.2	3.7 U	1.2
Cyclohexane	110-82-7	8260C	ug/Kg	44 U	31	1.8 U	0.46	45 U	31	1.7 U	0.41	1.7 U	0.41	1.8 U	0.44	1.7 U	0.44	1.8 U	0.44	1.8 U	0.45	1.5 U	0.38	1.7 U	0.43	1.8 U	0.45	1.9 U	0.47
Cyclohexanone	108-94-1	8260C	ug/Kg	7100 U	4100	74 U	62	7100 U	4100	66 U	56	66 U	56	71 U	60	70 U	59	71 U	60	71 U	60	61 U	51	69 U	58	72 U	60	75 U	63
Dibromomethane	74-95-3	8260C	ug/Kg	56 U	33	1.1 U	0.97	56 U	34	1.0 U	0.87	1.0 U	0.87	1.1 U	0.93	1.1 U	0.92	1.1 U	0.93	1.1 U	0.94	0.95 U	0.8	1.1 U	0.91	1.1 U	0.94	1.2 U	0.98
Dichlorobromomethane	75-27-4	8260C	ug/Kg	56 U	44	1.1 U	0.25	56 U	44	1.0 U	0.23	1.0 U	0.23	1.1 U	0.24	1.1 U	0.24	1.1 U	0.24	1.1 U	0.25	0.95 U	0.21	1.1 U	0.24	1.1 U	0.25	1.2 U	0.26
Dichlorodifluoromethane	75-71-8	8260C	ug/Kg	110 U	24	1.1 U	0.6	110 U	25	1.0 U	0.54	1.0 U	0.54	1.1 U	0.58	1.1 U	0.57	1.1 U	0.58	1.1 U	0.58	0.95 U	0.49	1.1 U	0.56	1.1 U	0.58	1.2 U	0.61
Ethyl methacrylate	97-63-2	8260C	ug/Kg	180 U	140	0.92 U	0.69	180 U	150	0.83 U	0.62	0.83 U	0.62	0.89 U	0.67	0.87 U	0.66	0.89 U	0.67	0.89 U	0.67	0.76 U	0.57	0.86 U	0.65	0.89 U	0.67	0.94 U	0.7
Ethylbenzene	100-41-4	8260C	ug/Kg	56 U Q	38	1.1 U	0.77	56 U Q	38	1.0 U	0.69	1.0 U	0.69	1.1 U	0.74	1.1 U	0.73	1.1 U	0.74	1.1 U	0.75	0.95 U	0.64	1.1 U	0.72	1.1 U	0.75	1.2 U	0.78
Hexachlorobutadiene	87-68-3	8260C	ug/Kg	89 U	54	1.1 U	0.63	89 U	55	1.0 U	0.57	1.0 U	0.57	1.1 U	0.61	1.1 U	0.6	1.1 U	0.61	1.1 U	0.61	0.95 U	0.52	1.1 U	0.59	1.1 U	0.61	1.2 U	0.64
Methyl acetate	79-20-9	8260C	ug/Kg	440 U	270	4.6 U	3.2	450 U	270	4.1 U	2.8	4.1 U	2.8	4.4 U	3	4.4 U	3	4.4 U	3.1	4.5 U	3.1	3.8 U	2.6	4.3 U	3	4.5 U	3.1	4.7 U	3.2
Methyl methacrylate	80-62-6	8260C	ug/Kg	360 U	97	1.8 U	1.2	360 U	97	1.7 U	1.1	1.7 U	1.1	1.8 U	1.1	1.7 U	1.1	1.8 U	1.1	1.8 U	1.1	1.5 U	0.98	1.7 U	1.1	1.8 U	1.2	1.9 U	1.2
Methyl tert-butyl ether	1634-04-4	8260C	ug/Kg	67 U	56	1.1 U	0.39	67 U	56	1.0 U	0.35	1.0 U	0.35	1.1 U	0.38	1.1 U	0.37	1.1 U	0.38	1.1 U	0.38	0.95 U	0.32	1.1 U	0.37	1.1 U	0.38	1.2 U	0.4
Methylene Chloride	75-09-2	8260C	ug/Kg	110 U	77	6.9 B	0.86	110 U	77	5.6 B	0.77	5.6 B	0.78	5.3 J B	0.83	5.0 J B	0.82	5.8 B	0.83	5.4 J B	0.84	4.5 J B	0.71	4.7 J B	0.81	6.2 B	0.84	5.9 B	0.88
m-Xylene & p-Xylene	179601-23-1	8260C	ug/Kg	110 U Q	87	2.3 U	1.2	110 U Q	87	2.1 U	1.1	2.1 U	1.1	2.2 U	1.2	2.2 U	1.1	2.2 U	1.2	2.2 U	1.2	1.9 U	0.99	2.2 U	1.1	2.2 U	1.2	2.3 U	1.2
Naphthalene	91-20-3	8260C	ug/Kg	110 U	42	1.1 U	0.72	110 U	42	1.0 U	0.65	1.0 U	0.65	1.1 U	0.7	1.1 U	0.69	1.1 U	0.7	1.1 U	0.7	0.95 U	0.6	1.1 U	0.68	0.81 U	0.7	1.2 U	0.74
N-Propylbenzene	103-65-1	8260C	ug/Kg	56 U	46	1.1 U	0.67	56 U	46	1.0 U	0.6	1.0 U	0.6	1.1 U	0.64	1.1 U	0.63	1.1 U	0.64	1.1 U	0.65	0.95 U	0.55	1.1 U	0.63	1.1 U	0.65	1.2 U	0.68
o-Xylene	95-47-6	8260C	ug/Kg	56 U Q	39	1.1 U	0.7	56 U Q	39	1.0 U	0.63	1.0 U	0.63	1.1 U	0.68	1.1 U	0.67	1.1 U	0.68	1.1 U	0.68	0.95 U	0.58	1.1 U	0.66	1.1 U	0.68	1.2 U	0.71
Styrene	100-42-5	8260C	ug/Kg	56 U Q	29	1.1 U	0.72	56 U Q	29	1.0 U	0.65	1.0 U	0.65	1.1 U	0.7	1.1 U	0.69	1.1 U	0.7	1.1 U	0.7	0.95 U	0.6	1.1 U	0.68	1.1 U	0.7	1.2 U	0.74
Tetrachloroethene	127-18-4	8260C	ug/Kg	56 U Q	30	1.1 U	0.68	56 U Q	30	1.0 U	0.61	1.0 U	0.61	1.1 U	0.65	1.1 U	0.64	1.1 U	0.66	1.1 U	0.66	0.95 U	0.56	1.1 U	0.64	1.1 U	0.66	1.2 U	0.69
Tetrahydrofuran	109-99-9	8260C	ug/Kg	710 U	260	7.4 U	3.7	710 U	260	6.6 U	3.3	6.6 U	3.3	7.1 U	3.5	7.0 U	3.5	7.1 U	3.5	7.1 U	3.6	6.1 U	3	6.9 U	3.4	7.2 U	3.6	7.5 U	3.7
Toluene	108-88-3	8260C	ug/Kg	67 U	43	1.1 U	0.79	67 U	44	1.0 U	0.71	1.0 U	0.71	1.1 U	0.76	1.1 U	0.75	1.1 U	0.77	1.1 U	0.77	0.95 U	0.66	1.1 U	0.74	1.1 U	0.77	1.2 U	0.81
trans-1,2-Dichloroethene	156-60-5	8260C	ug/Kg	67 U	50	1.1 U	0.45	67 U	50	1.0 U	0.4	1.0 U	0.4	1.1 U	0.43	1.1 U	0.43	1.1 U	0.43	1.1 U	0.43	0.95 U	0.37	1.1 U	0.42	1.1 U	0.44	1.2 U	0.46
trans-1,3-Dichloropropene	10061-02-6	8260C	ug/Kg	67 U	46	1.1 U	0.77	67 U	46	1.0 U	0.69	1.0 U	0.69	1.1 U	0.74	1.1 U	0.73	1.1 U	0.74	1.1 U	0.75	0.95 U	0.64	1.1 U	0.72	1.1 U	0.75	1.2 U	0.78
trans-1,4-Dichloro-2-butene	110-57-6	8260C	ug/Kg	180 U	58	1.8 U	0.77	180 U	58	1.7 U	0.69	1.7 U	0.69	1.8 U	0.74	1.7 U	0.73	1.8 U	0.74	1.8 U	0.75	1.5 U	0.64	1.7 U	0.72	1.8 U	0.75	1.9 U	0.78
Trichloroethene	79-01-6	8260C	ug/Kg	56 U	26	1.1 U	0.26	56 U	26	1.0 U	0.24	1.0 U	0.24	1.1 U	0.25	1.1 U	0.25	1.1 U	0.26	1.1 U	0.26	0.95 U	0.22	1.1 U	0.25	1.1 U	0.26	1.2 U	0.27
Trichlorofluoromethane	75-69-4	8260C	ug/Kg	67 U	56	2.3 U	1.2	67 U	56	2.1 U	1.1	2.1 U	1.1	2.2 U	1.2	2.2 U	1.1	2.2 U	1.2	2.2 U	1.2	1.9 U	0.99	2.2 U	1.1	2.2 U	1.2	2.3 U	1.2
Vinyl acetate	108-05-4	8260C	ug/Kg	560 U	78	11 U	1.2	560 U	78	10 U	1.1	10 U	1.1	11 U	1.2	11 U	1.2	11 U	1.2	11 U	1.2	9.5 U	1	11 U	1.2	11 U	1.2	12 U	1.3
Vinyl chloride	75-01-4	8260C	ug/Kg	56 U	30	2.3 U	1.5	56 U	30	2.1 U	1.4	2.1 U	1.4	2.2 U	1.5	2.2 U	1.5	2.2 U	1.5	2.2 U	1.5	1.9 U	1.3	2.2 U	1.4	2.2 U	1.5	2.3 U	1.6
Xylenes, Total	1330-20-7	8260C	ug/Kg	110 U	39	1.1 U	1.1	110 U	39	1.0 U	1	1.0 U	1	1.1 U	1.1	1.1 U	1.1	1.1 U	1.1	1.1 U	1.1	0.95 U	0.95	1.1 U	1.1	1.1 U	1.1	1.2 U	1.2

Notes:
RSLs - Regional Screening Levels
HWAD - Hawthorne Army Depot
MDL - Method Detection Limit
BGS - Below Ground Surface
mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
N/A- Not Applicable or Not Established
Bold - results above method detection limit

Laboratory Qualifiers
J - Estimated: The analyze was positively identified; the quantitation is an estimation
D - Sample result required a dilution
Q - One or more quality control criteria failed.
U - Undetected at the Limit of Detection.

TABLE E-2
ALL SOILSAMPLE RESULTS
SWMU KO3F
HAWTHORNE ARMY DEPOT, NEVADA

				K03F-04								K03F-05					
				K03F-04-S-8-10		K03F-04-S-18-20		K03F-04-S-28-30		K03F-04-S-28-30-Z		K03F-05-S-8-10		K03F-05-S-14-16		K03F-05-S-28-30	
				4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011		4/14/2011	
				8-10 ft bgs		18-20 ft bgs		28-30 ft bgs		Duplicate		8-10 ft bgs		14-16 ft bgs		28-30 ft bgs	
				Test America		Test America		Test America		Test America		Test America		Test America		Test America	
Analyte	CAS Number	Method	Units	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL	Result	MDL
Diesel Range Organics [C10-C28]																	
Diesel Range Organics [C10-C28]	N/A	8015B	mg/Kg	**3.1** J M	0.7	**2.0** J M	0.66	**5.8 M**	0.75	**9.8 M**	0.73	**270 M**	0.71	**2,900** D M	3.4	2.1 U	0.7
Volatile Organic Compounds																	
1,1,1,2-Tetrachloroethane	630-20-6	8260C	ug/Kg	1.3 U	0.72	1.1 U	0.61	1.3 U	0.72	1.2 U	0.69	1.0 U	0.57	0.99 U	0.55	1.1 U	0.62
1,1,1-Trichloroethane	71-55-6	8260C	ug/Kg	1.3 U	0.66	1.1 U	0.57	1.3 U	0.67	1.2 U	0.64	1.0 U	0.53	0.99 U	0.52	1.1 U	0.58
1,1,2,2-Tetrachloroethane	79-34-5	8260C	ug/Kg	1.3 U	0.78	1.1 U	0.67	1.3 U	0.78	1.2 U	0.75	1.0 U	0.62	0.99 U	0.6	1.1 U	0.68
1,1,2-Trichloroethane	79-00-5	8260C	ug/Kg	1.3 U	1.1	1.1 U	0.96	1.3 U	1.1	1.2 U	1.1	1.0 U	0.9	0.99 U	0.87	1.1 U	0.98
1,1-Dichloroethane	75-34-3	8260C	ug/Kg	1.3 U	0.27	1.1 U	0.23	1.3 U	0.27	1.2 U	0.26	1.0 U	0.22	0.99 U	0.21	1.1 U	0.23
1,1-Dichloroethene	75-35-4	8260C	ug/Kg	1.3 U	0.75	1.1 U	0.64	1.3 U	0.75	1.2 U	0.73	1.0 U	0.6	0.99 U	0.58	1.1 U	0.65
1,2,3-Trichlorobenzene	87-61-6	8260C	ug/Kg	1.3 U	0.96	1.1 U	0.82	1.3 U	0.96	1.2 U	0.92	1.0 U	0.77	0.99 U	0.74	1.1 U	0.83
1,2,3-Trichloropropane	96-18-4	8260C	ug/Kg	1.3 U	1	1.1 U	0.88	1.3 U	1	1.2 U	1	1.0 U	0.83	0.99 U	0.8	1.1 U	0.9
1,2,4-Trichlorobenzene	120-82-1	8260C	ug/Kg	1.3 U	0.93	1.1 U	0.8	1.3 U	0.93	1.2 U	0.9	1.0 U	0.75	0.99 U	0.72	1.1 U	0.81
1,2,4-Trimethylbenzene	95-63-6	8260C	ug/Kg	1.3 U	0.74	1.1 U	0.63	1.3 U	0.74	1.2 U	0.71	1.0 U	0.59	0.99 U	0.57	1.1 U	0.64
1,2-Dibromo-3-Chloropropane	96-12-8	8260C	ug/Kg	1.3 U	0.77	1.1 U	0.66	1.3 U	0.77	1.2 U	0.74	1.0 U	0.61	0.99 U	0.59	1.1 U	0.67
1,2-Dichlorobenzene	95-50-1	8260C	ug/Kg	1.3 U	0.57	1.1 U	0.49	1.3 U	0.58	1.2 U	0.55	1.0 U	0.46	0.99 U	0.45	1.1 U	0.5
1,2-Dichloroethane	107-06-2	8260C	ug/Kg	1.3 U	0.89	1.1 U	0.76	1.3 U	0.9	1.2 U	0.86	1.0 U	0.72	0.99 U	0.69	1.1 U	0.78
1,2-Dichloropropane	78-87-5	8260C	ug/Kg	1.3 U	0.7	1.1 U	0.6	1.3 U	0.7	1.2 U	0.68	1.0 U	0.56	0.99 U	0.54	1.1 U	0.61
1,3,5-Trimethylbenzene	108-67-8	8260C	ug/Kg	1.3 U	0.73	1.1 U	0.62	1.3 U	0.73	1.2 U	0.7	1.0 U	0.58	0.99 U	0.56	1.1 U	0.63
1,3-Dichloropropane	142-28-9	8260C	ug/Kg	1.3 U	0.65	1.1 U	0.56	1.3 U	0.65	1.2 U	0.63	1.0 U	0.52	0.99 U	0.51	1.1 U	0.57
1,4-Dichlorobenzene	106-46-7	8260C	ug/Kg	1.3 U	1	1.1 U	0.85	1.3 U	1	1.2 U	0.96	1.0 U	0.8	0.99 U	0.77	1.1 U	0.86
1,4-Dioxane	123-91-1	8260C	ug/Kg	100 U	72	87 U	61	100 U	72	99 U	69	82 U	57	79 U	56	89 U	62
2-Butanone (MEK)	78-93-3	8260C	ug/Kg	13 U	2.3	**2.3** J	2	13 U	2.3	12 U	2.3	10 U	1.9	**2.6** J	1.8	11 U	2
2-Chloro-1,3-butadiene	126-99-8	8260C	ug/Kg	1.0 U	0.66	0.87 U	0.57	1.0 U	0.67	0.99 U	0.64	0.82 U	0.53	0.79 U	0.52	0.89 U	0.58
2-Chlorotoluene	95-49-8	8260C	ug/Kg	1.3 U	0.65	1.1 U	0.56	1.3 U	0.65	1.2 U	0.63	1.0 U	0.52	0.99 U	0.51	1.1 U	0.57
2-Hexanone	591-78-6	8260C	ug/Kg	13 U	6.2	11 U	5.3	13 U	6.3	12 U	6	10 U	5	9.9 U	4.8	11 U	5.4
4-Chlorotoluene	106-43-4	8260C	ug/Kg	1.3 U	1	1.1 U	0.85	1.3 U	1	1.2 U	0.96	1.0 U	0.8	0.99 U	0.77	1.1 U	0.86
Acetone	67-64-1	8260C	ug/Kg	13 U	6.9	11 U	5.9	8 J	6.9	12 U	6.6	10 U	5.5	6.4 J	5.3	6.0 J	6
Acetonitrile	75-05-8	8260C	ug/Kg	41 U	3.5	35 U	3	41 U	3.5	39 U	3.4	33 U	2.8	32 U	2.7	35 U	3
Acrolein	107-02-8	8260C	ug/Kg	10 U	8.9	8.7 U	7.6	10 U	9	9.9 U	8.6	8.2 U	7.2	7.9 U	6.9	8.9 U	7.8
Acrylonitrile	107-13-1	8260C	ug/Kg	10 U	6.2	8.7 U	5.3	10 U	6.2	9.9 U	5.9	8.2 U	4.9	7.9 U	4.8	8.9 U	5.3
Benzene	71-43-2	8260C	ug/Kg	1.3 U	0.6	1.1 U	0.51	1.3 U	0.6	1.2 U	0.58	1.0 U	0.48	0.99 U	0.47	1.1 U	0.52
Bromobenzene	108-86-1	8260C	ug/Kg	1.3 U	0.63	1.1 U	0.54	1.3 U	0.63	1.2 U	0.6	1.0 U	0.5	0.99 U	0.49	1.1 U	0.54
Bromoform	75-25-2	8260C	ug/Kg	1.3 U	0.29	1.1 U	0.25	1.3 U	0.29	1.2 U	0.28	1.0 U	0.24	0.99 U	0.23	1.1 U	0.26
Bromomethane	74-83-9	8260C	ug/Kg	1.3 U	0.64	1.1 U	0.55	1.3 U	0.64	1.2 U	0.62	1.0 U	0.51	0.99 U	0.5	1.1 U	0.55
Carbon disulfide	75-15-0	8260C	ug/Kg	1.3 U	0.54	1.1 U	0.46	1.3 U	0.54	1.2 U	0.52	1.0 U	0.43	0.99 U Q	0.42	1.1 U	0.47
Carbon tetrachloride	56-23-5	8260C	ug/Kg	1.3 U	0.8	1.1 U	0.69	1.3 U	0.81	1.2 U	0.78	1.0 U	0.65	0.99 U	0.62	1.1 U	0.7
Chlorobenzene	108-90-7	8260C	ug/Kg	1.3 U	0.69	1.1 U	0.59	1.3 U	0.69	1.2 U	0.66	1.0 U	0.55	0.99 U	0.53	1.1 U	0.6
Chlorobromomethane	74-97-5	8260C	ug/Kg	1.3 U	0.38	1.1 U	0.33	1.3 U	0.38	1.2 U	0.37	1.0 U	0.31	0.99 U	0.3	1.1 U	0.33
Chloroform	67-66-3	8260C	ug/Kg	1.3 U	0.37	1.1 U	0.32	1.3 U	0.37	1.2 U	0.36	1.0 U	0.3	0.99 U	0.29	1.1 U	0.32
Chloromethane	74-87-3	8260C	ug/Kg	1.3 U	0.98	1.1 U	0.84	1.3 U	0.98	1.2 U	0.95	1.0 U	0.79	0.99 U	0.76	1.1 U	0.85
cis-1,2-Dichloroethene	156-59-2	8260C	ug/Kg	1.3 U	0.72	1.1 U	0.61	1.3 U	0.72	1.2 U	0.69	1.0 U	0.57	0.99 U	0.55	1.1 U	0.62
cis-1,3-Dichloropropene	10061-01-5	8260C	ug/Kg	2.6 U	1.6	2.2 U	1.4	2.6 U	1.6	2.5 U	1.6	2.0 U	1.3	2.0 U	1.3	2.2 U	1.4
cis-1,4-Dichloro-2-butene	1476-11-5	8260C	ug/Kg	4.1 U	1.3	3.5 U	1.1	4.1 U	1.3	3.9 U	1.3	3.3 U	1.1	3.2 U	1	3.5 U	1.2
Cyclohexane	110-82-7	8260C	ug/Kg	2.0 U	0.51	1.7 U	0.44	2.0 U	0.51	2.0 U	0.49	1.6 U	0.41	1.6 U	0.4	1.8 U	0.44
Cyclohexanone	108-94-1	8260C	ug/Kg	82 U	69	70 U	59	82 U	69	79 U	66	66 U	55	63 U	53	71 U	60
Dibromomethane	74-95-3	8260C	ug/Kg	1.3 U	1.1	1.1 U	0.92	1.3 U	1.1	1.2 U	1	1.0 U	0.86	0.99 U	0.83	1.1 U	0.93
Dichlorobromomethane	75-27-4	8260C	ug/Kg	1.3 U	0.28	1.1 U	0.24	1.3 U	0.28	1.2 U	0.27	1.0 U	0.23	0.99 U	0.22	1.1 U	0.24
Dichlorodifluoromethane	75-71-8	8260C	ug/Kg	1.3 U	0.66	1.1 U	0.57	1.3 U	0.67	1.2 U	0.64	1.0 U	0.53	0.99 U	0.52	1.1 U	0.58
Ethyl methacrylate	97-63-2	8260C	ug/Kg	1.0 U	0.77	0.87 U	0.66	1.0 U	0.77	0.99 U	0.74	0.82 U	0.61	0.79 U	0.59	0.89 U	0.67
Ethylbenzene	100-41-4	8260C	ug/Kg	1.3 U	0.86	1.1 U	0.73	1.3 U	0.86	1.2 U	0.83	1.0 U	0.69	0.99 U	0.66	1.1 U	0.74
Hexachlorobutadiene	87-68-3	8260C	ug/Kg	1.3 U	0.7	1.1 U	0.6	1.3 U	0.7	1.2 U	0.68	1.0 U	0.56	0.99 U	0.54	1.1 U	0.61
Methyl acetate	79-20-9	8260C	ug/Kg	5.1 U	3.5	4.4 U	3	5.1 U	3.5	4.9 U	3.4	4.1 U	2.8	4.0 U	2.7	4.4 U	3
Methyl methacrylate	80-62-6	8260C	ug/Kg	2.0 U	1.3	1.7 U	1.1	2.0 U	1.3	2.0 U	1.3	1.6 U	1.1	1.6 U	1	1.8 U	1.1
Methyl tert-butyl ether	1634-04-4	8260C	ug/Kg	1.3 U	0.43	1.1 U	0.37	1.3 U	0.43	1.2 U	0.42	1.0 U	0.35	0.99 U	0.34	1.1 U	0.38
Methylene Chloride	75-09-2	8260C	ug/Kg	5.6 J B	0.96	6.4 B	0.82	6.4 B	0.96	5.4 J B	0.92	4.9 J B	0.77	4.7 J B	0.74	4.7 J B	0.83
m-Xylene & p-Xylene	179601-23-1	8260C	ug/Kg	2.6 U	1.3	2.2 U	1.1	2.6 U	1.3	2.5 U	1.3	2.0 U	1.1	2.0 U	1	2.2 U J	1.2
Naphthalene	91-20-3	8260C	ug/Kg	1.3 U	0.8	1.1 U	0.69	1.3 U	0.81	1.2 U	0.78	1.0 U	0.65	0.99 U	0.62	1.1 U	0.7
N-Propylbenzene	103-65-1	8260C	ug/Kg	1.3 U	0.74	1.1 U	0.63	1.3 U	0.74	1.2 U	0.71	1.0 U	0.59	0.99 U	0.57	1.1 U	0.64
o-Xylene	95-47-6	8260C	ug/Kg	1.3 U	0.78	1.1 U	0.67	1.3 U	0.78	1.2 U	0.75	1.0 U	0.62	0.99 U	0.6	1.1 U	0.68
Styrene	100-42-5	8260C	ug/Kg	1.3 U	0.8	1.1 U	0.69	1.3 U	0.81	1.2 U	0.78	1.0 U	0.65	0.99 U	0.62	1.1 U	0.7
Tetrachloroethene	127-18-4	8260C	ug/Kg	1.3 U	0.75	1.1 U	0.64	1.3 U	0.75	1.2 U	0.73	1.0 U	0.6	0.99 U	0.58	1.1 U	0.65
Tetrahydrofuran	109-99-9	8260C	ug/Kg	8.2 U	4.1	7.0 U	3.5	8.2 U	4.1	7.9 U	3.9	6.6 U	3.3	6.3 U	3.2	7.1 U	3.5
Toluene	108-88-3	8260C	ug/Kg	1.3 U	0.88	1.1 U	0.75	1.3 U	0.88	1.2 U	0.85	1.0 U	0.71	0.99 U	0.68	1.1 U	0.77
trans-1,2-Dichloroethene	156-60-5	8260C	ug/Kg	1.3 U	0.5	1.1 U	0.43	1.3 U	0.5	1.2 U	0.48	1.0 U	0.4	0.99 U	0.39	1.1 U	0.43
trans-1,3-Dichloropropene	10061-02-6	8260C	ug/Kg	1.3 U	0.86	1.1 U	0.73	1.3 U	0.86	1.2 U	0.83	1.0 U	0.69	0.99 U	0.66	1.1 U	0.74
trans-1,4-Dichloro-2-butene	110-57-6	8260C	ug/Kg	2.0 U	0.86	1.7 U	0.73	2.0 U	0.86	2.0 U	0.83	1.6 U	0.69	1.6 U	0.66	1.8 U	0.74
Trichloroethene	79-01-6	8260C	ug/Kg	1.3 U	0.29	1.1 U	0.25	1.3 U	0.29	1.2 U	0.28	1.0 U	0.24	0.99 U	0.23	1.1 U J	0.26
Trichlorofluoromethane	75-69-4	8260C	ug/Kg	2.6 U	1.3	2.2 U	1.1	2.6 U	1.3	2.5 U	1.3	2.0 U	1.1	2.0 U	1	2.2 U	1.2
Vinyl acetate	108-05-4	8260C	ug/Kg	13 U	1.4	11 U	1.2	13 U	1.4	12 U	1.3	10 U	1.1	9.9 U	1.1	11 U	1.2
Vinyl chloride	75-01-4	8260C	ug/Kg	2.6 U	1.7	2.2 U	1.5	2.6 U	1.7	2.5 U	1.7	2.0 U	1.4	2.0 U	1.3	2.2 U	1.5
Xylenes, Total	1330-20-7	8260C	ug/Kg	1.3 U	1.3	1.1 U	1.1	1.3 U	1.3	1.2 U	1.2	1.0 U	1	0.99 U	0.99	1.1 U	1.1

Notes:
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mg/kg - milligram per kilogram
ug/kg - microgram per kilogram
N/A- Not Applicable or Not Established
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Laboratory Qualifiers
J - Estimated: The analyze was positively identified; the quantitation is an estimation
D - Sample result required a dilution
Q - One or more quality control criteria failed.
U - Undetected at the Limit of Detection.

5.0 FATE AND TRANSPORT

The site conceptual model for SWMU K03F is based on a release of fuel oil through cracks or filling of former Tank 2 followed by transport of contaminants to the soil. When the fuel leaks from a storage tank, gravitational forces act to draw the fuel downward. While fuel is migrating downward other forces act to retain the fuel, which is either adsorbed to the soil particles or trapped in the soil pore space.

Based on data collected during the limited site investigation at SWMU K03F, TPH-d contamination beneath the former Tank 2 UST basin is limited vertically to a depth of approximately 20 feet bgs and horizontally to a width of approximately 15 to 20 feet.

The contaminate pathway at K03F is through dissolution of residual TPH-d in the soil by infiltration of water. Due to low rainfall in the Hawthorne area (<5 inches per year) and the approximate depth of groundwater is 80 to 90 feet bgs, it is unlikely that consequential amounts of water might move through the soil and leach contamination to groundwater. Additionally, contaminant Fate and Transportation modeling completed at similar sites with similar soils and contamination (SWMU I07 and SWMU I08) supports TPH-d's limited migration potential, **Table 5-1.**

Table 5-1 COPC Modeled Transport Depth Comparison

SWMU	COPC	Highest COPC Concentration	COPC Depth in Feet bgs	Modeled Transport Depth in feet bgs
I07*	TPH-d	11,000 mg/kg	31-50	72
I08**	TPH-e (includes diesel and motor oil)	19,000 mg/kg	53	55
K03F	TPH-d	8,200 mg/kg	20	

* *Chung/Geofon, 2004. Final Remediation Report, Solid Waste Management Unit B29 and I07, Hawthorne Army Depot, Hawthorne, Nevada, February 2004.*

** *Secor, 2004. Final Remedial Investigation Report Additional Soils Remedial Investigation SWMU I08, Building 70 Pit/Landfill Hawthorne Army Depot, Hawthorne, Nevada. April 2004.*

5.1 Tier II SSTL for TPH-D

A Tier II Site Specific Target Level (SSTL) for TPH-d at Site K03F was developed to assist in evaluating the potential risk posed by petroleum contaminated soils present at the site. A similar method for determining a SSTL for TPH-d was utilized at site K03a, b, d (Plexus, 2007). NAC 445A.22705, allows for the application of the ASTM Standard E-1739-95 Risk Based Corrective Action (RBCA) to develop Tier II SSTLs in setting site-specific risk criteria. Because diesel contains relatively little of the more mobile and more toxic volatile organic compounds, the primary concern is on the prevention of free product on groundwater. NAC 445A.22735 requires that free product be reduced to less than 0.5 inch. Therefore the TPH-d SSTL was developed based on the prevention of free product migration to groundwater.

5.1.1 Background

Soil has the ability to retain non-mobile liquids in smaller and discontinuous pore spaces. The amount that a soil can hold is called its residual saturation. Once residual saturation has been exceeded, the liquid can migrate. Diesel exists as a light non-aqueous phased liquid (LNAPL) and is held in retention along with water. The American Petroleum Institute (API) published a summary of empirical models and compared the results with experimentally measured residual saturated values (API, 2000). The results of these comparisons were used to develop

screening level criteria for specific soils and products. The evaluation of the TPH-d SSTL will consider both the empirical results and the recommended values provided by the API.

5.1.2 Empirical Models

The API utilized three empirical models in developing a method for conservative screening levels. These included 1) a zero water method; 2) a field moisture capacity method (both developed by Hoag and Marley, 1986); and 3) a method developed by Zytner (1993). The Hoag and Marley methods are both based on average soil particle diameter and that residual retention is related to available surface area. In the zero water method, all the pore spaces are available for the LNAPL. In the field moisture capacity method some of the available pore space is occupied by water. Therefore, field conditions would be expected to range somewhere between the two methods. The Zytner method is based on observed relationships of residual saturation and the ratio of product density over soil bulk density. Equations are shown below and the results empirical models are summarized in **Table 5-2**.

The zero water method is as follows:

$$\text{EQ1)}\ Cres = (0.01154 \times dp + 0.000652) \times \frac{6}{2.65 \times dp} \times 10^6\ mg/kg$$

Where: dp = average grain diameter (in cm). Site soils are fine to medium sands. Average grain size is assumed to be 0.01 to 0.05 cm (recommended by API)

The field moisture capacity method is as follows:

$$\text{EQ2)}\ Cres = (0.01136 \times dp + 0.000131) \times \frac{6}{2.65 \times dp} \times 10^6\ mg/kg$$

The Zytner method is as follows

$$EQ3)\ Cres = \left(1.05 \times {}^{\rho o}/_{\rho s} \times \theta t - 0.15\right) \times 10^6\ mg/kg$$

Where: θt= total porosity, use 0.41, This is the average of fine to medium sand by Todd (1980). It is also the value recommended by API.

ρo= product density, use 0.8, this is the value recommended by API for diesel fuel (middle distillate).

ρs= soil dry bulk density (1.56 Calculated from porosity).

Table 5-2 Summary of Empirical Residual Saturation Results (Diesel)

Average grain diameter (cm)	Residual Saturation (mg/kg)		
	0.05	0.01	Average
Zero Water	56,000	174,000	115,000
Field Moisture Capacity	32,000	55,000	43,000
Zytner	71,000		NA
Average of all	--		77,000

Notes:
mg/kg - milligrams per kilogram
cm - centimeter

API Recommended Values

The API defined residual saturation to be as follows:

$$\text{EQ4)}\ Cres = Sr \times \theta t \times {}^{\rho o}/_{\rho s} \times 10^6\ mg/kg$$

Where: Sr= soil retention fraction (see text below)

θt= total porosity, use 0.41, this is the average of fine to medium sand by Todd (1980). It is also the value recommended by API.

ρo= product density, use 0.8, this is the value recommended by API for diesel fuel (middle distillate)

ρs= soil dry bulk density (1.56 Calculated from porosity)

The value for Sr was determined by the API by statistical evaluation of the above methods (plus the Zytner method) against measured residual saturation concentrations. This evaluation found that the median trend (50% confidence) was for diesel in fine to medium grained sand to have a Sr value of 0.19. Additionally, the value of Sr was 0.05 for diesel in fine to medium grained sands at confidence level of 90%. At a 90% confidence there is only a 10% probability of a measured value exceeding the calculated value. Results of the API values used in equation 4 are provided in **Table 5-3.**

Table 5-3 Summary of API Residual Saturation Results

Confidence level	Residual Saturation (mg/kg)
50%	40,000
90%	11,000

Notes
% - percent
mg/kg - milligrams per kilogram

5.1.3 Tier II SSTL Summary

Results of the empirical models indicated a residual saturated value of between 32,000 and 174,000 mg/kg. The average of the three methods is higher than the median API value. Therefore, applying the 90% confidence value of 11,000 mg/kg would provide an acceptable conservative margin. Groundwater contacting fine- to medium-grained soils with a TPH-d concentration less than 11,000 mg/kg would not likely result in free product.

Only one soil sample was found to exceed the 90% confidence level at a TPH-d concentration of 25,930 mg/kg but it was far below the median (50%) value for residual saturation. The sample was collected in 1993 from a depth of 17 feet bgs and groundwater is at a depth of approximately 80-90 feet bgs. Furthermore, in 2011 the highest TPH-d concentration detected was 8,200 mg/kg at 7.5-9.5 feet bgs, which is below the 90% confidence level. Given the depth of the soil sample above groundwater, if mobile product exists at this depth, the concentration would continue to decrease with vertical migration until it was immobilized.