

# FUEL STORAGE TANK REMOVAL ACTION REPORT

Environmental Investigation at the Formerly Used Defense Site (FUDS)  
at the Benicia Arsenal, Benicia, California

FUDS Number: J09CA075600

## FINAL

Prepared for:

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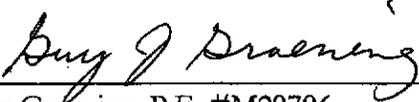
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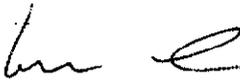
FUEL STORAGE TANK REMOVAL ACTION REPORT  
BENICIA ARSENAL, BENICIA, CALIFORNIA

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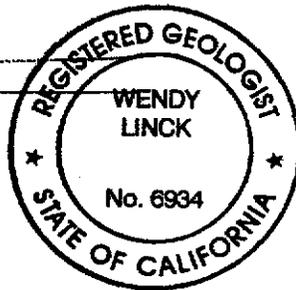
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## LIST OF ACRONYMS AND ABBREVIATIONS

Arsenal	Benicia Arsenal
AST	aboveground storage tank
BC	Brown and Caldwell
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COI	chemicals of interest
CPT	cone penetrometer testing
DCE	dichloroethene
DoD	United States Department of Defense
ECI	Ecology Control Industries, Inc.
EMAX	EMAX Laboratories, Inc.
EMLL	electromagnetic line locating
EPA	United States Environmental Protection Agency
ESL	Environmental Screening Levels
FA/BC	Forsgren Associates/Brown and Caldwell
FAR	further action recommended
FUDS	Formerly Used Defense Site
GPR	ground penetrating radar
GSA	General Services Administration
ICP	inductively coupled plasma
IDW	investigative derived waste
MD	metal detection
mg/L	milligrams per liter
MtBE	methyl tertiary-butyl ether
NDAI	no DoD action indicated
NORCAL	NORCAL Geophysical Consultants
PA	Preliminary Assessment
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PPE	personal protective equipment

**LIST OF ACRONYMS AND ABBREVIATIONS (continued)**

QC	quality control
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QCSR	Quality Control Summary Report
RA	Removal Action
RCRA	Resource Conservation and Recovery Act
ROE	right-of-entry
RWQCB	California Regional Water Quality Control Board, San Francisco Bay Region
SI	Site Inspection
SOP	Standard Operating Procedure
SVOC	semivolatile organic compound
TCE	trichloroethene
TEG	Transglobal Environmental Geochemistry Laboratory -Sacramento
TPH	total petroleum hydrocarbons
TPH-d	total petroleum hydrocarbons-diesel fuel range organics
TPH-g	total petroleum hydrocarbons-gasoline range organics
TPH-mo	total petroleum hydrocarbons-motor oil range organics
µg/L	micrograms per liter
USACE	United States Army Corps of Engineers
UST	underground storage tank
VOC	volatile organic compound

## EXECUTIVE SUMMARY

This Fuel Storage Tank Removal Action (RA) Report presents data from an environmental investigation conducted at nine of the 12 potential fuel storage tank sites between May 2004 and August 2004. This work was performed at the former Benicia Arsenal (Arsenal), a formerly used defense site (FUDS), located in Benicia, California. The work was performed on behalf of and with oversight by the United States Army Corps of Engineers (USACE), Sacramento District. The 12 suspected fuel storage tank sites were identified from historical information or landowner information as sites with tanks, and consist of two aboveground storage tanks (ASTs) and ten underground storage tanks (USTs) that had potentially not been removed.

### Summary of Field Activities

The following activities were completed during this project:

- Two potential AST sites were identified: Building 88 and Building 89. Site visits and visual surveys were performed at these buildings. The former ASTs no longer exist at either building. Groundwater samples were collected downgradient of these buildings as part of the Expanded Site Inspection (Brown and Caldwell [BC], 2005).
- Ten potential UST sites were identified: Building CL2, Building 27, Building 31, Building 42, Building 45, service station west of Building 45, Building 46(B), Building 47, Building 71, and Building 161.
- Right-of-entry (ROE) agreements were arranged with the current property owners for the Building 31, Building 42, service station west of Building 45, Building 46(B), Building 47, Building 71, Building 88, Building 89, and Building 161 sites. ROE was not granted by the landowner to USACE to search for the suspected USTs at Building 27 or CL2, or for the removal of a suspected UST at Building 161. Right of entry was granted at Building 45, but scaffolding located in the area of the suspected UST would not be removed by the landowner. Because no maps show the exact location of the UST, geophysics was to be used to search for it, but it was impossible because of the magnetic interference the scaffolding would produce. Therefore, no further investigation was possible.
- Geophysical surveys were performed at Buildings 31, 42, service station west of Building 45, 46(B), 47, 71 and 161.
- Geophysical anomalies the size and shape of USTs were identified at the Building 31, service station west of Building 45, Building 47 and Building 161 sites. At Buildings 31 and 47, test pits were excavated and tanks were removed. At the service station west of Building 45, it was concluded the anomaly was not related to a UST. No anomalies were identified at Buildings 42, 46(B) or 71. The ROE agreement at Building 161 was not able to be renegotiated to include tank removal activities. Therefore, the tank was not removed.
- After removal of the USTs, soil and/or groundwater samples were collected and analyzed to evaluate the presence or absence of DoD related fuel contamination.

## Recommendations

Additional investigations are warranted to identify and/or remove USTs at Buildings 27, 45, CL2 and 161. Investigations at these locations were not performed because ROE agreements could not be reached. Until USACE is granted access to these properties, no further USACE actions can be conducted at these sites.

Suspected DoD sources appear to have impacted soil on the north and northeast sides of the former UST at Building 31; however, the existing building and planter box prevent any overexcavation. Groundwater is impacted with fuels and solvents. The solvents are related to other sites in close proximity to Building 31. An evaluation of risk is recommended for the residual fuels in soil and the solvents in groundwater at this tank site.

The UST at Building 47 has not resulted in contamination and does not warrant additional investigation. In addition, geophysical and visual investigations determined that there were no USTs or ASTs remaining at Building 46(B), Building 71, Building 88, Building 89, Building 42, or the service station west of Building 45. No further DoD action is indicated at these locations.

## 1.0 INTRODUCTION, HISTORY AND BACKGROUND

The Benicia Arsenal (Arsenal) is located in Benicia, California, about 25 miles northeast of San Francisco (Figure 1-1). The Arsenal was created in 1849 with the transfer of 345 acres of land by the founders of the City of Benicia (Jacobs, 1999). Between 1849 and 1958, the facility grew by land acquisition to a total of 2,728 acres, of which 190 acres were located in Carquinez Strait to the south and Suisun Bay to the northeast. During its active life, this facility served the United States Army as a principal depot for ordnance and ordnance stores, issuance, and the manufacture and testing of small arms. The Arsenal was declared excess by the government in 1963. Deactivation and closure of the facility were completed in 1964 (Jacobs, 1999).

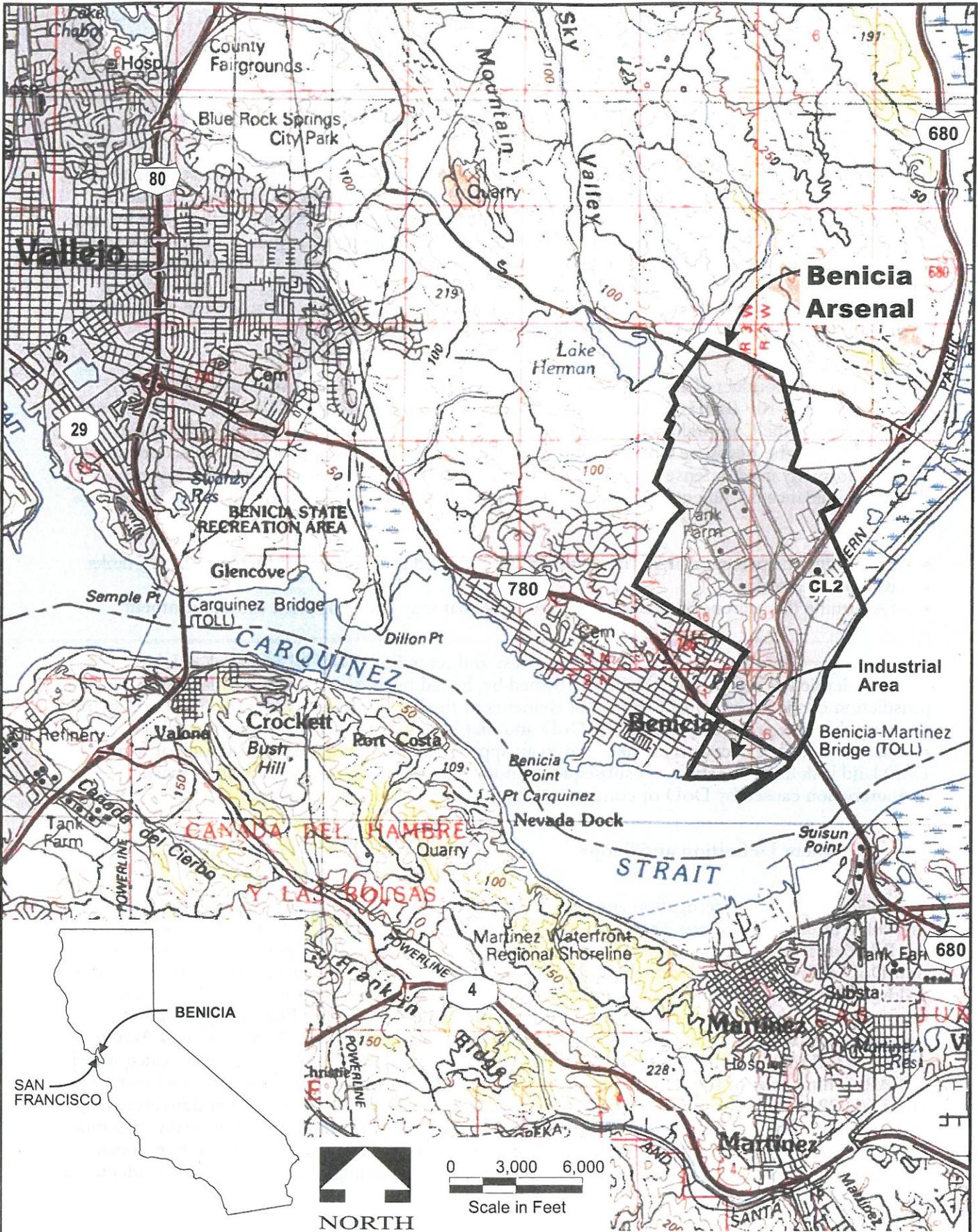
This project was conducted at the former Arsenal under General Services Administration (GSA) Contract No. GS-10F-0101L, Veterans Administration Purchase Order 674-V40113 to comply with requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation Recovery Act (RCRA), as appropriate. In accordance with the formerly used defense sites (FUDS) program goals and U.S. Army Corps of Engineers (USACE) guidance documents, this Fuel Storage Tank Removal Action Report (RA) was conducted to:

- Determine the presence or absence of previously owned Department of Defense (DoD) tanks.
- Remove the tanks.
- Determine the presence or absence of chemicals that may have impacted the environment.

FUDS program funding can only be used to assess and remediate DoD liability at eligible property, which is defined as real property formerly owned by, leased by, possessed by, or otherwise under the jurisdiction of the Secretary of Defense or elements of the U.S. military. Under the FUDS program, property that was previously utilized by DoD and that has no "beneficial use" history will be characterized and, if necessary, remediated to an appropriate standard. "Beneficial use" of former DoD land is defined as activity by subsequent landowners or lessors that would either mask contamination caused by DoD or continue contamination in the same manner.

### 1.1 Problem Definition and Scope

The fuel storage tank investigation and removal activities were based on the project approach presented in the Fuel Storage Tank Removal Action Plan (RA Plan) (BC, 2004). The foundation of the RA Plan was a Preliminary Assessment (PA) and subsequent research performed to determine if past DoD activities warrant further environmental investigation (Forsgren Associates/Brown and Caldwell [FA/BC], 2004a). The PA addressed DoD uses of this facility prior to its closure and decommissioning in 1964. Supplemental research performed for the RA Plan changed the recommendation of three sites from "Further Action Recommended" (FAR) to No DoD Action Indicated (NDAI). Of the 389 sites evaluated, 327 were considered NDAI and 62 were categorized as FAR. Thirty-four of the 62 sites have records indicating the possibility of up to 42 fuel storage tanks. At 22 of these locations, the fuel storage tanks have already been removed and investigated, or were never installed. The remaining ten sites were the subject of this RA. Additionally, two more sites were investigated after the landowner reported potential UST locations. One of these locations was identified in the work plan as the service station west of Building 45 and the other was identified as Building 42.



PROJECT 25952-007	DATE 5-17-05	TITLE Former Benicia Arsenal, Benicia, California Fuel Storage Tank RA Report Arsenal Location Map	FIGURE 1-1
<b>BROWN AND CALDWELL</b> 2701 Prospect Park Drive Rancho Cordova, CA 95670 (916) 444-0123 (916) 635-8805 fax			

The overall objectives of this RA include the following:

- 1) Locate aboveground storage tanks (ASTs).
- 2) Locate underground storage tanks (USTs) using geophysical techniques.
- 3) Confirm the location of the USTs and associated piping by pot-holing.
- 4) Identify DoD-related contamination from leakage from the fuel storage tanks and associated piping.
- 5) Remove the fuel storage tanks and associated piping.
- 6) Restore each site.
- 7) Delineate the residual contamination, if possible.

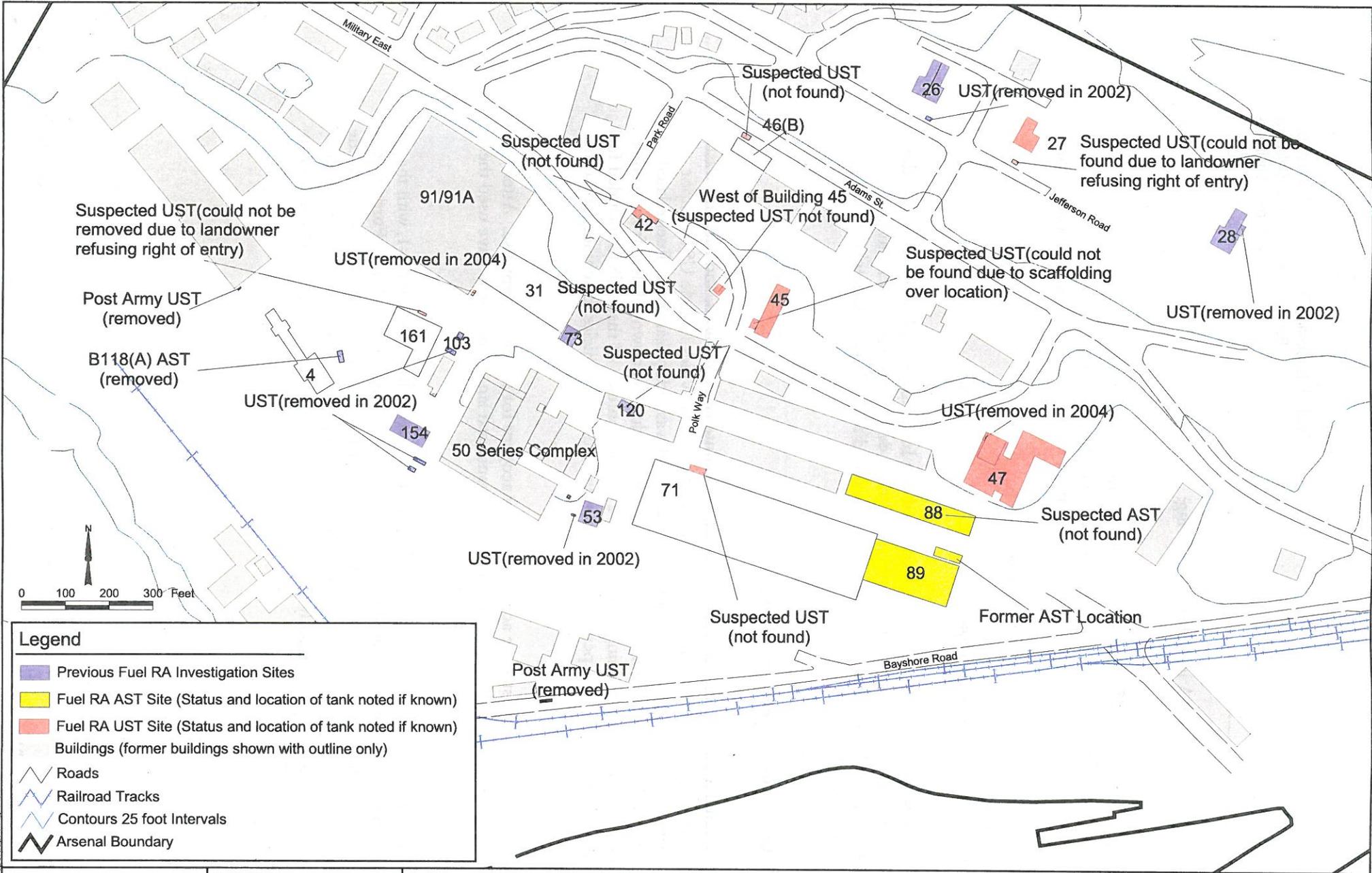
The RA activities were coordinated with the Expanded Site Investigation (SI) field effort, conducted in April 2004 through May 2004. A brief summary of those delineation efforts is included in this report as they apply to the RA sites. Details on the Expanded SI field effort are included in the Expanded SI Report (BC, 2005).

## 1.2 Site Locations and Historical Use

The Army operated industrial and manufacturing shops, maintenance facilities, and fuel and waste storage areas. Potential sources of chemical releases from these activities include USTs, vapor degreasers, maintenance pits, degreasing tanks and suspected waste disposal areas. Fuel-related petroleum hydrocarbons were expected at the former Arsenal due to known releases from former USTs and possibly from the remaining suspected USTs. The contents of these USTs included fuel oil, diesel fuel and gasoline. These petroleum products were used in vehicles, machinery and other equipment.

The above descriptions of fuel storage activities do not account for any post-Army use. After closure of the Arsenal, fuel storage tanks remained. Tenants and landowners may have used these tanks.

Information about each of the 12 potential fuel storage tank sites is listed in Table 1-1, with the DoD use, features and contents that are likely present based on its former DoD use. Further details and background information are provided in Appendix A. Eleven of the 12 sites are located in the industrial area of the Arsenal, as shown on Figure 1-2. The other RA site (CL2) is located on the eastern side of the Arsenal, approximately 1.5 miles north of the industrial area RA sites, as shown on Figure 1-1.



DATE: 5/18/05 PROJECT NO.: 125952-007



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SITE: Former Benicia Arsenal, Benicia, California

TITLE: Fuel Storage Tank RA Sites and Previous Investigation Sites in the Industrial Area

Figure 1-2

**Table 1-1. Fuel Storage Tank Sites Information**

Expanded SI	Area	Location	DoD Use	Number of Suspected USTs/ASTs	Installation date	Capacity (gallons)	Contents	Tank status	Summary
NO	I	Building 27	Captain's quarters	1 UST	1928	250	Heating oil	Unknown	Denied Right of Entry by landowner. Made multiple attempts to get ROE approval.
YES	I	Building 31	Dynamometer Room	1 UST	1942 (estimated)	1,000	Diesel	Located and removed during this RA	UST associated with a service pump along the east wall of Building 91/91a where it abuts Building 31. Service pump previously removed. This UST was part of a former fuel station that was later moved to Building 103 (across the street). The UST was located with geophysics and then confirmed by excavating.
NO	I	Building 42	Boiler Building	1 UST	Unknown	Unknown	Unknown	Not present	Landowner suspected UST was located near the former Boiler Building. Geophysical investigation performed in August, 2004 did locate one anomaly. However this anomaly is not believed to be a tank, and no other indications of a UST were found (revert pipes).
NO	I	Building 45	Enlisted Men's Barracks	1 UST	1929	400	Heating oil	Unknown	No investigation can be conducted due to the landowner's renovation of the building. Scaffolding is currently present in the area where the UST may be located. ROE was signed by landowner after several attempts by USACE, but the landowner was unwilling to move the scaffolding.
NO	I	West of Building 45	Service Station	1 UST	1943 (estimated)	Unknown	Unknown	Not present	This service station was identified by Buster Byerrum and reportedly used by civilian employees prior to 1946-47 when it was destroyed by fire. A geophysical investigation was performed and no anomalies were found that would indicate a UST.

**Table 1-1. Fuel Storage Tank Sites Information (continued)**

Expanded SI	Area	Location	DoD Use	Number of Suspected USTs/ASTs	Installation date	Capacity (gallons)	Contents	Tank status	Summary
NO	I	Building 46(B)	Administrative Office	1 AST/UST (type unknown)	1943 (estimated)	1,000	Unknown	Not present	<p>Included in the 1957 inventory documentation. The original Building 46(B) was moved and is the Benicia Yacht Club. The site has been renovated to accommodate a newer building after the original building was moved. A former Arsenal employee located the possible area of the fuel oil tank.</p> <p>Geophysics was used to scan the area where the former Arsenal employee located the UST. No anomalies were identified that indicated the presence of a UST. Therefore, the tank is assumed to have been removed, but it is still unknown what type of tank was once present.</p>
NO	I	Building 47	Administrative Office	1 UST	1929	400	Fuel oil	Located and removed during this RA	<p>A 400-gallon fuel oil tank was reportedly installed in December 1929 to accompany an enterprise rotary oil burner. The UST was located with geophysics and then confirmed by excavating.</p>
NO	I	Building 71	Artillery and Ordnance Materiel Storehouse	1 UST	Unknown	Unknown	Diesel oil	Not present	<p>A contract was awarded in 1950 to install new gas mains and convert the fuel oil furnace to natural gas. Jim Milburn, a former Arsenal employee, also recalled refueling a diesel UST.</p> <p>Geophysics was used to scan the area along the entire length of the northern side of former Building 71. No anomalies were identified that indicated the presence of a UST. In 2000, a geophysical survey was conducted to locate a suspected fillsite (Fillsite 1). Fillsite 1 encompassed the footprint of the former Building 71. The survey and subsequent trenching did not reveal a UST.</p>

**Table 1-1. Fuel Storage Tank Sites Information (continued)**

Expanded SI	Area	Location	DoD Use	Number of Suspected USTs/ASTs	Installation date	Capacity (gallons)	Contents	Tank status	Summary
NO	I	Building 88	Storehouse	1 AST	1942	Unknown	Fuel oil	Removed	Remnants (e.g. tank stand and piping) of the former AST were not found. As a result, the exact location is not known.
NO	I	Building 89	Storehouse	1 AST	1942	Unknown	Fuel oil	Removed. Approximate former location identified	There is an existing AST, and the approximate location of the former AST was identified. This AST is not the same AST used to fuel the fuel oil furnace installed by DoD.
NO	I	Building 161	Motor Cleaning Building	1 UST	1945 (estimated)	3,000	Kerosene	Located during this RA. Not Removed	Tank identified in a 1945 drawing. Tank fill pipe located, waste oil found in tank. Tank limits not determined due to interference of concrete surface and metal fence during geophysical survey. Right of Entry not granted by property owner for the removal of the UST during this RA.
YES	W	Building CL2	Boiler House	1 UST	1942	3,180	Fuel Oil	Potentially Removed	Request for demolition of the UST was approved in 1955, to be replaced with a 5,000-gallon AST. ROE was not granted to USACE to determine the status of the UST. A geophysical survey is recommended to determine the status of the UST. Until USACE is granted access to the property, no further USACE actions can be conducted at this site.

AST = aboveground storage tank  
 UST = Underground storage tank

### 1.3 Previous Investigations for Fuels

Most of the investigation activity to date for the presence or absence of fuels has been conducted in Area I, the Industrial Area. Only those investigations with suspected or confirmed fuel-related releases are discussed below. The locations of these previous investigation sites are shown on Figure 1-2.

#### 1.3.1 50 Series Complex

The 50 Series Complex is a collection of buildings within the central portion of Area I. The complex was originally constructed as three separate workshop buildings (Building 55, Building 56, and Building 57) between 1876 and 1884 (Photo 1). The remodeling of the original buildings occurred over many phases and included the addition of eight buildings and the removal and relocation of three buildings. Important features within the 50 Series Complex included a former smokestack/incinerator, degreasers, dip tanks, forges, firing ranges and USTs. Low-lying marshland areas to the west of the complex were filled in the 1920s during site development.

A site investigation was performed at the 50 Series Complex between 7 September 1999 and 28 September 1999 (FA/BC, 2004b). Identified chemicals of interest (COI) are attributed to historical DoD use at the complex. However, post-Arsenal use has also occurred in these buildings and evidence exists that some original structures (Parkerizing vat in Building 56, commonly referred to as Building 57A) had post-Army beneficial use.

Solvents and fuel-related hydrocarbons were identified in several of the areas investigated at the 50 Series Complex during the 1999 investigation. Metals were also identified and are expected in soil because these constituents generally occur naturally, but there were areas that indicated concentrations of various metals above typical ambient values. The predominant COIs in soil, soil gas and groundwater were chlorinated solvents. Fuel-related compounds and metals were also found in soil and groundwater. Some of the COIs detected were widespread and from multiple sources, while others may have been the result of an isolated source.

Methyl tertiary-butyl ether (MtBE), a fuel oxygenate used since the early 1970s (i.e., after Arsenal closure), was detected in three groundwater samples at concentrations of 0.59 micrograms per liter ( $\mu\text{g/L}$ ), 0.52  $\mu\text{g/L}$ , and 17  $\mu\text{g/L}$ . Because MtBE has been used as a gasoline additive only subsequent to Arsenal closure, these detections indicate a post-Army gasoline release. MtBE was



Photo 1. Looking southwest at Buildings 55, 56, and 57, from left to right. (Circa Early 1900s)

found in groundwater at Building 56 (commonly referred to as Building 57A) and southeast of Building 56A.

### 1.3.2 Area I Fuel Facilities

On behalf of and with oversight by the USACE, FA/BC conducted site investigations for the Area I Fuel Only Facilities in June 2000 (FA/BC, 2002). Area I fuel facilities included Building 15, Building 25, Building 26, Building 27, Building 28, Building 45, Building 46(B), Building 53, Building 54, Building 73, Building 103, Building 118(A), Building 152, Building 154, and Building 178. Due to budget constraints, only the most likely sites with fuel storage tanks were investigated in 2000. As many as 13 fuel storage tanks were suspected at these locations. The FA/BC investigation focused on confirming the existence of the tanks and associated piping, and verifying whether past DoD activities caused environmental impacts to soil or groundwater by petroleum hydrocarbons and/or lead. Both surface geophysical methods and pot-holing were used to identify the location of suspected USTs and associated piping.

Six of the 13 suspected tanks, all USTs, were identified during this investigation (one 1,000-gallon UST at Building 53, one 15,000-gallon UST at Building 103, one 7,000-gallon and one 10,000-gallon UST at Building 154, one 250-gallon UST at Building 26 and one 250-gallon UST at Building 28). In March 2002, Geofon, with guidance from the USACE, removed the six confirmed USTs (Geofon, 2003).

Building 53, Building 103, Building 154, and Building 118(A) had reported total petroleum hydrocarbon (TPH), polynuclear aromatic hydrocarbon (PAH), and/or lead levels above soil or groundwater Environmental Screening Levels (ESLs) established by the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB). These findings are discussed below in further detail. Results from these investigations, results from the RA, and results of further investigations performed during the Expanded SI are included in the Expanded SI report (BC, 2005). The ESLs are published in *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater (Interim Final)* (RWQCB, 2003). Information on the remaining fuel facility buildings at the former Arsenal can be found in more detail in the following reports:

- *Technical Memorandum for Area I Fuel Facilities* (FA/BC, 2000) [includes Buildings 53, 73, 103 and 154],
- *Technical Memorandum for Area I – Fuel Storage Facilities at Buildings 15, 25, 26, 27, 28, 45, 46(B), 54, 118(A), 152 and 178 for the Benicia Arsenal* (FA/BC, 2002), and
- *Revised Final Underground Storage Tank Removal Report* (Geofon, 2003).

**Building 53.** In 2002, two soil samples were collected from the northern and southern sidewalls of the UST excavation at Building 53. Both samples were collected at 5 feet below ground surface (bgs) at the soil/water interface. The northern soil sample reported TPH as diesel range organics (TPH-

d), TPH as gasoline range organics (TPH-g), toluene, ethylbenzene, xylenes and lead above ESLs. The southern sample reported TPH-d, TPH as motor oil range organics (TPH-mo) and lead above ESLs at 5 feet bgs.

The UST at Building 53 was located within a hollowed-out sandstone cavity and groundwater at this location is shallow (approximately 4 feet bgs to 5 feet bgs). The vertical extent of impacted soil could not be delineated because of the presence of shallow groundwater. Because of shallow groundwater, the soil sample was most likely saturated and the reported analytical results are likely due to contaminants in groundwater.

Dichloroethene (DCE) isomers were detected in groundwater samples collected at this location. The presence of DCE is likely due to degradation of trichloroethene (TCE) that had been released in the past. Further information about the presence and extent of the solvent-related contamination can be found in the Expanded SI Report (BC, 2005).

Geofon recommended further investigation at Building 53 based on the detection of hydrocarbons and lead above ESLs in groundwater and/or soil samples. Investigation of shallow surface soils was also recommended to determine the vertical and lateral extent of impacted soil (Geofon, 2003). The RWQCB confirmed that additional investigation was needed, which was performed during the Expanded SI (BC, 2005).

**Building 103.** TPH-d and TPH-mo were detected above ESLs in a soil sample collected along the southern sidewall of the UST excavation near the soil/water interface. The soil sample was collected at 10 feet bgs. Fuels and lead in three other samples collected from the northern and eastern excavation sidewalls were less than ESLs. A groundwater sample collected from the excavation also reported TPH-g, toluene and xylenes above ESLs. TPH-d was not evaluated in the water sample.

Geofon recommended further investigation at Building 103 based on the detection of hydrocarbons and lead above ESLs in groundwater and/or soil samples. Investigation of shallow surface soils was also recommended to determine the vertical and lateral extent of impacted soil (Geofon, 2003). The RWQCB confirmed that additional investigation was needed, which was performed during the Expanded SI (BC, 2005).

**Building 154.** Fuels and lead were not identified above ESLs in soil samples collected from the UST excavation at Building 154. However, groundwater was impacted with TPH-g and lead above the ESLs. Isomers of DCE were detected in groundwater samples as a result of TCE degradation.

Geofon recommended further investigation at Building 154 based on the detection of hydrocarbons and lead above ESLs detected in groundwater (Geofon, 2003). RWQCB confirmed that additional investigation was needed, which was performed during the Expanded SI (BC, 2005).

**Building 118(A).** The FA/BC investigation included a geophysical survey and the excavation of five test pits. All soil and groundwater samples were collected from the test pits. TPH-g and TPH-mo did not exceed the ESLs for soil. However TPH-d exceeded ESLs for soil and groundwater and TPH-mo in groundwater exceeded the ESL.

Recommendations were made to collect and analyze additional samples in the area of test pit TR005 at former Building 118(A) to determine the extent of TPH and volatile organic compounds (VOCs) in soil and groundwater (FA/BC, 2002). This additional testing was performed during the Expanded SI (BC, 2005).

### 1.3.3 Fillsite 1

FA/BC conducted an environmental site inspection at Fillsite 1, Fillsite 2, Quarry 1 and Quarry 3 between November 2000 and October 2002 (FA/BC, 2003c). These suspected fillsites and quarries were identified from historical information as possible repositories for industrial wastes from the shop area and other facilities at the former Arsenal. Of the two fillsites and two quarries investigated, only Fillsite 1 is located in an area covered by the Expanded SI. Therefore, only the results from the previous investigation at Fillsite 1 are discussed below.

Fillsite 1 is noted on the 1918 map included in “Benicia, Portrait of an Early California Town,” (Jacobs, 1999). Identified on the 1918 map is a “dump” located slightly northeast of the former industrial shop buildings, at what appears to be the beginning of a swale leading northwest from the swamp area to Area I. The swamp area below the swale has since been filled. Building 71 was constructed over the filled swamp in 1920 and overlies the “dump”. Compressible clays caused this building and others built on the former swamp to settle unevenly. The Army made several attempts to enhance the structural foundation of this building, including replacing wooden piling supports with concrete piling supports or buttresses. Building 71 was demolished in the 1980s by the current landowner. The site is now paved and used for temporary storage of new vehicles. The exact location and extent of Fillsite 1 are unknown.

The types of materials managed at Fillsite 1 are also unknown. This area is adjacent to the 50 Series Complex, which used a variety of fuels and solvents when the former Arsenal was operational. Thus, Fillsite 1 may have been a location for dumping of waste fuels and solvents generated at the 50 Series Complex, and acids, metal cleaning corrosives, petroleum, oils, lubricants, foundry wastes, infectious wastes, and pesticides may also be present. It should be noted that such unregulated dumping of waste materials was a common practice prior to the 1970s.

FA/BC conducted a geophysical evaluation of the Fillsite 1 area, collected and analyzed soil and groundwater samples. These samples were analyzed for constituents related to materials that may have been commonly used at the 50 Series Complex and discarded at this location.

Geophysical techniques identified metallic and non-metallic anomalies at Fillsite 1, in locations where debris was found by trenching. The stratigraphy of Fillsite 1 was found to consist of artificial

fill with underlying Bay Mud. Fill material included unconsolidated sandy silt with gravel and occasional wood, brick, and a discontinuous buried asphalt layer beneath the western third of the site.

No refuse was encountered in any trenches at Fillsite 1, although motor oil, diesel fuel and lead were detected in soil samples. All of these contaminants decreased with depth. Groundwater at Fillsite 1 was found to contain, diesel fuel, motor oil, and solvents. No USTs were found.

The source of the solvents in Fillsite 1 groundwater is not clearly understood, but is likely associated with a nearby source area (i.e., the 50 Series Complex or another unknown upgradient area). Widespread use of solvents in manufacturing began during World War II after the area was filled in and Building 71 was placed on top of the suspected “dump.”

Fuels were used throughout the former Arsenal and could have been discarded at Fillsite 1. However, it is more likely that the hydrocarbons reported in soil and groundwater at this location result from decomposition of the buried asphalt layer. Additionally, low levels of MtBE were detected in groundwater samples from Fillsite 1. The discovery of MtBE in groundwater at this location demonstrates that fuels were released after the former Arsenal closed.

Based on the findings of FA/BC (2003c), soil and/or groundwater at Fillsite 1 appear to have been impacted to some extent by DoD activities. FA/BC recommended additional groundwater testing to assess the vertical and lateral extent of the solvents detected in groundwater at the Fillsite 1 area and identify the source area for these constituents. This additional testing was performed during the Expanded SI (BC, 2005).

## 2.0 FIELD METHODS

This section presents the technical approach to investigation at AST and UST sites and a description of the field sampling procedures and analytical parameters for the Fuel Storage Tank RA. Additional description of the field methods and procedures, field quality control (QC) procedures and the site Health and Safety Plan are included in the RA Plan (BC, 2004). Standard Operating Procedures (SOPs) implemented during the project are listed in Table 6-1 of the RA Plan and are included in Appendix F of the Quality Assurance Project Plan (QAPP) for environmental investigations at the former Arsenal (FA/BC, 2001).

### 2.1 Technical Approach

The following technical approach was used to investigate the potential AST sites:

- A right-of-entry (ROE) agreement was arranged with the landowner.
- Visual surveys were performed to identify current ASTs or locations of historical ASTs.
- If an AST was identified that was not used after the Arsenal closure in 1964, it was removed and soil samples would have been collected from under the AST location. If an AST was removed and remnants of the supporting structure remained, soil samples were collected from under the AST location.
- If the exact location or remnants of a former AST were not clearly identified, direct-push cone penetration testing (CPT) groundwater samples were collected downgradient of the area to determine the presence or absence of any fuel-related release from the AST as part of the Expanded SI.

The following technical approach was used to investigate the potential UST sites:

- A ROE agreement was arranged with the landowner.
- Geophysical surveys were performed to identify anomalous areas that may indicate the presence of USTs and associated piping. Geophysical surveys were also used to identify buried utilities in the vicinity of the anomaly.
- If an anomaly was identified, a test pit was excavated to determine the reason for the anomaly. Lithologic data was obtained during excavation.
- If tanks were found, they were removed from site.

- Soil and/or groundwater samples were collected from each confirmed fuel storage tank location and analyzed to determine the presence or absence of DoD-fuel related contamination at each location.
- If contamination was discovered above project criteria, additional direct-push cone CPT groundwater samples were collected to delineate the DoD-related fuel contamination as part of the Expanded SI.
- The site was restored.

## 2.2 Sampling Procedures

Samples were collected to identify and delineate DoD-related fuel contamination. As part of the Fuel Storage Tank RA, soil samples were collected at each of the UST removal sites in accordance with the RA Plan (BC, 2004). The sample procedures, locations, and analytical parameters are described in the following sections.

Direct-push CPT groundwater samples and soil gas samples were collected as part of the Expanded SI in order to delineate the DoD-related fuel contamination identified at several of the Fuel RA sites as well as other historical fuel storage tank sites at the Benicia Arsenal. The methods, locations, and results of CPT groundwater sampling are described in the Expanded SI Report (BC, 2005).

### 2.2.1 Sample Collection

Samples were collected from the UST excavations, and from stockpiles of excavated soil. Depth-discrete soil samples were collected using an impact slide hammer with an attached sampler. Extension rods were added to the sampler for excavations greater than 4 feet deep. All decontamination was performed as specified in the QAPP (FA/BC, 1999a). Decontamination of sampling equipment was staged at the BC Benicia Arsenal Field Office at 942 Tyler Street.

**UST Excavations.** In accordance with Solano County requirements, one soil sample was collected from under the UST or the concrete slab (if present) for tanks less than 1,000 gallons. For USTs between 1,000 gallons and 10,000 gallons, one sample was collected from under each end of the UST. For tanks over 10,000 gallons, three samples were collected, one from under the center of the UST, and one from under each end. If groundwater was encountered the same number of samples were collected from the side walls of the excavation instead of from saturated soil beneath the UST.

**Excavated Soil.** Soil excavated from around the USTs was stockpiled into separate soil bins at each UST site. Four grab samples were collected and composited into one sample from each of the UST sites. At a minimum, one composite sample was collected for every 50 cubic yards of excavated soil.

### 2.2.2 Analytical parameters

Soil and groundwater samples were analyzed for the following parameters:

- TPH-d and TPH-mo residual range organics by Environmental Protection Agency (EPA) Modified Method 8015;
- VOCs and TPH-g organics by EPA Method 8260B;
- Metals, including antimony, barium, beryllium, total chromium, cobalt, copper, manganese, molybdenum, nickel, silver, tin, vanadium and zinc by 6010B, cadmium and lead by 6010B inductively coupled plasma (ICP) trace, arsenic by 7060A, selenium by 7740, thallium by 7841 and mercury by 7471A;
- PAHs by EPA Method 8310; and
- Methanol/Ethanol by EPA modified Method 8015.

### 3.0 RESULTS AND ANALYSIS

This section presents the investigation and laboratory results for the eleven potential fuel tank sites with full access and one site (Building 161) with only geophysical access. Two USTs were located and removed and a total of five soil samples and one grab groundwater sample were collected from the removal sites. This section also summarizes the disposal of investigative derived waste (IDW) generated during the project.

#### 3.1 Above Ground Storage Tanks

The potential AST sites, Building 88 and Building 89, were investigated following the methods described in Section 2. The following sections describe the results of the investigation.

##### 3.1.1 Results of Visual Surveys

The historic ASTs no longer exist at either Buildings 88 or 89. No visible signs of a former AST were identified at Building 88. Based on information provided by the current owner and the presence of bollard holes in the asphalt, it is likely that the former AST at Building 89 was located near the northwest corner of the building. (Photo 2).

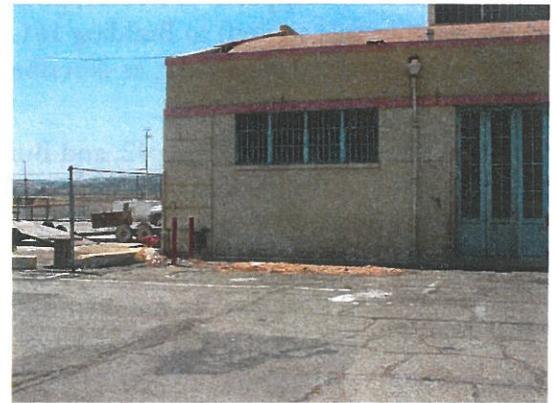


Photo 2. Looking south at suspected former AST location, northwest corner of Building 89. Photo taken 5/28/2004.

##### 3.1.2 Results of Downgradient Sampling

As part of the Expanded SI, a groundwater sample was collected downgradient of Buildings 88 and 89 to identify and delineate DoD contamination from these sites. The groundwater samples were collected from borings FS01HP012 and FS01HP013, and piezometers PZ-5 and PZ-6. Results of this sampling are described in the Expanded SI Report.

#### 3.2 Underground Storage Tanks

The potential UST sites, consisting of Buildings 31, 42, , 46(B), 47, 71, 161 and the service station west of Building 45, were investigated following the methods described in Section 2. ROE was not obtained for the Building 27 site and scaffolding at Building 45 prevented further investigation. Building 161 removal activities were not completed because the ROE was revoked after the geophysics were completed. The following sections describe the results of these activities.

### 3.2.1 Results of Geophysical Surveys

NORCAL Geophysical Consultants (NORCAL) performed geophysical investigations at Buildings 31, 46(B), 47, 71 and 161 on May 17, 18 and 24, 2004 and at Building 42 on August 9, 2004. Three geophysical methods were used: metal detection (MD), electromagnetic line locating (EMLL), and ground penetrating radar (GPR). Appendix B contains letter reports by NORCAL, dated June 24, 2004 and August 31, 2004 that describe the geophysical surveys.

NORCAL identified anomalies suggesting the presence of USTs at Building 31 and 47. Findings at Building 161 were inconclusive due to interference from the reinforced concrete surface and a fence with metal supports. However, potential fuel lines were located that extended from Building 31 (a former fuel station) to Building 161 (a former maintenance facility). A fuel fill pipe was also located in an underground vault, as described in Section 3.2.2.

At Building 71, Building 42, and Building 46(B), no anomalies were found in the areas searched that suggested the presence of a UST. The areas searched at each site are shown in the NORCAL report.

A MD anomaly was identified at the service station west of Building 45; however, the GPR suggested the anomaly was disturbed soil. It was concluded that the anomaly is likely caused by a localized concentration of debris or metallic objects (NORCAL letter, August 31, 2004).

Buildings 31, 47 and 161 were investigated further as described in Section 3.2.2.

### 3.2.2 Findings of Removal Activities

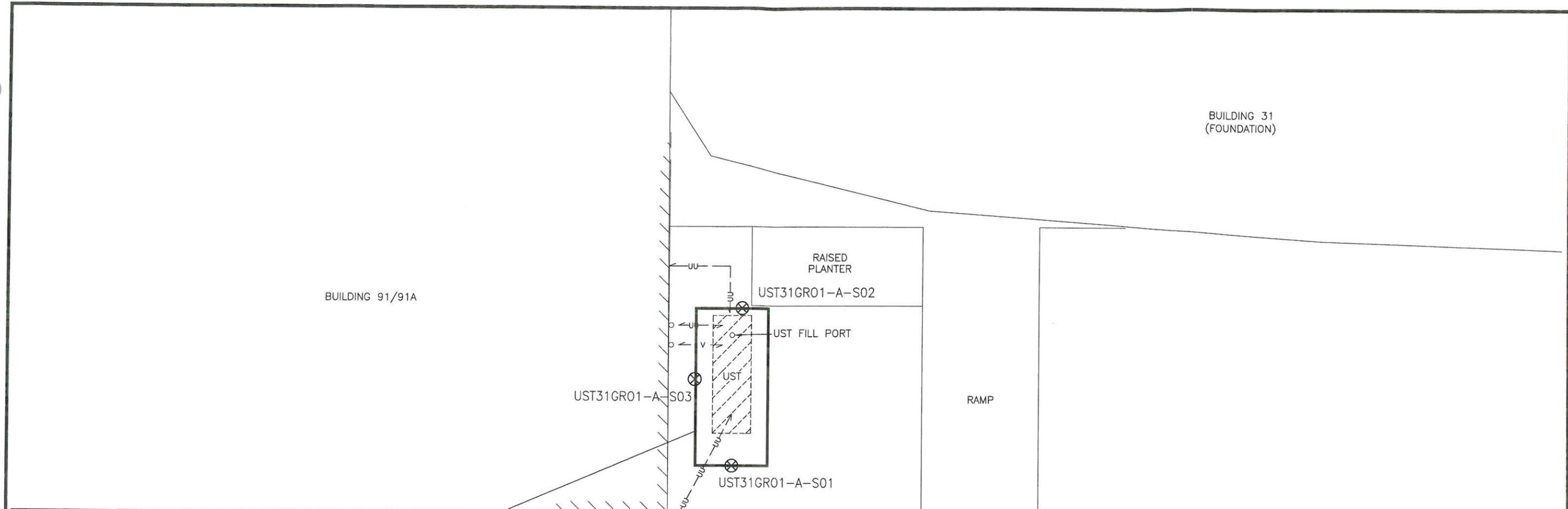
Test pits were excavated and tanks were removed at Buildings 31 and 47. The removal activities are described in detail below. Removal activities were overseen by Mr. Gary Riley of the RWQCB, Mr. Mike Rees of the Solano County Environmental Health Department, and Mr. Chuck Shaw of the City of Benicia Fire Department Hazardous Materials Division.

**Building 31.** A 1,000-gallon single-walled steel tank was located near former Building 31. Based on the results of the analytical samples, the tank was likely used to hold diesel fuel. The tank was located south of former Building 31, at the southwest corner of the existing J.R. Schneider building (Figures 3-1 through 3-5, Photo 3). The tank was 11 feet long and four feet in diameter, and the ends of the tank were orientated approximately north-south.



Photo 3. Looking north at Building 31 UST location, marked with white outline. Photo taken 5/24/2004.

Photo Image Filename: | Xref Filename: | Path: P:\US Army Corps\Ber...enal\Reports\F... File Name: FRA-13-1\_Site316W-metals Plot Date: Feb 04, 2005-11:21:00am CAD User: jagers



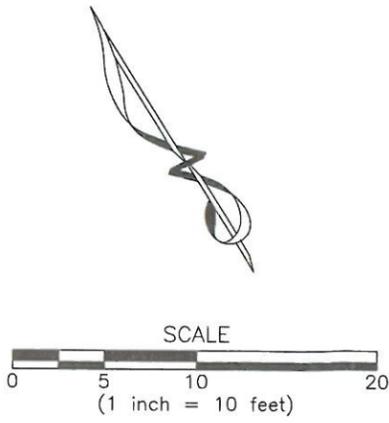
**(GRAB SAMPLE FROM UST EXCAVATION) UST31GR01-A-W01**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.8	25-May-04	SW6010B	BARIUM	0.122 MG/L
3.8	25-May-04	SW6010B	CALCIUM	25.1 MG/L
3.8	25-May-04	SW6010B	LEAD	0.00213 J MG/L
3.8	25-May-04	SW6010B	MAGNESIUM	13.2 MG/L
3.8	25-May-04	SW6010B	MANGANESE	0.28 MG/L
3.8	25-May-04	SW6010B	MOLYBDENUM	0.0113 J MG/L
3.8	25-May-04	SW6010B	POTASSIUM	5.81 MG/L
3.8	25-May-04	SW6010B	SODIUM	114 MG/L
3.8	25-May-04	SW6010B	ZINC	0.0174 J MG/L
3.8	25-May-04	SW7041	ANTIMONY	0.011 MG/L

**B031HP003-A-W01**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
5	20-May-04	SW6010B	ALUMINUM	0.0698 J MG/L
5	20-May-04	SW6010B	ARSENIC	0.00473 J MG/L
5	20-May-04	SW6010B	BARIUM	0.0401 MG/L
5	20-May-04	SW6010B	CALCIUM	77.2 MG/L
5	20-May-04	SW6010B	IRON	0.0756 J MG/L
5	20-May-04	SW6010B	MAGNESIUM	30.9 MG/L
5	20-May-04	SW6010B	MANGANESE	0.258 MG/L
5	20-May-04	SW6010B	MOLYBDENUM	0.0112 J MG/L
5	20-May-04	SW6010B	NICKEL	0.0109 J MG/L
5	20-May-04	SW6010B	POTASSIUM	1.98 J MG/L
5	20-May-04	SW6010B	SODIUM	128 MG/L
5	20-May-04	SW6010B	VANADIUM	0.00878 J MG/L
5	20-May-04	SW6010B	ZINC	0.03 MG/L
5	20-May-04	SW7041	ANTIMONY	0.00117 J MG/L

LEGEND	
	LIMITS OF EXCAVATION
	SOIL SAMPLE LOCATION
	HYDROPUNCH SAMPLE LOCATION
	UNDIFFERENTIATED UTILITY LINE
	VENT LINE
	UST



Only detected concentrations are shown.  
 MG/L = Milligrams per Liter  
 J = The analyte was positively identified.  
 The value is an estimated quantity.

BUILDING 31  
(FOUNDATION)

BUILDING 91/91A

RAISED PLANTER  
UST31GR01-A-S02

UST FILL PORT

UST

UST31GR01-A-S03

RAMP

UST31GR01-A-S01

JACKSON STREET

TO BUILDING  
161 UST

B031HP003

Source: NORCAL Geophysical, Inc.

Fuel Storage Tank RA Report, Former Benicia Arsenal,  
Benicia, California

Building 31 UST Site Map and  
Detected Metals in Groundwater

PROJECT 25952-007	DATE 2-4-05
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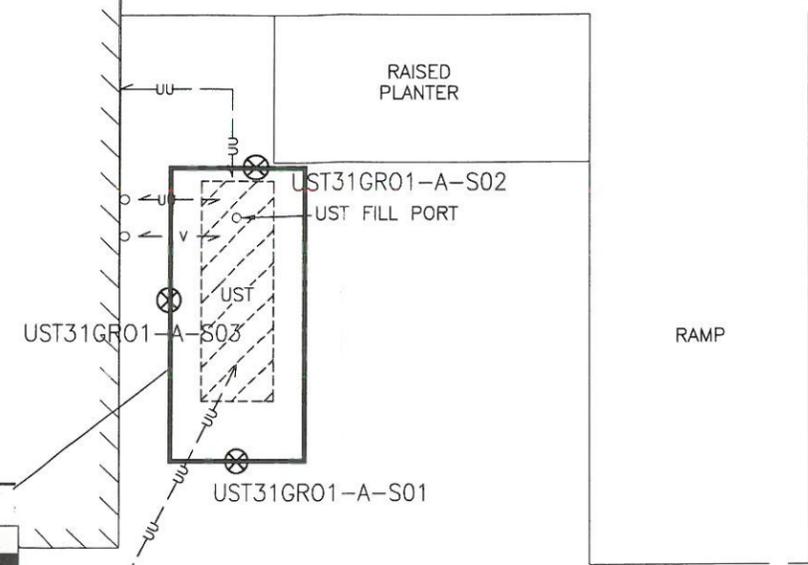
**BROWN AND  
CALDWELL**

2701 Prospect Park Drive  
Rancho Cordova, CA 95670  
(916) 444-0123  
(916) 635-8805 fax

FIGURE  
**3-1**

BUILDING 31  
(FOUNDATION)

BUILDING 91/91A



(GRAB SAMPLE FROM UST EXCAVATION)

UST31GR01-A-W01

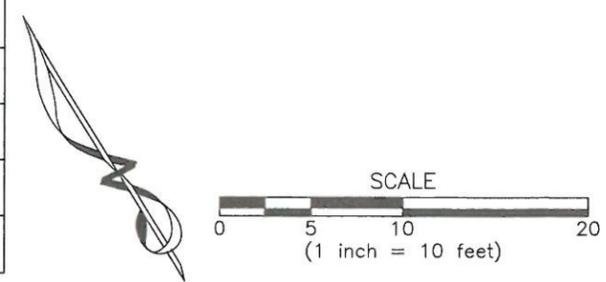
Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.8	25-May-04	SW8015B	<b>DIESEL RANGE ORGANICS</b>	<b>14000 J UG/L</b>
3.8	25-May-04	SW8260B	1,2,4-TRIMETHYLBENZENE	1300 UG/L
3.8	25-May-04	SW8260B	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	380 UG/L
3.8	25-May-04	SW8260B	ETHYLBENZENE	300 UG/L
3.8	25-May-04	SW8260B	<b>GASOLINE RANGE ORGANICS</b>	<b>2200 UG/L</b>
3.8	25-May-04	SW8260B	ISOPROPYLBENZENE (CUMENE)	40 UG/L
3.8	25-May-04	SW8260B	M,P-XYLENE (SUM OF ISOMERS)	1500 UG/L
3.8	25-May-04	SW8260B	NAPHTHALENE	260 UG/L
3.8	25-May-04	SW8260B	n-PROPYLBENZENE	73 UG/L
3.8	25-May-04	SW8260B	O-XYLENE (1,2-DIMETHYLBENZENE)	420 UG/L
3.8	25-May-04	SW8260B	P-CYMENE (p-ISOPROPYLTOLUENE)	8.1 J UG/L
3.8	25-May-04	SW8260B	SEC-BUTYLBENZENE	10 J UG/L
3.8	25-May-04	SW8260B	t-BUTYLBENZENE	170 UG/L
3.8	25-May-04	SW8260B	TOLUENE	12 J UG/L
3.8	25-May-04	SW8310	ACENAPHTHENE	26 UG/L
3.8	25-May-04	SW8310	BENZO(b)FLUORANTHENE	0.14 J UG/L
3.8	25-May-04	SW8310	NAPHTHALENE	150 J- UG/L
3.8	25-May-04	SW8310	PHENANTHRENE	0.46 UG/L

JACKSON STREET  
TO BUILDING 161 UST

B031HP003-A-W01

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
5	20-May-04	SW8015B	DIESEL RANGE ORGANICS	35 J UG/L
5	20-May-04	SW8260B	cis-1,2-DICHLOROETHYLENE	12 UG/L
5	20-May-04	SW8260B	TOLUENE	0.82 J UG/L
5	20-May-04	SW8260B	trans-1,2-DICHLOROETHENE	0.71 J UG/L

LEGEND	
	LIMITS OF EXCAVATION
	SOIL SAMPLE LOCATION
	HYDROPUNCH SAMPLE LOCATION
	UNDIFFERENTIATED UTILITY LINE
	VENT LINE
	UST



Only Detected Concentrations are shown.

Bold and shaded values exceed or equal their respective Environmental Screening Levels (ESLs) for Diesel (640 ug/L), Motor Oil (640 ug/L), and Gasoline (500 ug/L). Their ESLs were established by RWQCB in 2003.

UG/L = Micrograms per Liter

J = The analyte was positively identified. The value is an estimated quantity.  
J- = The analyte was positively identified with low bias; the associated numerical value is the approximate concentration of the analyte in the sample.

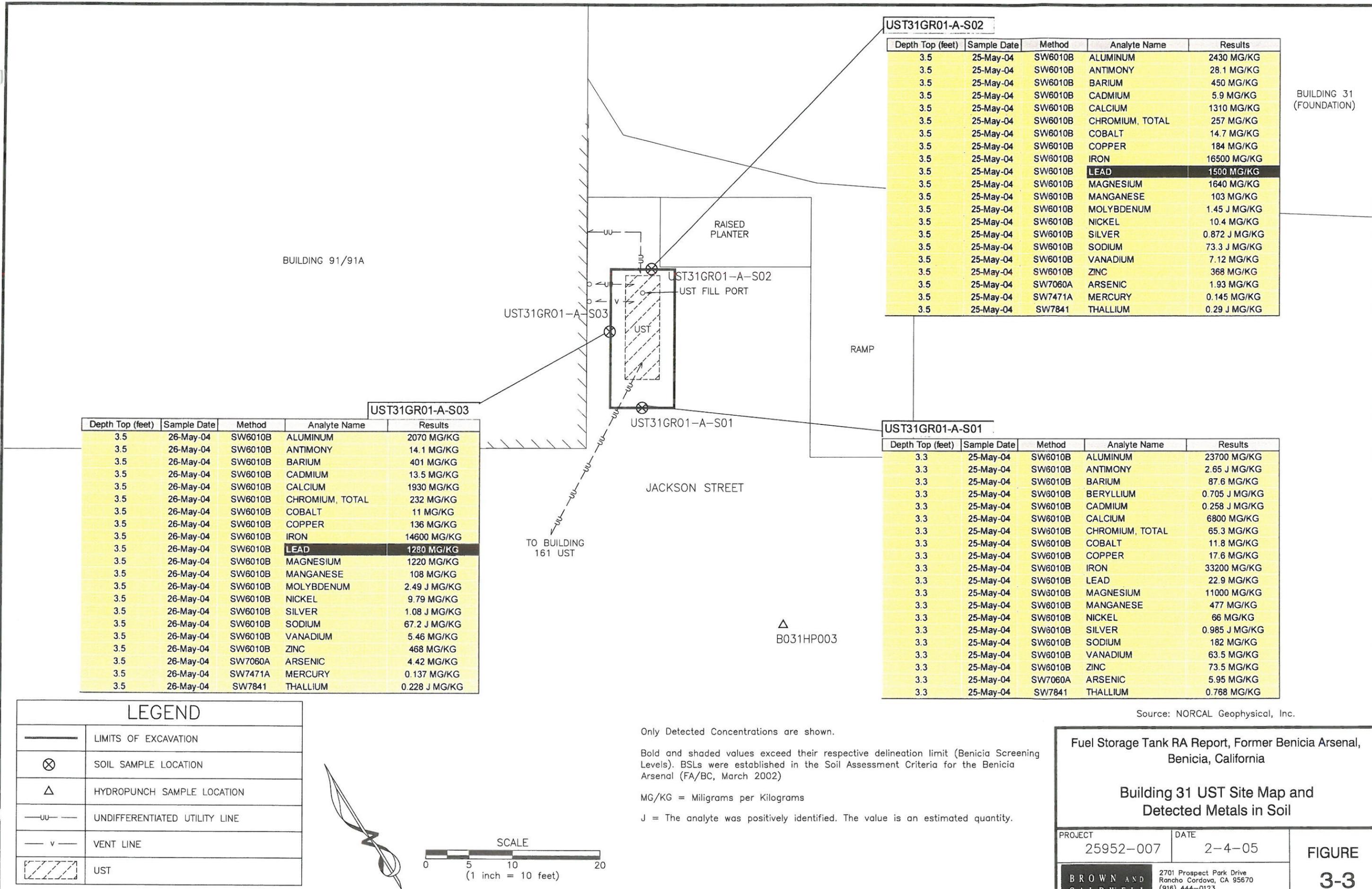
Source: NORCAL Geophysical, Inc.

Fuel Storage Tank RA Report, Former Benicia Arsenal, Benicia, California  
**Building 31 UST Site Map and Detected Fuel, Solvent, and Polyaromatic Hydrocarbons in Groundwater**

PROJECT 25952-007	DATE 2-4-05	FIGURE <b>3-2</b>
<b>BROWN AND CALDWELL</b> 2701 Prospect Park Drive Rancho Cordova, CA 95670 (916) 444-0123 (916) 635-8805 fax		

Photo Image Filename: | Xref Filename: | Path: P:\US Army Corps\Benicia Arsenal\Reports\VE File Name: FR-13-2\_Site31GV-FuelRA Plot date: Feb 04, 2005-11:17:01am CAD User: Rogers

Photo Image Filename | Xref Filename | Path: P:\US Army Corps\Bem...nal\Report\F... Filename: FRA-13-3\_Site3\soil-metals Plot date: Feb 04, 2005-11:49:55am CAD User: jrogers



**UST31GR01-A-S02**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.5	25-May-04	SW6010B	ALUMINIUM	2430 MG/KG
3.5	25-May-04	SW6010B	ANTIMONY	28.1 MG/KG
3.5	25-May-04	SW6010B	BARIUM	450 MG/KG
3.5	25-May-04	SW6010B	CADMIUM	5.9 MG/KG
3.5	25-May-04	SW6010B	CALCIUM	1310 MG/KG
3.5	25-May-04	SW6010B	CHROMIUM, TOTAL	257 MG/KG
3.5	25-May-04	SW6010B	COBALT	14.7 MG/KG
3.5	25-May-04	SW6010B	COPPER	184 MG/KG
3.5	25-May-04	SW6010B	IRON	16500 MG/KG
3.5	25-May-04	SW6010B	<b>LEAD</b>	<b>1500 MG/KG</b>
3.5	25-May-04	SW6010B	MAGNESIUM	1640 MG/KG
3.5	25-May-04	SW6010B	MANGANESE	103 MG/KG
3.5	25-May-04	SW6010B	MOLYBDENUM	1.45 J MG/KG
3.5	25-May-04	SW6010B	NICKEL	10.4 MG/KG
3.5	25-May-04	SW6010B	SILVER	0.872 J MG/KG
3.5	25-May-04	SW6010B	SODIUM	73.3 J MG/KG
3.5	25-May-04	SW6010B	VANADIUM	7.12 MG/KG
3.5	25-May-04	SW6010B	ZINC	368 MG/KG
3.5	25-May-04	SW7060A	ARSENIC	1.93 MG/KG
3.5	25-May-04	SW7471A	MERCURY	0.145 MG/KG
3.5	25-May-04	SW7841	THALLIUM	0.29 J MG/KG

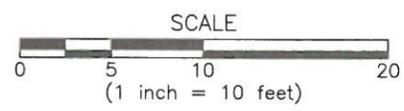
**UST31GR01-A-S03**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.5	26-May-04	SW6010B	ALUMINIUM	2070 MG/KG
3.5	26-May-04	SW6010B	ANTIMONY	14.1 MG/KG
3.5	26-May-04	SW6010B	BARIUM	401 MG/KG
3.5	26-May-04	SW6010B	CADMIUM	13.5 MG/KG
3.5	26-May-04	SW6010B	CALCIUM	1930 MG/KG
3.5	26-May-04	SW6010B	CHROMIUM, TOTAL	232 MG/KG
3.5	26-May-04	SW6010B	COBALT	11 MG/KG
3.5	26-May-04	SW6010B	COPPER	136 MG/KG
3.5	26-May-04	SW6010B	IRON	14600 MG/KG
3.5	26-May-04	SW6010B	<b>LEAD</b>	<b>1280 MG/KG</b>
3.5	26-May-04	SW6010B	MAGNESIUM	1220 MG/KG
3.5	26-May-04	SW6010B	MANGANESE	108 MG/KG
3.5	26-May-04	SW6010B	MOLYBDENUM	2.49 J MG/KG
3.5	26-May-04	SW6010B	NICKEL	9.79 MG/KG
3.5	26-May-04	SW6010B	SILVER	1.08 J MG/KG
3.5	26-May-04	SW6010B	SODIUM	67.2 J MG/KG
3.5	26-May-04	SW6010B	VANADIUM	5.46 MG/KG
3.5	26-May-04	SW6010B	ZINC	468 MG/KG
3.5	26-May-04	SW7060A	ARSENIC	4.42 MG/KG
3.5	26-May-04	SW7471A	MERCURY	0.137 MG/KG
3.5	26-May-04	SW7841	THALLIUM	0.228 J MG/KG

**UST31GR01-A-S01**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.3	25-May-04	SW6010B	ALUMINIUM	23700 MG/KG
3.3	25-May-04	SW6010B	ANTIMONY	2.65 J MG/KG
3.3	25-May-04	SW6010B	BARIUM	87.6 MG/KG
3.3	25-May-04	SW6010B	BERYLLIUM	0.705 J MG/KG
3.3	25-May-04	SW6010B	CADMIUM	0.258 J MG/KG
3.3	25-May-04	SW6010B	CALCIUM	6800 MG/KG
3.3	25-May-04	SW6010B	CHROMIUM, TOTAL	65.3 MG/KG
3.3	25-May-04	SW6010B	COBALT	11.8 MG/KG
3.3	25-May-04	SW6010B	COPPER	17.6 MG/KG
3.3	25-May-04	SW6010B	IRON	33200 MG/KG
3.3	25-May-04	SW6010B	LEAD	22.9 MG/KG
3.3	25-May-04	SW6010B	MAGNESIUM	11000 MG/KG
3.3	25-May-04	SW6010B	MANGANESE	477 MG/KG
3.3	25-May-04	SW6010B	NICKEL	66 MG/KG
3.3	25-May-04	SW6010B	SILVER	0.985 J MG/KG
3.3	25-May-04	SW6010B	SODIUM	182 MG/KG
3.3	25-May-04	SW6010B	VANADIUM	63.5 MG/KG
3.3	25-May-04	SW6010B	ZINC	73.5 MG/KG
3.3	25-May-04	SW7060A	ARSENIC	5.95 MG/KG
3.3	25-May-04	SW7841	THALLIUM	0.768 MG/KG

LEGEND	
	LIMITS OF EXCAVATION
	SOIL SAMPLE LOCATION
	HYDROPUNCH SAMPLE LOCATION
	UNDIFFERENTIATED UTILITY LINE
	VENT LINE
	UST



Only Detected Concentrations are shown.

Bold and shaded values exceed their respective delineation limit (Benicia Screening Levels). BSLs were established in the Soil Assessment Criteria for the Benicia Arsenal (FA/BC, March 2002)

MG/KG = Milligrams per Kilograms

J = The analyte was positively identified. The value is an estimated quantity.

Source: NORCAL Geophysical, Inc.

**Fuel Storage Tank RA Report, Former Benicia Arsenal, Benicia, California**  
**Building 31 UST Site Map and Detected Metals in Soil**

PROJECT 25952-007	DATE 2-4-05	<b>FIGURE</b>  <b>3-3</b>
<b>BROWN AND CALDWELL</b> 2701 Prospect Park Drive Rancho Cordova, CA 95670 (916) 444-0123 (916) 635-8805 fax		

UST31GR01-A-S02

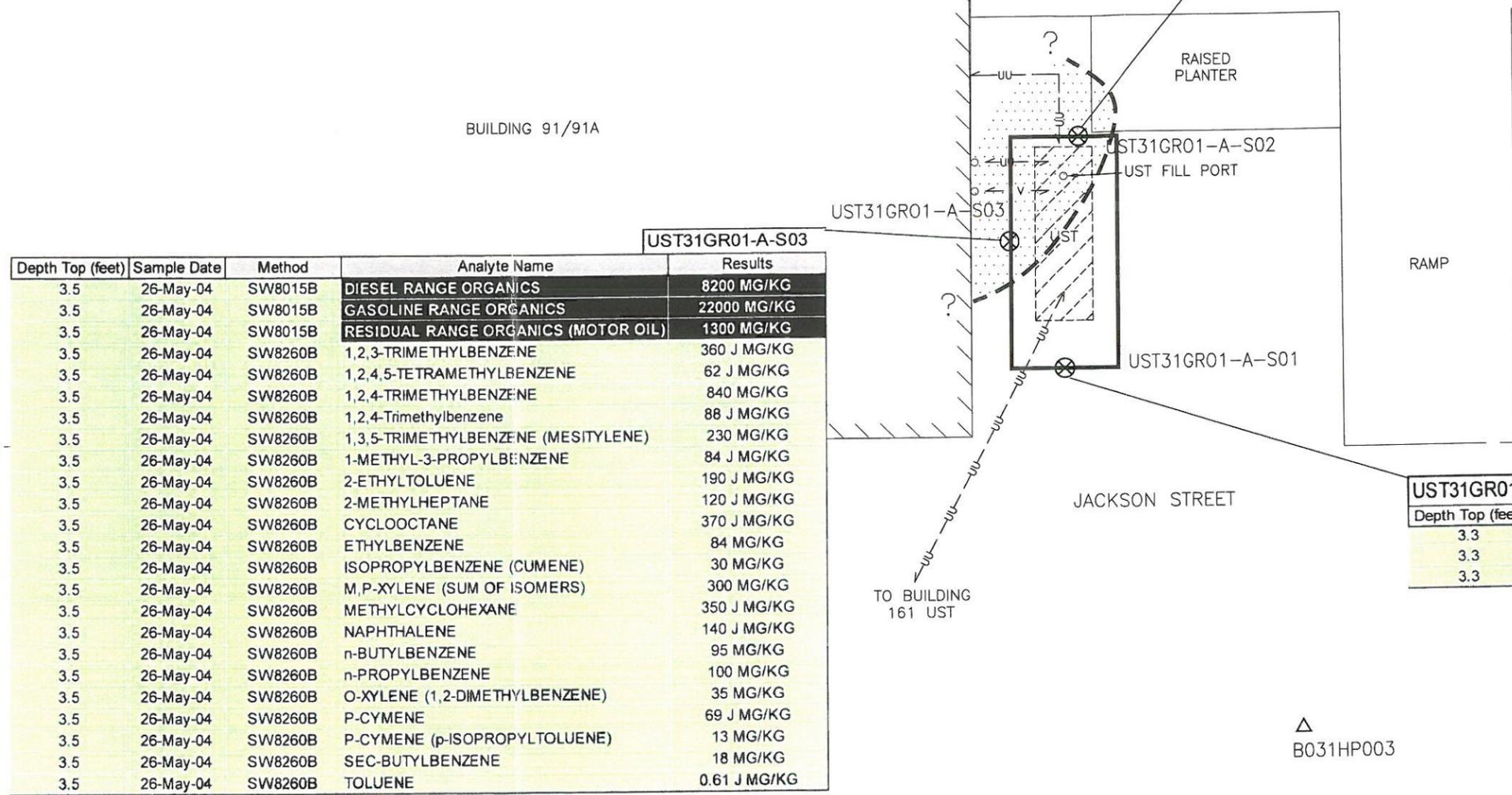
Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.5	25-May-04	SW8015B	<b>DIESEL RANGE ORGANICS</b>	<b>1900 J MG/KG</b>
3.5	25-May-04	SW8015B	<b>RESIDUAL RANGE ORGANICS (MOTOR OIL)</b>	<b>1600 J MG/KG</b>
3.5	25-May-04	SW8260B	ETHYLBENZENE	0.049 MG/KG
3.5	25-May-04	SW8260B	GASOLINE RANGE ORGANICS	2.7 J MG/KG
3.5	25-May-04	SW8260B	ISOPROPYLBENZENE (CUMENE)	0.018 J MG/KG
3.5	25-May-04	SW8260B	M,P-XYLENE (SUM OF ISOMERS)	0.028 MG/KG
3.5	25-May-04	SW8260B	n-PROPYLBENZENE	0.034 MG/KG
3.5	25-May-04	SW8260B	P-CYMENE (p-ISOPROPYLTOLUENE)	0.027 MG/KG
3.5	25-May-04	SW8260B	SEC-BUTYLBENZENE	0.016 J MG/KG

UST31GR01-A-S03

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.5	26-May-04	SW8015B	<b>DIESEL RANGE ORGANICS</b>	<b>8200 MG/KG</b>
3.5	26-May-04	SW8015B	<b>GASOLINE RANGE ORGANICS</b>	<b>22000 MG/KG</b>
3.5	26-May-04	SW8015B	<b>RESIDUAL RANGE ORGANICS (MOTOR OIL)</b>	<b>1300 MG/KG</b>
3.5	26-May-04	SW8260B	1,2,3-TRIMETHYLBENZENE	360 J MG/KG
3.5	26-May-04	SW8260B	1,2,4,5-TETRAMETHYLBENZENE	62 J MG/KG
3.5	26-May-04	SW8260B	1,2,4-TRIMETHYLBENZENE	840 MG/KG
3.5	26-May-04	SW8260B	1,2,4-Trimethylbenzene	88 J MG/KG
3.5	26-May-04	SW8260B	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	230 MG/KG
3.5	26-May-04	SW8260B	1-METHYL-3-PROPYLBENZENE	84 J MG/KG
3.5	26-May-04	SW8260B	2-ETHYLTOLUENE	190 J MG/KG
3.5	26-May-04	SW8260B	2-METHYLHEPTANE	120 J MG/KG
3.5	26-May-04	SW8260B	CYCLOOCTANE	370 J MG/KG
3.5	26-May-04	SW8260B	ETHYLBENZENE	84 MG/KG
3.5	26-May-04	SW8260B	ISOPROPYLBENZENE (CUMENE)	30 MG/KG
3.5	26-May-04	SW8260B	M,P-XYLENE (SUM OF ISOMERS)	300 MG/KG
3.5	26-May-04	SW8260B	METHYLCYCLOHEXANE	350 J MG/KG
3.5	26-May-04	SW8260B	NAPHTHALENE	140 J MG/KG
3.5	26-May-04	SW8260B	n-BUTYLBENZENE	95 MG/KG
3.5	26-May-04	SW8260B	n-PROPYLBENZENE	100 MG/KG
3.5	26-May-04	SW8260B	O-XYLENE (1,2-DIMETHYLBENZENE)	35 MG/KG
3.5	26-May-04	SW8260B	P-CYMENE	69 J MG/KG
3.5	26-May-04	SW8260B	P-CYMENE (p-ISOPROPYLTOLUENE)	13 MG/KG
3.5	26-May-04	SW8260B	SEC-BUTYLBENZENE	18 MG/KG
3.5	26-May-04	SW8260B	TOLUENE	0.61 J MG/KG

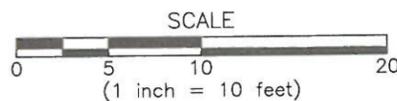
UST31GR01-A-S01

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.3	25-May-04	SW8015B	<b>DIESEL RANGE ORGANICS</b>	<b>54 J MG/KG</b>
3.3	25-May-04	SW8015B	<b>RESIDUAL RANGE ORGANICS (MOTOR OIL)</b>	<b>120 J MG/KG</b>
3.3	25-May-04	SW8260B	1,2,4-TRIMETHYLBENZENE	0.0027 J MG/KG



LEGEND

	DELINEATION OF FUEL CONTAMINATED SOIL
	LIMITS OF EXCAVATION
	SOIL SAMPLE LOCATION
	HYDROPUNCH SAMPLE LOCATION
	UNDIFFERENTIATED UTILITY LINE
	VENT LINE
	UST



Only Detected Concentrations are shown.

Bold and shaded values exceed their respective Environmental Screening Levels (ESLs) for diesel (500 mg/kg), motor oil (1,000 mg/kg), and gasoline (400 mg/kg). ESLs were established by RWQCB in 2003.

MG/KG = Milligrams per Kilograms

J = The analyte was positively identified. The value is an estimated quantity.

Source: NORCAL Geophysical, Inc.

Fuel Storage Tank RA Report, Former Benicia Arsenal,  
Benicia, California

Building 31 UST Site Map and  
Detected Fuels and Solvents in Soil

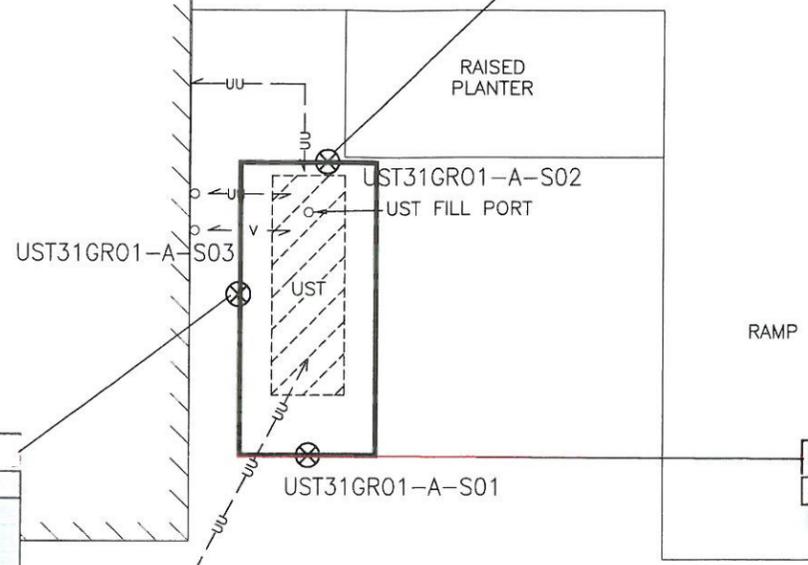
PROJECT 25952-007	DATE 2-4-05	FIGURE <b>3-4</b>
BROWN AND CALDWELL 2701 Prospect Park Drive Rancho Cordova, CA 95670 (916) 444-0123 (916) 635-8805 fax		

Photo Image Filename: | Xref Filename: | Path: P:\US Army Corps Benicia Arsenal\Reports\F... Filename: FRA-13-...\_Site31soil-fuel Plot date: Feb 04, 2005-11:53:39am CAD User: jrogers

**UST31GR01-A-S02**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.5	25-May-04	SW8310	BENZO(a)ANTHRACENE	0.19 J+ MG/KG
3.5	25-May-04	SW8310	BENZO(b)FLUORANTHENE	0.43 J+ MG/KG
3.5	25-May-04	SW8310	BENZO(k)FLUORANTHENE	0.083 J+ MG/KG
3.5	25-May-04	SW8310	CHRYSENE	0.38 J+ MG/KG
3.5	25-May-04	SW8310	INDENO(1,2,3-c,d)PYRENE	0.097 J+ MG/KG
3.5	25-May-04	SW8310	NAPHTHALENE	0.35 J+ MG/KG
3.5	25-May-04	SW8310	PHENANTHRENE	0.47 J+ MG/KG

BUILDING 91/91A



**UST31GR01-A-S03**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.5	26-May-04	SW8310	ACENAPHTHENE	27 MG/KG
3.5	26-May-04	SW8310	ACENAPHTHYLENE	12 J+ MG/KG
3.5	26-May-04	SW8310	ANTHRACENE	0.76 J+ MG/KG
3.5	26-May-04	SW8310	BENZO(a)PYRENE	0.1 J+ MG/KG
3.5	26-May-04	SW8310	BENZO(b)FLUORANTHENE	0.12 J+ MG/KG
3.5	26-May-04	SW8310	BENZO(g,h,i)PERYLENE	0.14 J+ MG/KG
3.5	26-May-04	SW8310	BENZO(k)FLUORANTHENE	0.036 J MG/KG
3.5	26-May-04	SW8310	CHRYSENE	0.26 J+ MG/KG
3.5	26-May-04	SW8310	FLUORANTHENE	0.97 J+ MG/KG
3.5	26-May-04	SW8310	FLUORENE	2.6 J+ MG/KG
3.5	26-May-04	SW8310	INDENO(1,2,3-c,d)PYRENE	0.038 J MG/KG
3.5	26-May-04	SW8310	NAPHTHALENE	130 MG/KG
3.5	26-May-04	SW8310	PHENANTHRENE	1.4 MG/KG

**UST31GR01-A-S01**

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
3.3	25-May-04	SW8310	PHENANTHRENE	0.0016 J MG/KG

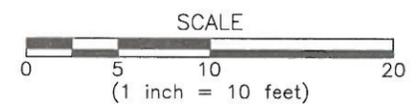
JACKSON STREET

TO BUILDING 161 UST

△  
B031HP003

**LEGEND**

	LIMITS OF EXCAVATION
	SOIL SAMPLE LOCATION
	HYDROPUNCH SAMPLE LOCATION
	UNDIFFERENTIATED UTILITY LINE
	VENT LINE
	UST



Only Detected Concentrations are shown.

MG/KG = Milligrams per Kilograms

J = The analyte was positively identified. The value is an estimated quantity.  
 J+ = The analyte was positively identified with high bias; the associated numerical value is the approximate concentration of the analyte in the sample.

Source: NORCAL Geophysical, Inc.

Fuel Storage Tank RA Report, Former Benicia Arsenal, Benicia, California

**Building 31 UST Site Map and Detected Polyaromatic Hydrocarbons in Soil**

PROJECT 25952-007	DATE 2-4-05
----------------------	----------------

**FIGURE  
3-5**

**BROWN AND  
CALDWELL**

2701 Prospect Park Drive  
Rancho Cordova, CA 95670  
(916) 444-0123  
(916) 635-8805 fax

Photo Image Filename: | Xref Filename: | File Name: FRA-13-S\_Site31hoil-arp | Plot Date: Feb 04, 2005-11:55:17am | CAD User: jrogers | Path: P:\US Army Corps\Ber |

The fill port of the tank extended to the ground surface and was uncapped allowing infiltration of rainwater. Surface asphalt was removed using a saw-cutter and the soil around the tank was excavated with a backhoe to uncover the tank. The tank was strapped to a concrete pad to prevent it from floating in groundwater, which covered approximately the bottom half of the tank in the excavation. The groundwater elevation was approximately 38-inches bgs. The tank appeared to have small holes from rust in several locations along the waterline but was otherwise in good condition. The thin walls of the tank were punctured during excavation activities and the contents (rainwater/groundwater with a petroleum odor) emptied into the excavation as the tank was removed. Styrofoam packing material flowed out of the tank with the water.

Several pipes were found connected to the tank and were, if possible, removed. Most pipes were connected at the north end of the tank, which is also where the fill port was located. One pipe extended to the southwest, across Jackson Street, towards Building 161. The locations of the pipes and their current status are shown on Figures 3-1 through 3-5. Below the asphalt and approximately 6-inches of sand and gravel fill, dark brown silty sand was encountered that had no visible stains until approximately 6-inches above the waterline. Near the waterline the soil was stained black along the north and west edges of the excavation and had a strong petroleum odor. The excavation and tank are shown in Photo 4.



Photo 4. Building 31 UST excavation.  
Photo taken 5/24/2004.

The tank site was closely confined by the presence of a building to the west, a large wooden planter box and concrete wall to the north, and a driveway ramp to the east. Although impacted soil was observed to the north and west sides of the excavation, the presence of the planter box, ramp, and building prevented any over excavation in these directions to remove impacted soil.

### ***Building 47***

A 400-gallon single-walled steel tank was located at Building 47. Based on the results of the PA, the tank was historically used to hold heating oil for the building. The tank was located on the west side of the building, partway under the asphalt parking lot and partway under the sidewalk, as shown in Figure 3-6, Figure 3-7 and in Photo 5.

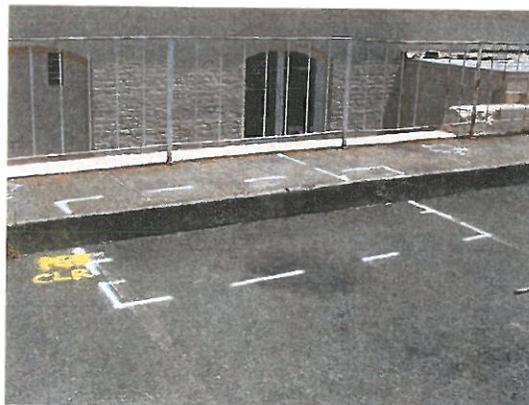


Photo 5. Looking east at Building 47 and UST location, marked in white outline. Photo taken 5/24/2004.

UST47GR01-A-S02  
NA

UST47GR01-A-S01

SIDEWALK

MOAT

BUILDING 47

UST47GR01-A-S01

Depth Top (feet)	Sample Date	Method	Analyte Name	Results
4	26-May-04	SW6010B	ALUMINUM	14600 MG/KG
4	26-May-04	SW6010B	BARIIUM	50.6 MG/KG
4	26-May-04	SW6010B	BERYLLIUM	0.524 J MG/KG
4	26-May-04	SW6010B	CADMIUM	0.229 J MG/KG
4	26-May-04	SW6010B	CALCIUM	11000 MG/KG
4	26-May-04	SW6010B	CHROMIUM, TOTAL	33.4 MG/KG
4	26-May-04	SW6010B	COBALT	7.14 MG/KG
4	26-May-04	SW6010B	COPPER	7.07 MG/KG
4	26-May-04	SW6010B	IRON	24100 MG/KG
4	26-May-04	SW6010B	LEAD	16.7 MG/KG
4	26-May-04	SW6010B	MAGNESIUM	5510 MG/KG
4	26-May-04	SW6010B	MANGANESE	403 MG/KG
4	26-May-04	SW6010B	NICKEL	11.2 MG/KG
4	26-May-04	SW6010B	SILVER	0.783 J MG/KG
4	26-May-04	SW6010B	SODIUM	180 MG/KG
4	26-May-04	SW6010B	VANADIUM	55 MG/KG
4	26-May-04	SW6010B	ZINC	54.7 MG/KG
4	26-May-04	SW7060A	ARSENIC	7.27 MG/KG
4	26-May-04	SW7471A	MERCURY	0.0345 J MG/KG
4	26-May-04	SW7841	THALLIUM	0.837 MG/KG

SHED

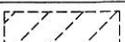
MOAT

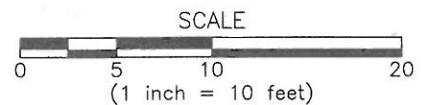
Only detected concentrations are shown.

NA = Not Analyzed

MG/KG = Milligrams per Kilograms

J = The analyte was positively identified. The value is estimated quantity.

LEGEND	
	LIMITS OF EXCAVATION
	SOIL SAMPLE LOCATION
	UNDIFFERENTIATED UTILITY LINE
	PIPE (UNKNOWN USE)
	UST



Source: NORCAL Geophysical, Inc.

PROJECT NUMBER  
25952-007

DATE  
2-4-05

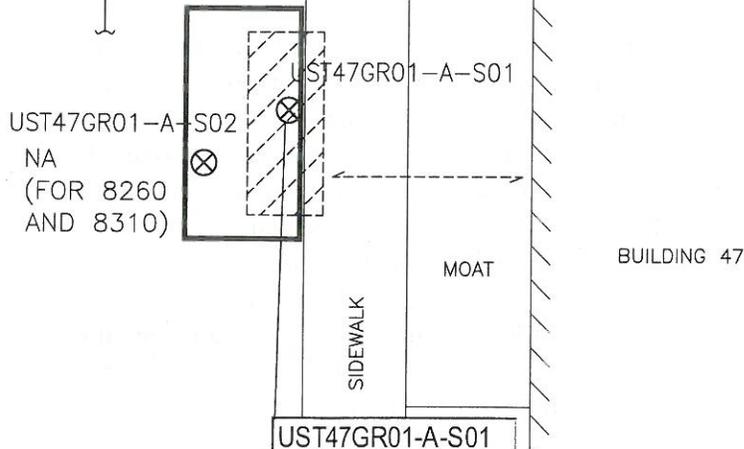
TITLE  
Fuel Storage Tank RA Report, Former Benicia Arsenal,  
Benicia, California

**BROWN AND CALDWELL**  
2701 Prospect Park Drive  
Rancho Cordova, CA 95670  
(916) 444-0123  
(916) 635-8805 fax

Building 47 UST Site Map and Detected Metals in Soil

FIGURE  
3-6

Xref Filename: Path: P:\US Army Corps\Benicia Arsenal\Reports\F File: FRA-13-6\_Site47Map Plot date: Feb 04, 2005-12:00:14pm CAD User: jrogers



Depth Top (feet)	Sample Date	Method	Analyte Name	Results
4	26-May-04	SW8260B	1,2,4-TRIMETHYLBENZENE	0.0048 J+ MG/KG
4	26-May-04	SW8260B	1,3,5-TRIMETHYLBENZENE (MESITYLENE)	0.0023 J MG/KG
4	26-May-04	SW8260B	ACETONE	0.042 J+ MG/KG
4	26-May-04	SW8260B	Dodecane	0.11 NJ MG/KG
4	26-May-04	SW8260B	METHYL ETHYL KETONE (2-BUTANONE)	0.005 J+ MG/KG
4	26-May-04	SW8260B	NAPHTHALENE	0.0087 J MG/KG
4	26-May-04	SW8260B	n-BUTYLBENZENE	0.002 J MG/KG
4	26-May-04	SW8260B	N-TRIDECANE (C13)	0.43 NJ MG/KG
4	26-May-04	SW8260B	P-CYMENE (p-ISOPROPYLTOLUENE)	0.0013 J MG/KG
4	26-May-04	SW8260B	SEC-BUTYLBENZENE	0.00058 J MG/KG
4	26-May-04	SW8260B	TRICHLOROFLUOROMETHANE	0.006 J+ MG/KG
4	26-May-04	SW8260B	UNDECANE	0.054 NJ MG/KG
4	26-May-04	SW8260B	Undecane, 2,6-Dimethyl-	0.22 NJ MG/KG
4	26-May-04	SW8260B	Undecane, 2-methyl-	0.059 NJ MG/KG
4	26-May-04	SW8310	BENZO(a)ANTHRACENE	0.028 J MG/KG
4	26-May-04	SW8310	FLUORENE	0.013 J MG/KG
4	26-May-04	SW8310	PHENANTHRENE	0.022 J MG/KG

Only detected concentrations are shown.

NA = Not Analyzed

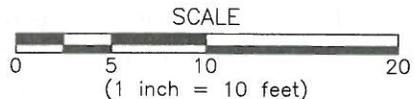
MG/KG = Milligrams per Kilograms

J = The analyte was positively identified. The value is an estimated quantity.

J+ = The analyte was positively identified with high bias; the associated numerical value is the approximate concentration of the analyte in the sample.

NJ = The analyte identification is presumptive. Reported value is an estimated concentration.

LEGEND	
	LIMITS OF EXCAVATION
	SOIL SAMPLE LOCATION
	UNDIFFERENTIATED UTILITY LINE
	PIPE (UNKNOWN USE)
	UST



Source: NORCAL Geophysical, Inc.

Photo Image Filename: Xref Filename: Path: P:\US Army Corps\Ben File Name: FRA-13-7\_SiteMap Plot date: Feb 04, 2005-12:05:42pm CAD User: jrogers

PROJECT NUMBER 25952-007	DATE 2-4-05	TITLE Fuel Storage Tank RA Report, Former Benicia Arsenal, Benicia, California Building 47 UST Site Map and Detected Fuel, Solvent, and Polyaromatic Hydrocarbons in Soil	FIGURE 3-7
		2701 Prospect Park Drive Rancho Cordova, CA 95670 (916) 444-0123 (916) 635-8805 fax	

Surface asphalt was removed using a saw-cutter and the soil around the tank was excavated with a backhoe to uncover the tank. The tank was in good condition. The tank piping had been previously removed, leaving open holes along the top of the tank. The tank was filled with water with an oily sheen and petroleum odor and had a layer of sludge or dirt at the bottom. During the uncovering of the tank, no stains were observed in the soil around and beneath the tank. No groundwater was encountered. The excavation and tank are shown in Photo 6.



Photo 6. Building 47 UST excavation. Photo taken 5/24/2004.

The contents of the tank were pumped to a temporary holding tank for future disposal, and the tank was removed from the excavation and transported to a disposal facility. During removal of the tank contents and the tank itself, a small amount of the water (approximately 10 gallons) was spilled into the excavation. Soil impacted by this water was removed with the excavator and placed into a soil bin for disposal. Mr. Gary Riley of the RWQCB and Mr. Mike Rees of Solano County Environmental Health Department confirmed that any significantly impacted soil had been removed prior to backfill of the excavation.

### ***Building 161***

As part of the ROE agreement to perform geophysical surveying at Building 161, a visual inspection was also performed of a pipe riser located in a vault near the suspected tank location. The vault is located under a fence along Jackson Street (see Photo 7 and Appendix B, NORCAL Report).

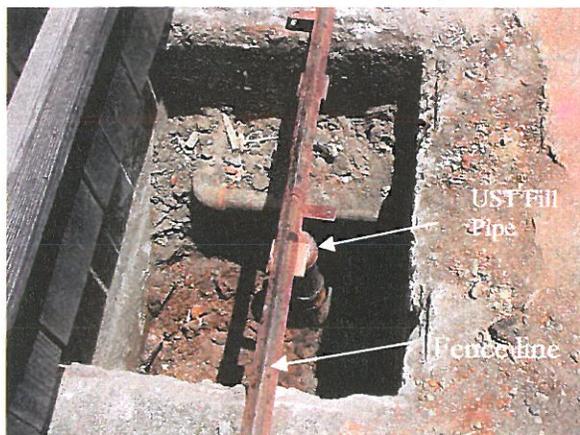


Photo 7. Building 161 UST fill pipe located in vault. Photo taken 5/28/2004.

When the cap was unscrewed, it was found that the pipe opened into a steel UST, approximately 4 feet in diameter. The tank appeared to contain waste oil to a depth of approximately 3 feet above the bottom of the tank. Based on limited probing performed in the vault, it appears likely that the UST extends to the east lengthwise from the vault location. It also appears likely that the pipe running from the Building 31 UST site (noted above in description of Building 31 removal activities) connects to the tank. During removal of the UST at Building 31, this pipe was extended above the restored pavement and capped.

When additional access was requested in order to remove the tank, the property owner rescinded all access to the property. To date, the tank remains in place and the pipe running from Building 31 UST towards Building 161 has not been grouted or sampled.

### 3.2.3 Sampling Activities

Sampling activities were overseen by Mr. Gary Riley of the RWQCB and Mr. Mike Rees of the Solano County Environmental Health Department.

Groundwater was encountered at the Building 31 tank site, therefore two soil samples were collected from the north and south ends of the 1,000 gallon tank excavation. One additional sample was collected from the western side wall of the excavation at the request of the RWQCB in order to identify contaminant levels near the building. Soil samples were collected approximately six inches above the soil/groundwater interface, which was at approximately 4 feet bgs. In addition, one groundwater sample was collected from the water in the excavation. The sample locations are shown on Figures 3-1 through 3-5.

A pipe extending north from the Building 31 tank site under the building foundation was not able to be sampled.

At the Building 47 site, one soil sample was collected from under the center of the 400-gallon tank. On August 9, 2004, a soil boring was performed to collect a second sample from under the tank location and analyzed for TPH-d organics and TPH-mo (these analyses had inadvertently not been performed on the original sample). The sample locations are shown on Figures 3-6 and 3-7. NORCAL identified a pipe that extends from the basement of Building 47 towards the UST. It is unclear whether this pipe was a product line from the UST to the former boiler in the basement of Building 47 as the pipe was not found in the UST excavation and could not be traced into the building. The original pipes associated with the Building 47 UST had already been removed from the tank prior to this investigation. Additionally, the boiler has been removed and the interior of the basement of Building 47 has been renovated. The pipe identified by NORCAL is located approximately six feet bgs, and is visible in a moat that circles the building at this level. If the pipe was a product line to the former boiler in the basement of Building 47, the pipe would have elbowed vertically up to the top of the UST, which sits approximately 5 feet higher than the pipe. This pipe may extend beneath the UST for another purpose and was not sampled as part of this investigation.

No samples were collected from the Building 161 UST or the piping extending from the Building 31 tank site towards the former Building 161 site. However, groundwater samples were collected downgradient of Building 161 as part of the Expanded SI (BC, 2005). Borings B118HP001, B118HP002, B161HP001, and B161HP002 were advanced and sampled downgradient of former Building 161. Results are discussed in the Expanded SI Report (BC, 2005).

### 3.2.4 Analytical Results

Analytical results for parameters detected in groundwater and soil samples at Building 31 are presented in Figures 3-1 through 3-5. Analytical results for parameters detected in soil samples at Building 47 are presented in Figures 3-6 and 3-7. A "Hits Report" (analytical results exceeding method detection limits) summarizing all parameters detected in any sample is presented at the end

of this report. Appendices C through E present a legend and the analytical laboratory reports for these samples.

### ***Building 31***

Detected metals results from a grab groundwater sample collected from the excavation are shown on Figure 3-1, along with metal results from boring B031HP003, located approximately 30 feet south (downgradient) of the excavation. Antimony, barium, lead, manganese, molybdenum, and zinc are notable metals detected above reporting limits. With the exception of lead, the same metals were reported in the downgradient location, B031HP003, at similar concentrations. Lead was not reported above the method detection limit of 0.002 milligrams per liter (mg/L) at B031HP003. Lead in groundwater in the tank excavation slightly exceeds this limit at 0.00213 mg/L.

TPH-g organics and TPH-d organics were detected at high levels in the grab groundwater sample collected from the excavation. Ethylbenzene and xylenes were detected at a maximum concentration of 1,000 µg/L. However, as shown on Figure 3-2, TPH-d organics were detected at very low levels in a groundwater sample collected from boring B031HP003. TPH-g, ethylbenzene and xylenes were not detected at boring B031HP003.

Soil samples collected from the north and west walls of the excavation contained elevated levels of TPH-g organics, TPH-d organics, and TPH-mo, exceeding their respective commercial/industrial ESLs. Lead was also detected at elevated levels in these two samples as shown on Figure 3-3. As discussed in Section 3.2.2, the presence of the planter box, ramp, and building prevented any over excavation in these directions to remove impacted soil. The south wall sample (in the suspected downgradient direction) contained much lower levels of TPH-g organics, TPH-mo and lead. A downgradient water sample was also collected, B031HP003-A-W01, and TPH and lead results were below their respective ESLs. Cis-1,2 DCE was detected at 0.0012 mg/L, although it is probably not a result of the UST and is addressed in the Expanded SI Report. Analytical results for TPH-g organics, TPH-d organics and TPH-mo are shown on Figure 3-4, which also shows the results of detected solvents. Figure 3-5 shows the results of detected PAHs in soil.

### ***Building 47***

Analytical results at Building 47 indicate that the soil beneath the former UST was not significantly impacted from leaks or spills. Analytical results for metals are shown on Figure 3-6. Analytical results for TPH-g organics, TPH-d organics and TPH-mo and lead are shown on Figure 3-7, which also shows the results of other detected parameters.

## **3.3 Investigative Derived Waste Disposal**

IDW generated as part of the field effort included soil, water (including tank contents and decontamination rinsate from sampling equipment), asphalt, tanks and associated piping from tank excavation activities, and disposable protective clothing and ground covers.

Table 3-1 presents the quantities of soil IDW generated during this investigation. The soil containers were stored at temporary waste staging areas at the Building 31 and Building 47 sites. Four grab samples were collected and composited into one sample from each of the soil containers (one at each UST site). IDW samples were also analyzed for the following parameters:

- TPH-d organics and TPH-mo by EPA Modified Method 8015;
- VOCs and TPH-g organics by EPA Method 8260B;
- Metals, including antimony, barium, beryllium, total chromium, cobalt, copper, manganese, molybdenum, nickel, silver, tin, vanadium and zinc by 6010B, cadmium and lead by 6010B ICP trace, arsenic by 7060A, selenium by 7740, thallium by 7841 and mercury by 7471A; and
- PAHs by EPA Method 8310.

In addition, the Building 31 IDW soil sample was analyzed for lead and chromium following the Toxic Characteristic Leaching Procedure (EPA Method 1311).

Based on analytical results, IDW soil from the Building 47 excavation contained low levels of petroleum hydrocarbons and was manifested as non-hazardous soil. IDW soil from the Building 31 excavation contained petroleum hydrocarbons and hazardous levels of total lead. Integrated Waste Management of Milpitas, California transported both the non-hazardous and the hazardous soil to Chemical Waste Management in Kettleman Hills, CA. Soil IDW waste manifests are included in Appendix D.

**Table 3-1. Quantities of Soil IDW**

Location	Quantity	Waste Classification
Building 47	7.69 tons	Non-Hazardous Waste, solid (Soil)
Building 31	17.35 tons	RCRA Hazardous Waste, solid (Soil with Lead)

Water removed from the fuel storage tank at Building 47 was combined with decontamination rinsate and purge water from Expanded SI drilling activities and stored in a temporary tank at Building 47. One grab sample was collected from the temporary water tank located at Building 47 and analyzed for the same parameters as the soil waste. Based on analytical results, the 550 gallons of IDW water was manifested as non-hazardous. Integrated Waste Management transported the non-hazardous liquid to Seaport R&E in Redwood City, CA. Water IDW waste manifests are included in Appendix D.

Asphalt was removed from the surface at Buildings 31 and 47 and transported to a recycling facility by Nielson Construction. Ecology Control Industries, Inc. (ECI) transported the fuel storage tanks and associated piping to their recycling and disposal facility in Richmond, California. ECI also cleaned residual solids from the tanks as part of its recycling activities. Tank manifests and tank destruction certificates are included in Appendix F. Excess disposable wastes derived from sampling, such as personal protective equipment (PPE), gloves, and bailers were disposed by BFI, which provides local garbage disposal service for the area.

### 3.4 Survey of Former UST Locations

At the request of the RWQCB, analytical data with the coordinate location of each UST removed is submitted electronically into the Geotracker database. The RWQCB requires sub-meter accuracy in a California State plane coordinate system. Coordinates for the USTs removed previously, Buildings 26, 28, 53, 103, and 154 were not located per RWQCB requirements. On 9 November 2004, Chaudhary and Associates, a California licensed land surveyor measured the locations of the former USTs at Buildings 26, 28, 31, and 47. The landowner of Buildings 53, 103, and 154, the same landowner of Building 161, would not allow access for the survey.

## 4.0 DATA USABILITY

This section summarizes the data quality assessment of analytical results reported for soil, soil gas and groundwater samples collected during this investigation. Only significant data quality issues are summarized. More detailed information and discussions, including verification/validation of the analytical results, are found in the Quality Control Summary Report (QCSR). Validation and/or verification of the laboratory analytical data was performed per the criteria specified in the Benicia QAPP (FA/BC, 1999a).

Soil and water samples were collected by BC on 25, 26 May and 9 August 2004. Some samples were collected and analyzed in real time on site by Transglobal Environmental Geochemistry Laboratory - Sacramento (TEG), a mobile laboratory. The other samples were sent under chain-of-custody by overnight shipment to EMAX Laboratories, Inc. (EMAX) in Torrance, California. EMAX is a USACE validated laboratory and both TEG and EMAX are California-certified laboratories. Data was received in both hard copy and electronic formats. In general, the data collected in support of this investigation are considered usable for the purpose of engineering decision making.

The results of the diesel fuel analysis performed by TEG are qualified as estimated with a possible low bias due to Quality Assurance/Quality Control (QA/QC) deficiencies. There were some systematic deficiencies noted based on the level IV data review for TEG. It was noted that TEG did not produce valid extraction efficiency indicators such as laboratory control samples or surrogate recoveries for the samples reviewed, which resulted in that data being qualified as estimated. The TEG diesel fuel results will be considered usable for screening and not as definitive data. This is due in part to provide the difficulty of performing the extraction and concentrations steps in the mobile setting. In the future, samples for TPH-extractable analysis that are analyzed by a mobile laboratory will also be analyzed by a fixed laboratory to provide definitive analytical results.

A summary of primary samples and associated quality control (QC) samples are included in Table 4-1.

Overall, the non-rejected data are of acceptable quality and are suitable for the purposes of this project.

**Table 4-1. QC Sample Summary Fuel RA**

Analytical Methods	Soil			Water		
	Number of Primary Samples	Number of Field Duplicate Samples	Number of USACE QA Samples	Number of Primary Samples	Number of Field Duplicate Samples	Number of USACE QA Samples
VOCs (8260B)	4	0	0	1	0	0
SVOCs (8270C)	NC	NC	NC	NC	0	0
Organochlorine Pesticides (8081A)	NC	NC	NC	NC	0	0
PCBs (8082)	NC	NC	NC	NC	0	0
PAHs (8310)	4	0	0	1	0	0
Explosives (8330)	NC	NC	NC	NC	NC	NC
TPH-g (8015B)	2	0	0	NC	0	0
TPH-d/motor oil (8015B)	4	0	0	1	0	0
TPH-ethanol/methanol (8015B)	4	0	0	1	0	0
Metals (6010B/7000)	4	0	0	1	0	0
Cyanide (9014)	NC	NC	NC	NC	0	0
Alkalinity (A2320)	NC	NC	NC	NC	0	0
Total Dissolved Solids (E160.1)	NC	NC	NC	NC	0	0
Anions (E300)	NC	NC	NC	NC	0	0
<b>Total number of analyses</b>	<b>22</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>0</b>	<b>0</b>

NC – None Collected  
 SVOCs – Semivolatile organic compounds  
 PCBs – polychlorinated biphenyls

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

The following section summarizes the results of the UST Removal Action.

- The historical ASTs no longer exist at either Buildings 88 or 89.
- At Buildings 42, service station West of Building 45, 46(B), and 71 no geophysical anomalies were reported in the areas searched that suggested the presence of a UST.
- Geophysical anomalies were identified at Buildings 31 and 47 that suggested the presence of USTs.
- A geophysical survey at Building 161 was inconclusive due to interference from the reinforced concrete surface and a fence with metal supports. Potential fuel lines were located extending from Building 31 (a former fuel station) to Building 161 (a former maintenance facility). A fuel fill pipe was also located in an underground vault. Additional access was requested in order to remove the tank; however, the property owner rescinded all access to the property. To date, the tank remains in place and the pipe running from Building 31 UST towards Building 161 has not been grouted or sampled.
- A 400-gallon single-walled steel tank was located and removed at Building 47.
- A 1,000-gallon single-walled steel tank was removed near the former Building 31.
- ROE was denied by the landowners at Building 27 and CL2.
- Scaffolding at Building 45 prevented any investigation to find the suspected UST.

### 5.1 Recommendations

Additional investigations are warranted to identify and/or remove USTs at Buildings 27, 45, 161, and CL2. Investigations at these locations were not performed because a ROE agreement was not reached or existing scaffolding (Building 45) prohibited investigation.

Suspected DoD sources appear to have impacted soil on the north and northeast sides of the former UST at Building 31; however, the existing building and planter box prevent any overexcavation. Groundwater is impacted with fuels and solvents. The solvents are related to other sites in close proximity to Building 31. An evaluation of risk is recommended for the residual fuels in soil and the solvents in groundwater at this tank site.

The UST at Building 47 has not resulted in contamination and does not warrant additional investigation. In addition, geophysical and visual investigations determined that there were no USTs or ASTs remaining at Building 42, Building 46(B), Building 71, Building 88, Building 89, or the service station west of Building 45. No further DoD action is indicated at these locations.

## 6.0 REFERENCES

- Brown and Caldwell. 2005. *Expanded Site Inspection Field Site Investigation Report*. Draft. April.
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- California Regional Water Quality Control Board. 2003. *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater*. Interim Final. July.
- Forsgren Associates/Brown and Caldwell. 2004a. *Preliminary Assessment Report for the Former Benicia Arsenal*. Final. Prepared for U.S. Army Corps of Engineers, Sacramento, California. October.
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- Forsgren Associates/Brown and Caldwell. 2002. *Technical Memorandum for Area I Fuel Storage Facilities at Buildings 15, 25, 26, 28, 45, 46(B), 54, 118(A), 152, and 178 for the Benicia Arsenal*. March.
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**HITS REPORTS**

**Detected Analytes in  
Soil  
PAHs by EPA Method  
8310 (mg/kg)**

Location-ID	Sample Date	Depth (feet)	Soil Code	ACENAPHTHENE	ACENAPHTHYLENE	ANTHRACENE	BENZO(a)ANTHRACENE	BENZO(a)PYRENE	BENZO(b)FLUORANTHENE	BENZO(g,h,i)PERYLENE	BENZO(k)FLUORANTHENE	CHRYSENE	FLUORANTHENE	FLUORENE	INDENO(1,2,3-c,d)PYRENE	NAPHTHALENE	PHENANTHRENE
				< 0.015	< 0.027	< 0.0015	< 0.00095	< 0.0011	< 0.002	< 0.002	< 0.0017	< 0.00095	< 0.002	< 0.0023	< 0.0021	< 0.0012	0.0016 J
				< 0.016	< 0.029	< 0.0016	0.19 J+	< 0.0011	0.43 J+	< 0.0021	0.083 J+	0.38 J+	< 0.0021	< 0.0024	0.097 J+	0.35 J+	0.47 J+
				27	12 J+	0.76 J+	< 0.0049	0.1 J+	0.12 J+	0.14 J+	0.036 J	0.26 J+	0.97 J+	2.6 J+	0.038 J	130	1.4
				< 0.014	< 0.025	< 0.0014	0.028 J	< 0.00099	< 0.0019	< 0.0019 UJ	< 0.0015	0.00088 UJ		0.013 J	< 0.002 UJ	< 0.0011	0.022 J

Number of Detects:	1	1	1	2	1	2	1	2	2	1	2	2	1	2	2	4
Total Number of Analyses:	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Minimum Concentration:	27	12	0.76	0.028	0.1	0.12	0.14	0.036	0.26	0.97	0.013	0.038	0.35	0.0016		
Maximum Concentration:	27	12	0.76	0.19	0.1	0.43	0.14	0.083	0.38	0.97	2.6	0.097	130	1.4		
Mean Detected Concentration:	27	12	0.76	0.109	0.1	0.275	0.14	0.0595	0.32	0.97	1.3065	0.0675	65.175	0.4734		

**QUALIFIER LEGEND:**

- (blank) Unqualified result.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J- The analyte was positively identified with low bias; the associated numerical value is the approximate concentration of the analyte in the sample.
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- NJ The analyte identification is presumptive. Reported value is an estimated concentration.
- R The material was analyzed for and was reported as detected by the laboratory. The data are unusable. The analyte may or may not be present.
- U The analyte was not detected above the reported sample quantitation limit.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- UR The material was analyzed for and was reported as not detected by the laboratory. The data are unusable. The analyte may or may not be present.

**Detected Analytes in Soil  
Fuels by EPA Method B (mg/g)**

**DIESEL (C10-C24)**

**GASOLINE (~C6-C10)**

**MOTOR OIL (C20-C36)**

Location-ID	Sample Date	Depth (feet)	Soil Code	DIESEL (C10-C24)	GASOLINE (~C6-C10)	MOTOR OIL (C20-C36)
				54 J		120 J
				180 J		1600 J
				8200	22000	1300

<b>Number of Detects:</b>	3	1	3
<b>Total Number of Analyses:</b>	5	5	5
<b>Minimum Concentration:</b>	54	22000	120
<b>Maximum Concentration:</b>	8200	22000	1600
<b>Mean Detected Concentration:</b>	3384.667	22000	1006.667

**QUALIFIER LEGEND:**

- (blank) Unqualified result.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J- The analyte was positively identified with low bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified with high bias; the associated numerical value is the approximate concentration of the analyte in the sample.
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**Detected Analytes in Soil  
VOCs by EPA Method 8260B (mg/kg)**

Location-ID	Sample Date	Depth (feet)	Soil Code	1,2,3-TRIMETHYLBENZENE	1,2,4,5-TETRAMETHYLBENZENE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE (MESITYLENI)	1-METHYL-3-PROPYLBENZENE	2,6-DIMETHYLUDECANE	2-ETHYLTOLUENE	2-METHYLHEPTANE	2-METHYL-UNDECANE	ACETONE	CYCLOOCTANE	DODECANE	ETHYLBENZENE	GASOLINE (~C6-C10)	ISOPROPYLBENZENE (CUMENE)	M,P-XYLENE (SUM OF ISOMERS)	METHYL ETHYL KETONE (2-BUTANONE)	METHYLCYCLOHEXANE	NAPHTHALENE	n-BUTYLBENZENE	n-PROPYLBENZENE	N-TRIDECANE (C13)	O-XYLENE (1,2-DIMETHYLBENZENE)	P-CYME	P-CYME (p-ISOPROPYLTOLUENE)	SEC-BUTYLBENZENE	TOLUENE	TRICHLOROFLUOROMETHANE	UNDECANE
UST31GR01	5/25/2004	3.3 - 3.5				0.0027 J	< 0.0017									< 0.0016	< 0.057	< 0.0018	< 0.0036			< 0.0023	< 0.0017	< 0.0015		< 0.0017		< 0.0014	< 0.0015	< 0.0026	< 0.0024	
UST31GR01	5/25/2004	3.5 - 3.7				< 0.009	< 0.0085									0.049	2.7 J	0.018 J	0.028			< 0.0115	< 0.0085	0.034		< 0.0085		0.027	0.016 J	< 0.013	< 0.012	
UST31GR01	5/26/2004	3.5 - 4	360 J	62 J	88 J	230	84 J			190 J	120 J		< 1.7	370 J		84		30	300	< 1.7	350 J	140 J	95	100		35	69 J	13	18	0.61 J	< 0.17	
UST47GR01	5/26/2004	4 - 4.5				0.0048 J+	0.0023 J		0.22 NJ			0.059 NJ	0.042 J+		0.11 NJ	< 0.00033		< 0.00047	< 0.00073	0.005 J+		0.0087 J	0.002 J	< 0.00025	0.43 NJ	< 0.00028		0.0013 J	0.00058 J	< 0.00055	0.006 J+	0.054 NJ

Number of Detects:	1	1	3	2	1	1	1	1	1	1	1	1	1	1	2	1	2	2	2	1	1	2	2	2	1	1	1	3	3	1	1	1	
Total Number of Analyses:	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Minimum Concentration:	360	62	0.0027	0.0023	84	0.22	190	120	0.059	0.042	370	0.11	0.049	2.7	0.018	0.028	0.005	350	0.0087	0.002	0.034	0.43	35	69	0.0013	0.00058	0.61	0.006	0.054				
Maximum Concentration:	360	62	88	230	84	0.22	190	120	0.059	0.042	370	0.11	84	2.7	30	300	0.005	350	140	95	100	0.43	35	69	13	18	0.61	0.006	0.054				
Mean Detected Concentration:	360	62	29.33583	115.0012	84	0.22	190	120	0.059	0.042	370	0.11	42.0245	2.7	15.009	150.014	0.005	350	70.00435	47.501	50.017	0.43	35	69	4.342767	6.005527	0.61	0.006	0.054				

**QUALIFIER LEGEND:**

- (blank) Unqualified result.
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- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- UR The material was analyzed for and was reported as not detected by the laboratory. The data are unusable. The analyte may or may not be present.

**Detected Analytes in Water  
PAHs by EPA Method 8310 (ug/L)**

Location-ID	Sample Date	Depth(feet)	ACENAPHTHENE	BENZO(b)FLUORANTHENE	NAPHTHALENE	PHENANTHRENE
			26	0.14 J	150 J-	0.46

<b>Number of Detects:</b>	1	1	1	1
<b>Total Number of Analyses:</b>	1	1	1	1
<b>Minimum Concentration:</b>	26	0.14	150	0.46
<b>Maximum Concentration:</b>	26	0.14		0.46
<b>Mean Detected Concentration:</b>	26	0.14	-150	0.46

**QUALIFIER LEGEND:**

- (blank) Unqualified result.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J- The analyte was positively identified with low bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified with high bias; the associated numerical value is the approximate concentration of the analyte in the sample.
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- U The analyte was not detected above the reported sample quantitation limit.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- UR The material was analyzed for and was reported as not detected by the laboratory. The data are unusable. The analyte may or may not be present.

**Detected Analytes in Soil  
Metals (mg/kg)**

Location-ID	Sample Date	Depth (feet)	Soil Code	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM, TOTAL	COBALT	COPPER	IRON	LEAD	MAGNESIUM	MANGANESE	MERCURY	MOLYBDENUM	NICKEL	SILVER	SODIUM	THALLIUM	VANADIUM	ZINC
UST31GR01	5/25/2004	3.3 - 3.5		23700	2.65 J	5.95	87.6	0.705 J	0.258 J	6800	65.3	11.8	17.6	33200	22.9	11000	477	< 0.0321	< 0.743	66	0.985 J	182	0.768	63.5	73.5
UST31GR01	5/25/2004	3.5 - 3.7		2430	28.1	1.93	450	< 0.158	5.9	1310	257	14.7	184	16500	1500	1640	103	0.145	1.45 J	10.4	0.872 J	73.3 J	0.29 J	7.12	368
UST31GR01	5/26/2004	3.5 - 4		2070	14.1	4.42	401	< 0.154	13.5	1930	232	11	136	14600	1280	1220	108	0.137	2.49 J	9.79	1.08 J	67.2 J	0.228 J	5.46	468
UST47GR01	May 26, 2004	4 - 4.5		14600	< 1.84	7.27	50.6	0.524 J	0.229 J	11000	33.4	7.14	7.07	24100	16.7	5510	403	0.0345 J	< 0.689	11.2	0.783 J	180	0.837	55	54.7

<b>Number of Detects:</b>	4	3	4	4	2	4	4	4	4	4	4	4	4	4	4	4	4	3	2	4	4	4	4	4	4
<b>Total Number of Analyses:</b>	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
<b>Minimum Concentration:</b>	2070	2.65	1.93	50.6	0.524	0.229	1310	33.4	7.14	7.07	14600	16.7	1220	103	0.0345	1.45	9.79	0.783	67.2	0.228	5.46	54.7			
<b>Maximum Concentration:</b>	23700	28.1	7.27	450	0.705	13.5	11000	257	14.7	184	33200	1500	11000	477	0.145	2.49	66	1.08	182	0.837	63.5	468			
<b>Mean Detected Concentration:</b>	10700	14.95	4.8925	247.3	0.6145	4.97175	5260	146.925	11.16	86.1675	22100	704.9	4842.5	272.75	0.1055	1.97	24.3475	0.93	125.625	0.53075	32.77	241.05			

**QUALIFIER LEGEND:**

- (blank) Unqualified result.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J- The analyte was positively identified with low bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified with high bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- N The analyte identification is presumptive.
- NJ The analyte identification is presumptive. Reported value is an estimated concentration.
- R The material was analyzed for and was reported as detected by the laboratory. The data are unusable. The analyte may or may not be present.
- U The analyte was not detected above the reported sample quantitation limit.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- UR The material was analyzed for and was reported as not detected by the laboratory. The data are unusable. The analyte may or may not be present.

**Detected Analytes in Water  
Fuels by EPA Method B (ug/L)**

**DIESEL (C10-C24)**

Location-ID	Sample Date	Depth(feet)
		14000 J

Number of Detects:	1
Total Number of Analyses:	1
Minimum Concentration:	14000
Maximum Concentration:	14000
Mean Detected Concentration:	14000

**QUALIFIER LEGEND:**

- (blank) Unqualified result.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J- The analyte was positively identified with low bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified with high bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- N The analyte identification is presumptive.
- NJ The analyte identification is presumptive. Reported value is an estimated concentration.
- R The material was analyzed for and was reported as detected by the laboratory. The data are unusable. The analyte may or may not be present.
- U The analyte was not detected above the reported sample quantitation limit.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- UR The material was analyzed for and was reported as not detected by the laboratory. The data are unusable. The analyte may or may not be present.

**Detected Analytes in Water Metals (mg/L)**

Location-ID	Sample Date	Depth(feet)	ANTIMONY	BARIUM	CALCIUM	LEAD	MAGNESIUM	MANGANESE	MOLYBDENUM	POTASSIUM	SODIUM	ZINC
			0.011	0.122	25.1	0.00213 J	13.2	0.26	0.0113 J	5.81	114	0.0174 J

<b>Number of Detects:</b>	1	1	1	1	1	1	1	1	1	1	1	1
<b>Total Number of Analyses:</b>	1	1	1	1	1	1	1	1	1	1	1	1
<b>Minimum Concentration:</b>	0.011	0.122	25.1	0.00213	13.2	0.26	0.0113	5.81	114	0.0174		
<b>Maximum Concentration:</b>	0.011	0.122	25.1	0.00213	13.2	0.26	0.0113	5.81	114	0.0174		
<b>Mean Detected Concentration:</b>	0.011	0.122	25.1	0.00213	13.2	0.26	0.0113	5.81	114	0.0174		

**QUALIFIER LEGEND:**

- (blank) Unqualified result.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J- The analyte was positively identified with low bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified with high bias; the associated numerical value is the approximate concentration of the analyte in the sample.
- N The analyte identification is presumptive.
- NJ The analyte identification is presumptive. Reported value is an estimated concentration.
- R The material was analyzed for and was reported as detected by the laboratory. The data are unusable. The analyte may or may not be present.
- U The analyte was not detected above the reported sample quantitation limit.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- UR The material was analyzed for and was reported as not detected by the laboratory. The data are unusable. The analyte may or may not be present. may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.