## SECTION 6
## RESULTS AND ANALYSIS

In this section, the analytical results of samples specified in Section 3.0 are discussed. This section is organized by WIRMS classifications and by geographic order starting from the north, with Area R and ending up at the southern end of the former Arsenal, Area I (the industrial area). The sites within each of the WIRMS area are listed below.

- Area R
  - Former burn cages at Spurs A, E and G
- Area S
  - Former firing range
- Area W
  - Sites surrounding the former NIKE Missile Assembly Facility (the Septic Tank 194, Waste Areas, Open Ditch, CL1 and CL2)
- Area M
  - Post Dumpsite
  - Popping Pot
  - Salvage Yard
  - Fillsite 3
  - Former vehicle maintenance buildings T221, T222, 171 and 172
  - Former heavy equipment yard (Buildings 50 and 111)
- Area I
  - Former Sandblast Building/Paint Spray (Building 4)
  - Former Store House/Engine Rebuild (Building 31)
  - Former Garage/Repair Shop (Building 42)
  - Former Drum Storage/Maintenance Area (Building 51)
  - Former Dynamometer Shop/Engine Testing (Building 53) UST
  - Blacksmith Shop/ Machine/Welding Shops (Building 55), Leather & Canvas Shop/ Welding Shop (Building 56), Small Arms Shop/Leather Canvas Shop (Building 56A) and Small Arms Shop, Firing Range (Building 57)
  - Former Boiler Houses (Buildings 58(A) and 65A)
  - Former Tool House/Degreaser Pit (Building 59)
  - Former Tool House (Building 59(A))
  - Former Locomotive Building (Building 90)
  - Former Machine Shop/Combat Vehicle and Artillery Repair (Building 91)
  - Former Machine Shop/ Engine Rebuild (Building 91A)
  - Former Truck Storage Building/MMW Repair, Motor Vehicle Maintenance Building (Building 93)
  - Former Battery Charge Building (Building 101)
  - Former Service Station (Building 103) UST
  - Former Building 118A ASTs
  - Former Quartermaster Storage/Shop/Electroplating (Building 120)
  - Former Motor Test Shed (Building 154) USTs
  - Former Locomotive House (Building 156)
  - Former Motor Cleaning Building/Steam Cleaning/Paint Spray/Fuel Storage (Building 161)
  - Former Reclamation Building/Transport Vehicle Shop (Building 165)

- Former Steam Cleaning Building (Building 165A)/ Former Maintenance Building, Body and Radiator Shop (Building T199)
- Former Motor Cleaning Building/Steam Cleaning/Paint Spray/Fuel Storage (Building 161),
- Former Paint Shop (Building 166)
- Former Bar Stock Building/Storage/Vehicle Shops for Motor Pool (Building 167 and Building 168)
- Fillsite 1
- Former Storehouse/Shop (Building TO131)
- Industrial Area Groundwater

The industrial area is discussed with an emphasis on treating the area as a whole since the sites are closely located. Where possible, if results indicate a single source area that can be attributed to a specific building or activity, that building or activity is discussed separately. Within this subsection, the results and analysis of the storm water sampling is discussed.

A total of 14 soil samples, 16 soil gas samples, 117 Hydropunch® groundwater samples, 15 storm water catch basin samples, and 14 groundwater well samples were collected during this investigation. These sample counts do not include QA/QC samples.

If applicable, a comparison of data from previous investigations is included in this section (i.e., PCHM, Fillsite 1, 50 Series SI, and UST investigations at Buildings 53, 73, 103, and 154). Analytical results that have values greater than method detection limits (MDLs) are provided at the end of this report in a separate section titled "Hits Report". These tables are organized first by analyte type (i.e., VOCs, SVOCs, PAHs, TPH) and then by matrix (i.e., VOCs for soil and groundwater).

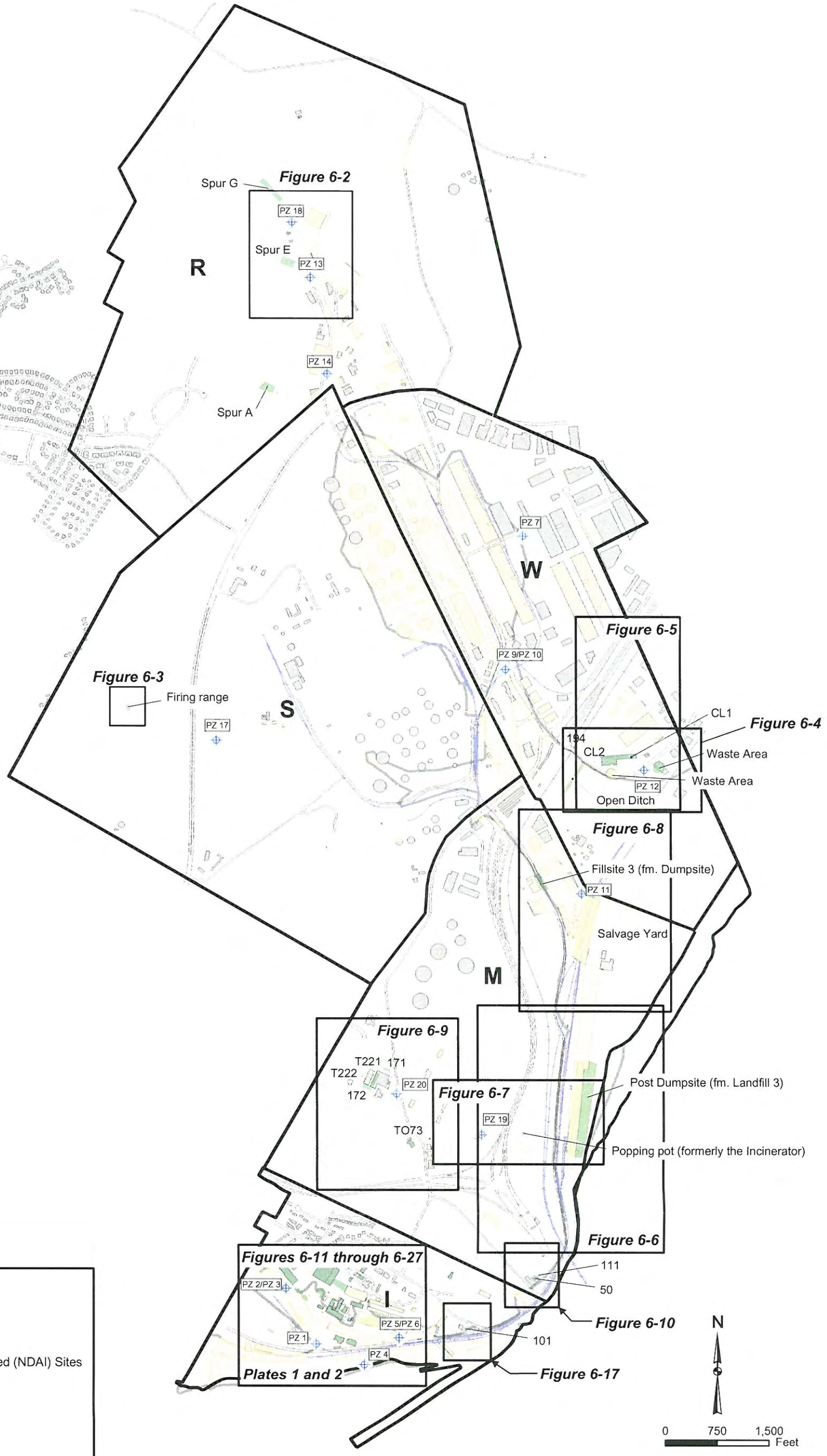
For all the analytical results from this sampling event, there is Appendices G through J. Appendix G is a legend for the abbreviations and acronyms used in Appendices H, I and J. Appendices H, I, and J contain all results, for soil, soil gas and groundwater, respectively. Both detected values and non-detected values are on CD in PDF format.

Figure 6-1 is a map of the Arsenal that locates the figures for this section.

Figures and tables in this section are formatted to show only analytes detected above MDLs. Some figures are further refined to show analytes detected above a comparison criteria in order to provide clarity because of the amount of detections above the MDLs.

## 6.1 Area R

Area R is described in more detail in in Section 1.3.2 entitled Arsenal History. After the end of World War II, Area R was used primarily to destroy obsolete or damaged ammunition (Jacobs, 1999). Expanded SI Sites within Area R consist of former burn cages at Spurs A, E, and G, and their approximate location is shown on Figure 6-1.

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PROJECT: 24785-007
DATE: 4/8/2005

TITLE:
SITE:

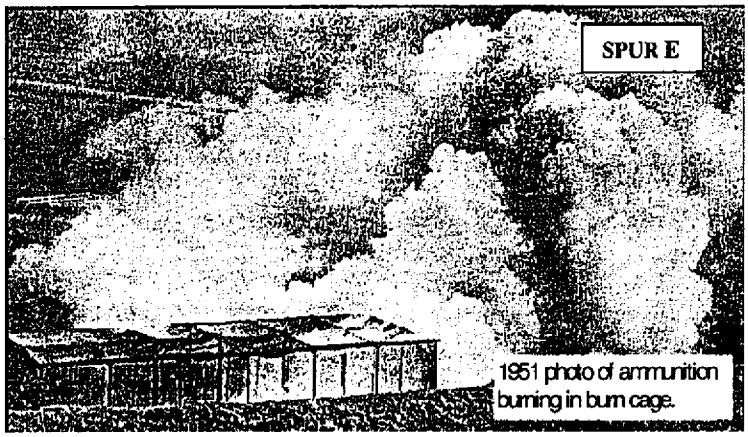
**Expanded SI Site Locations and Figure Reference Map**
**Benicia Arsenal, Benicia, California**

**Figure 6-1**

### 6.1.1 Former Burn Cages at Spurs A, E, and G

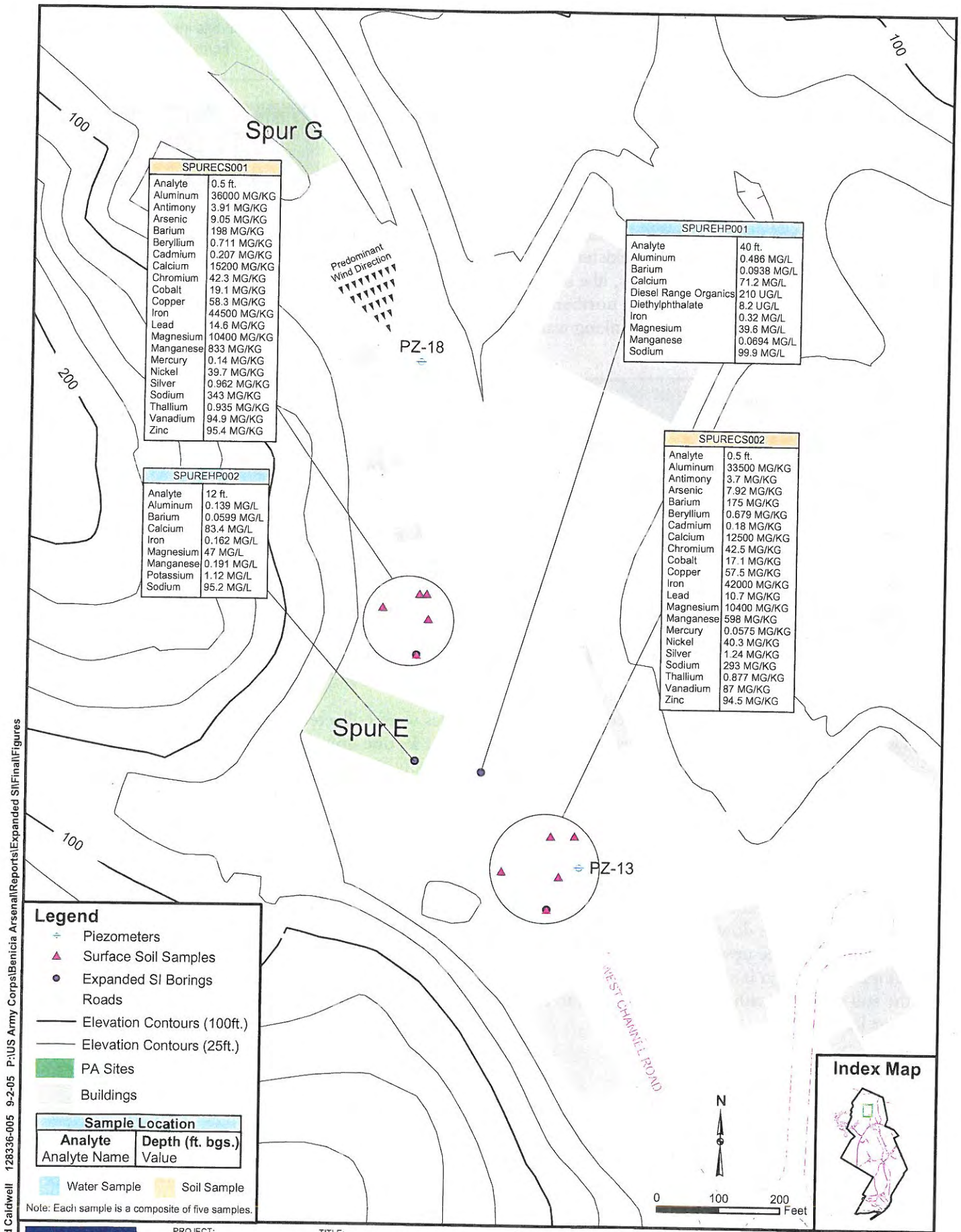
**No further DoD Action is Indicated at Former Burn Cages Spur A, E and G**

These burn cages were reportedly used to burn outdated .30, .50, and .37 caliber ammunition. The ammunition was dumped into the cage, covered with kerosene, then set on fire. Burn cages were used by the Army from approximately 1948 to 1954 and were constructed with concrete walls and floor. The sides and roof were composed of screened mesh. The existence and location of Spur A and Spur G could not be confirmed, but several photographs, like the photo below, show burning in the Spur E burn cage. These burn cages are located in the northern portion of the former Arsenal within a highland valley where groundwater is a possible drinking water source.




Since the location and existence of the other burn cages at Spur A and Spur E could not be confirmed, the Expanded SI focused sampling criteria at the known burn cage, Spur E. If results from the samples collected at Spur E indicated the presence of fuels (diesel fuel or motor oil) in groundwater, then sampling was planned at the approximate locations of Spur A and Spur G. Based on results from the sampling at the Spur E burn cage, sampling did not take place at Spur A and Spur G.

Two composite soil samples and two groundwater samples were collected for analysis at Spur E. Two 5-point composite soil samples were collected at Spur E, one upwind (SPURECS001) and one downwind (SPURECS002) of the former burn cage below any aggregate or paving materials to determine the presence or absence of metals and explosives from former burning of ammunition in a burn cage. The downwind sample was to provide information on impacts to surface soil from particulates produced during burning, which were blown, downwind of the former burn cage. The upwind sample results were used to determine ambient concentrations in the area. Table 6-1 shows the results, the percentage difference between the upwind or ambient background sample and the downwind sample and the BSL for each metal reported. The percent difference column shows a "+" sign when the downwind sample was detected at a higher concentration than the upwind sample. When the upwind soil sample was detected at a higher concentration than the downwind sample, a "-" sign is shown in the percent difference column. Figure 6-2 illustrates the location of the soil samples (with results) in relation to the approximately location of the former burn cage at Spur E.

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PROJECT: 24785-007
DATE: 4/4/2005

TITLE: Sampling Locations and Detected Results at Spur E
SITE: Benicia Arsenal, Benicia, California

Figure 6-2

Table 6-1. Spur E Composite Soil Samples

| Metal | Upwind Ambient Sample | Downwind Sample | Percent Difference | BSL | Ambient Background |
|---|---|---|---|---|---|
| Aluminum | 36,000 | 33,500 | -7% | 1,680,000 | 28,300 |
| Antimony# | 3.91 | 3.7 | -5% | 818 | 8.52 |
| Arsenic# | 9.05 | 7.92 | -12% | 439 | 16.9 |
| Barium | 198 | 175 | -12% | 124,000 | 224 |
| Beryllium | 0.711 | 0.679 | -5% | 3,690 | 0.829 |
| Cadmium | 0.207 | 0.18 | -13% | 1,010 | 0.866 |
| Calcium | 15,200 | 12,500 | -18% | NE | NE |
| Chromium | 42.3 | 42.5 | +0.5% | 448+ | 75.3 |
| Cobalt | 19.1 | 17.1 | -10% | 123,000 | 13.3 |
| Copper# | 58.3 | 57.5 | -1% | 75,800 | 40.5 |
| Iron | 44,500 | 42,000 | -6% | 613,000 | 52,600 |
| Lead# | 14.6 | 10.7 | -27% | 750 | 20.1 |
| Magnesium | 10,400 | 10,400 | 0% | NE | NE |
| Manganese | 833 | 598 | -28% | 32,300 | 1,070 |
| Mercury | 0.14 | 0.0575 | -59% | 613 | 0.287 |
| Nickel | 39.7 | 40.3 | +2% | 40,900 | 38.3 |
| Silver | 0.962 | 1.24 | +29% | 10,200 | 1.67 |
| Sodium | 343 | 293 | -15% | NE | NE |
| Thallium | 0.935 | 0.877 | -6% | 135 | 0.85 |
| Vanadium | 94.9 | 87 | -8% | 14,300 | 92.2 |
| Zinc# | 95.4 | 94.5 | -1% | 613,000 | 126 |

* - Commerical/Industrial worker- noncarcinogen (FA/BC, 2002a)
+ - Commercial/Industrial worker – carcinogen (FA/BC, 2002a)
^ - FA/BC, 2004b
# - Metals that are typically associated with ammunition (Interstate Technology and Regulatory Council, 2003).
NE – not established.

Metal concentrations from the upwind sample were up to 59 percent greater in concentration than the downwind sample, except for chromium, nickel, and silver. Metals that are typically associated with ammunition are antimony, arsenic, copper, lead, and zinc (Interstate Technology and Regulatory Council, 2003). These metals were found in greater concentrations in the upwind sample than the downwind sample and all of these results are below BSLs and below ambient concentrations except copper. Copper was identified above ambient concentrations in the upwind and the downwind soil sample. Even though copper was found above ambient concentrations, the evidence of the other ammunition-related metals concentrations that were below ambient concentrations or BSLs, especially in the downwind sample, indicates that there is no significant impact from the former burning of ammunition in the burn cage at Spur E.

Two groundwater samples were also collected at Spur E: one location (SPUREHP001) downgradient of the former burn cage; and one location (SPUREHP002) near the former burn cage as shown on Figure 6-2. The purpose of the groundwater samples was to determine the presence or absence of a suspected release of fuels from former burning of ammunition in the burn cage. These samples were also analyzed for metals, explosives and semi-volatile compounds. Low-level diesel

fuel concentrations (210 µg/L) were detected in groundwater at SPUREHP001. A step-out hydropunch, SPUREHP002, was advanced based on the diesel fuel detected at SPUREHP001. SPUREHP002 was drilled closer to the former burn cage to determine if there are higher concentrations of diesel fuel in groundwater. Fuels were not detected in groundwater at SPUREHP002 and the diesel fuel detected in SPUREHP001 does not exceed its respective ESL of 640 µg/L (Table 6-2).

The SPUREHP001 groundwater sample was also sent for additional analysis by EPA Method 8270 because of distinct peaks on the fuel chromatography that may indicate non fuel-related compounds. Diethylphthalate, a plasticizer used in a wide variety of consumer products, including plastic packaging films, cosmetic formulations, and toiletries, as well as in medical treatment tubing, was found in the sample. However, the hold time was exceeded and the compound could not be matched to the peaks on the fuel chromatography.

Metals and explosives were analyzed in both groundwater samples collected at Spur E. Explosives were not detected above the MDL. Aluminum, barium, calcium, iron, magnesium, manganese, potassium and sodium were detected in the groundwater samples (Table 6-2). As stated above, metals that are typically associated with ammunition are antimony, arsenic, copper, lead, and zinc. None of these metals were detected in groundwater and none of these metals exceeded established MCLs.

Table 6-2. Groundwater Concentrations at the Former Burn Cage at Spur E

| [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|
| Aluminum | 0.486 | 0.139 | 1 |
| Barium | 0.0938 | 0.0599 | 1 |
| Calcium | 71.2 | 83.4 | NE |
| Diesel fuel | 210 µg/L | <24 µg/L | 100 µg/L (ESL) |
| Diethylphthalate | 8.2 µg/L | Not analyzed | NE |
| Iron | 0.32 | 0.162 | NE |
| Magnesium | 39.6 | 47 | NE |
| Manganese | 0.0694 | 0.191 | NE |
| Potassium | < 1 | 1.12 | NE |
| Sodium | 99.9 | 95.2 | NE |

ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005).
MCL = maximum contaminant level (California Department of Health Services, 2004)
NE = not established
mg/L = milligrams per liter
µg/L = micrograms per liter

No further DoD action is indicated at the former burn cage at Spur E for the following reasons:

- metals in soil do not exceed BSLs;
- metals associated with ammunition were not detected in groundwater and do not exceed established MCLs;
- explosives were not detected in groundwater; and

- diesel range hydrocarbons found in groundwater appear to be isolated, may be something other than diesel fuel that is non-DoD, and do not exceed the ESL for diesel fuel.

Because there is no DoD impact from former burning activities at Spur E, no further DoD action is indicated at Spurs A and G as well.

## 6.2 Area S

Area S is described in more detail in Section 1.3.2 entitled Arsenal History. Area S was used primarily to store ammunition and as general storage (Jacobs, 1999). Only one Expanded SI Site is within Area S; the Firing Range Target Berm.

### 6.2.1 Firing Range Target Berm

This firing range target berm is located in the western portion of Area S, a remote area of the former Arsenal and now part of a restricted buffer zone for the Valero Refinery (Figure 6-1). The Army used the target berm to test fire .45 and .50 caliber weapons in the 1940s.

No further DoD Action is Indicated at the Firing Range Target Berm

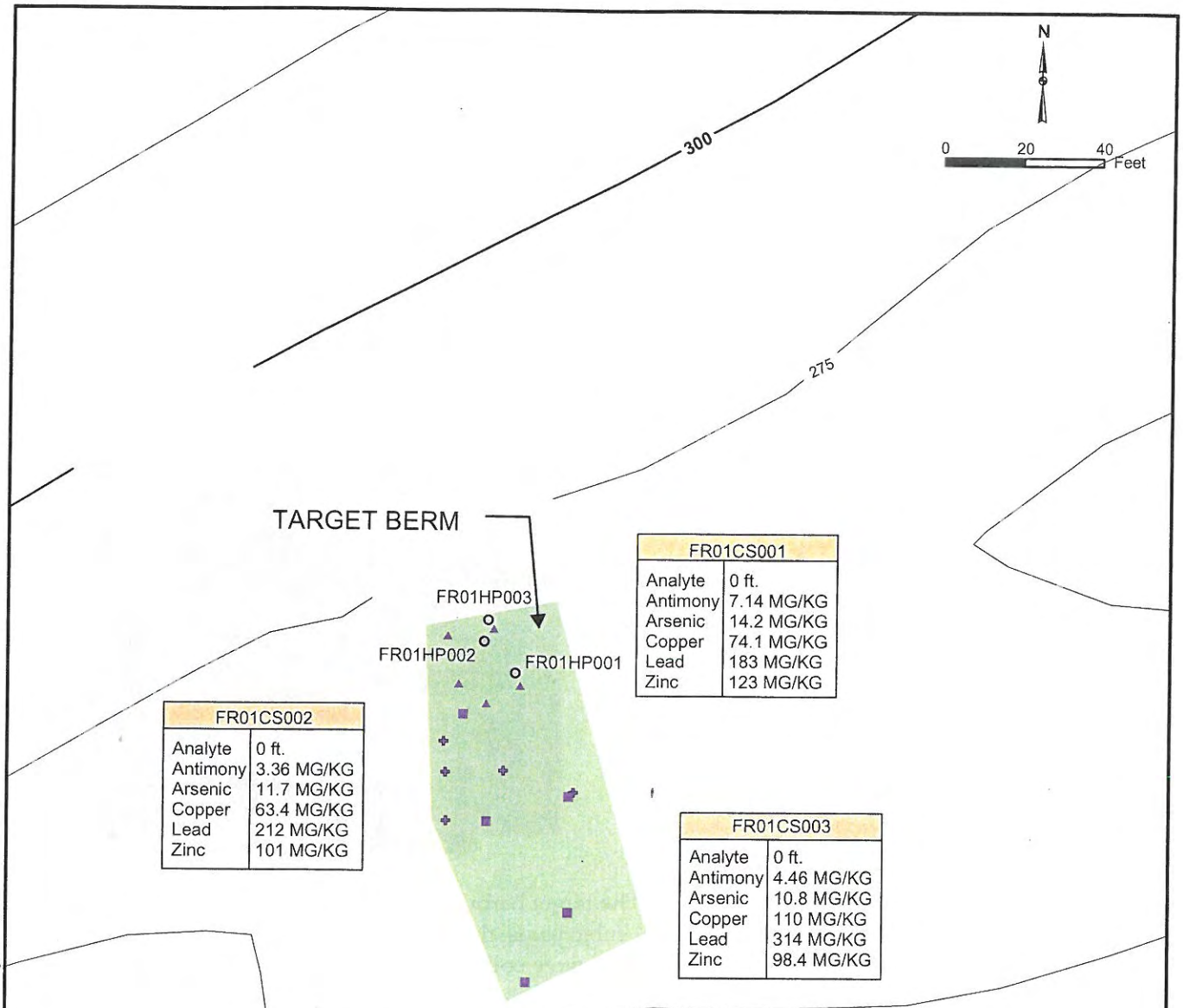
After removing brush from the area, the shape of the berm and presence of slugs indicated the soil pile was used as a target berm or backstop. Measuring the length, width and height approximated the volume of the target berm. The target berm measured approximately 150 cubic yards. Composite samples were taken every 50 cubic yards, therefore, three composite soil samples (FR01SC001 through FR01SC003). These samples were collected to determine the presence or absence of antimony, arsenic, copper, lead, and zinc, metals commonly associated with ammunition (Interstate Technology and Regulatory Council, 2003), in the target berm soil. Each composite soil sample was composed of five individual samples representing every 50 cubic yards of the berm. Slugs and slug fragments were removed from the soil using a No. 10 sieve. Results of typical metals associated with slugs or ammunition are shown on Figure 6-3 and in Table 6-3.

All the sample results for the individual metals were below BSLs (Table 6-3).

**Table 6-3. Composite Metals Concentrations in Soil from the Former Firing Range Target Berm**

| | Concentrations in mg/kg | | | |
|---|---|---|---|---|
| **Metal** | **FR01CS001** | **FR01CS002** | **FR01CS003** | **BSL*** |
| Antimony | 7.14J- | 3.36J | 4.46J | 818 |
| Arsenic | 14.2 | 11.7 | 10.8 | 439 |
| Copper | 74.1 | 63.4 | 110 | 75,800 |
| Lead | 183 | 212 | 314 | 750 |
| Zinc | 123 | 101 | 98.4 | 613,000 |

- Commerical/Industrial worker- noncarcinogen (FA/BC, 2002a)
BSL = Benicia Screening Level - Commerical/Industrial worker- noncarcinogen (FA/BC, 2002a) *carcinogen




**Legend**

Surface Soil Samples
- FR01CS001
- FR01CS002
- FR01CS003

Attempted Groundwater Sample Locations
- FR01HP001

Elevation Contours (100ft.)

Elevation Contours (25ft.)

PA Sites

| Sample Location | |
|---|---|
| **Analyte** | **Depth (ft. bgs.)** |
| Analyte Name | Value |

Soil Sample

Each sample is a composite of five samples (noted by different symbols). Slugs and slug fragments were sieved from each sample.

**Index Map**

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PROJECT: 24785-007
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**Sampling Locations and Detected Results at the Firing Range Benicia Arsenal, Benicia, California**

**Figure 6-3**

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Three borings (FR01HP001 through FR01HP003) were hand augered downslope of the target berm to determine if precipitation onto the berm mobilized the metals in the berm, percolated through the berm soil into subsurface soil and then into groundwater. The locations of these borings are shown on Figure 6-3. Groundwater was not encountered; and expected result based on the location of the target berm in the Highlands foothills. A thin veneer of silt and sand alluvium was encountered overlying sandstone at 4.5 feet bgs.

The target berm is located in a remote area and within the Valero buffer zone, where its access is controlled. After decades of precipitation, the analytical data indicates that metals are not mobilizing into the surrounding soil and there is no groundwater in the area to impact. Therefore, there is no significant threat to human health or the environment. No further DoD action is indicated for the firing range target berm.

## 6.3 Area W

Area W is described in more detail in Section 1.3.2 entitled Arsenal History. Area W was used primarily to receive and store small arms, ammunition, and related supplies throughout World War II (Jacobs, 1999). Expanded SI Sites within Area W include: the Septic Tank 194, Waste Area, Open Ditch, CL1 and CL2 (all surrounding the Former NIKE Missile Assembly Facility).

### 6.3.1 Sites Surrounding the Former NIKE Missile Assembly Facility (the Septic Tank 194, Waste Areas, Open Ditch, CL1 and CL2)

Non DoD upgradient solvent plume may extend beneath the former NIKE Missile Assembly Facility. There is also a recent source of diesel fuel.

The sites surrounding the Former NIKE Missile Assembly Facility are the Septic Tank 194, Waste Areas, Open Ditch, CL1 and CL2, which are located in the southern portion of Area W (Figure 6-1). CL1 was a clip-link and belt plant from 1942 to 1944. By December 1943, activities related to the Arsenal's new mission as the transshipment depot replaced this small arms ammunition activity. During 1944 and 1955, Building CL1 was used for renovation and reclamation of returned materiel from World War II and the Korean conflict. This exercise included re-packing many hundreds of thousands of pounds of propellant powder. In 1954, the Arsenal was assigned the mission of rebuilding NIKE guided missile propellant systems and internal guidance systems. In May 1959, Building CL1 was upgraded to accommodate the NIKE Hercules missile, an all-solid propellant model. Building CL1 continued to re-build guided missiles until the closure of the Arsenal in 1964. Contaminants associated with CL 1 consist of degreasers, paints, oils, thinners, and gasoline that powered air compressors. The COIs for CL1 are solvents and fuels.

CL2 was a former boiler house. A 3,180-gallon UST was installed near Building CL2 at the time of the building's construction in 1942. In 1955, a request to remove the UST was approved but it is unknown if the tank was removed. A 5,000-gallon capacity AST reportedly replaced the UST adjacent to Building CL2. COIs for CL2 are fuels.

After the Arsenal was decommissioned in 1964, Benicia Industries, Inc., now Amports, Inc., granted dumping rights under the lease to Weldon Leather to dispose of their waste leather in the area. The approximate locations of these Waste Areas are shown on Figure 6-4. It was estimated that 10,000 to 12,000 cubic yards of scrap leather was dumped between 1965 and early 1969 when Benicia Industries, Inc., stopped the practice. The bulk of the material had been removed in 1974 in accordance with a Cleanup and Abatement Order issued by the RWQCB. The COIs for the Waste Areas are solvents. For this discussion, the Waste Areas are referred as the western and eastern Waste Area because there are distinct differences in the contaminants found in each area.

The boundary between the highlands and the lowlands crosses the former NIKE missile assembly facility sites. The Open Ditch is located in the lowlands, while CL1, CL2, and the former septic tank 194 are located in the highlands (Figure 6-4). The Waste Areas straddle the border.

As part of the sampling along the proposed Concord to Sacramento pipeline route, URS Corporation collected samples in the area of the former NIKE Missile Assembly facility for Kinder Morgan Energy Partners (URS, 2004). Since this section contains several sites and two separate investigations, it is organized by introducing the URS investigation and then combining the results of the URS investigation into the Expanded SI with the Open Ditch/Western Waste Area and the CL1/Eastern Waste Area as subsections.

URS Investigation

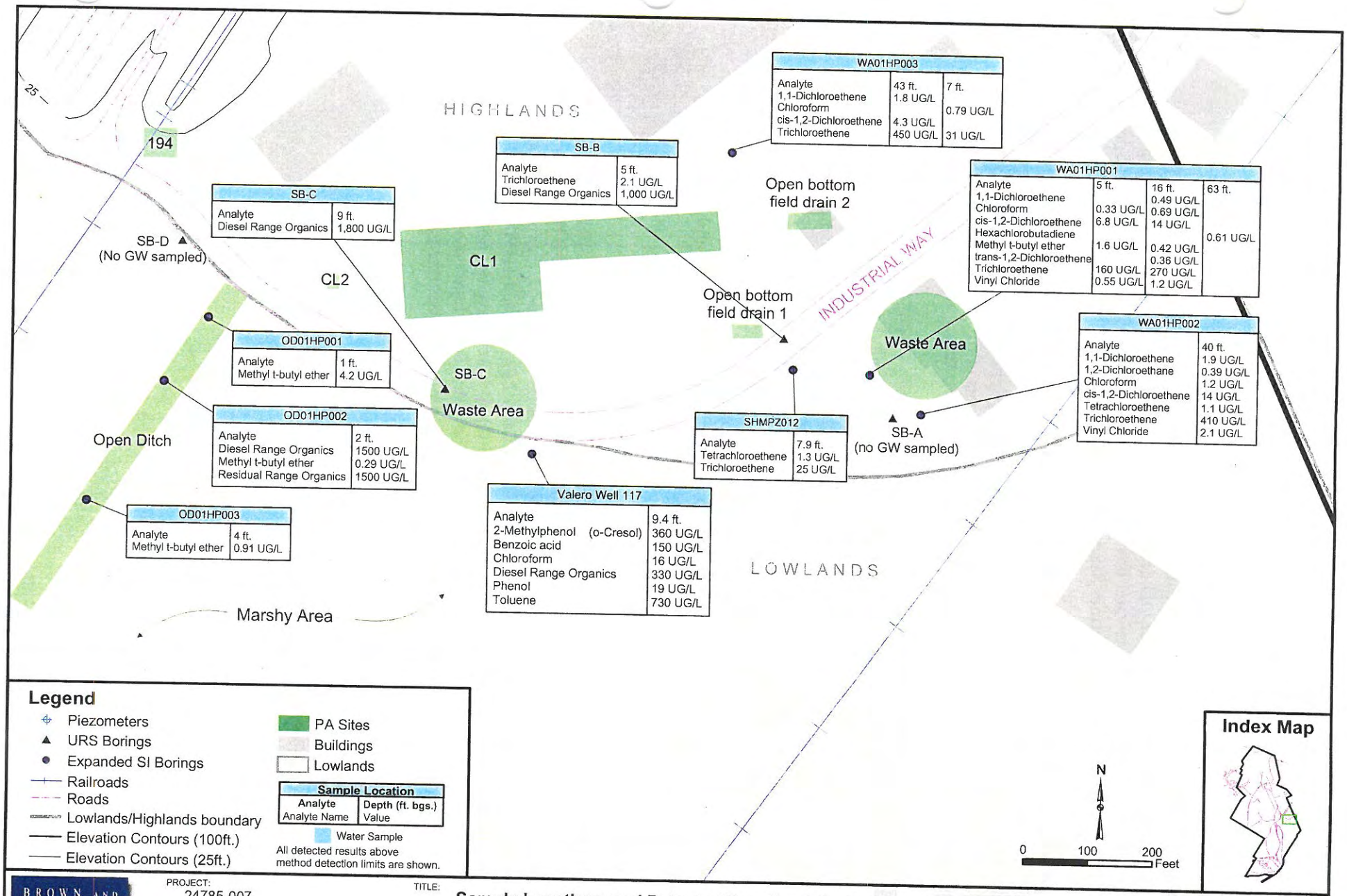
Four locations (SB-A, SB-B, SB-C, and SB-D) were drilled along the pipeline right-of-way. SB-A, SB-B and SB-C are down gradient of the site (Figure 6-4). SB-A is close to WA001HP001 and WA001HP002 and SB-C is near Valero Well #117 (Figure 6-4). Tables from the URS investigation are included in Appendix K.

The URS borings were advanced to 10 feet bgs with soil samples collected at 0, 5, and 9.5 feet bgs and analyzed for:

- SVOCs by EPA Method 8270C,
- Total petroleum hydrocarbons as gasoline (TPH-g) and total petroleum hydrocarbons as diesel (TPH-d) by EPA Method 8015B,
- Title 22 metals by EPA method 6010B,
- polychlorinated biphenyls by EPA Method 8082,
- organochlorine pesticides by EPA Method 8081,
- moisture content by American Society for Testing and Materials (ASTM) D2216, and
- pH by EPA Method 9045.

Groundwater was collected at SB-B and SB-C at 6 to 9 feet bgs, respectively. The other borings reported no groundwater encountered.

Results from the URS investigation are combined into the Expanded SI investigation results below.

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PROJECT: 24785-007
DATE: 3/24/2005

TITLE: Sample Locations and Detected Results at the former Nike Missile Assembly Facility

SITE: Benicia Arsenal, Benicia, California

Figure 6-4

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Expanded SI Investigation

The purpose of the groundwater investigation was to determine if there is any solvent or fuel–impacted groundwater from former DoD activities at the former NIKE Missile Assembly facility (CL 1), such as the disposal of wastewater into two waste areas, into two open bottom field drains, into a nearby open ditch or into a former Septic Tank 194.

Investigation at CL1 and CL2 was not possible due to the landowner denying USACE right-of-entry. This forced USACE to investigate downgradient of CL1 and CL2. After contaminants were found in the downgradient samples, access was acquired upgradient of CL1. Investigation at septic tank 194 could not be performed because a property transfer was in progress during the field event. As a result, the areas investigated are the Open Ditch and the two Waste Areas (Figure 6-4).

Three hand augered borings (OD01HP001 through OD01HP003) were completed within the Open Ditch area and a sample was collected from a nearby monitoring well (Valero Well #117) owned by the adjacent Valero Refinery to determine the presence or absence of a suspected discharge of solvents or fuels from the CL1 to groundwater. Valero Well #117 is located near the western Waste Area and the sample from this well was also used to evaluate any impacts to groundwater from the western Waste Area. Three borings were advanced around the former eastern Waste Area (WA001HP001 through WA001HP003) and an existing piezometer, PZ-12, was sampled. All samples were analyzed for VOCs and petroleum hydrocarbons. Boring locations, building locations, investigation features (i.e. waste areas, open bottom field drains and open ditch) and analytical results are shown on Figure 6-4.

Open Ditch/Western Waste Area

Data from the hand auger borings OD01HP001 through OD01HP003, Valero Well #117 and URS boring SB-C was used to evaluate this area. Analysis of shallow (between 2 and 8 feet bgs) groundwater samples at the Open Ditch reported concentrations of diesel fuel up to 1,800 µg/L (SB-C), motor oil at 1,500 µg/L (OD01HP001) and MtBE at 4.2 µg/L (OD01HP001). MtBE was detected in all three groundwater samples collected in the Open Ditch area, but not in the sample from the Valero Well #117. Concentrations are reported in Table 6-4. In addition to the diesel fuel and MtBE reported in the groundwater sample from URS boring SB-C, acetone and carbon disulfide were detected at 16 and 5.6 µg/L, respectively.

Table 6-4. MtBE and Fuel Concentrations in Groundwater at the Open Ditch and the Western Waste Area

| | | | | | |
|---|---|---|---|---|---|
| OD01HP001 | Expanded SI Investigation | 1-3 | 4.2 | <10 | <230 |
| OD01HP002 | | 2-2.5 | 0.28 | <1,500 | **1,500** |
| OD01HP003 | | 4-5.5 | 0.91 | <10 | <230 |
| Valero Well #117 | | 9.4-18.3 | <0.28 | 330 | <230 |
| SB-C | URS Investigation | 9 | NR | **1,800** | NA |
| ESL^ | | | 1,800 | 640 | 640 |

^ ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
NA – not analyzed
NR – concentrations not included in the URS report
URS Investigation Source: Report for Soil Investigation at the Benicia Industries Property and Former Nike Missile Battery 10 Site, Concord to Sacramento Pipeline Project by URS Corporation, May 14, 2004.
**Bolded** values exceed their respective ESL.
bgs – below ground surface
µg/L – micrograms per liter

No significant concentrations were reported from the URS soil samples. Chlorinated solvents, semi-volatile organics, gasoline range organics, and organochlorine pesticides in soil were not identified above analytical reporting limits. The maximum soil concentration for petroleum hydrocarbons as diesel fuel or motor oil was 150 mg/kg at 0-0.5 feet bgs in SB-A.

Because of the diesel fuel and the motor oil detections in the Open Ditch borings and in Valero Well #117 from the Expanded SI sampling, further evaluation necessary to determine if the occurrence of these constituents were found previously in Valero Well #117. Historical concentrations for fuel-related compounds were acquired from Valero Refinery and summarized in Table 6-5 and compared to ESLs.

Table 6-5. Historical Fuel Concentrations in Groundwater at Valero Well #117

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3/13/1992 | <0.5 | <0.5 | <0.5 | <0.5 | <50 | NR | 330 | 500 | NR |
| 5/13/1992 | <0.5 | <0.5 | <0.5 | <0.5 | <50 | NR | 420 | <500 | NR |
| 7/7/1992 | <0.5 | <0.5 | <0.5 | <0.5 | <50 | NR | 340 | **700** | NR |
| 10/13/1992 | NR | NR | NR | NR | <50 | NR | 180 | 520 | NR |
| 1/19/1993 | <0.5 | 0.57 | <0.5 | <0.5 | <50 | NR | 590 | **1,000** | NR |
| 9/24/1993 | <0.5 | <0.5 | <0.5 | <2 | <50 | NR | **1,500** | <200 | NR |
| 1/24/1994 | <0.5 | 0.7 | <0.5 | <2 | <50 | NR | **900** | <200 | NR |
| 4/29/1994 | 0.9 | <0.5 | <0.5 | <2 | <50 | NR | **1,700** | **2,500** | NR |
| 7/28/1994 | 1 | <0.5 | <0.5 | <2 | <50 | NR | 300 | 200 | NR |
| 10/26/1994 | <0.5 | <0.5 | <0.5 | <2 | <50 | NR | **1,900** | <200 | NR |
| 1/19/1995 | 0.7 | 1 | <0.5 | <2 | <50 | NR | NR | NR | NR |
| 4/25/1995 | 0.8 | <0.5 | <0.5 | <2 | <50 | NR | **2,000** | 600 | NR |
| 7/26/1995 | 3 | <0.5 | <0.5 | <2 | <50 | NR | **850** | 500 | NR |
| 10/20/1995 | 2 | <0.5 | <0.5 | <2 | <50 | NR | **710** | 300 | <50 |

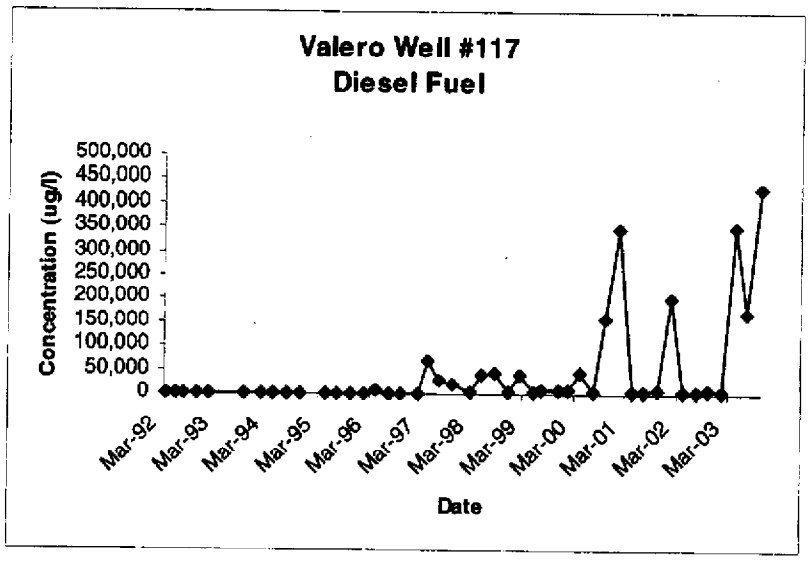
Table 6-5. Historical Fuel Concentrations in Groundwater at Valero Well #117

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1/26/1996 | <3 | 5.1 | <3 | <10 | <300 | NR | **1,600** | 300 | <300 |
| 4/23/1996 | 1.2 | 1 | <0.5 | <2 | <50 | NR | **6,400** | <1,000 | 150 |
| 7/18/1996 | 1.3 | 5.3 | <0.5 | <2 | 80 | NR | **1,300** | <200 | 5 |
| 10/30/1996 | <0.5 | 0.5 | <0.5 | <2 | <50 | NR | 630 | <200 | <5 |
| 2/13/1997 | <5 | 8 | <5 | <20 | <500 | NR | **1,700** | 300 | <50 |
| 4/23/1997 | <5 | 74 | <5 | <5 | **630** | NR | **67,000** | **20,000** | <20 |
| 7/31/1997 | <0.5 | 11 | <0.5 | 1.2 | 100 | NR | **29,000** | <10,000 | <2 |
| 10/24/1997 | NR | NR | NR | NR | 66 | NR | **22,000** | <5000 | NR |
| 2/27/1998 | <5 | **6,400** | 8.7 | 20 | **6,500** | NR | **3,100** | **1,200** | NR |
| 5/7/1998 | <5 | **650** | <5 | <5 | **1,200** | NR | **41,000** | **2,500** | <20 |
| 8/6/1998 | NR | NR | NR | <0.5 | **955** | NR | **46,300** | <5,000 | NR |
| 11/6/1998 | <0.5 | 4.38 | <0.5 | <0.5 | <50 | NR | **4,640** | <250 | <2 |
| 2/23/1999 | <0.5 | **333** | <0.5 | <0.5 | **593** | NR | **41,500** | <2,500 | <2 |
| 5/4/1999 | <1 | **242** | <1 | <1 | 393 | **29,300** | **5,620** | <2,500 | <4 |
| 7/19/1999 | <5 | **334** | <5 | <5 | **846** | NR | **7,700** | 392 | <20 |
| 11/9/1999 | <1 | 27.4 | <1 | <0.5 | 132 | **45,700** | **8,850** | <2,500 | <5 |
| 1/26/2000 | 4.72 | 29.5 | <2.5 | 9.8 | 288 | **10,700** | **8,720** | <2,500 | <12.5 |
| 4/21/2000 | <2.5 | 74.7 | <2.5 | <2.5 | <250 | **143,000** | **43,600** | <5,000 | <12.5 |
| 7/28/2000 | <0.5 | 26.5 | <0.5 | <0.5 | 87.5 | **30,200** | **5,080** | 593 | <2.5 |
| 10/25/2000 | <1 | 40.1 | <1 | 2.98 | **2,160** | **739,000** | **159,000** | <5,000 | <5 |
| 1/10/2001 | <1 | 28.1 | <1 | <1 | 202 | NR | **346,000** | **7,870** | <5 |
| 4/17/2001 | <1 | **458** | <1 | <1 | **816** | NR | **6,010** | **1,010** | <5 |
| 7/16/2001 | <1 | 49 | <1 | <1 | **770** | NR | **5,400** | **800** | <5 |
| 10/15/2001 | <1 | 20 | <1 | <1 | **1,200** | NR | **7,600** | **1,200** | <5 |
| 1/14/2002 | <1 | **520** | <1 | <1 | **900** | NR | **200,000** | <7,500 | <5 |
| 4/15/2002 | <10 | **3,300** | <10 | <10 | **6,300** | NR | **3,200** | <250 | <50 |
| 7/15/2002 | <1 | **170** | <1 | <1 | 450 | NR | **5,100** | **790** | <5 |
| 10/21/2002 | <2.5 | 46 | <2.5 | <2.5 | <250 | NR | **6,700** | <250 | <12 |
| 1/29/2003 | <2.5 | **460** | <2.5 | <2.5 | **790** | NR | **4,600** | 540 | <12 |
| 4/9/2003 | <5 | **1,600** | <5 | <5 | **2,500** | NR | **350,000** | **9,700** | <25 |
| 7/7/2003 | <0.5 | 65 | <0.5 | 0.7 | 380 | NR | **170,000** | **4,100** | <2.5 |
| 10/13/2003 | <2.5 | 36 | <2.5 | <2.5 | <250 | NR | **430,000** | <27,000 | <12 |
| ESL | 46 | 130 | 290 | 100 | 500 | 500 | 640 | 640 | 1,800 |

Source: Secor International Incorporated, 2nd QTR, 2004 Groundwater Monitoring Report
Concentrations greater than ESLs are **bolded**.
NR – Concentrations not included in the Secor report.
ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)

Diesel fuel concentrations in Valero Well #117 have steadily increased as shown on the following graph. In 2003, toluene, gasoline, diesel fuel, and motor oil have been reported in this well at concentrations that exceed their respective ESLs (Table 6-5). According to the Valero Refinery, a detailed evaluation was performed in 1999-2000 that showed the contaminants detected in Valero Well 117 are not related to Valero activities and do not originate from the Valero Refinery property

(URS, 2003). The source of the hydrocarbons is not known but appears to be related to a recent release or discharge in the area.




2-Methylphenol (also known as o-Cresol) was detected at 360 µg/L in the groundwater sample from Valero Well #117 (Valero117-A-W01). The o-cresol isomer is used in plastics and resins manufacturing and in solvents. O-Cresol has been detected in motor vehicle exhaust, tobacco smoke and emissions from wood pulping, coal tar and petroleum refining, and ore floatation and textile scouring operations. It is also a photooxidation product of toluene (California Air Resources Board, 2004). Toluene concentration is 730 µg/L.

CL1/Eastern Waste Area

Data from the eastern Waste Area borings WA001HP001 through WA001HP003, sample SHMPZ012 from piezometer PZ-12, Valero Well #117 and URS borings SB-B and SB-C were used to evaluate this area. Chlorinated solvents, (TCE, cis-1,2 DCE, vinyl chloride), diesel fuel, and MtBE were detected at the Waste Area in borings, PZ-12, and URS borings SB-B and SB-C (Table 6-6) but not in Valero Well #117. As stated above, the Waste Areas are located on the border between the highlands and the lowlands; therefore, MCLs for TCE, cis-1,2 DCE, vinyl chloride, and MtBE and the ESL for diesel fuel were used as a comparison criteria since the area may have groundwater that meets drinking water standards. Concentrations of TCE, cis-1,2 DCE, and vinyl chloride exceed MCLs. Other VOCs detected in the eastern Waste Area include trans-1,2 DCE, PCE, 1,2 DCE and 1,1-DCE. The upgradient boring, WA01HP003, detected cis-1,2 DCE, 1,1-DCE, and TCE. TCE was detected at a concentration of 450 µg/L (Table 6-6). Diesel fuel was reported in URS boring SB-B, located approximately 50 feet north of PZ-12, at concentrations that exceed the ESL of 640 µg/L, but diesel fuel was not reported in PZ-12 (Table 6-6).

Other contaminants detected were the following:

- Chloroform (16 µg/L) in Valero Well #117, and
- Toluene (1 µg/L), ethylbenzene (1.1 µg/L), m,p-xylenes (3 µg/L), and o-xylenes (0.8 µg/L) in URS boring SB-C.

Toluene concentrations from the Valero Well #117 exceed the MCL of 150 µg/L. The other contaminants do not exceed their respective MCLs, if established (chloroform MCL is not established, ethylbenzene is 300 µg/L, and total xylenes is 1,750 µg/L).

Table 6-6. TCE, cis-1,2 DCE, Vinyl Chloride Diesel Fuel, and MtBE Groundwater Concentrations at the Eastern Waste Area

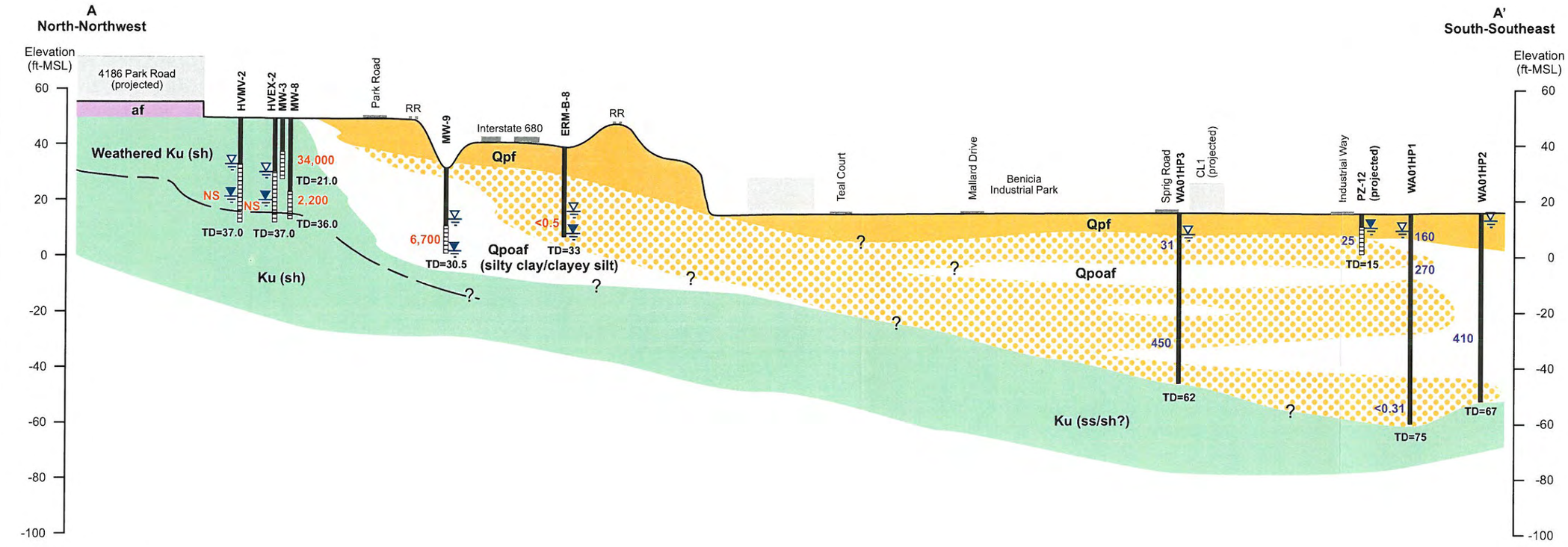
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| WA01HP001 | 5-10 | Expanded SI Investigation | **160** | **6.8** | **0.55** | <10 | 1.6 |
| | 16-25 | | **270** | **14** | **1.2** | <10 | 0.42 |
| | 63-73 | | <0.31 | <0.37 | <0.12 | <10 | <0.28 |
| WA01HP002 | 40-50 | | **410** | **14** | **2.1** | <10 | <0.28 |
| WA01HP003 | 7-12 | | **31** | <0.37 | <0.12 | <10 | <0.28 |
| | 43-50 | | **450** | 4.3 | <0.24 | <10 | <0.56 |
| PZ-12 | 7.9-15 | | **25** | 0.37 | <0.12 | <9* | <0.28 |
| SB-B | 6 | URS Investigation | 2.1 | <0.5 | <0.5 | **1,000** | NA |
| MCL | | | 5 | 6 | 0.5 | 100 (ESL) | 13 |

URS Investigation - Source: Report for Soil Investigation at the Benicia Industries Property and Former Nike Missile Battery 10 Site, Concord to Sacramento Pipeline Project by URS Corporation, May 14, 2004.
ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
NA – not analyzed
**Bolded** values exceed their respective MCL/ESL.
*Sample collected on 2/7/2002.
bgs – below ground surface

Summary of Results

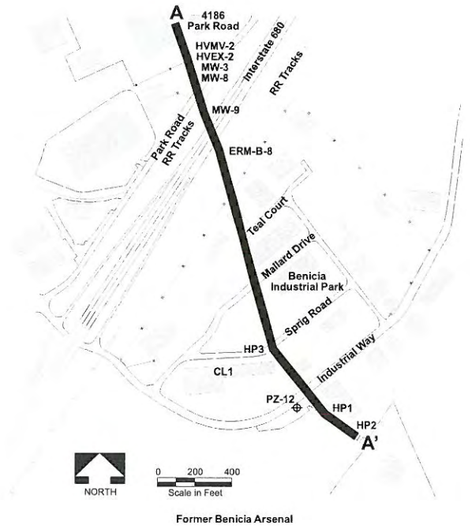
The intent of the investigation was to collect groundwater samples at CL1 and CL2, but lack of entry by the landowner forced the investigation downgradient and upgradient of the former facility. In the downgradient samples, a source of the diesel fuel and motor oil was found in the area of the Open Ditch, Valero Well #117, and the western Waste Area. The source of the fuels is unknown but is likely attributed to a recent release or discharge in the area. Additionally, MtBE was identified in the groundwater samples from the Open Ditch, which indicates post-Army use, since its use as a fuel additive did not begin until after the Arsenal closed in 1964. Based on these results, no further DoD action is indicated at the Open Ditch or the western Waste Area.

Concentrations of TCE, cis-1,2 DCE, and vinyl chloride exceed MCLs in the boring locations downgradient of CL1 and at the eastern Waste Area. TCE was detected in an upgradient boring (WA01HP003), which suggests there may be another source of contamination other than from former DoD activities. RWQCB files provided information on a current RWQCB site nearby, upgradient to CL 1, the Open Ditch and the Waste Areas, 4186 Park Road, as shown on Figure 6-5. This figure illustrates the lithology of the area and TCE concentrations in groundwater from 4186 Park Road to the former NIKE missile Assembly facility (CL1). Reportedly, solvent waste was dumped directly on the ground surface and a sump within the building leaked at 4186 Park Road. TCE has impacted groundwater up to 34,000 µg/L (based on February 2004 sampling). Bedrock at 4186 Park Road is shale with reportedly 10 to 20 feet of the shale weathered. Older reports indicate that the bedrock is sandstone. The geologic unit for this area is the Great Valley sequence, which is characterized by interbedded sandstone and shale.




| Hydrostratigraphic Units | Geologic Units | |
|---|---|---|
| Relatively Permeable Units | | Artificial Fill (af) |
| | | Alluvium Fan and Fluvial Deposits (Qpf) - clay/silty clay |
| | | Older Alluvial Fan Deposits (Qpoaf) - sandy silt/siltwith lenses of silty sand/sand, some cobbles and gravel |
| Relatively Non Permeable Unit | ss/sh | Bedrock (Ku) - Great Valley Sequence, interbedded sandstone (ss) and shale (sh) |
| | ? | A Contact, located very approximately, or conjectural |

| Explanation | |
|---|---|
| PZ-3 | Piezometer |
| | Boring |
| | Screen Interval |
| TD=30 | Total Depth, Feet Below Ground Surface |
| | First Encountered Groundwater - estimated |
| | Static Groundwater - estimated (measured at PZ-12 on 5/6/04) |
| 6,700 | TCE concentration in ug/L (2/04) |
| 25 | TCE concentration in ug/L (5/04) |
| NS | Not Sampled |




1. Boring logs, cross sections, and analytical results were obtained from investigations at 635 Indiana Street and 4186 Park Road.
   - Preliminary Report for Subsurface Investigation at Benicia Industrial Park, 4186 Park Road and 635 Indiana Street, Benicia California, Kleinfelder, Inc., May 2001.
   - Additional Site Investigation and Remediation Report, ERM-West, Inc., May 2004.
   - Further Assessment of the Horizontal Extent and Potential Source Areas of Halogenated Volatile Organic Affected Ground Water, Benicia Industrial Park, Benicia California, Kleinfelder Inc., July 20, 2001.
2. The extent and depth of artificial fill is not represented on the cross section except at 4186 Park Road.

**Figure 6-5**
**Geologic Cross Section A-A' from 4186 Park Road to Former Nike Assembly Facility**
Expanded Site Inspection Report
*Former Benicia Arsenal*

The conceptual site model for this area is very similar to the industrial area where the highlands, with an absence of water at shallow bedrock, meet the lowlands where water is within alluvial sediments. The primary difference between the models is that the Bay Mud (marshland) is farther away (0.25 mile) from the highlands and the alluvium in this area is much thicker (10-15 feet in the industrial area compared to 75 feet at WA01HP001). At 4186 Park Road, solvents are within the weathered portion of the shale and exiting into the alluvium likely at the contact between the alluvium and the shale at a point between MW-8 and MW-9 (Figure 6-5). At ERM-B-8, TCE was not reported in groundwater (Figure 6-5). Based on the stratigraphy, the higher TCE concentrations are likely to be found at contact between the alluvium/shale, which is approximately 15 feet below the total depth of the boring. It is plausible that the solvent-impacted groundwater from 4186 Park Road has traveled past ERM-B-8.

Once access to Septic Tank 194 and CL2 is granted, a geophysical investigation is recommended at CL 2 to determine if a UST is present and an investigation at Septic Tank 194 is recommended to determine if discharge from CL 1 has impacted groundwater. No further action by USACE can be done until access is provided. No further DoD action is indicated for the Open Ditch and Western Waste due to MtBE and the recent diesel fuel and motor oil concentrations reported in Valero Well #117.

The RWQCB is currently reviewing an investigation report on 4186 Park Road. After RWQCB has submitted comments and the 4186 Park Road site is fully characterized, the USACE will re-evaluate CL 1 and the eastern Waste Area.

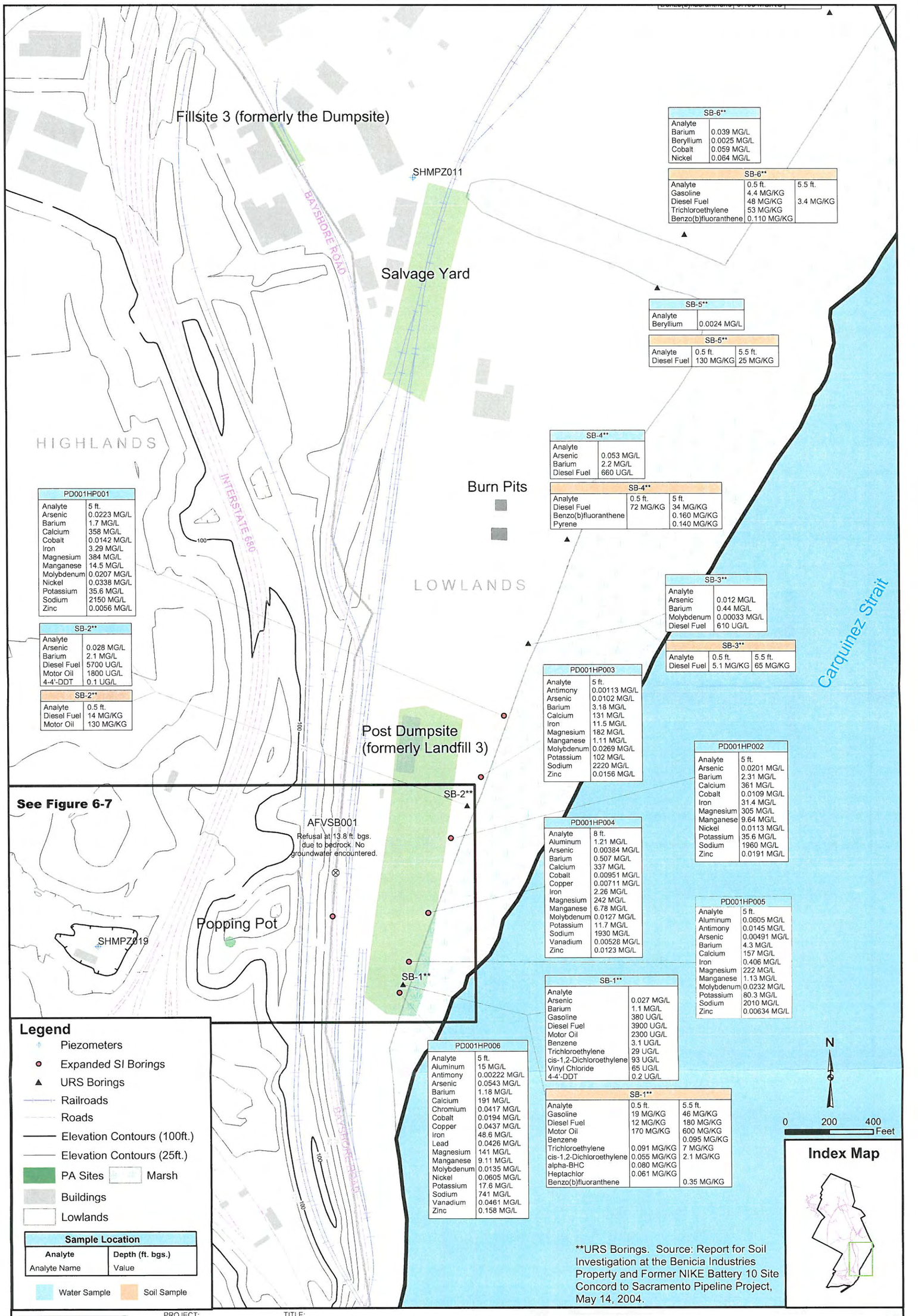
## 6.4 Area M

Area M is described in more detail in the section entitled Arsenal History in Section 1.3.2. Area M was used primarily for ammunition, powder, and ordnance storage and for the manufacturing of black powder (Jacobs, 1999). Expanded SI sites within Area M include: Post Dumpsite, the Popping Pot, Salvage Yard, Fillsite 3, Former Heavy Equipment Yard (Buildings 50 and 111) and the former Vehicle Maintenance Areas (Buildings T222, T221, 171, 172, and TO73).

### 6.4.1 Post Dumpsite

**Further Investigation is Recommended at the Post Dumpsite**

The Post Dumpsite was reportedly in operation from 1940 through 1964 and located in the eastern side of Area M (Figure 6-1). It is suspected that the disposal and burning of scrap lumber associated with the industrial area carpenter shops, and pilings and other waste material from repairs made to the Arsenal wharf were placed at this dumpsite. Thousands of gallons of gasoline were reportedly burned in pits at the north end of the site near Sulphur Springs Creek drainage canal (Figure 6-6). Based on aerial photographs, this area at the north end of the site does not appear to have been used as a disposal area but two black circular areas are present that may indicate the locations of the burn pits (Figure 6-6). An interview with Mr. Leroy Bailey, a former Arsenal employee, also indicated that this area received industrial waste, including acids, metal-cleaning corrosives, dichloro dipheryl trichloroethane (DDT), high-octane gasoline, and other waste generated at the Arsenal (FA/BC, 2004a). The majority of the information from this interview could not be substantiated; however, aerial photos and other interviews did substantiate Mr. Bailey's statement about the disposal of metal cleaning corrosives and the burning of scrap lumber in the pits.




BROWN AND CALDWELL

PROJECT: 24785-007

DATE: 4/13/2005

TITLE: **Sampling Locations and Detected Results at the Post Dumpsite**

SITE: **Benicia Arsenal, Benicia, California**

**Figure 6-6**

Since the Expanded SI field work, a soil and groundwater investigation was performed by the URS Corporation for Kinder Morgan Energy Partners in April 2004 (URS, 2004). This investigation along with the Expanded SI investigation is discussed below.

URS Investigation.

The URS investigation included sampling along the proposed Concord to Sacramento pipeline route, in particular, along the eastern boundary of the Post Dumpsite and near the former burn pits. Seven locations (SB-1 through SB-7) were drilled along the pipeline right of way in this area (Figure 6-6). SB-1 and SB-2 are located near the Post Dumpsite. SB-4 and SB-5 are the borings nearest but are not directly downgradient (east to southeast) of the former burn pits (Figure 6-6). URS borings SB-6 and SB-7 are located approximately 280 feet and 1,500 feet northeast of SB-5, respectively (Figure 6-6).

The URS borings were advanced between 3.5 and 10 feet bgs. Groundwater was first encountered between 2 and 7 feet bgs. Refusal was encountered at three different locations in SB-2, all at 3.5 feet bgs, without explanation in the URS report. Based on research for the PA, layers of timbers were placed by the Army on top of the marshland to support imported fill. The timbers have been found during the excavation or repair of utility poles at about 3 to 4 feet bgs and coincide with the depth that URS encountered refusal during drilling at SB-2.

Soil samples were collected at 0 to 0.5 feet bgs and 5 to 5.5 feet bgs in all borings with the exception of SB-2 and SB-4. The deeper soil sample was not collected in SB-2 and the deeper sample in SB-4 was collected at 4-4.5 feet bgs. Samples were analyzed for:

- SVOCs by EPA Method 8270C,
- TPHG and TPHD by EPA Method 8015B,
- Title 22 metals by EPA method 6010B,
- polychlorinated biphenyls by EPA Method 8082,
- organochlorine pesticides by EPA Method 8081,
- moisture content by ASTM D2216, and
- pH by EPA Method 9045.

The URS results in the subject report are incomplete. In some instances there were samples collected but no results reported. Analytes not reported in the URS report are marked as "NR" in the following tables. The tables from the URS report are attached as Appendix K. The boring locations and analytical results for the URS investigation are shown on Figure 6-6.

URS results in shallow soil (less than 0.5 feet bgs) contain solvents and fuel related compounds, such as benzene, xylene and 1,3-5 trimethylbenzene. Fuels, in particular diesel fuel, were detected in each of the URS borings but qualified in the report, in whole or in part, contributed from the naturally occurring non-petroleum organics in soil. The highest concentrations were detected in SB-1 and SB-2 (diesel fuel at 180 mg/kg and motor oil at 600 mg/kg) (Table 6-7). The highest concentrations were compared to RWQCB ESLs for shallow soil (less than 9.8 feet [3 meters]) and for commercial land use. All of the detected analytes did not exceed their respective ESLs, except TCE (Table 6-7). TCE was detected in soil exceeding its ESL but the soil concentrations at 5 to 5.5 feet bgs should be considered approximate. Since groundwater is approximately 2 to 7 feet bgs, soil samples collected

5 to 5.5 feet bgs were most likely saturated or within the capillary fringe. Therefore, all the contaminants in soil are assumed to be from impacted groundwater.

For groundwater, RWQCB ESLs were also used as comparison criteria. Diesel fuel, motor oil and vinyl chloride were reported above their respective groundwater ESLs at URS borings SB-1, SB-2 and SB-4 (Table 6-7).

**Table 6-7. Fuels and Solvents in Soil and Groundwater at the Post Dumpsite and Former Burn Pits**

| Boring Name | Depth (ft bgs) | Gasoline | Diesel fuel | Motor oil | Benzene | TCE | cis-1,2-DCE | VC |
|---|---|---|---|---|---|---|---|---|
| SB-1 | 0-0.5 | 19 | 12 | 170 | <0.0055 | 0.091 | 0.055 | ND |
| | 5-5.5 | 46 | 180 | 600 | 0.095 | **7** | 2.1 | ND |
| | GW | 380 | **3,900** | **2,300** | 3.1 | 29 | 93 | **65** |
| SB-2 | 0-0.5 | <1.1 | 14 | 130 | <0.0053 | <0.0053 | <0.0053 | ND |
| | GW | <50 | **5,700** | **1,800** | <0.5 | <0.5 | <0.5 | <0.5 |
| SB-3 | 0-0.5 | <1.2 | 5.1 | -- | <0.0054 | <0.0054 | <0.0054 | ND |
| | 5-5.5 | <2 | 65 | | <0.0087 | <0.0087 | <0.0087 | ND |
| | GW | <50 | 610 | -- | <0.5 | <0.5 | <0.5 | <0.5 |
| SB-4 | 0-0.5 | <1.2 | 72 | -- | <0.0052 | <0.0052 | <0.0052 | ND |
| | 4-5 | <1.2 | 34 | -- | <0.0053 | <0.0053 | <0.0053 | ND |
| | GW | <50 | **660** | -- | <0.5 | <0.4 | <0.5 | <0.5 |
| SB-5 | 0-0.5 | <1.1 | 130 | -- | <0.0052 | <0.0052 | <0.0052 | ND |
| | 5-5.5 | <1.6 | 25 | -- | <0.007 | <0.007 | <0.007 | ND |
| | GW | NR | NR | NR | NR | NR | NR | NR |
| SB-6 | 0-0.5 | 4.4 | 48 | -- | <0.0052 | **53** | <0.0052 | ND |
| | 5-5.5 | <1.1 | 3.4 | -- | <0.0058 | <0.0058 | <0.0058 | ND |
| | GW | NR | NR | NR | NR | NR | NR | NR |
| SB-7 | 0-0.5 | <1.1 | 27 | -- | <0.0052 | <0.0052 | <0.0052 | ND |
| | 5-5.5 | <1.3 | 3 | | <0.0058 | <0.0058 | <0.0058 | ND |
| | GW | NR | 250 | NR | NR | NR | NR | NR |
| ESL | Soil | 400 | 500 | 1,000 | 0.38 | 0.73 | 3.6 | 0.019 |
| | GW | 500 | 640 | 640 | 46 | 360 | 590 | 3.8 |

Source: Report for Soil Investigation at the Benicia Industries Property and Former Nike Missile Battery 10 Site, Concord to Sacramento Pipeline Project by URS Corporation, May 14, 2004. Results are qualified in the URS report but are not carried forth in the table above for brevity. Please refer to the complete tables provided as an appendix in this report.
Soil concentrations in mg/kg.
Groundwater concentrations in µg/L.
**Bolded** values exceed their respective ESLs.
cis-1,2-DCE = cis-1,2-dichloroethene
ESL = Environmental Screening Level (RWQCB, 2005). ESL values for soil are for shallow soils (<3 meters bgs) and commercial/industrial land use. Groundwater ESLs correspond to groundwater that is not a current or potential source of drinking water.
ND – not detected
NR – Concentrations not reported in the URS report.
TCE = trichloroethene
VC = vinyl chloride

Organochlorine pesticides and semi-volatile organics were also detected in soil samples at low concentrations from the URS borings (Table 6-8). The pesticides, heptachlor and 4-4'-DDT, exceed their respective ESL but not their respective BSL in soil at URS boring SB-1.

**Table 6-8. Organochlorine Pesticides and SVOCs Detected in URS Samples at the Post Dumpsite and Former Burn Pits**

| Boring | Depth | alpha-BHC | heptachlor | benzo(b)fluoranthene | Pyrene | 4-4'-DDT |
|---|---|---|---|---|---|---|
| | (ft bgs) | Soil (mg/kg) | Soil (mg/kg) | Soil (mg/kg) | Soil (mg/kg) | Water (µg/L) |
| SB-1 | 0-0.5 | 0.080 | **0.061** | <0.078 | <0.078 | **0.2** |
| SB-1 | 5-5.5 | <0.011 | <0.011 | 0.35 | <0.350 | |
| SB-2 | 0-0.5 | <0.0098 | <0.0098 | <0.077 | <0.077 | **0.1** |
| SB-4 | 4-5 | <0.120 | <0.120 | 0.160 | 0.140 | <0.9 |
| SB-6 | 0-0.5 | <0.018 | <0.018 | 0.110 | <0.071 | NR |
| SB-7 | 0-0.5 | <0.018 | <0.018 | 0.100 | <0.070 | NR |
| ESL | | Not established | 0.014 | 1.3 | 85 | 0.001 |
| BSL | | 0.59* | 0.55* | 2.9* | 5,400 | 12* |

Soil concentrations in mg/kg.
Groundwater concentrations in µg/L
BSL = Benicia Screening Level - Commerical/Industrial worker- noncarcinogen (FA/BC, 2002a) *carcinogen
ESL = Environmental Screening Level (RWQCB, 2005). ESL values for soil are for shallow soils (<3 meters bgs) and commercial/industrial land use.
NR – Concentrations not reported in the URS report.
**Bolded** values exceed their respective ESLs.

Expanded SI Results Compared with URS Results.

The area is now largely paved, with several buildings constructed over the former fill area. Six hydropunches (PD001HP001 through PD001HP006) were advanced at the Post Dumpsite located in the lowlands area of Area M to determine if there was a suspected release of metal cleaning corrosives.

The URS and Expanded SI boring logs indicate that the fill is a mixture of gravelly sand to silty sand, approximately 2.5 to 5 feet thick. The marshland or Bay Mud is thinnest at the southern end (PD001HP001) approximately 20 feet thick to approximately 70 feet thick at PD001HP006. Below the marshland are sequences of silt and sand silts from 100 feet bgs to greater than 108 feet bgs, where the top of the sandstone was encountered. The total depth of this sequence could not be determined at PD001HP005 because the depth to the top of sandstone bedrock was greater than amount of CPT rod available (108 feet).

Six borings were advanced during the Expanded SI investigation and groundwater samples were collected and analyzed for metals. Metals concentrations from the URS and the Expanded SI sampling are compared in Table 6-9. Antimony, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, vanadium, and zinc were detected in both URS and the Expanded SI investigations at similar concentrations. Arsenic, barium, cobalt, copper, lead, nickel, vanadium and zinc were reported in groundwater that exceeds their respective ESLs (Table 6-9). At CPT location, PD1HP6, six metals (arsenic, barium, lead, nickel, vanadium and zinc) exceeded ESLs. Barium was detected in concentrations that exceeded ESLs in eight of the 13 borings advanced during the Expanded SI and the URS investigation (Table 6-9).

## Table 6-9. Metals in Groundwater at the Post Dumpsite

| | Concentrations in mg/L | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Constituent** | **SB-1*** | **SB-2*** | **SB-3*** | **SB-4*** | **SB-5*** | **SB-6*** | **SB-7*** | **PD1HP1** | **PD1HP2** | **PD1HP3** | **PD1HP4** | **PD1HP5** | **PD1HP6** | **ESL^** |
| Antimony | NR | NR | NR | NR | NR | NR | NR | <0.0005 | <0.0005 | 0.00113J | <0.0005 | 0.0145 | 0.00222J | 0.030 |
| Arsenic | 0.027 | 0.028 | 0.012 | **0.053** | NR | NR | NR | 0.0223 | 0.0201 | 0.0102 | 0.00384J | 0.00385J | **0.0543** | 0.036 |
| Barium | **1.1** | **2.1** | 0.44 | **2.2** | NR | 0.039 | NR | **1.7** | **2.31** | **3.18** | 0.507 | **4.04J+** | **1.18** | 1.0 |
| Beryllium | NR | NR | NR | NR | 0.0024 | 0.0025 | NR | NA | NA | NA | NA | NA | NA | 0.0027 |
| Chromium | NR | NR | NR | NR | NR | NR | NR | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 0.0417 | 0.18 |
| Cobalt | <0.02 | <0.02 | <0.02 | <0.02 | NR | **0.059** | NR | **0.0142J** | **0.0109J** | <0.005 | **0.00951J** | <0.005 | **0.0194J** | 0.003 |
| Copper | NR | NR | NR | NR | NR | NR | NR | <0.005 | <0.005 | <0.005 | **0.00711J** | <0.005 | 0.0437 | 0.0031 |
| Iron | NR | NR | NR | NR | NR | NR | NR | 3.29 | 31.4 | 11.5 | 2.26 | 0.193J | 48.6 | NE |
| Lead | NR | NR | NR | NR | NR | NR | NR | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | **0.0426** | 0.0025 |
| Manganese | NR | NR | NR | NR | NR | NR | NR | 14.5 | 9.64 | 1.11 | 6.78 | 0.981 | 9.11 | NE |
| Molybdenum | ND | ND | 0.00033 | ND | ND | ND | ND | 0.0207J | <0.01 | 0.0269J | 0.0127J | 0.0211J | 0.0135J | 0.24 |
| Nickel | <0.02 | <0.02 | <0.02 | <0.02 | NR | **0.064** | NR | **0.0338** | **0.0113J** | <0.01 | <0.01 | <0.01 | **0.0605** | 0.0082 |
| Vanadium | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.005 | <0.005 | <0.005 | **0.00528J** | <0.005 | **0.0461** | 0.0019 |
| Zinc | <0.02 | <0.02 | <0.02 | <0.02 | NR | NR | NR | 0.0056J | 0.0191J | 0.0156J | 0.0123J | <0.005 | **0.158** | 0.081 |

* - Source: Report for Soil Investigation at the Benicia Industries Property and Former Nike Missile Battery 10 Site, Concord to Sacramento Pipeline Project by URS Corporation, May 14, 2004.
^ ESL = Environmental Screening Level. Groundwater is <u>not</u> a current or potential drinking water source (RWQCB, 2005)
Concentrations > ESLs are **bolded**.
NA – not analyzed
NE – not established
NR – Concentrations not reported in the URS report.
ND – Not detected

Even though the data from the URS report is not complete, there is evidence to suggest that solvents, fuels, metals, and two pesticides, heptachlor and 4-4'-DDT, may have been disposed of at the Post Dumpsite. Further investigation is warranted to determine if wastes had been buried at the Post Dumpsite. A geophysical investigation is recommended to locate ferrous and non-metallic debris. Based on the results of this survey, samples will be collected to determine the lateral and vertical extent of these contaminants in soil and groundwater. The diesel fuel found in groundwater at URS boring SB-4 may be indicative of the diesel fuel reportedly used at the burn pits. Therefore, additional investigation is warranted to determine the source of the diesel fuel and the lateral and vertical extent in the area of the former burn pits.

### 6.4.2 Popping Pot (also known as the Armored Fighting Vehicle)

Access restrictions and site conditions forced the investigation away from the Popping Pot (or AFV). Fuels reported in groundwater may indicate a release from the nearby Post Dumpsite.

This site is known by several names, the Incinerator, the Popping Pot, the Armored Fighting Vehicle and the General Grant Tank Site. Most recently the Popping Pot or the Armored Fighting Vehicle (AFV) are the names most commonly used. It is located east of the Post Dumpsite in low-lying hills (Figure 6-7). The AFV is a World War II era General Grant type tank that was gutted then modified for use as a "popping pot" to destroy unserviceable ordnance. The tank turret was removed and the tank hull was modified to be used as a furnace. A conveyor belt was constructed to feed ordnance to the furnace and a small fuel line supplied diesel fuel to keep the furnace burning. The diesel fuel was likely supplied by a nearby above ground tank a short distance up hill from the AFV. The AFV site contains one immobilized and demilitarized General Grant Tank. Popping pot operations were stopped periodically to allow the removal of burned fuses and debris. The burned fuses and debris were disposed of adjacent to the AFV. In 2001, Explosive Ordnance Disposal Technology, Inc. performed a clearance effort over a two-week period around the area of the AFV. They removed and inspected 8,445 burned fuses.

Located on Caltrans property, fill has been placed over the AFV comprising of sandstone boulders 2 feet in diameter and larger, and up to 15 feet thick. The large boulders in the 15 feet of fill material placed on top of the AFV prohibited drilling with a small rig, and the steep incline of the adjacent slopes and access road prohibited access of a larger drill rig. Because of the fill and access restrictions by Caltrans at the site of the AFV, the nearest possible sampling location was identified approximately 300 feet downgradient of the AFV on Bayshore Road. Because of the distance, groundwater samples were the best method to determine if any of the burnt material has impacted groundwater. This section summarizes the field effort performed in November 2004 to determine the impact from fuels, metals and explosive residues that may have impacted groundwater (shallow and deeper) downgradient of the AFV. The complete letter report documenting this field effort is included as Appendix L in this report.

Note there were incorrect conclusions included in the letter report. The comparison criterion for the lowlands (i.e. RWQCB ESLs for groundwater that is not a current or potential source of drinking water) was used instead of criteria based on the highlands (i.e. MCLs or RWQCB ESLs for groundwater that is a current or potential source of drinking water). The interpretations of the analytical results presented in this report, the Expanded SI, are correct.

NORTH

0 100 200
Scale in Feet

| Analyte | 2 ft bgs |
|---|---|
| **Antimony** | **199 mg/kg** |
| Barium | 212 mg/kg |
| **Cadmium** | **1.72 mg/kg** |
| **Cobalt** | **19.8 mg/kg** |
| Chromium (total) | 38.8 mg/kg |
| **Copper** | **90.5 mg/kg** |
| Mercury | 0.095 mg/kg |
| **Nickel** | **41.8 mg/kg** |
| **Lead** | **154 mg/kg** |
| Selenium | 19.1 mg/kg |
| Vanadium | 63.7 mg/kg |
| **Zinc** | **206 mg/kg** |

| Analyte | 18 ft bgs | 5 ft bgs |
|---|---|---|
| Arsenic | | 0.0168 mg/L |
| Barium | 0.0179 mg/L | 0.328 mg/L |
| Chloride | 115 mg/L | 96.7 mg/L |
| Nitrate (as N) | 0.324 mg/L | 0.187 mg/L |
| Sulfate | 38.4 mg/L | 8.86 mg/L |
| Total Dissolved Solids | 846 mg/L | 743 mg/L |
| Zinc | 0.00644 mg/L | 0.0118 mg/L |
| Diesel Range Organics | 90 ug/L | 910 ug/L |
| Motor Oil Range Organics | 160 ug/L | 3,000 ug/L |

Soil sample results at 1 ft bgs and 2 ft bgs were less than reporting limits for VOCs, gasoline, diesel fuel and motor oil range hydrocarbons, and semi-volatile organics.

Legend

- **PZ-19** Existing Piezometer Location
- **AFVSB001** Boring Location
- **Caltrans1** Approximate Soil Sample Locations Collected April 2002 and May 2002 (Environ Survey, 2002)

Detected results are shown.
**Bolded** values exceed ambient metals concentrations in soil.

- Bridge Expansion Fill (as of 11/02)
- Artificial Fill
- Holocene Alluvium (includes Colluvium and Weathered Bedrock)
- Bay Mud (Primarily Holocene Estuarine Deposit)
- Older Alluvium
- Bedrock (Sandstone/Siltstone)
- Groundwater elevation (Measured 11/26/02 and 11/07/04)

Topographic contours as of 2002, prior to Benicia-Martinez Bridge Expansion Project. The landscape east and west of the I-680/I-780 interchange has dramatically changed with mostly cutting on the west side and filling to the east.

# Figure 6-7
## Buried AFV Location and Hydrogeologic Cross Section Armored Fighting Vehicle Sampling

Expanded Site Inspection Report
*Former Benicia Arsenal*

Subsurface investigation activities consisted of advancing two CPT borings (AFVSB001 and AFVSB002) (Figure 6-7) and collecting grab groundwater samples for laboratory analyses. A mixture of clayey silt, sandy silt, silty sand and silt overlies weathered sandstone bedrock in AFVSB001. Refusal was reached at 13.8 feet bgs. The lithology in AFVSB002 consists of younger alluvium composed of clay, clayey silts and silt overlying a small zone of Bay Mud (approximately 2 feet thick at 11 to 13 feet bgs). From approximately 13 feet to 25 feet bgs older alluvium composed of silty sand, silt, and sandy silt is found. Weathered sandstone bedrock and sandy silt-silty sand units are interbedded between 25 to 28 feet bgs, which changes to weathered bedrock. Refusal was reached at 37.57 feet bgs.

No groundwater was encountered at AFVSB001, whereas two water-bearing zones were identified in AFVSB002 as expected from the previous CPT drilling in the industrial area in April 2004 and May 2004. Depth to weathered sandstone from AFVSB001 to AFVSB002 deepens from 5 feet bgs to 25 feet bgs, which indicates AFVSB002 is within the historic valley and in the path of groundwater flow from the AFV site. The AFV is located within the highlands, where fresh groundwater would be expected.

Both water samples from AFVSB002 are characterized as fresh water based on TDS concentrations less than 1,000 mg/L. Therefore, this boring location is also located in the highlands as the AFV (Figure 6-7).

Petroleum hydrocarbons were detected in both the shallow and deep water samples collected at AFVSB002 (Table 6-10). Metals reported above laboratory MDLs included arsenic, barium and zinc (Table 6-11). Of these metals, none of the concentrations exceed their respective MCLs. Zinc does not have an established MCL so the RWQCB ESL of 0.081 mg/L is compared to the detected concentration in the groundwater sample. Concentrations of zinc do not exceed its RWQCB ESLs (Table 6-11). Explosives were not reported above MDLs.

**Table 6-10. TPH Results in Groundwater at AFVSB002**

| [illegible] | [illegible] | [illegible] |
|---|---|---|
| 5-10 | **910** | **3,000** |
| 18-25 | 90 | **160** |
| ESL | 100 | 100 |

**Bolded** values exceed their respective ESL.
ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005).
bgs = below ground surface

**Table 6-11. Detected Metals in Groundwater at AFVSB002**

| [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|
| 5-10 | 0.0168 | 0.328 | 0.0118 J |
| 18-25 | <0.0015 | 0.0179 | 0.00644 J |
| ESL | 0.36 | 1 | 0.081 |
| MCL | 0.05 | 1 | NE |

ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
**Bolded** values exceed their respective ESL or MCL
NE = not established
mg/L = milligrams per liter

Caltrans collected two soil samples (Caltrans 1 and Caltrans 2) from the area of AFV before the area was filled in. These sample locations and results are shown on Figure 6-7. The samples were collected at 1 foot bgs and 2 feet bgs. Caltrans 1 was analyzed for solvents, fuels and semi-volatiles and these analytes were reported at concentrations less than analytical reporting limits. Caltrans 2 was analyzed for only for metals and explosives. Antimony, cadmium, copper, lead, nickel, selenium, and zinc were detected at concentrations exceeding ambient metals concentrations. The metals concentrations were all below BSLs established in soil for the industrial worker (Table 6-12). Explosives were not reported above analytical reporting limits.

**Table 6-12. Detected Metals in Soil at Caltrans 2**

| Metal | Concentration (mg/kg) | Ambient Concentration (mg/kg) | BSL* (mg/kg) |
|---|---|---|---|
| Antimony | **199** | 8.52 | 818 |
| Barium | 212 | 224 | 124,000 |
| Cadmium | **1.72** | 0.866 | 1,010 |
| Chromium (total) | 38.8 | 75.3 | 448 |
| Cobalt | 19.8 | 13.3 | 123,000 |
| Copper | **90.5** | 40.5 | 75,800 |
| Lead | **154** | 20.1 | 750 |
| Mercury | 0.095 | 0.287 | 613 |
| Nickel | **41.8** | 38.3 | 40,900 |
| Selenium | **19.1** | 0.605 | 10,200 |
| Vanadium | 63.7 | 92.2 | 14,300 |
| Zinc | **206** | 126 | 613,000 |

**Bolded** values exceed ambient concentrations
* For industrial/commercial workers.
BSL = Benicia Screening Level (FA/BC, 2002a)

The conclusions from the Expanded SI and the Caltrans investigation are as follows:

- The stratigraphy encountered in boring AFVSB002 indicates that this boring is within the same alluvial valley as the AFV. In addition, the deep groundwater sample collected beneath the Bay Mud in the older alluvium at AFVSB002 is representative of groundwater downgradient of the AFV.
- Several metals (antimony, cadmium, copper, lead, nickel, selenium and zinc) were found in shallow soil at concentrations exceeding their respective ambient metals concentrations at Caltrans 2 but do not exceed their respective BSLs. Explosives were not reported above analytical reporting limits.
- TPH concentrations for diesel fuel and motor oil in groundwater exceed their respective ESLs. Oils from the roadway and the nearby railroad tracks percolating into shallow groundwater may be a contributor to shallow groundwater concentrations. Arsenic, barium, and zinc were reported in groundwater at concentrations that do not exceed their respective MCLs or ESLs at the AFV locations. Explosives were not reported above MDLs.
- Chemical results in the deeper water sample are used to determine if there is sufficient evidence to determine if there is an impact from the AFV. Even though explosives and metals were not found at significant concentrations in the deeper groundwater sample, these contaminants would not likely be expected approximately 300 feet downgradient of the AFV. However, diesel fuel

and motor oil was present in the deeper groundwater sample. Therefore, there is insufficient evidence to eliminate the possibility of a release from the AFV site. The source of the diesel fuel and motor oil could be from the Post Dumpsite. As discussed in the previous section above for the Post Dumpsite, diesel fuel and motor oil were found in groundwater at concentrations up to 5,700 µg/L diesel fuel and 1,800 µg/L motor oil in URS locations SB-1 and SB-2, located approximately 450 feet to 700 feet crossgradient to downgradient of the AFV (Figure 6-6). If the fuels at these locations are related to the fuels reported in the AFV boring, then the investigation recommended for the Post Dumpsite should provide the evidence necessary to eliminate the AFV as a source. Therefore, no further investigation at AFV is recommended until the Post Dumpsite groundwater contamination is delineated.

### 6.4.3 Salvage Yard

**No further DoD Action is Indicated at the Salvage Yard**

The Salvage Yard stored vehicles sold for scrap and for salvaging various parts and equipment, during the DoD occupation (FA/BC, 2004a). The site is located in the northern portion of Area M near the border between Area M and Area W (Figure 6-1). Oil and fuel was reportedly drained from vehicles directly on the ground surface (FA/BC, 2004a). Three borings were advanced at the Salvage Yard (OS29HP001 through OS29HP003) in the downgradient direction of the former yard to determine the presence or absence of a suspected release of solvents or fuels in groundwater from former DoD waste disposal activities. Groundwater samples were collected at the water table (5 to 15 feet bgs) and at the interface between alluvium and the sandstone bedrock at 36 to 87 feet bgs. Boring locations and analytical results are shown on Figure 6-8.

Similar to the geology encountered at the Post Dumpsite, remnants of the marshland in the area are the thickest (55 feet) at OS29HP002, which coincides with the Sulfur Springs Creek drainage area or the lowlands.

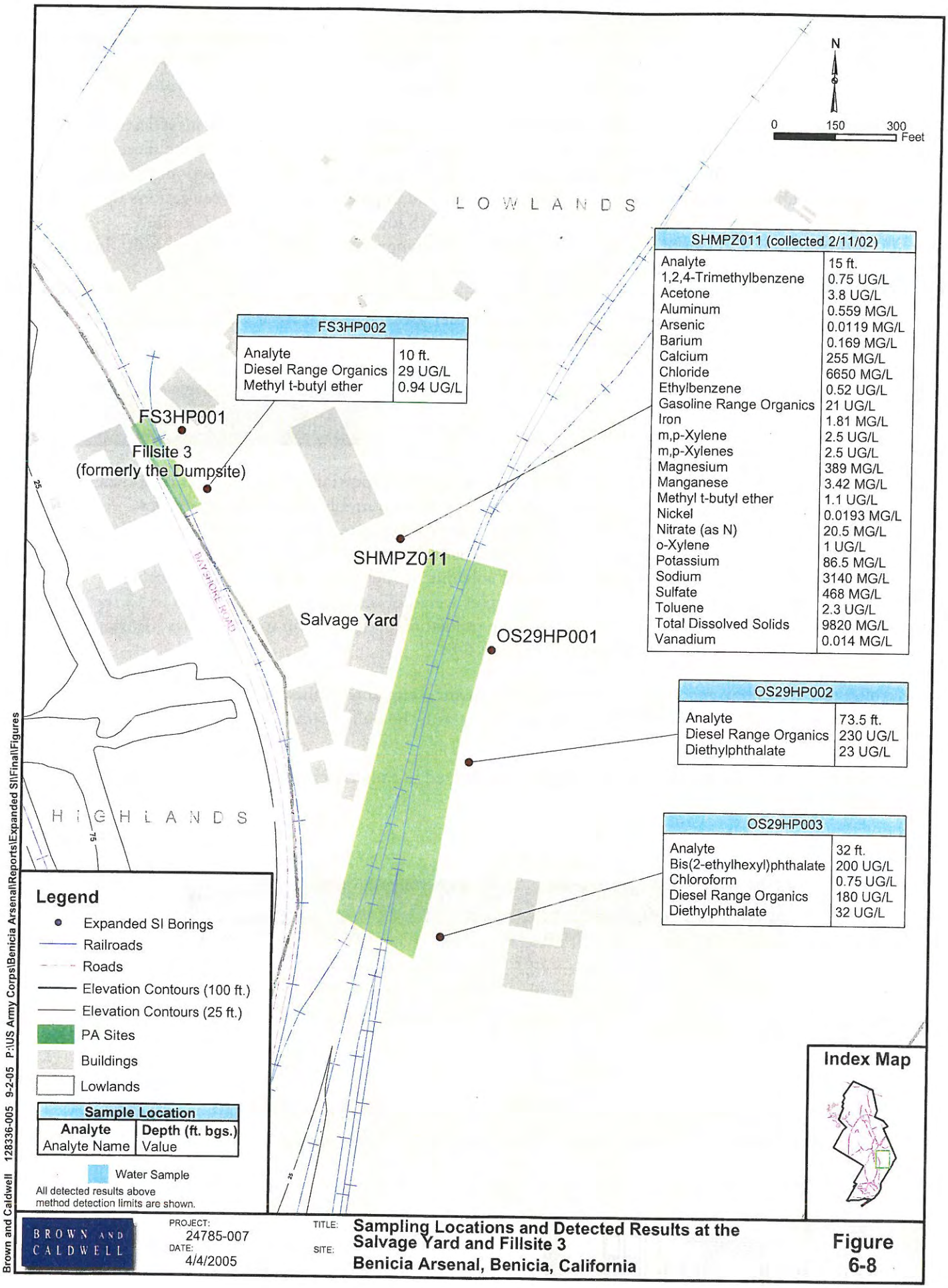
Petroleum hydrocarbons in the diesel range were detected in the deeper groundwater samples (Table 6-13).

**Table 6-13. Diesel Fuel Concentrations at the Salvage Yard**

| Boring | Screened Depth (feet bgs) | Concentration (µg/L) |
|---|---|---|
| OS29HP002 | 73-75 | 230 |
| OS29HP003 | 32-35 | 180 |
| ESL | | 640 |

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005).

Other than chloroform detected at trace concentrations (0.75 µg/L) in OS29HP003 at 32 to 35 feet bgs, no other analytes were detected above laboratory MDLs at the Salvage Yard.

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PROJECT: 24785-007
DATE: 4/4/2005

TITLE: Sampling Locations and Detected Results at the Salvage Yard and Fillsite 3
SITE: Benicia Arsenal, Benicia, California

Figure 6-8

There were distinct peaks identified on the diesel fuel chromatogram for samples OS29HP002 and OS29HP003 that did not match a typical diesel pattern and may indicate non fuel-related compounds. In an attempt to identify these peaks, the groundwater samples were sent for additional analysis by EPA Method 8270. Diethylphthalate and bis(2-ethylhexyl)phthalate were found in the samples (Table 6-14), but the compounds could not be definitely linked with peaks on the fuel chromatogram. The concentrations of these compounds do exceed their respective ESLs (Table 6-14).

**Table 6-14. Detected Phthalates in Groundwater at the Salvage Yard**

| Location | Depth (feet bgs) | Diethylphthalate Concentration (µg/L) | Bis(2-ethylhexyl)phthalate Concentration (µg/L) |
|---|---|---|---|
| OS29HP002 | 73.5-74 | **23** | Not found on chromatogram |
| OS29HP003 | 32-35 | **32** | **200** |
| ESL | | 1.5 | 32 |

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
**Bolded** values exceed their respective ESL
bgs = below ground surface
µg/L = micrograms per liter

Phthalates are wildly used as plasticizers, primarily in the production of polyvinyl chloride (PVC) resins. Plasticizers are added to synthetic plastic resins to impart flexibility to the finished product, improve workability during fabrication and extend or modify properties not present in the original resins. PVC resins are used in a wide diversity of products including cable insulation, flooring, furniture upholstery, wall coverings, car upholstery and seat covers, footwear and food and medical packaging material. (Ohio Environmental Protection Agency, 2004). Historical records for the Arsenal do not indicate any DoD related sources that used or manufactured items composed of phthalates. Therefore, the occurrence of these phthalates is from a post Army source.

In summary, fuels and motor oil were not detected in shallow groundwater, the location where oil and fuel draining on the ground would impact first. The low level hydrocarbons found in deeper groundwater do not exceed the ESL of 640 µg/L for diesel fuel and are likely attributed to the non-petroleum organics in the soil. Additionally, the phthalates found in groundwater are associated with a post Army source. Therefore, no further DoD action is indicated for the Salvage Yard.

### 6.4.4 Fillsite 3

**No further DoD Action is Indicated at Fillsite 3**

North of the Salvage Yard, is Fillsite 3 (Figure 6-8). The fillsite is suspected to have accepted unknown types of solid waste, fill material, and also was used for tire storage (FA/BC, 2003a). The purpose of the two borings advanced, FS003HP001 and FS003HP002, was to determine the presence or absence of solvents and fuels in groundwater from possible disposal activities in this area. Boring locations and analytical results are shown on Figure 6-8.

There is no marshland in this area but there is clay approximately 15 to 25 feet thick sandwiched between interbedded sequences of silts and sandy silts. This clay is also located at or below sea level which supports that Fillsite 3 is within the lowlands. Sandstone was encountered at 26 to 34 feet bgs, with the deepest depth encountered farther away from the hills, as expected. First groundwater was encountered within the silt and sandy silt above the clay, which fits the conceptual site model.

Groundwater samples collected from Fillsite 3 contained trace amounts of diesel fuel and MtBE at concentrations of 29 µg/L and 0.94 µg/L, respectively. MtBE was also detected in the nearby piezometer PZ-11 at 1.1 µg/L in 2002. No other analytes were detected above laboratory MDLs at Fillsite 3. Since the concentrations of diesel fuel are less than the ESL of 640 µg/L and the presence of MtBE indicates a post Army impact, there is no evidence of a significant impact from possible DoD disposal activities. Therefore, no further DoD action is indicated at Fillsite 3.

### 6.4.5 Former Vehicle Maintenance Buildings (T222, T221, 171, 172 and TO 73)

**No further DoD action is indicated for the Former Vehicle Maintenance Buildings T222, T221, 171, 172, and TO 73.**

Buildings T222, T221, 171, 172 and TO 73 are located in the low-lying hills in the western portion of Area M. Vehicle maintenance and steam cleaning activities occurred in these buildings (FA/BC, 2004a). Four borings (B171HP001, B172HP001, T222HP001 and TO73HP001) were advanced, one at each building, and an existing piezometer was also sampled to determine the presence or absence of a suspected release of solvents and fuels from former DoD cleaning or maintenance activities in these buildings. Building and sampling locations are shown on Figure 6-9.

All CPT borings advanced were dry. Based on the Decision Diagram (Diagram 1-1), soil gas samples were collected because the locations were near existing buildings. These samples were analyzed for VOCs. Chloroform was detected at trace levels (110 ppbv) in B171HP001 at 3 to 4 feet bgs.

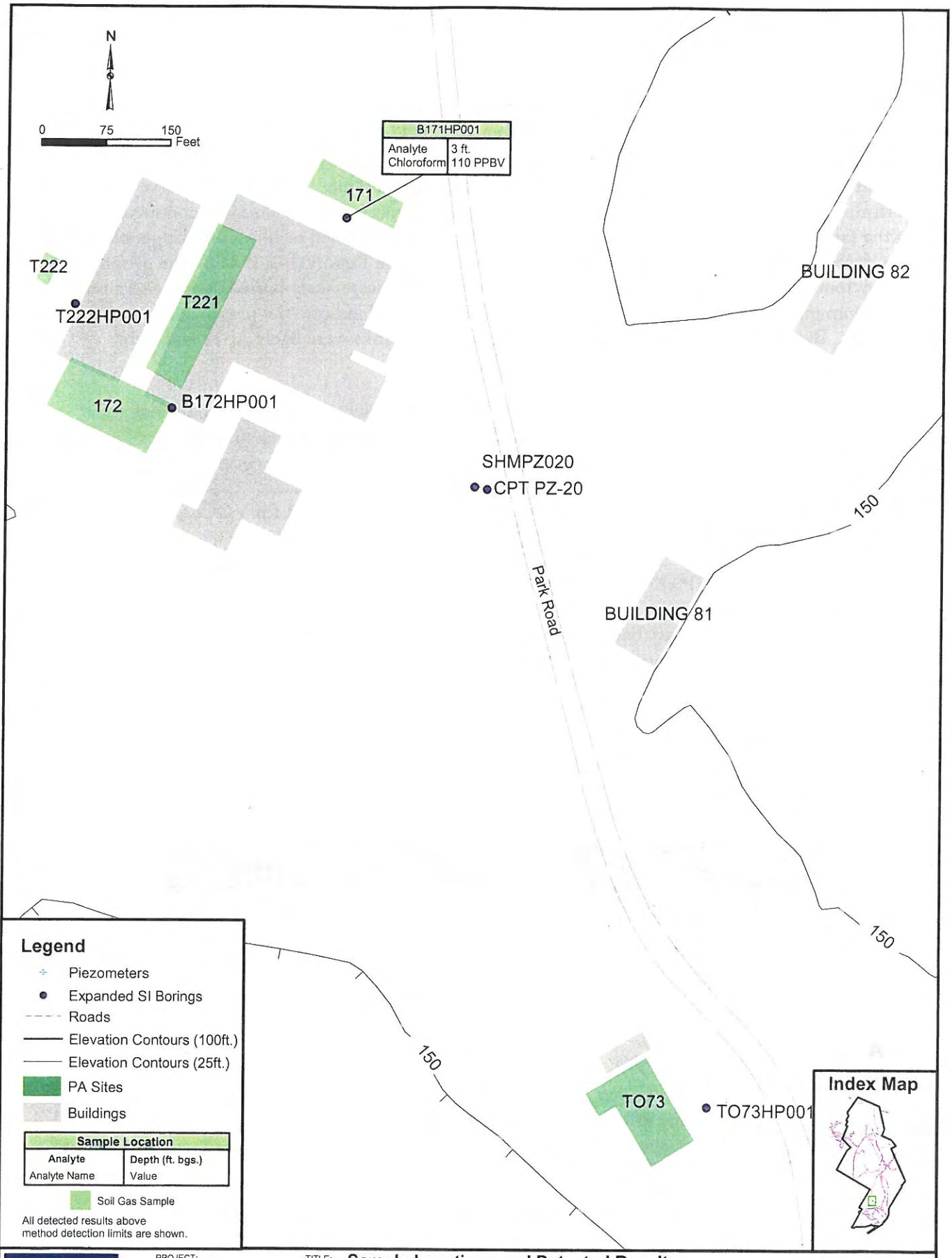
One groundwater sample was collected in this area, from the existing piezometer, PZ-20. Samples were analyzed for VOCs and fuels. All analytes analyzed in groundwater for PZ-20 were below the laboratory MDLs.

There is no evidence of solvents or fuels released to groundwater from vehicle maintenance and steam cleaning activities. Chloroform was detected at trace levels in soil gas and is not a COI expected to be found from vehicle maintenance activities. Chloroform can be released to the environment from direct processes (production, storage, transit, or use) or as a result of its formation from other substances, in processes such as paper bleaching with chlorine and water chlorination (World Health Organization, 2004). Pulp and paper mills, municipal wastewater treatment plants, chemical manufacturing plants, and waste incinerators represent anthropogenic sources of chloroform (World Health Organization, 2004). Therefore, there are no indications of a DoD release at T222, T221, 171, 172 and TO 73 and no further DoD action is indicated.

### 6.4.6 Former Heavy Equipment Yard (Buildings 50 and 111)

**Post DoD contaminant was found in groundwater**

A paint shop (Building 50) and an equipment shop (Building 111) were part of the former heavy equipment yard located in the southeast corner of Area M near the Carquinez Strait (Figure 6-1). Building 50 reportedly maintained a 500-gallon stove oil tank and two 5,500-gallon road oil tanks (FA/BC, 2004a). After the Army left the installation in 1964, a 3,000-gallon kerosene UST was removed in 1987 and a 10,000-gallon gasoline UST was removed in 1995. These tanks are assumed to be installed post Army. Solano County

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PROJECT: 24785-007
DATE: 4/4/2005

TITLE: Sample Locations and Detected Results at the Former Vehicle Maintenance Shops
SITE: Benicia Arsenal, Benicia, California

Figure 6-9

Department of Environmental Management issued a UST site closure letter in 1995 and no further investigation or action was required for these removed USTs. The USTs that were removed and investigated in 1987 through 1995 are assumed to be different than the tanks associated with the former Building 50 oil storage tanks since the sizes are not the same. A geophysical survey was performed in February 2005 to determine if the Army tanks were USTs. This was conducted as part of the Fuel Storage Tank Removal Action Plan (BC, 2004b). Detailed results from the geophyscical survey are described in the Fuel Storage Tank Removal Action Report (BC, 2005). The geophysical survey found a reinforced concrete pad, some anomalies that were likely buried debris, and a buried petroleum pipeline. There were no other anomalies that would indicate the presence of any USTs in this area. Based on the results of the geophysics, the Army tanks were likely ASTs and were removed from the site.

Two borings (B050HP001 and B111HP001) were advanced downgradient of the buildings to determine the presence or absence of a possible release of solvents and fuels from former DoD cleaning and fueling activities at these buildings. Figure 6-10 shows the two boring locations advanced. Groundwater and soil gas samples were collected at each boring. All soil gas samples collected were analyzed for VOCs. Groundwater samples were analyzed for VOCs and fuels; the groundwater sample collected at Building 50 was also analyzed for metals.

The CPT logs for B050HP001 and B111HP001 (Appendix C) do not indicate the presence of clay characteristic of Bay Mud (noted as clay or sensitive fines on the CPT log) at or below mean sea level. Therefore, the boundary between the highlands and the lowlands is assumed to be south of former Buildings 50 and 111 and the groundwater quality at the CPT locations is assumed to be representative of the highlands. The boundary of the highlands and the lowlands is shown on Figure 6-10.

Trace concentrations of o-xylene, m,p-xylene and MtBE were reported in groundwater at Buildings 50 and 111 (Table 6-15 and Figure 6-10). Soil gas samples collected at these two locations did not detected any analytes above laboratory MDLs.

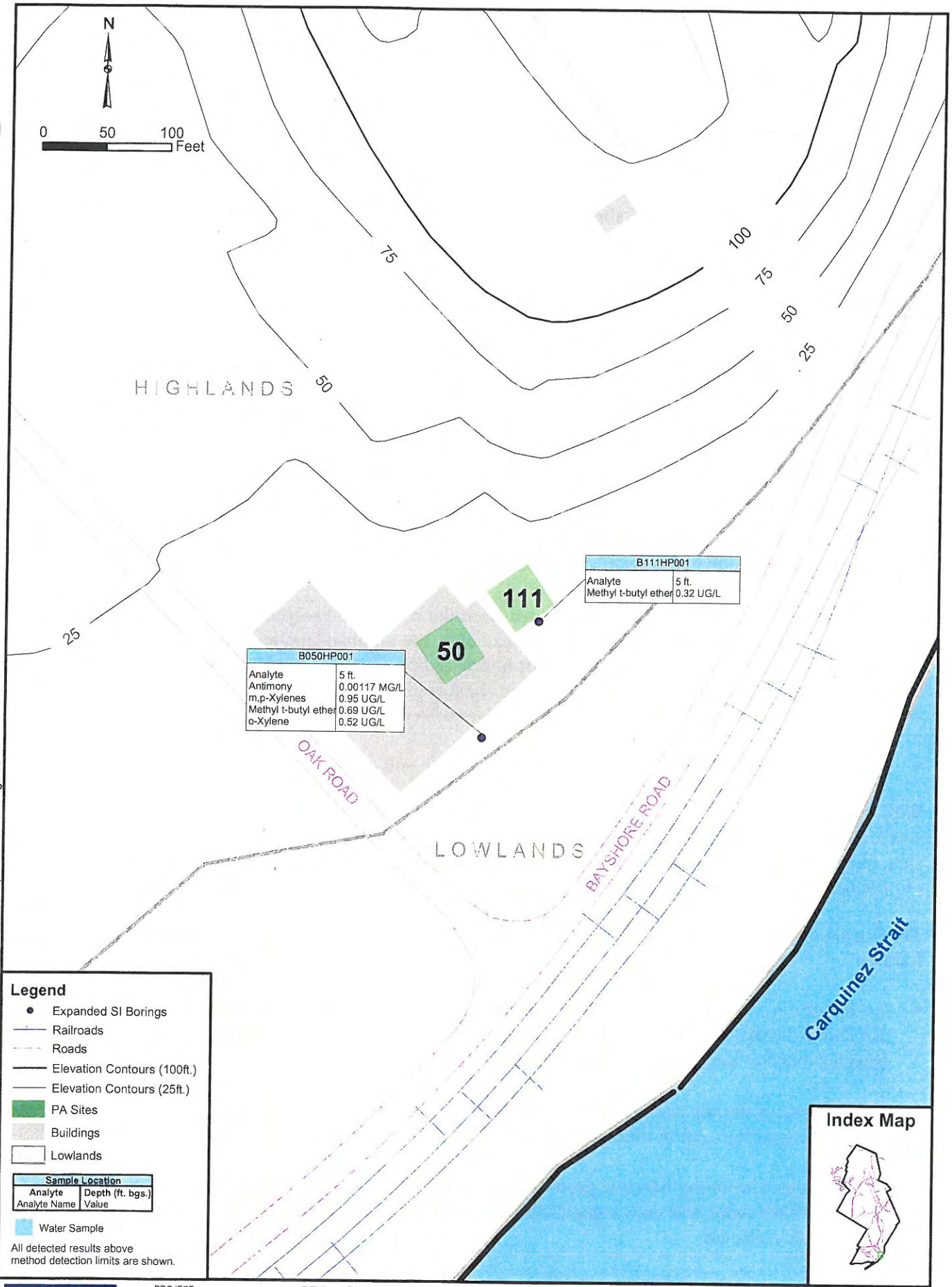
**Table 6-15. Detected Groundwater Concentrations at the Former Heavy Equipment Yard (Buildings 50 and 111)**

Concentrations in µg/L unless otherwise noted

| Metal | B050HP001 | B111HP001 | MCL |
|---|---|---|---|
| Antimony | 0.00117 mg/L | NA | 0.006 mg/L |
| m,p-xylenes | 0.95 | <0.69 | 1,750 |
| Methyl t-butyl ether | 0.69 | 0.32 | 13 |
| o-xylenes | 0.52 | <0.33 | 1,750 |

MCL = maximum contaminant level (California Department of Health Services, 2004)
NA = not analyzed
**Bolded** values exceed MCLs.

The result from this sampling effort indicates no DoD impact due to any release from these stove oil or road oil ASTs. Residual concentrations of gasoline were reported in the groundwater and are the result of the post Army release. Therefore, no further DoD action is indicated for the former heavy equipment yard.

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PROJECT: 24785-007
DATE: 4/4/2005

TITLE: Sampling Locations and Detected Results at the Former Heavy Equipment Yard
SITE: Benicia Arsenal, Benicia, California

Figure 6-10

## 6.5 Area I (Industrial Area)

The industrial area was the center of activity at the former Arsenal containing several machine, manufacturing, cleaning and repair shops. Each activity was evaluated to determine chemicals used and probable contaminant locations. Based on previous investigations, the primary COIs are solvents and fuels. Other COIs specific to a building's use, such as metals, were also evaluated. Building and sampling locations are shown on Figure 6-11. This figure shows previous sampling locations (in blue and yellow), Expanded SI sampling locations (in purple), and the location of the Expanded SI sites in relation to the lowlands and the highlands. A subset of the previous sampling locations are the fuel AST/UST locations shown with a yellow symbol. Table 3-1 in Section 3.2 lists the analytical methods and rationale for the Expanded SI boring locations.

This section presents the results for soil, soil gas and groundwater samples collected during the site investigation in the industrial area. This section is organized as described below.

- Groundwater in the industrial area is impacted with fuels and solvents that are beneath multiple buildings and are co-mingled such that the source is difficult to determine. As such, groundwater for fuels and solvents are described separately and not by building.

- Buildings with impacts that can be separated from the co-mingled solvent and fuel plumes in the industrial area are discussed separately. For example, the sandblasting building, Building 4, did not indicate any impacts to groundwater from the lead-based paints but solvents detected appear to be a part of the larger co-mingled plume in shallow groundwater. So, the lead based paints at Building 4 are discussed separately from the larger solvent based groundwater plume.

- Lastly, the storm water drain system is described at the end of this subsection.

With exception of the sites located on the hills (north of Jackson Street), the rest of the industrial area is located in the lowlands, where the quality of the groundwater is brackish to saline and chemical quality is compared to RWQCB ESLs representative of groundwater that is not a current or potential source of drinking water.

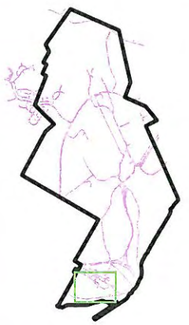
The format of the figures and plates with groundwater concentrations in this subsection are as follows:

- Each location is shown by an unfilled or filled circle based on whether the analyte is detected or not above the MDLs. A location with a non-detected value is shown as unfilled circle and a detected location is shown as a filled in circle.

- For locations with only one groundwater sample, the detected values and the name is shown next to the location. All of these samples were collected at less than 15 feet bgs.

- For locations with more than one groundwater sample with a detected value, a matrix box is shown with the name and each value (detected and not detected) is placed beneath the depth of each sample collected.

# Index Map



## Legend

Sample Locations

- Previous Investigations
- Expanded SI
- Fuel AST/UST Locations
- Wells
- Area I boundary
- Railroad
- Roads
- Elevation Contours (100ft.)
- Elevation Contours (20ft.)
- UST Excavations
- UST Locations
- PA Sites
- Buildings
- Lowlands

0 50 100 Feet

0 100 200 Feet

N

# Figure 6-11

**Industrial Area Sampling Locations**

SITE:

**Benicia Arsenal, Benicia, California**

PROJECT: 24785

DATE: 4/4/2005

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- If more than one groundwater sample was collected and both results were non-detect, then an asterisk is placed after the location name, for example SWAMPAHP004*.

- Plume boundaries are shown on the Figures and represent the ESL of 640 µg/L for diesel fuel and motor oil and non-detect for cis-1,2-DCE.

- The locations where no groundwater was encountered are also shown on each of these Figures or plates. A symbol of a circle with an "X" denotes these locations with the name of the location next to the symbol. These locations were used to define the edges of the groundwater plume boundaries.

- Lastly, Plates 1, 2 and 3 have numerous locations with groundwater concentrations detected above the MDLs. In order to provide some clarity among all the locations, the locations with detections vary in color based on a range of concentrations. The ranges are 0 to 50 µg/L, 50 to 500 µg/L, 500 to 5,000 µg/L, and 5,000 to 50,000 µg/L.

The plates reference in this section are located at the back of this section.

**No further DoD Action is indicated at Building 4**

### 6.5.1 Former Sandblast Building/Paint Spray (Building 4).

This building served as part of the reclamation project for World War II equipment returns. The building had been constructed without pilings on reclaimed tideland (lowlands) and had settled beyond economic repair, according to 1957 Army records. The building was demolished in early 1970s and was located west of the 50 Series Complex near Building 165 (Figure 6-11). The Expanded SI focused on potential groundwater impacts of metals and solvents from the possible disposal of solvent-based and lead-based paints downgradient of the building and the impacts of solvents in groundwater from other locations in the industrial area. Two borings (B004HP001 and B004HP002) were advanced downgradient of the former building location. A third boring, B004HP003, was advanced approximately 60 feet southwest of the original borings to delineate solvents in groundwater. See section 6.5.27 for further discussion on chlorinated solvents in reported groundwater. At Building 4, where lead-based paints may have been used, lead was not detected above MDLs in either shallow groundwater sample collected at B004HP001 or B004HP002.

Barium, a naturally occurring metal found only in combination with other elements, was reported in B004HP001 and B004HP002 at 1.55 mg/L and 2.22 mg/L, respectively, in shallow groundwater (5 to 10 feet bgs). The RWQCB ESL for barium is 1 mg/L (RWQCB, 2005) but studies of barium concentrations in fresh water and seawater indicate that ambient concentrations for barium can be as much as 25 times higher than measured in groundwater beneath former Building 4. Barium concentrations of 7 mg/L to 15 mg/L and 6 mg/L have been measured in fresh water and seawater, respectively (World Health Organization, 2001). The mean barium content of various US surface waters ranges from 43 to 57 mg/L (World Health Organization, 2001). Groundwater erosion of sedimentary rocks is the primary source of naturally occurring barium in drinking water. Other occurrences of barium is in barite to make high-density oil and gas well drilling muds and small amounts of barium sulfide is used in the manufacture of paint and glass. Two commonly found forms of barium are barium sulfate and barium carbonate. These forms of barium are not very

soluble in water except in acidic environments. The pH of groundwater measured at B004HP001 and B004HP002 is neutral based on measurements of 7.42 and 6.27, respectively. These conditions indicate that the barium present in the groundwater is not mobilizing. Additionally, groundwater in this area is typically categorized as saline based on TDS values of nearby piezometers PZ-2 and PZ-3. The source of barium could be from natural processes or from anthropogenic sources, like paints. However, the low concentrations of barium found in the saline groundwater beneath former Building 4 compared to other studies, there is no significant impact to groundwater. Therefore, no further DoD action is indicated for the barium detected in groundwater.

Based on no lead found in groundwater and the solvents found in groundwater are from another source area, there is no evidence of a significant release at this building. Therefore, no further DoD action is indicated. A risk assessment for the solvents found in groundwater is recommended as part of an industrial area–wide approach.

### 6.5.2 Former Store House/Engine Rebuild (Building 31).

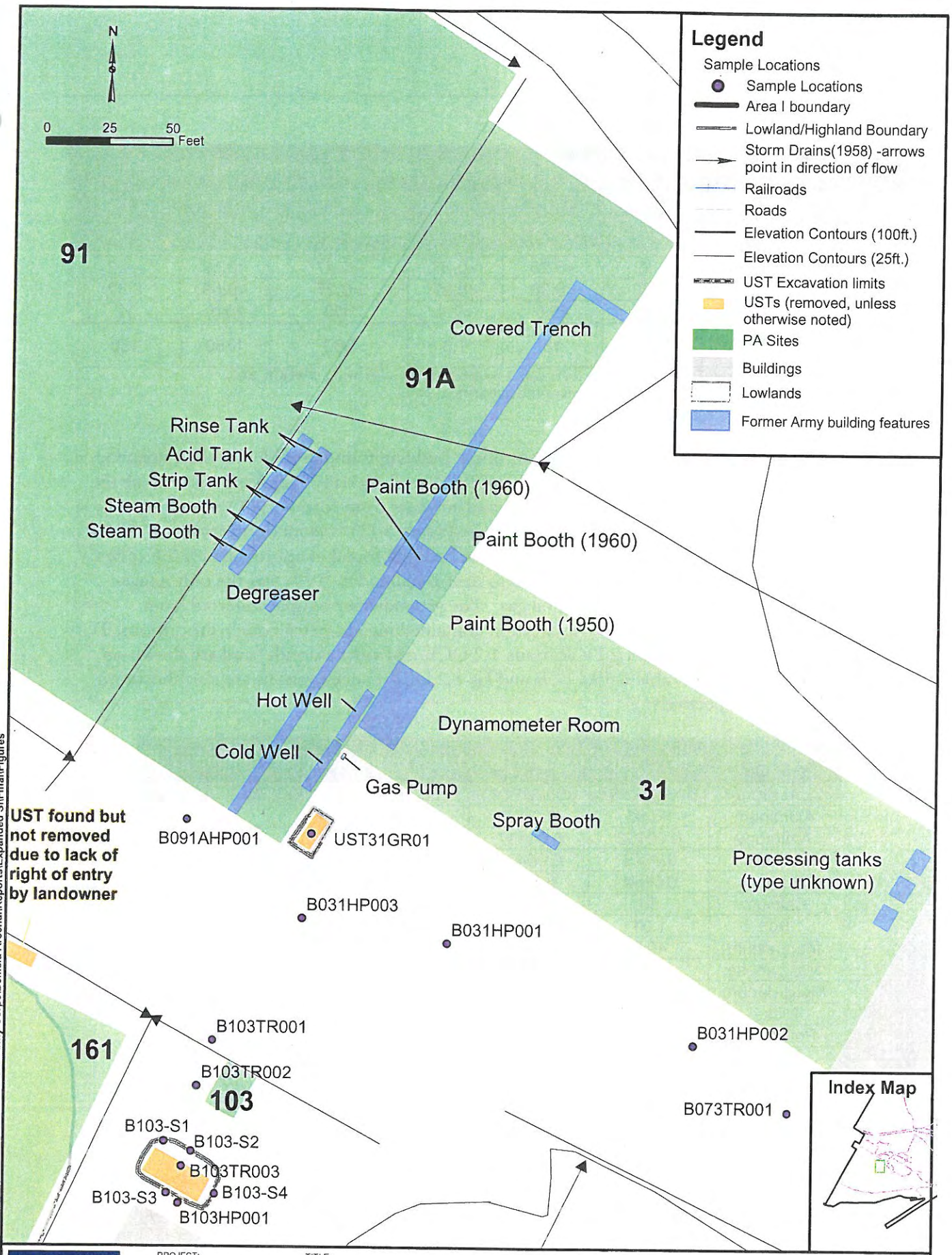
**A risk evaluation is recommended for the residual fuel-related contaminants in soil and groundwater at Building 31. Groundwater impacted with solvents is part of a larger co-mingled plume from other sources.**

Building 31 was used by the army prior to 1942 as a store house and afterwards for engine rebuilding and some fuel storage. As an engine rebuilding area, several ASTs were used which included three caustic tanks, an acid tank, a hot water tank, a dichromate tank, and solvent and degreaser tanks. The building also contained a hydraulic press. Based on a 1950 Army map, the building contained a dynamometer room, a spray booth and three processing tanks (type unknown) (Figure 6-12). The locations of the other tanks or hydraulic press are not known. The building no longer exists but the raised foundation remains. There was also a UST and service pump associated with Building 31 (Figure 6-12). The UST was removed in May 2004 and described in detail in the Fuel Storage Tank Remedial Action Investigation Report (BC, 2005). Soil samples collected from the excavation pit detected concentrations of gasoline, diesel fuel, motor oil, lead, ethylbenzene, xylenes, and naphthalene above ESLs (Table 6-16). However, Building 91A and a planter box prevented overexcavating the remaining soil impacted with petroleum hydrocarbons along the western and northern sidewalls of the excavation. A downgradient groundwater sample (B031HP003) was collected. The groundwater sample downgradient of the former UST contained 12 µg/L cis-1,2 DCE, 0.71 µg/L trans-1,2 DCE, and 35 µg/L diesel fuel (Table 6-17).

**Table 6-16. Petroleum Hydrocarbon Concentrations in Soil Detected at Building 31**

| Location | Diesel Fuel (mg/kg) | Gasoline (mg/kg) | Motor Oil (mg/kg) | Lead (mg/kg) | Ethylbenzene (mg/kg) | Xylenes (mg/kg) | Naphthalene (mg/kg) |
|---|---|---|---|---|---|---|---|
| UST31GR01-A-S03 (west sidewall) | **8200** | **22000** | **1280** | **1280** | **84** | **300** | **140** |
| UST31GR01-A-S02 (north sidewall) | **1900** | 2.7 | **1600** | **1500** | 0.049 | 0.028 | <0.0115 |
| UST31GR01-A-S01 (south sidewall) | 54 | <0.057 | 120 | 22.9 | <0.0016 | <0.0036 | <0.0023 |
| ESL (mg/kg) | 500 | 400 | 1000 | 750 | 32 | 11 | 1.5 |

ESL = Environmental Screening Level (RWQCB, 2005). ESL values for soil are for shallow soils (<3 meters bgs) and commercial/industrial land use.
mg/kg = milligrams per kilograms
**Bolded** values exceed ESLs.

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PROJECT: 24785-007
DATE: 4/4/2005

TITLE: Former Building 31 and Building 91A Army Features
SITE: Benicia Arsenal, Benicia, California

Figure 6-12

**Table 6-17. Petroleum Hydrocarbon Concentrations in Groundwater Detected at Building 31**

| Location | Diesel Fuel (µg/L) | Gasoline (µg/L) | MtBE (µg/L) | Benzene (µg/L) | Ethylbenzene (µg/L) | Xylenes (µg/L) | Toluene (µg/L) |
|---|---|---|---|---|---|---|---|
| B031HP001 | <24 | <25 | <0.28 | <0.37 | <0.27 | <0.69 | <4.2 |
| B031HP003 | 35 | <25 | <0.28 | <0.37 | <0.27 | <0.69 | 0.82 |
| B031GR01 | **14,000** | **2200** | <5.6 | <7.4 | **300** | **1920** | 12 |
| MCL/ESL^ (µg/L) | 100^ | 100^ | 13 | 1.0 | 300 | 1750 | 150 |

^ Environmental Screening Level (ESL). Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
**Bolded** values exceed ESLs or MCLs.
µg/L - micrograms per liter

Two CPT borings were advanced downgradient of the building foundation during the Expanded SI. The purpose of advancing two CPT borings (B031HP001 and B031HP002) was to determine the presence or absence of a possible release of fuels and solvents from former DoD repair activities in the building. The building is located in the highlands (Figure 6-11). Groundwater was not encountered at B031HP002 due to shallow sandstone bedrock found at approximately 5 feet bgs. Soil gas was sampled since the boring location was near Building 98. TCE was the only analyte reported above the MDLs at 140 ppbv in soil gas. The groundwater sample collected from B031HP001, B031HP003 and the UST excavation contained metals, petroleum hydrocarbons, TCE and its degradation products (cis-1,2 DCE, trans-1,2 DCE and vinyl chloride) and are shown on Table 6-17, Table 6-18 and Table 6-19. TCE and cis-1,2 DCE concentrations are also shown on Plate 2 and Plate 3, respectively.

**Table 6-18. Metal Concentrations Detected in Groundwater at Building 31**

| Constituent | B031HP001 | B031HP003 | B031GR01 | MCL/ESL^ (mg/L) |
|---|---|---|---|---|
| Aluminum | <0.06 | 0.0698 | <0.06 | 1.0 |
| Antimony | 0.00102 | 0.00117 | 0.011 | 0.006 |
| Arsenic | 0.0355 | 0.00473 | <0.0036 | 0.05 |
| Barium | 0.0694 | 0.0401 | 0.122 | 1.0 |
| Calcium | 80 | 77.2 | 25.1 | NE |
| Iron | 1.91 | 0.0756 | <0.03 | NE |
| Magnesium | 40.8 | 30.9 | 13.2 | NE |
| Manganese | 1.2 | 0.258 | 0.26 | NE |
| Molybdenum | <0.01 | 0.0112 | 0.0113 | 35^ |
| Nickel | <0.01 | 0.0109 | <0.01 | 0.1 |
| Potassium | <1.0 | 1.98 | 5.81 | NE |
| Sodium | 115 | 128 | 114 | NE |
| Vanadium | <0.005 | 0.00878 | <0.005 | 15^ |
| Zinc | 0.00815 | 0.03 | 0.0174 | 81^ |

^ - Environmental Screening Level (ESL). Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
NE = not established

No metal concentrations exceed their respective ESL or MCL concentrations (Table 6-18).

Diesel fuel, gasoline, ethylbenzene and xylene concentrations exceed their respective ESLs from the sample collected in the excavation (Table 6-17).

**Table 6-19. Solvent Contaminants Detected in Groundwater at Building 31**

| Location | TCE (µg/L) | Cis-1,2 DCE (µg/L) | Trans-1,2 DCE (µg/L) | Vinyl Chloride (µg/L) |
|---|---|---|---|---|
| B031HP001 | 1.6 | **68** | 3.6 | **16** |
| B031HP003 | <0.31 | 12 | 0.71 | <0.12 |
| B031GR01 | <6.2 | <7.4 | <6.6 | <2.4 |
| MCL | 5.0 | 6.0 | 10.0 | 0.5 |

MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
**Bolded** values exceed MCLs.
µg/L = micrograms per liter

Cis-1,2-DCE and vinyl chloride identified in the groundwater sample collected from the B031HP001 exceed their respective MCLs (Table 6-19). The occurrence of the TCE and its degradation products are part of a larger plume (see Plate 2) and is discussed further in Section 6.5.27. In summary, the groundwater data in the industrial area indicates that the primary sources of the TCE are from other locations. There is no documented DoD use of solvents at Building 31. Therefore, no further DoD action is indicated for the building. A risk assessment for the residual fuels found in groundwater is recommended.

### 6.5.3 Former Garage/Repair Shop (Building 42).

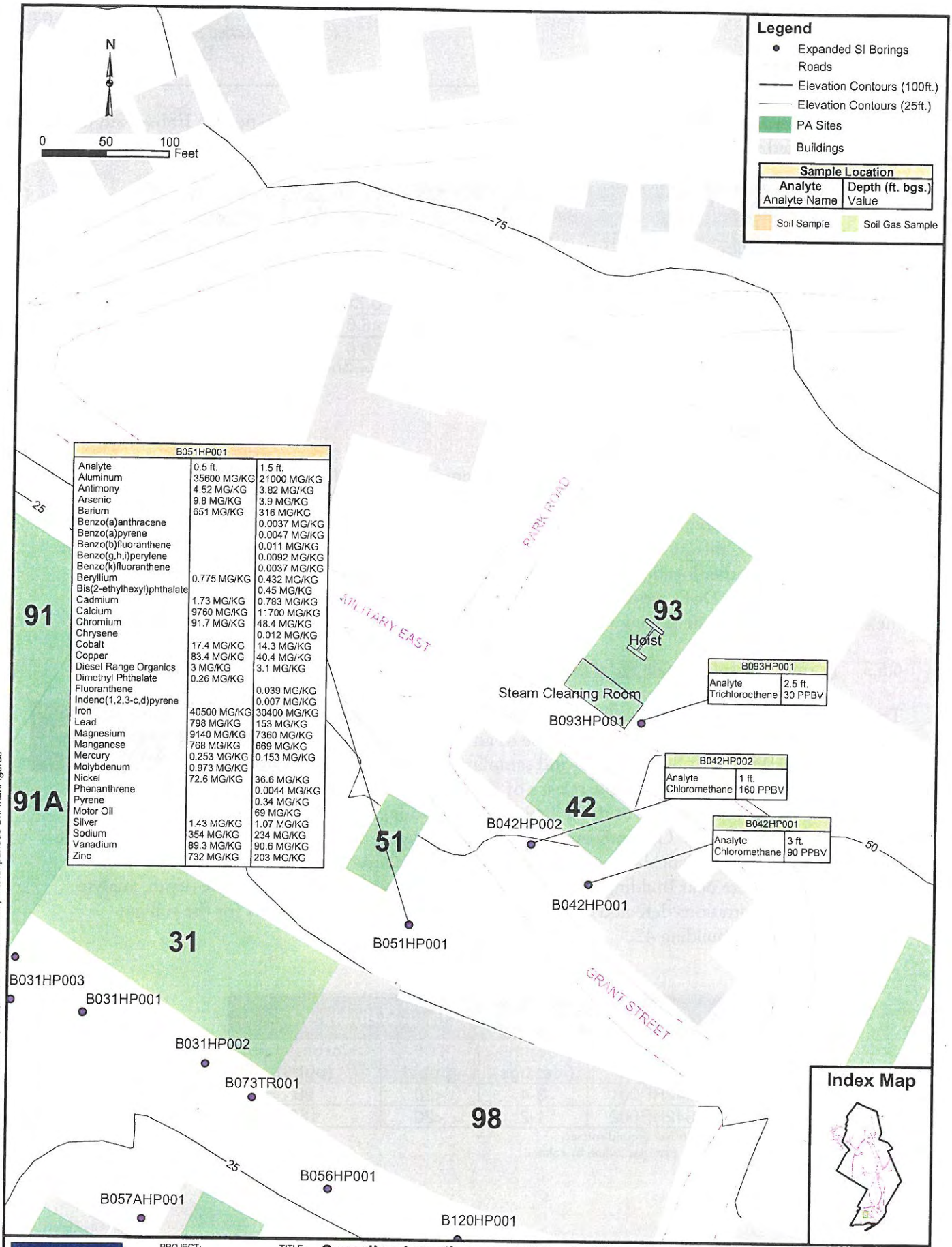
**No further DoD Action is Indicated at Building 42**

There is little known about this building, except that it was a garage then renovated to a repair shop. The purpose of advancing two CPT borings (B042HP001 and B042HP002) and sampling was to determine the presence or absence of a possible release of fuels and solvents from former DoD repair activities in the building. The borings were placed on the downhill side of the building (Figure 6-13). Groundwater was not encountered, as expected, due to its location in the Highlands foothills. Analytical results are shown on Figure 6-13. Soil gas was sampled since the boring locations were near Building 42. Table 6-20 lists the boring number, sample depth, analyte and soil gas concentrations detected above laboratory method detection limits for the soil gas samples collected at Building 42.

**Table 6-20. Soil Gas Detections at Building 42**

| Location | Depth (feet bgs) | TCE (ppbv) | Chloromethane (ppbv) |
|---|---|---|---|
| B042HP001 | 3-4 | <20 | 90 |
| B042HP002 | 1-2 | <20 | 160 |

bgs = below ground surface
ppbv = parts per billion by volume

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PROJECT: 24785-007
DATE: 4/4/2005

TITLE: **Sampling Locations and Detected Results at Buildings 42, 51 and 93**
SITE: **Benicia Arsenal, Benicia, California**

**Figure 6-13**

The soil gas sample depths vary slightly due to depth of the surface material (asphalt/concrete). At boring B042HP002, the CPT rig reached refusal at approximately 2 feet bgs; therefore, the soil gas samples were collected at a more shallow depth than proposed 3 to 5 feet bgs in the FSIP.

Chloromethane (also known as methyl chloride) concentrations were reported at Building 42 at a maximum concentration of 160 ppbv. According to the World Health Organization (2000), these are the sources of human and environmental exposure for methyl chloride:

- Natural sources of methyl chloride dominate over anthropogenic sources. The major source appears to be the marine/aquatic environment, likely associated with algal growth. Other sources are biomass burning (forest fires), degradation of wood by fungi, and direct and indirect anthropogenic sources.

- In almost all of the commercial uses, methyl chloride is reacted to form another product. The current principal uses are in the production of silicones and also as a general methylating agent. The use of methyl chloride in the manufacture of synthetic rubber, its refrigerant and extractant applications, and its use as a tetramethyllead intermediate now have secondary importance.

- Indirect sources of methyl chloride are tobacco smoke, turbine exhaust, incineration of municipal and industrial waste, chlorination of drinking-water, and sewage effluent.

Based on the sources of methyl chloride (chloromethane), there is no known association with historic uses at the former garage/repair shop. Therefore, there is no evidence of a DoD release at this building and no further DoD action is indicated

6.5.4 Former Drum Storage/Maintenance Area (Building 51).

**Further investigation is warranted at the former drum storage area at Building 51**

Building 51 was used as a drum storage/maintenance area by the DoD and was sampled to determine if former DoD activities have impacted the near surface and subsurface soil from a possible surface release of fuels and solvents. The building is located on the hills above Building 31 and Building 98 (Figure 6-11). Other COIs investigated were PAHs, semi-volatile organics and metals. As stated in the Expanded SI FSIP, sample depths were dependent on the presence of asphalt paving (BC, 2004a). No asphalt was present; therefore, the plan was to collect soil samples at 0.5 feet and 5 feet below subgrade materials (e.g., baserock). However sandstone was encountered at 2 feet bgs. As a result, the deeper soil sample was collected at a shallower depth than planned. One boring (B051HP001) was hand augered and two soil samples were collected at 0.5 feet to 1.0 feet and 1.5 feet to 2.0 feet bgs. No groundwater was encountered.

Detected results from Building 51 are shown on Figure 6-13. No metal concentrations exceeded their respective BSLs. However, in the duplicate sample at 0.5 feet to 1.0 feet, lead concentration was 798 mg/kg and exceeded the risk to commercial/industrial worker of 750 mg/kg. It is appropriate to average the concentrations of the primary sample and the duplicate sample. The average lead concentration for the 0.5 feet to 1.0 foot soil sample is 477 mg/kg. Lead concentrations do decrease in concentration with depth (Table 6-21).

**Table 6-21. Petroleum Hydrocarbons and Lead in Soil at Building 51**

| | BSL*/ESL (mg/kg) | Depth 0.5 feet - 1.0 feet bgs (mg/kg) | Depth 1.5 feet - 2.0 feet bgs (mg/kg) |
|---|---|---|---|
| Diesel Fuel | 500 | 3 | 3.1 |
| Motor Oil | 1,000 | <68 | 69 |
| Gasoline | 400 | 0.99 | <0.057 |
| Lead | 750 | **155/798**** | 153 |

* - Commercial/Industrial worker- noncarcinogen. (FA/BC, 2002a)
**- Duplicate sample
BSL = Benicia Screening Level (FA/BC, 2002a)
ESL = Environmental Screening Level (RWQCB, 2005)
**Bolded** values exceed their respective BSLs or ESLs
mg/kg = milligrams per kilograms

Petroleum hydrocarbon concentrations shown in Table 6-21 do not exceed their respective ESLs. Concentrations of hydrocarbons reported in the shallow soil samples decrease in concentration with depth.

PAHs and semi-volatile compounds were detected in the soil above laboratory MDLs and their concentrations are also listed on Figure 6-13 and Table 6-22. Dimethyl phthalate, a SVOC, was detected above its respective RWQCB ESL ( Table 6-22). As discussed for the Salvage Yard, the presence of phthalates is not related to any DoD activities.

**Table 6-22. Detected PAHs and SVOCs in Soil at Building 51**

| | ESL (mg/kg) | Depth 0.5-1.0 feet bgs (mg/kg) | Depth 1.5-2.0 feet bgs (mg/kg) |
|---|---|---|---|
| bis(2-ethylhexyl) phthalate | 2 | <0.11 | 0.45 |
| Benzo(a)anthracene | 1.3 | <0.001 | 0.0037 |
| Benzo(a)pyrene | 0.13 | <0.0011 | 0.0047 |
| Benzo(b)fluoranthene | 1.3 | <0.0021 | 0.011 |
| Benzo(g,h,i)perylene | 27 | <0.0021 | 0.0092 |
| Benzo(k)fluoranthene | 1.3 | <0.0018 | 0.0037 |
| Dimethyl phthalate | 0.035 | **0.26** | <0.13 |
| Fluoranthene | 40 | <0.0021 | 0.039 |
| Indeno(1,2,3-c,d)pyrene | 1.3 | <0.0023 | 0.007 |
| Phenanthrene | 11 | <0.0011 | 0.0044 |
| Pyrene | 85 | <0.0019 | 0.34 |

ESL = Environmental Screening Level for Commercial/Industrial land use (RWQCB, 2005)
**Bolded** values exceed their respective BSLs or ESLs
mg/kg = milligrams per kilograms

Since the lead reported in shallow soil may be indicative of a nearby source area and PAHs were present in the deeper soil sample, additional investigation is warranted to determine if there is a source for the lead and PAHs in soil in the area of the former drum storage area at Building 51.

### 6.5.5 Former Dynamometer Shop/Engine Testing (Building 53) UST.

**A risk evaluation is recommended at the location of the former Building 53 UST**

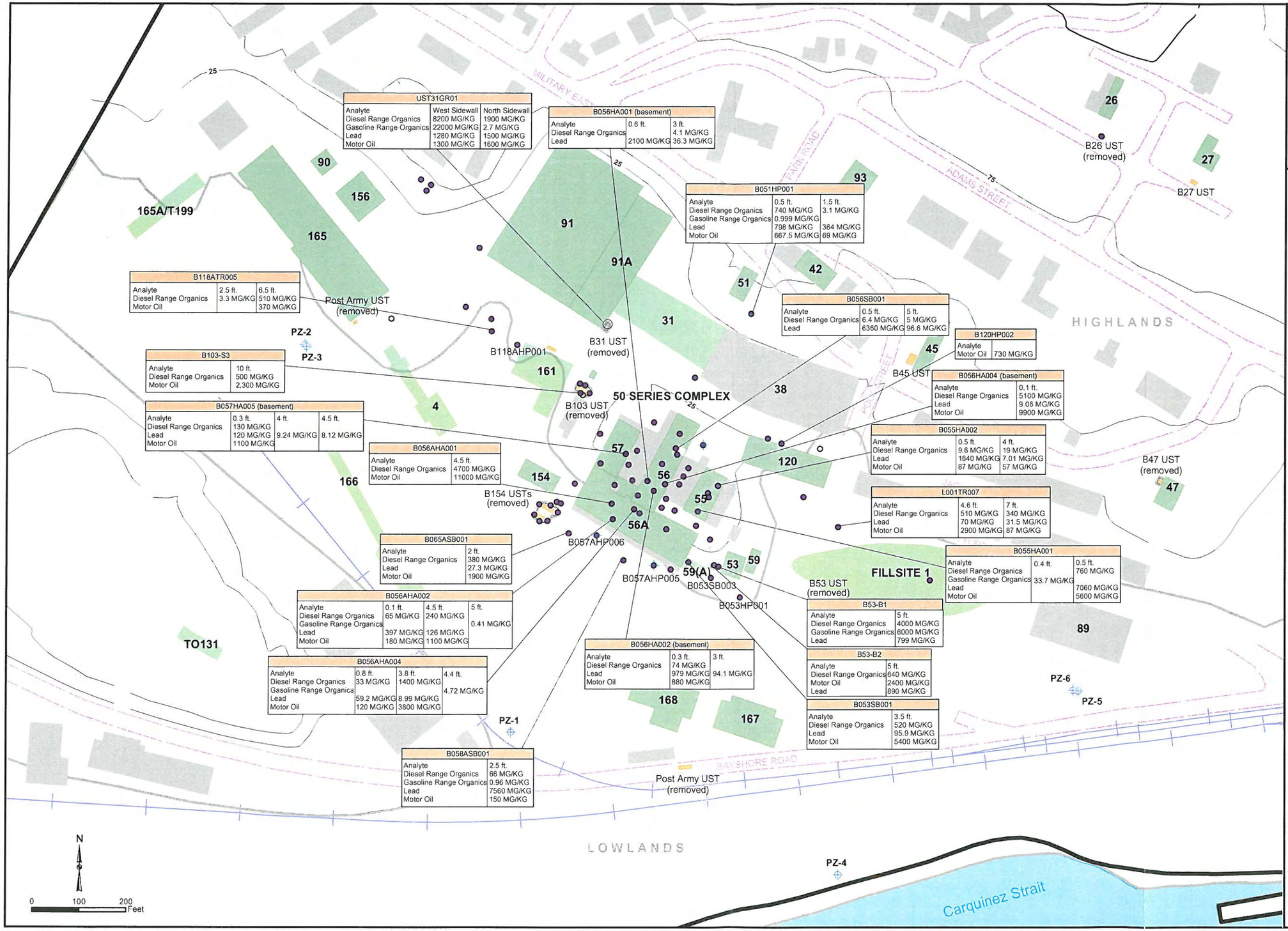
The Building 53 gasoline UST once supplied fuel to the Dynamometer Shop and Engine Testing Shop in the building. In 2002, the USACE removed a 4,000-gallon UST and associated product piping (Geofon, 2003). Soil samples collected near Buildings 53 were recommended in the UST removal investigation (Geofon, 2003) in an effort to delineate lead and fuel impacted soil. A soil sample was collected in boring B053HP001, located approximately 25 feet south of the former excavation at Building 53, to delineate the lateral extent of fuels and lead in soil.

The results shown on Figure 6-14 show that the lateral extent of fuels and lead in soil are laterally defined to their respective ESL. Figure 6-14 is a concentration figure showing soil samples detected with gasoline, diesel fuel, motor oil and lead. Each location shown is based on whether gasoline, diesel fuel or motor oil concentrations are reported above 400 mg/kg or lead concentrations are above 750 mg/kg. The concentration of 400 mg/kg represents the lowest ESL for each of the fuel ESLs. In this case, it represents the ESL for gasoline. The concentration of 750 mg/kg for lead represents the BSL for a commercial or industrial worker. A risk assessment is recommended for the remaining fuel and lead-impacted soil in the area of the former Building 53 UST.

Diesel fuel, motor oil, gasoline, lead and solvents have been identified in groundwater samples collected from the UST excavation. During groundwater investigations prior to the Extended SI, cis-1,2-DCE, TCE, vinyl chloride, lead, and petroleum hydrocarbons were detected in groundwater near the former UST excavation (Geofon, 2003; FA/BC, 2000). The presence of cis-1,2 DCE and vinyl chloride are likely due to degradation of TCE that had been released in the past.

Dissolved lead was present in groundwater collected in the excavation during the UST removal at a concentration of 0.19 mg/L, which exceeds its ESL of 0.0025 mg/L. Other groundwater samples in the area (B053SB002, B053HP001, B053SB001) have lead concentrations in groundwater below the ESL. Based on their location to the former UST, the lateral extent of lead has been defined in groundwater.

Analysis of the groundwater sample collected in boring B053HP001 did not report any hydrocarbons, toluene, TCE, cis-1,2 DCE or vinyl chloride above laboratory MDLs. Groundwater samples collected approximately 100 feet downgradient of the former excavation detected TCE and toluene at B059AHP001. Toluene was detected at 2.7 µg/L and TCE at 1.3 µg/L.




## Index Map

## Legend

Sample Locations
- Non-Detections
- With Detections

Wells

Area I boundary

Railroad

Roads

Elevation Contours (100ft.)

Elevation Contours (25ft.)

Army USTs (removed unless otherwise noted)

PA Sites

Buildings

Lowlands

| Sample Location | |
|---|---|
| **Analyte** | **Depth (ft. bgs.)** |
| Analyte Name | Value |

Soil Sample

Notes:
1- Detected results shown for Fuels > 400 mg/kg and Lead > 750 mg/kg (BSL-Commercial Risk) are shown.

2- Soil Delineated to ESLs of 400 mg/kg Gasoline, 500 mg/kg Diesel, and 1,000 mg/kg Motor Oil.

# Figure 6-14

**Gasoline, Diesel Fuel, Lead, and Motor Oil Range Organics in Soil**

SITE:

**Benicia Arsenal, Benicia, California**

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Plate 1, Figure 6-15, and Figure 6-16 show the extent of diesel fuel, gasoline and motor oil in groundwater and have been defined to their respective ESLs. The reported TCE concentration in B059AHP001 is part of a larger solvent plume (see Plate 2) and is discussed in Section 6.5.27. A risk assessment is recommended for impacted groundwater from the former Building 53 UST.

6.5.6 Blacksmith Shop/ Machine/Welding Shops (Building 55), Leather & Canvas Shop/ Welding Shop (Building 56), Small Arms Shop/Leather Canvas Shop (Building 56A) and Small Arms Shop, Firing Range (Building 57).

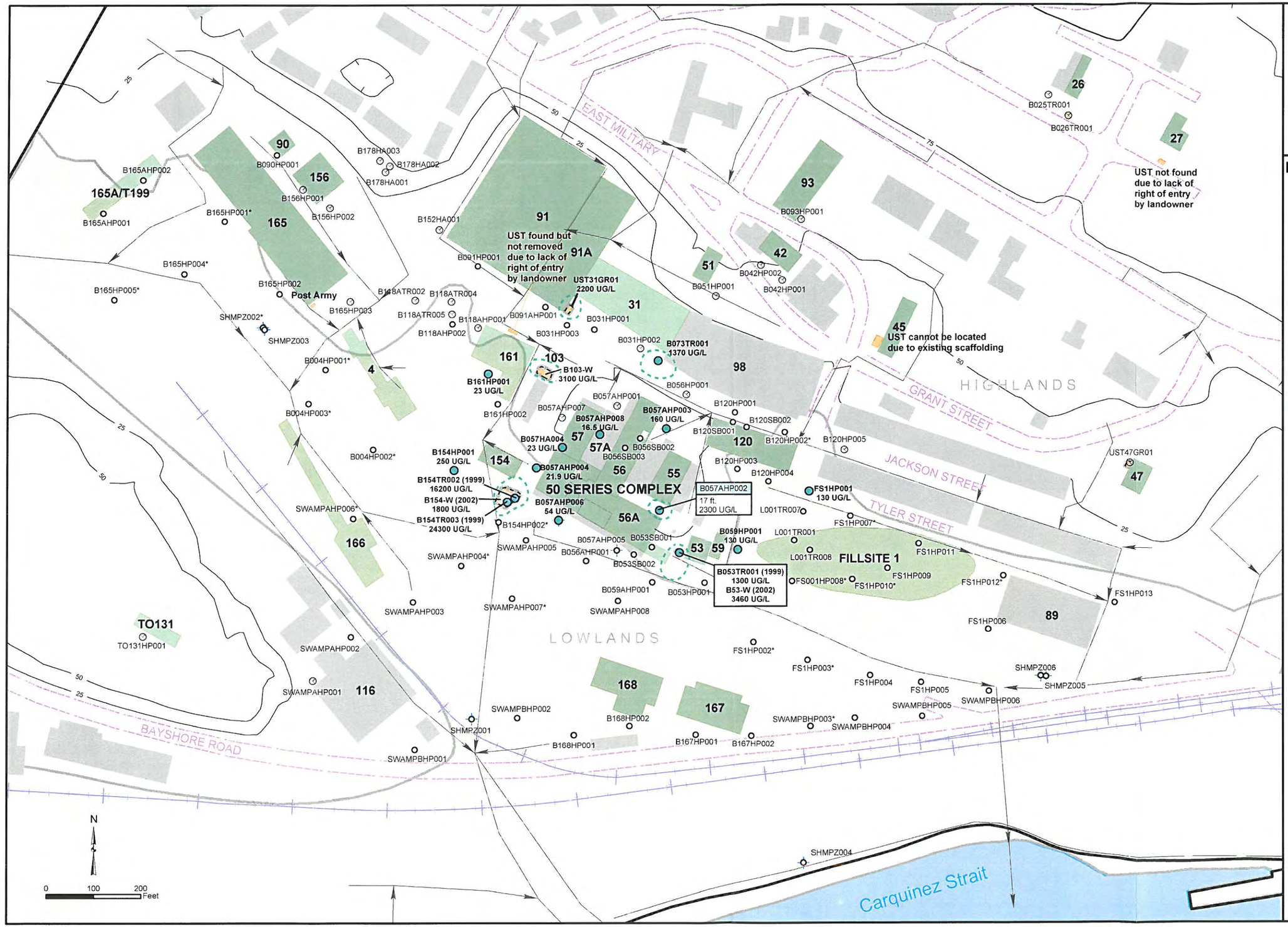
A risk evaluation is recommended at the 50 Series Complex.

A description of the history and results from previous investigations at these buildings are not included in this section for brevity but can be found in the 50 Series Complex SI Report (FA/BC, 2004b). These buildings are part of the 50 Series Complex, which is located in the central part of the industrial area (Figure 6-11). Previous investigations have determined impacts to soil and groundwater from fuels and solvents. However, the lateral and vertical extent of solvents and fuels in groundwater had not been defined so borings were advanced on all sides of the complex during the Expanded SI. The results of the Expanded SI have determined that the fuels in groundwater are isolated to the areas generally associated with the former USTs at Building 53 (Section 6.5.5), Building 103 (Section 6.5.15), and Building 154 (Section 6.5.18) that surround the Complex. TCE and its daughter products are co-mingled with several other source areas and is discussed further in Section 6.5.27. In summary, the data from previous investigations and the Expanded SI indicate that the known contaminants have been identified and delineated. Therefore, a risk assessment is recommended for these contaminants found in soil and groundwater.

6.5.7 Former Boiler Houses (Buildings 58(A) and 65A).

- Further investigation is recommended to delineate lead in soil in the area of the former boiler house at Building 58A
- A risk evaluation is recommended for the former boiler house at Building 65A

The former locations of Building 58(A) and Building 65A are beneath Building 56A, which is located in the 50 Series Complex and in the lowlands of the industrial area (Figure 6-11). In the early 1900's, Building 58(A) served as a facility for loading projectiles with explosive powder. The building was also used as a tinning plant and for small arms repair. It was later converted into a boiler room. The building was removed at about the time Building 56A was constructed in 1944. Built in 1910, Building 65A was also a boiler house. It was removed before the construction of Building 56A in 1944. Coal or wood was used to fire the boiler before an oil burner was installed in 1928.




## Index Map

## Legend

Sample Locations
- Non-Detections
- With Detections
- Dry - no groundwater
- Wells

- Area I boundary
- Lowland/Highland Boundary
- Storm Drains(1958) -arrows point in direction of flow
- Railroads
- Roads
- Elevation Contours (100ft.)
- Elevation Contours (25ft.)
- UST Excavation limits
- Delineation of gasoline range organics in shallow groundwater (< 15 feet bgs)
- USTs (removed, unless otherwise noted)
- PA Sites
- Buildings
- Lowlands

| Sample Location |
|---|
| Depth (ft. bgs.) |
| Value |

Notes:
1- Unless otherwise noted, groundwater samples were collected at depths of < 15 ft bgs.

2 - All detected results are shown, including older data.

3 - Gasoline plumes are delineated to the ESL of 500 UG/L.

4 - * Denotes locations with no detectable concentration at shallow and deep groundwater.

# Figure 6-15

**Gasoline Detected in Groundwater**

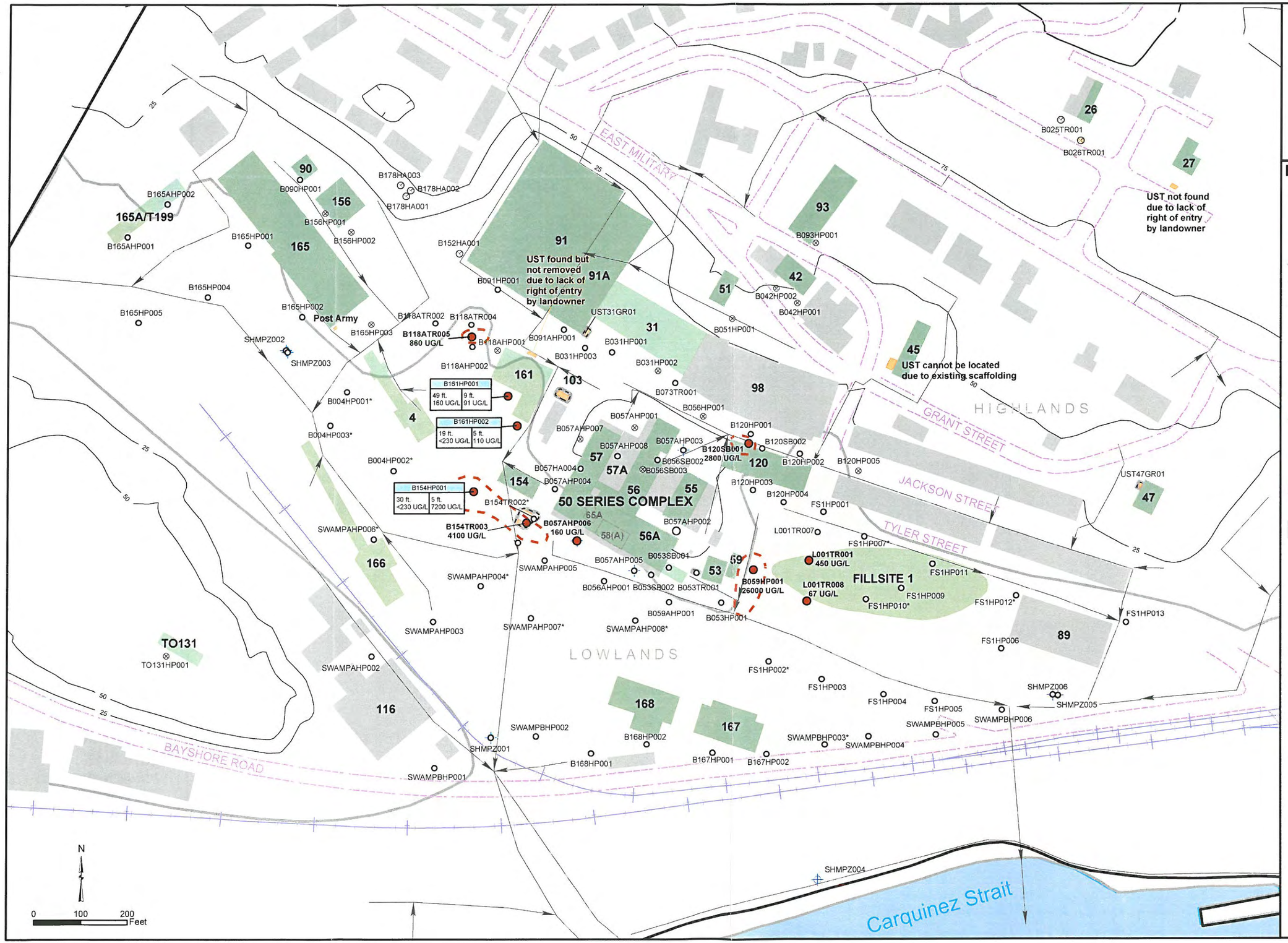
SITE:

**Benicia Arsenal, Benicia, California**

PROJECT: 24785

DATE: 3/28/2005

BROWN AND CALDWELL




## Index Map

## Legend

Sample Locations

- Non-Detections
- With Detections
- Dry - no groundwater
- Wells
- Area I boundary
- Lowland/Highland Boundary
- Storm Drains(1958) -arrows point in direction of flow
- Railroads
- Roads
- Elevation Contours (100ft.)
- Elevation Contours (25ft.)
- UST Excavation limits
- Delineation of motor oil range organics in shallow groundwater (< 15 feet bgs)
- USTs (removed, unless otherwise noted)
- PA Sites
- Buildings
- Lowlands

| Sample Location |
|---|
| Depth (ft. bgs.) |
| Value |

Notes:

1- Unless otherwise noted, groundwater samples were collected at depths of < 15 ft bgs.

2 - All detected results are shown, including older data.

3 - Plumes delineated to the ESL of 640 UG/L.

4 - * Denotes locations with no detectable concentration at shallow and deep groundwater.

# Figure 6-16

**Motor Oil Detected in Groundwater**

SITE:

**Benicia Arsenal, Benicia, California**

PROJECT: 24785

DATE: 4/4/2005

BROWN AND CALDWELL

An investigation was performed in 1999 to locate a possible UST associated with the former boiler houses and to collect soil and groundwater samples (FA/BC, 2004b). There was no evidence from the geophysical survey that indicated a UST. Soil samples were collected beneath the concrete floor of Building 56A in the area of the former boiler houses at borings B056AHA001 and B056AHA002. Hydrocarbons, PAHs, and lead were reported in the soil samples (Table 6-23). Diesel fuel and motor oil exceeded their respective ESLs (Table 6-23). In 1999, the source of the contamination could not be totally attributed to former boiler houses because of a known source of TPH approximately 50 feet away at Building 154, a former UST site. Further investigation was recommended to delineate fuels, lead and PAHs in soil.

**Table 6-23. Petroleum Hydrocarbons, Lead and PAHs in Soil at the former Boiler Houses (Buildings 58(A) and 65A)**

| | ESL | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|
| Gasoline | 400 | <0.22 | 3.3 | <0.21 | 0.41 |
| Diesel Fuel | 500 | 73 | **4700** | 65 | 240 |
| Motor Oil | 1000 | 500 | **11000** | 180 | **1100** |
| Lead | 750 | 306 | 8.68 | 397 | 126 |
| Benzo(a)pyrene | 0.13 | 0.015 | **0.31** | <0.0753 | **0.12** |
| Benzo(b)fluoranthene | 1.3 | 0.016 | <0.17 | <0.158 | 0.19 |
| Benzo(k)fluoranthene | 1.3 | 0.005 | 0.22 | <0.0753 | <0.0277 |
| Benzo(g,h,i)perylene | 27 | 0.019 | 0.4 | <0.114 | <0.131 |
| Chrysene | 13 | 0.015 | <0.0971 | <0.0923 | 0.13 |
| Fluoranthene | 40 | 0.028 | <0.332 | <0.316 | 0.41 |
| Indeno(1,2,3-c,d)pyrene | 1.3 | 0.02 | <0.0817 | <0.0656 | 0.32 |
| Phenanthrene | 11 | 0.038 | <0.133 | <0.126 | 0.094 |
| Pyrene | 85 | 0.016 | <0.166 | <0.158 | 0.2 |

ESL = Environmental Screening Level for Commercial/Industrial land use (RWQCB, 2005)
**Bolded** values exceed their respective ESLs
bgs = below ground surface
mg/kg = milligrams per kilograms

Two soil samples, B058ASB001 and B065ASB001, were collected south of the 50 Series Complex, south of the former Buildings 58A and 65A (Figure 6-11), to delineate fuels, PAHs, and lead in soil from a possible fuel release from the two former boiler houses.

The soil boring at Building 58A, B058ASB001, was sampled from 2.5 to 3.0 feet bgs. Petroleum hydrocarbons, lead and PAHs detected at B058ASB001 are shown in Table 6-24 along with their respective ESLs.

| Table 6-24. Analyte Soil Concentrations in Boring B058ASB001 at a Depth of 2.5-3.0 feet bgs | | |
|---|---|---|
| Analyte | Concentration (mg/kg) | ESL (mg/kg) |
| Lead | **7,560** | 750 |
| Diesel Fuel | 66 | 500 |
| Motor Oil | 150 | 1,000 |
| Gasoline | 0.96 | 400 |
| Anthracene | 0.18 | 2.8 |
| Benzo(g,h,i)perylene | 0.21 | 27 |
| Dibenz(a,h)anthracene | 0.016 | 0.38 |
| Fluoranthene | 1.9 | 40 |
| Fluorene | 0.11 | 8.9 |
| Indeno(1,2,3-c,d)pyrene | 0.24 | 1.3 |
| Phenanthrene | 0.77 | 11 |
| Pyrene | 0.78 | 85 |

ESL = Environmental Screening Level for Commercial/Industrial land use (RWQCB, 2005).
**Bolded** values exceed their respective BSLs or ESLs.
mg/kg = milligrams per kilograms

Lead was detected at a concentration of 7,560 mg/kg, above the ESL of 750 mg/kg. This is the only analyte detected at a concentration higher than the ESL. The nearest samples collected for lead to B058ASB001 are piezometers B057AHP005 and B057AHP006 and soil boring B056AHA002 (located inside Building 56A), see Figure 6-14. These samples were collected during the 50 Series Complex Site Investigation in 1999 (FA/BC, 2004b). Lead concentrations in these borings do not exceed the ESL of 750 mg/kg (Table 6-25). Based on these results, lead in soil has been defined north, west and east of B058AHP001 but not to the south. Therefore, additional investigation is recommended to complete the delineation of lead in soil.

| Table 6-25. Lead Concentrations in Soil near Boring B058ASB001 | | |
|---|---|---|
| Boring Name | Depth (feet bgs) | Concentration (mg/kg) |
| B057AHP005 | 3.5-4 | 7.14 |
| B057AHP006 | 2.5-3 | 16.7 |
| B056AHA002 | 0.1-0.6 | 397 |
| B056AHA002 | 4.5-5 | 126 |
| ESL | | 750 |

ESL = Environmental Screening Level for Commercial/Industrial land use (RWQCB, 2005).

A boring, B065ASB001, was advanced downgradient of the former boiler at Building 65A. Diesel fuel, motor oil, cis-1,2-DCE, and TCE were detected at a depth of 2 feet to 2.5 feet bgs (Table 6-26). PAHs were less than their respective ESLs (Table 6-26).

**Table 6-26. Soil Concentrations of Diesel Fuel, Motor Oil, cis-1,2,-DCE, and TCE in B065ASB001 at 2-2.5 feet bgs**

| Analyte | Concentration (mg/kg) | ESL (mg/kg) |
|---|---|---|
| Gasoline | <0.61 | 400 |
| Diesel Fuel | 380 | 500 |
| Motor Oil | **1,900** | 1,000 |
| Benzo(a)anthracene | 0.53 | 1.3 |
| Phenanthrene | 0.35 | 11 |

ESL = Environmental Screening Level (RWQCB, 2005)
**Bolded** values exceed their respective BSLs or ESLs.
mg/kg = milligrams per kilograms

Motor oil range organics exceeded the ESL of 1,000 mg/kg at B065ASB001. Motor oil range organics were present in several borings scattered throughout the area (Figure 6-14). The source is not clear but is likely from oiling the macadam[1] roads that lead to the Complex. With the advent of motor vehicles, dust became a serious problem on macadam roads. The vacuum created under fast moving vehicles sucked the dust out of the surface leading to a gradual raveling of the larger size materials, as well as an unpleasant dust cloud. This problem was rectified by spraying tar on the surface thus creating tar-bound macadam, or tarmac. A macadam road-like pavement was found during the excavation of test pits at Fillsite 1, approximately 100 feet southeast of the 50 Series Complex.

In summary, fuels and PAHs detected in soil have been delineated. PAHs were not detected above their respective ESLs. Lead was detected at a concentration of 7,560 mg/kg, above the ESL of 750 mg/kg in B058AHP001. Additional investigation is recommended to complete the delineation of lead in soil. The impact of motor oil range organics appears to be widespread through the area and there is no distinct source for the motor oil (e.g., UST realease). It is recommended to evaluate the risk to human health and the environmental for diesel and motor oil based on the soil data collected.

**Groundwater is impacted with Fuels, in particular, Motor Oil at Building 59.**

### 6.5.8 Former Tool House/Degreaser Pit (Building 59).

Building 59 is located in the highlands at the southeast corner of the 50 Series Complex (Figure 6-11). In 1910, the building was built as a tool house. In 1951, a degreaser pit was built into the foundation of the building. The building was used as a machine shop from 1969 to 1976. The degreaser pit has been filled in and covered to grade with concrete.

[1] **Macadam** is a type of road construction pioneered by John Loudon McAdam in the early 1800s. It consists of three layers of stones laid on a sloped subgrade, with side ditches for drainage. The first two layers consisted of angular aggregate hand-broken, maximum size 3 inches (75 mm) for a total depth of about 8 inches (200 mm). The third layer was about 2 inches (50 mm) thick with a maximum aggregate size of 1 inch (25 mm). The layers would be compacted with a heavy roller. This caused the angular stones to lock to their neighbors. This basic method of construction is sometimes known as water-bound macadam. Although this method required a great deal of manual labor, it resulted in a strong and free-draining pavement. Roads which were constructed in this manner were described as **Macadamized**. Source: http://en.wikipedia.org/wiki/Macadam

During the Expanded SI, two CPT borings were advanced to the east (B059HP001) and south of the building (B053HP001) to determine the presence of solvents and fuels from a possible release into groundwater downgradient of the building. B053HP001 is also downgradient of a former gasoline UST at Building 53 (see Section 6.5.5). Several fuel-related contaminants were reported in shallow groundwater as shown in Table 6-27. Gasoline, diesel fuel and motor oil concentrations exceed their respective ESLs.

**Table 6-27. Detected Fuel-related Contaminant Concentrations in Groundwater at Building 59**

| Analyte | Groundwater Concentration (µg/L) B059HP001 (at 2.5 to 5 bgs) | B053HP001 (at 2.5 to 5 bgs) | ESL / MCL / BSL |
|---|---|---|---|
| Gasoline | **130** | <25 | 100* |
| Diesel fuel | **13,000** | <24 | 100* |
| Motor oil | **26,000** | <230 | 100* |
| Benzene | 0.44 | <0.37 | 1 |
| MtBE | 0.45 | <0.28 | 13 |

ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
**Bolded** values exceed ESLs or MCLs.
BSL = Benicia Screening Level - Commerical/Industrial worker- noncarcinogen (FA/BC, 2002a)
*carcinogen

The 13,000 µg/L concentration of diesel fuel at B059HP001 is not the highest in this area (Plate 1). Diesel fuel was also detected at a much higher concentration of 510,000 µg/L at B120HP004, approximately 160 feet north of B059HP001. B120HP004 and B059HP001 are near the same storm drain line and B120HP004 is upstream of B059HP001. Shallow groundwater is most likely being intercepted by the storm drain system (see Section 6.5.30). Therefore, the source of the diesel fuel at B059HP001 is from diesel fuel being conveyed through the storm drain line from an upstream source area.

Motor oil was only detected in shallow groundwater at B059HP001 (Figure 6-16). The lateral extent of motor oil was drawn assuming that the storm drain line intercepts the motor oil impacted groundwater in this area (Figure 6-16).

Solvents such as TCE, and its daughter product, cis 1,2-DCE and vinyl chloride were also detected in the downgradient groundwater sample at concentrations of 0.78 µg/L, 45 µg/L, and 11 µg/L respectively. The occurrence of the TCE and its degradation products are part of a larger plume that is discussed further in Section 6.5.27. There is no documented DoD use of solvents at Building 59.

Based on the data from this investigation, motor oil has been found in shallow groundwater at Building 59. The source of the impact is not known. A risk assessment is recommended for the former DoD tool house for the fuel-related contaminants found in groundwater.

### 6.5.9 Former Tool House (Building 59(A)).

**A risk evaluation is recommended for former Building 59(A)**

Built in 1910 and removed before 1945, the building was used to store oils and paints. It was located in the highlands at the southeast corner of the 50 Series Complex (Figure 6-11). In 1999, B053SB001 was advanced in the former footprint of the building. Soil samples were collected to determine if there was a release to soil and groundwater from oils. This boring was also positioned near a UST at Building 53 and additional analyses were fuels, lead and solvents. Several PAHs were detected above their respective MDLs (Table 6-26).

During the Expanded SI, soil sample was collected in boring B053SB003, located approximately 25 feet south of the former excavation at Building 53 and approximately 60 feet east of B053SB001, to delineate the lateral extent of PAHs reported in 1999. None of the PAHs reported in the 1999 boring, B053SB001, or the Expanded SI boring, B053SB003, exceed their respective ESLs (Table 6-28).

**Table 6-28. PAH Soil Concentrations at Former Tool House (Building 59(A))**

| PAH | B053SB001 | B053SB003 | ESL |
|---|---|---|---|
| Acenaphthylene | <1.3 | 0.34 | 13 |
| Anthracene | <0.09 | 0.028 | 2.8 |
| Benzo(a)pyrene | <0.062 | 0.0059 | 0.13 |
| Benzo(b)fluoranthene | 0.19 | 0.012 | 1.3 |
| Benzo(k)fluoranthene | <0.05 | 0.0088 | 1.3 |
| Chrysene | <0.076 | 0.054 | 13 |
| Dibenz(a,h)anthracene | 0.29 | <0.0029 | 0.38 |
| Fluoranthene | <0.26 | 0.08 | 40 |
| Indeno(1,2,3-c,d)pyrene | 0.12 | 0.01 | 1.3 |
| Naphthalene | <0.72 | 0.23 | 1.5 |
| Phenanthrene | <0.1 | 0.088 | 11 |
| Pyrene | 0.068 | <0.0018 | 85 |

ESL = Environmental Screening Level (RWQCB, 2005). ESL values for soil are for shallow soils (<3 meters bgs) and commercial/industrial land use and groundwater that is a current or potential source of drinking water.
bgs = below ground surface
mg/kg = milligrams per kilograms

Motor oil and diesel fuel soil concentrations at B053SB001 are 5,400 mg/kg and 520 mg/kg, respectively (Figure 6-14). These concentrations exceed their respective ESLs of 1,000 and 100 mg/kg. As discussed in Section 6.5.5, motor oil has been found throughout the subsurface soil in the area of the 50 Series Complex. The source of diesel fuel in soil is not known. A risk assessment is recommended for the former DoD tool house for the fuel-related contaminants found in soil.

6.5.10 Former Locomotive Building (Building 90).

**A risk evaluation is recommended for Building 90**

Constructed in 1941 to house the Arsenal's two diesel locomotives and associated maintenance facilities, Building 90 had a concrete locomotive pit. The actual location of the sump or drain lines from the pit are unknown and the location of the pit could not be confirmed during site visits. Between 1972 and 1975, the building was used to manufacture aluminum wheels for automobiles and for installing fiberglass truck beds on pick-up trucks. The aluminum wheel process included pouring the aluminum into a form then grinding and cleaning the wheel. The chemicals used in the cleaning are unknown. Currently, the building is used as an industrial painting operation.

One Hydropunch™ boring (B090HP001) was advanced to determine the presence or absence of a possible release of fuels and solvents from former DoD activities in the building. The building is located in the highlands (Figure 6-11), where there is a thin lens of saturated alluvium overlying sandstone bedrock. There is an estimated 3 foot lens of saturated clayey silt overlying weathered

sandstone at approximately 9 feet bgs. Depth to groundwater was 5.7 feet. Refusal into competent sandstone occurred at 13 feet bgs. A groundwater sample was collected and analytical results for diesel fuel, TCE and cis-1,2 DCE are shown on Plates 1, 2 and 3. Diesel fuel was detected at a concentration of 97 µg/L. Cis-1,2 DCE and TCE was detected at 13 and 96 µg/L, respectively. The occurrence of the TCE is part of a larger plume and is discussed further in Section 6.5.27. The groundwater contamination could be associated with the post-arsenal wheel manufacturing. A risk assessment is recommended for the former DoD Locomotive Building 90 for the solvents and their degradation products found in groundwater.

6.5.11 Former Machine Shop/Combat Vehicle and Artillery Repair (Building 91).

**Groundwater impacted with solvents is part of a larger co-mingled plume from other sources. It is not known if solvents used in this building have contributed to this plume.**

Used for vehicle repair, Building 91 contained several hydraulic presses, a broiler room, several solvent dip tanks, a degreaser, a paint spray booth, blast machine, infrared dryer, and a carbon jet cleaning machine. The locations of these structures within the building are unknown. In 1951, the building was remodeled and a sump pump was added in the broiler room. Post-arsenal activities include metal fabrication and casting and the building is currently used to manufacture filtration systems. One Hydropunch™ boring (B091HP001) was advanced during this investigation to determine if there was a release of metals, solvents, and petroleum hydrocarbons from the former DoD degreasing and cleaning activities at the building. Soil samples were also collected during the Area I Fuel Storage Facilities in September 2000 (BC, 2002b) to determine if there was a release of hydrocarbons. The building is located in the highlands near the border between the highlands and the lowlands (Figure 6-11).

In September 2000, a soil sample was collected at 4.0 feet bgs from boring B152HA001, near the northwest corner of Building 91. The soil sample contained 64 mg/kg motor oil, 320 mg/kg diesel fuel, and numerous PAHs, shown in Table 6-29.

**Table 6-29. Detected Contaminant Concentrations in Groundwater downgradient of Building 91**

| Analyte | Soil Concentration (mg/kg) | ESL (mg/kg) |
|---|---|---|
| Diesel Fuel | **320** | 100 |
| Motor Oil | 64 | 1,000 |
| Benzo(a)anthracene | 0.023 | 1.3 |
| Benzo(a)pyrene | 0.0084 | 0.13 |
| Benzo(g,h,i)perylene | 0.0052 | 27 |
| Benzo(k)fluoranthene | 0.04 | 1.3 |
| Dibenz(a,h)anthracene | 0.0083 | 0.38 |
| Fluoranthene | 0.17 | 40 |
| Fluorene | 0.11 | 8.9 |
| Indeno(1,2,3-c,d)pyrene | 0.0072 | 1.3 |
| Phenanthrene | 0.097 | 11 |
| Pyrene | 0.025 | 85 |

ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005)
**Bolded** values exceed ESLs.
mg/kg = milligrams per kilograms

Diesel fuel concentration (320 mg/kg) in soil exceeds the RWQCB ESL of 100 mg/kg (Table 6-29).

Metal concentrations are shown in Table 6-30. No metal concentrations exceeded their respective MCL/ESLs (Table 6-30).

**Table 6-30. Metal Concentrations Detected in Groundwater at Building 91**

| Analyte | B091HP001 (mg/L) | MCL/ESL (mg/L) |
|---|---|---|
| Aluminum | 0.0754 | 1.0 |
| Antimony | 0.00475 | 0.006 |
| Arsenic | 0.0677 | 0.05 |
| Barium | 0.247 | 1.0 |
| Calcium | 145 | NE |
| Iron | 1.42 | NE |
| Magnesium | 80.4 | NE |
| Manganese | 2.34 | NE |
| Molybdenum | 0.0122 | 35* |
| Potassium | 1.34 | NE |
| Sodium | 105 | NE |
| Zinc | 0.00933 | 81,000* |

ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
NE = not established
**Bolded** values exceed ESLs.
mg/kg = milligrams per kilograms

Approximately 100 feet southeast of B152HA001, a downgradient Hydropunch™ sample was collected (B091HP001). Benzene, toluene, diesel fuel, cis-1,2 DCE, and vinyl chloride were detected and are listed in Table 6-31. Diesel fuel and cis-1,2-DCE are shown on Plate 1 and Plate 3.

**Table 6-31. Detected Contaminant Concentrations in Groundwater downgradient of Building 91**

| Analyte | Groundwater Concentration (ug/L) | MCL/ESL (ug/L) |
|---|---|---|
| cis-1,2- dichloroethene | 2.7 | 6.0 |
| Vinyl Chloride | **0.87** | 0.5 |
| Benzene | 0.91 | 1.0 |
| Xylenes | 0.41 | 1750 |
| Toluene | 0.59 | 150 |
| Diesel Fuel | 51 | 100* |

ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
**Bolded** values exceed ESLs.
BSL = Benicia Screening Level - Commerical/Industrial worker- noncarcinogen (FA/BC, 2002a) *carcinogen

Vinyl chloride is the only detected contaminant that exceeds its MCL/ESL. The occurrence of vinyl chloride is a daughter product from the degradation of TCE and is part of a larger plume in the industrial area. Section 6.5.27 discusses the source of TCE and its degradation products. In summary, the data in the industrial area indicates that the primary sources of TCE and its degradation products are from other locations. However, there was an

unknown number of solvent dip tanks used in Building 91. Building 91 is located on the edge of the larger solvent impacted groundwater plume based on the low concentrations of cis-1,2-DCE (2.7 µg/L) in groundwater at B91HP001 (Plate 3). Since solvents were used in this building, it is not known if disposal activities in Building 91 may have contributed to the larger plume.

6.5.12 Former Machine Shop/ Engine Rebuild (Building 91A).

**Groundwater impacted with solvents is part of a larger co-mingled plume from other sources.**

This building was used as a machine shop and repaired, rebuilt, and replaced inner components of trucks, and passenger vans. Numerous ASTs/dip tanks were used for cleaning parts and a spray paint booth was used. A 1950 Army map shows the location of two series of tanks within the building. Each series of tanks consisted of a rinse, acid, strip, and two steam tanks (Figure 6-12). This map also shows the location of utility trench, a degreaser, several paint booths, and a "hot" and "cold" well (Figure 6-12). The functions of the hot and cold wells are not known. Parts were cleaned with an alkali compound, a caustic solution, phosphoric acid and hot water for rinsing. After the parts were cleaned, they were assembled and taken to the paint booths. Post-arsenal uses include fabrication of electrical signs, storage of furniture and household good and the manufacture of plastic pipes. Currently, the building is used for storage. The tanks no longer exist and have been filled in with concrete, but the outline of the dip tanks and the rail system where the parts hung from the ceiling remain inside the building. One boring (B091AHP001) was advanced downgradient of the building to determine if there was a release of metals, solvents, and fuels from the former DoD degreasing and cleaning activities. The building is located in the highlands near the border between the highlands and the lowlands (Figure 6-11).

One downgradient Hydropunch™ sample was collected (B091AHP001). Metal concentrations detected above laboratory limits are shown in Table 6-32. No metals exceed their respective ESLs (Table 6-32).

**Table 6-32. Metal Concentrations Detected in Groundwater at Building 91A**

| Constituent | B091AHP001 (mg/L) | MCL/ESL* (mg/L) |
|---|---|---|
| Arsenic | 0.00876 | 0.05 |
| Barium | 0.0571 | 1.0 |
| Calcium | 117 | NE |
| Iron | 0.48 | NE |
| Magnesium | 58.6 | NE |
| Manganese | 1.7 | NE |
| Sodium | 227 | NE |
| Zinc | 0.0117 | 0.081* |

*ESL = Environmental Screening Level. Groundwater is a current or potential drinking water source (RWQCB, 2005)
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
NE = not established

Cis-1,2 DCE and 1,1-DCA were detected in the groundwater at concentrations of 1.3 and 0.47 µg/L, below the MCLs of 6.0 and 5.0 µg/L. No other solvents or fuels were detected above laboratory method detection limits. The occurrence of cis-1,2-DCE is a daughter product of TCE and is part of a larger plume that is discussed further in Section 6.5.27. As stated above for Building 91, there are several primary sources of TCE at other locations in the industrial area. Like Building 91, Building 91A is located on the edge of the larger solvent impacted groundwater plume based on the low concentrations of cis-1,2-DCE (1.3 µg/L) in groundwater at B91AHP001 (Plate 3). There is no documentation that indicates that the degreaser in Building 91A contained solvents. Therefore, no further DoD action is indicated for the building.

6.5.13 Former Truck Storage Building/MMW Repair, Motor Vehicle Maintenance Building (Building 93).

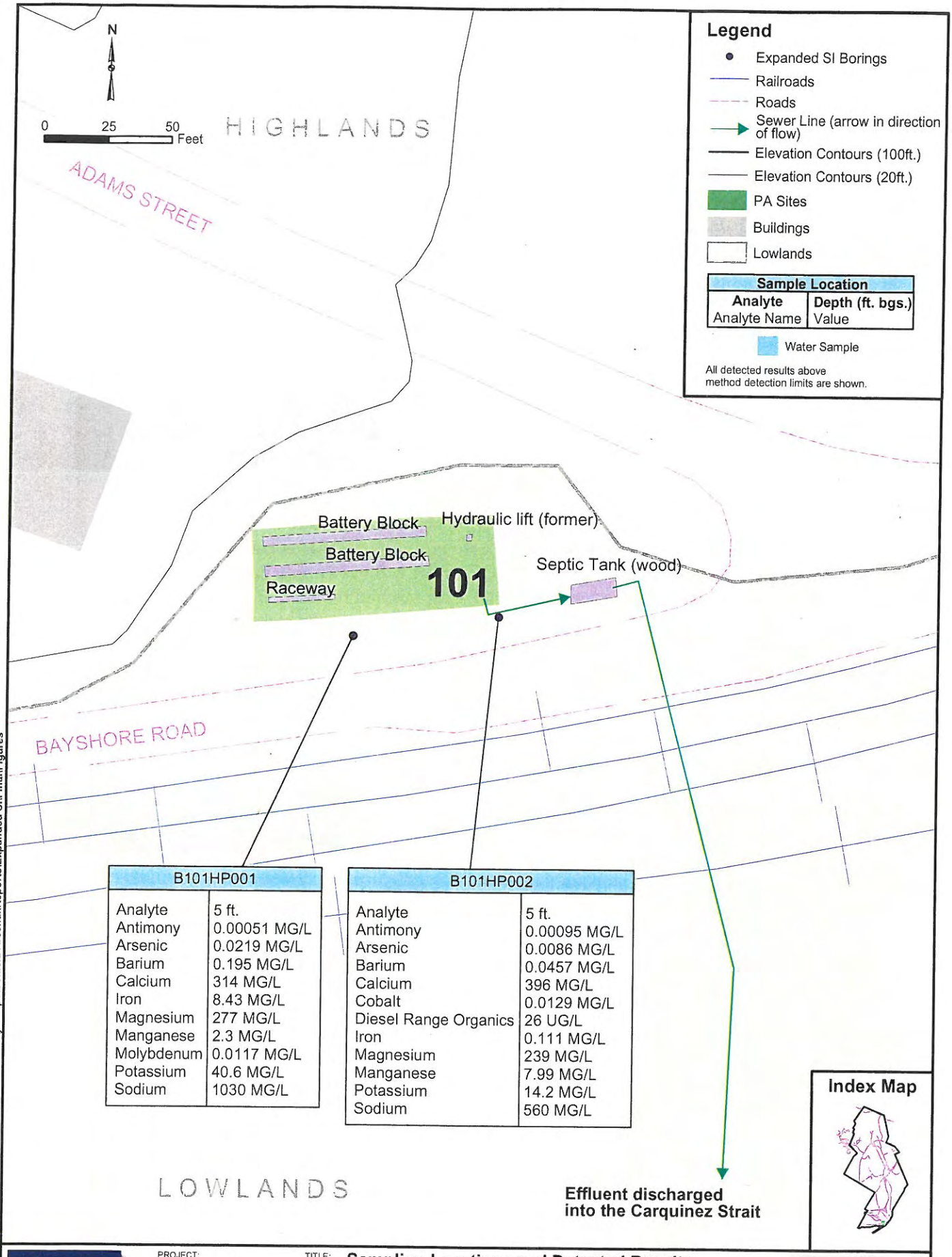
**A risk evaluation is recommended for Building 93**

This building was used to repair vehicles and contained a hoist, steam cleaning room and floor drains. A soil boring was placed outside of the building (Figure 6-13) next to the drainpipes to determine the possible impact of fuels and solvents from the former DoD repair activities. One Hydropunch™ boring (B093HP001) was advanced. As with Building 42, no groundwater was encountered; therefore, a soil gas sample was collected and analyzed for VOCs. The soil gas sample depth was collected at a shallower depth (2.5 to 3.5 feet bgs) because the CPT rig reached refusal at 3.5 feet bgs than the proposed 3 to 5 feet bgs in the FSIP. A trace TCE concentration in the soil gas sample at 30 ppbv was detected at 2.5 to 3.5 feet bgs. Sandstone (competent) is at 4.8 feet bgs. Based on the soil gas concentrations, there is no evidence of a significant release at this building. However, a risk assessment is recommended for the former DoD vehicle repair facility at Building 93 for the TCE found in soil gas.

6.5.14 Former Battery Charge Building (Building 101)

**No further DoD Action is indicated at former Building 101**

Built in 1942, building operations included steam cleaning of battery cases. The building is located on the eastern side of Area I (Figure 6-1). A septic tank, located on the east side of the building, served the building and was constructed of wood (Figure 6-17). The septic tank discharged into a pipe that crossed beneath Bayshore Road and the railroad tracks to a point at the Carquinez Strait. The building foundation was constructed with floor drains, a hydraulic lift, two battery blocks, and a raceway approximately 26 feet long and 2 feet deep (Figure 6-17). The hydraulic lift is no longer present. The foundation of this building is located at the northwest corner of Bayshore Road and Adams Street (Figure 6-17). Two borings (B101HP001 and B101HP002) were drilled on the south or downgradient side of the building foundation. The purpose of these samples was to determine the presence or absence of metals and fuels from DoD steam cleaning of battery cases. These samples were analyzed for metals and diesel fuel and motor oil. Building location and sampling locations are shown on Figure 6-17.




| B101HP001 | |
|---|---|
| Analyte | 5 ft. |
| Antimony | 0.00051 MG/L |
| Arsenic | 0.0219 MG/L |
| Barium | 0.195 MG/L |
| Calcium | 314 MG/L |
| Iron | 8.43 MG/L |
| Magnesium | 277 MG/L |
| Manganese | 2.3 MG/L |
| Molybdenum | 0.0117 MG/L |
| Potassium | 40.6 MG/L |
| Sodium | 1030 MG/L |

| B101HP002 | |
|---|---|
| Analyte | 5 ft. |
| Antimony | 0.00095 MG/L |
| Arsenic | 0.0086 MG/L |
| Barium | 0.0457 MG/L |
| Calcium | 396 MG/L |
| Cobalt | 0.0129 MG/L |
| Diesel Range Organics | 26 UG/L |
| Iron | 0.111 MG/L |
| Magnesium | 239 MG/L |
| Manganese | 7.99 MG/L |
| Potassium | 14.2 MG/L |
| Sodium | 560 MG/L |

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Figure 6-17

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CPT locations are located in the lowlands (Figure 6-17). The boundary of the lowlands and the highlands shown on Figure 6-17 is based on TDS concentrations that indicate groundwater in this area is brackish. The TDS data was reported from groundwater samples collected in test pits and trenches excavated during a previous investigation for a suspected fillsite (Fillsite 2). Fillsite 2 is located on the north side of Adams Street and approximately 200 feet from former Building 101 (FA/BC, 2004c). This boundary is also based on the presence of bedrock and alluvium encountered in the excavations.

**Table 6-33. Detected Groundwater Concentrations at the Former Battery Charge Building (Building 101)**

| Metal | Concentrations in mg/L unless otherwise noted: B101HP001 | B101HP002 | ESL |
|---|---|---|---|
| Antimony | 0.00051 | 0.00095 | 0.030 |
| Arsenic | 0.0219 | 0.0086 | 0.036 |
| Barium | 0.195 | 0.0457 | 1 |
| Calcium | 314 | 396 | NE |
| Cobalt | <0.005 | **0.0129** | 0.003 |
| Diesel fuel | <24 µg/L | 26 µg/L | 640 µg/L |
| Iron | 8.43 | 0.111 | NE |
| Magnesium | 277 | 239 | NE |
| Manganese | 2.3 | 7.99 | NE |
| Molybdenum | 0.0117 | <0.01 | 0.24 |
| Potassium | 40.6 | 14.2 | NE |
| Sodium | 1,030 | 560 | NE |

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
NE = not established
**Bolded** values exceed ESLs.
µg/L = micrograms per liter

Low to trace concentrations of metals and fuels were reported in groundwater ( Figure 6-17). Cobalt was the only metal that exceeded its RWQCB ESLs (Table 6-33). Research was performed to determine if cobalt was used in the manufacture of vehicular batteries at the time the Army occupied the Arsenal. There are eight metals commonly used in batteries including lead, mercury, nickel, cadmium, lithium, silver, zinc, and manganese (Colorado Department of Public Health and the Environment, 2002). Lead-acid batteries, developed in the late 1800s, were the first commercially practical batteries. Cobalt has been only recently (since the 1990s) used in the development of longer lasting rechargeable lithium ion, nickel-cadmium, and nickel-metal hydride batteries. The source of cobalt in groundwater at concentrations that exceed ESLs is unknown, but is not associated with the type of batteries that were cleaned by the Army in this building. Based on the data, there appears to be no significant DoD impact. Therefore, no further DoD action is indicated for the former battery charge building (Building 101).

### 6.5.15 Former Service Station (Building 103) UST.

**A risk evaluation is recommended at the location of the former Building 103 UST**

Building 103 was a service station with a pump island and a 15,000-gallon gasoline UST. In 2002, the USACE removed the UST, associated product piping, and collected soil samples beneath the former tank and product piping (Geofon, 2003). In the UST removal report by Geofon, a soil sample was recommended at Building 103 to determine the vertical and lateral extent of fuel-impacted soil. For the Expanded SI, the soil sample was collected at B103HP001 at a depth of 5 feet to 6 feet bgs and analyzed for petroleum hydrocarbons and VOCs. All analytes were reported below laboratory MDLs. A risk assessment is recommended using the existing data for the remaining fuel-impacted soil at the former Building 103 UST.

A groundwater sample collected from the excavation reported gasoline range organics, toluene and xylenes above ESLs. Diesel fuel range organics were not evaluated in the water sample. During the Expanded SI, no groundwater was encountered at the boring advanced, B103HP001. Diesel fuel, gasoline, and motor oil were not above ESLs in the closest downgradient groundwater sample, B031HP003 (approximately 100 feet north) (Plate 1, Figure 6-15, and Figure 6-16). The UST related contamination is delineated and a risk assessment is recommended for the remaining contaminants at the former Building 103 UST.

6.5.16 Former Building 118A ASTs.

**A risk evaluation is recommended for the former Building 118A ASTs**

A September 1945 map identifies Building 118A as a 10,000-gallon diesel tank. Two tanks were mentioned in the Army records and are suspected in the same vicinity as the 10,000-gallon diesel tank. It is presumed that the tanks were ASTs and removed prior to 1961 but records were unclear.

Since the historical records were unclear on which tanks were ASTs or possibly USTs, a geophysical survey was conducted and five test pits (B118ATR001 through B118ATR005) were excavated to locate the suspected USTs in 2002 (FA/BC, 2002b). No evidence of a UST was found, but a thin lens of soil with a slight to moderate hydrocarbon odor was encountered in a few pits. Groundwater was reached in some pits and samples of groundwater and soil were taken. Diesel fuel and motor oil were detected in the soil samples and solvents were detected in the groundwater samples. The highest diesel fuel concentration in soil was detected at 510 mg/kg in test pit B1181TR005, which exceeds the ESL of 500 mg/kg. Motor oil concentrations were less than 400 mg/kg, which is less than the ESL of 1,000 mg/kg. The lateral extent of the fuel contamination in soil was delineated on all sides except to the east and south.

For the Expanded SI, two borings, B118AHP001 and B118AHP002, were advanced near former Building 118A in an effort to delineate the suspected fuel release. B118AHP001 was placed south of test pit B118ATR005 and soil was sampled at a depth of 4.5-5.0 feet bgs. Concentrations of diesel fuel and motor oil were reported at 78 mg/kg and 57 mg/kg, respectively; below their respective ESLs. The boring locations are shown on Figure 6-11.

The second boring was advanced east of test pit B118ATR005. The boring, B118AHP002, encountered approximately 5 feet of silt overlying weathered sandstone. No water was encountered in the boring. Based on the lithology and the location of the boring, the lack of water was expected. The sandstone bedrock rises close to the surface towards Building 31, east of this area, so that water is found only in the former marshland and in the deepest part of the alluvium north of the marsh. These are two different environments that are not connected by any continuous lithologic units (e.g., sand). Any soil in this area would not be representative of the area beneath former Building 118A. Therefore, a soil sample was not taken at B118AHP002. Since the fuel concentrations in the soil sample collected south of the former Building 118A were low, it is suggested that the eastern extent would not extend any farther than the edge of the former marshland (Figure 6-11). A risk assessment for the fuel-impacted soil at former Building 118A is recommended.

In groundwater, several solvents and fuels were reported in shallow groundwater in 2002 (FA/BC, 2202b). Their maximum concentrations are shown in Table 6-34. Trace amounts of DIPE (an oxygenate) was also detected in the groundwater samples at a maximum concentration of 1 µg/L. Diesel fuel and motor oil were reported in a groundwater sample collected from B118ATR005 at a concentration of 2,700 µg/L and 860 µg/L, respectively. The lateral extent is defined in this area (Plate 1 and Figure 6-16) based on concentrations of diesel fuel and motor oil that are less than ESLs at B118ATR004 and B118AHP002. The source may be attributed to a small release from the former ASTs.

**Table 6-34. Maximum Solvents Concentrations in Groundwater in the area of the former Building 118A ASTS**

| Analyte | Maximum Concentration (µg/L) |
|---|---|
| Trichloroethene | 13 |
| cis-1,2- dichloroethene | 24 |
| trans-1,2-dichloroethene | 1.2 |
| tetrachloroethene | 2.7 |
| 1,1-dichloroethane | 1.2 |

6.5.17 Former Quartermaster Storage/Shop/Electroplating (Building 120).

**A risk evaluation is recommended for solvent-impacted groundwater**

Building 120 was built in 1943 and located north of the 50 Series Complex (Figure 6-11). The building once contained a photographic laboratory and a series of copper, chromium, nickel and cadmium electroplating tanks. Waste water from building drained into a neutralizer tank on the north side of the building and then into the storm drain line. There was a control valve before the neutralizer tank that could bypass the neutralizer tanks and allow direct disposal into the storm drain. A former Arsenal employee indicated that fuel oil USTs were filled by railcar with #5 fuel oil, at the present location of the Building 120. The USTs were not found. The building also contained a degreaser pit. During the 1999 USACE soil and groundwater investigation for the 50 Series Complex, fuels were reported in soil and groundwater on the north side of the building. Additionally, solvents were reported in groundwater. Diesel fuel and motor oil soil concentrations were less than ESLs. The Expanded SI focused on the determining the extent of fuels and solvents in groundwater from six locations (B120HP001 through B120HP005 and FS1HP001).

Soil samples were collected to determine the concentrations of metals (i.e., cadmium, nickel, copper, chromium and cyanide) known to be used in Building 120's electroplating processes. These soil samples were collected from the boring (B120HP002) closest to the location of the neutralizer tank. A soil gas sample was also collected south of Building 120 because key indicator chemicals were present at detectable concentrations. Analysis of the soil gas samples collected at B120HP004 reported TCE at 40 ppbv.

Results of the soil and groundwater samples are shown in Table 6-35. These concentrations are below BSLs in soil and do not indicate a significant DoD release of metals or cyanide to soil. Therefore, no further soil sampling is recommended. Even though copper and nickel, metals used in the electroplating processes in Building 120, were reported in groundwater that exceed their respective RWQCB ESLs (Table 6-35) at B120HP002, these metals were not reported above their respective ESLs in borings nearest to Building 120 (Fillsite 1 [L001TR007], former Building 73 [B073TR001], and former Building 31[B031HP001]). Based on these results, it appears that

groundwater has not been significantly impacted from leaks from the neutralizer tank or the storm drain from the former electroplating processes in Building 120.

**Table 6-35. Building 120 Metals and Cyanide Soil and Groundwater Concentrations**

Samples collected from B120HP003

| Metal | Groundwater Concentration (mg/L) | Groundwater ESL (mg/L) | Soil Concentration at 3-3.5 ft bgs (mg/kg) | Soil BSL (mg/kg) |
|---|---|---|---|---|
| Cadmium | <0.0007 | 0.0011 | 0.443 | 1000* |
| Chromium | 0.015J | 0.18 | 85.2 | 450+ |
| Copper | **0.0139J** | 0.0031 | 47.9 | 76,000* |
| Nickel | **0.024J** | 0.0082 | 54.8 | 41,000* |
| Cyanide | <0.0029 | 0.001 | NA | 41,000* |

* - Commercial/Industrial worker- noncarcinogen. (FA/BC, 2002a)
+ - Commercial/Industrial worker – carcinogen. (FA/BC, 2002a)
ESL = Environmental Screening Level. Groundwater is not a current to potential drinking water source (RWQCB, 2005).
NA = not analyzed
BSL = Benicia Screening Level (FA/BC, 2002a)
**Bolded** values exceed their respective BSLs/ESLs
mg/L = micrograms per liter
mg/kg = milligrams per kilograms

Diesel fuel, gasoline and motor oil were detected in shallow groundwater north of Building 120 and diesel fuel was also detected in groundwater samples south of Building 120. USTs were suspected in this area, although no conclusive geophysical evidence was obtained. If they were present, they were removed when Building 120 was constructed. The TPH detected in groundwater at this location is from an unknown source. Plate 1, Figure 6-15 and Figure 6-16 illustrate the detections and lateral extent of diesel fuel, gasoline, and motor oil in shallow groundwater. Solvents were also detected in groundwater. TCE and cis-1,2-DCE concentrations have been identified up to 57 µg/L and 150 µg/L, respectively on the south side of the building in B120HP003 (Plate 2 and Plate 3). A risk evaluation is recommended for the solvents and fuels remaining in groundwater at Building 120.

### 6.5.18 Former Motor Test Shed (Building 154) USTs

Building 154 was a Motor Test Shed. A 10,000-gallon UST, gasoline pumps, and a 7,000-gallon 80 octane gasoline UST served the motor test shed and the Dynamometer Building (Building 53). The USTs were removed in 2002 (Geofon, 2003). Analysis of soil samples collected during the Geofon investigation at Building 154 did not report COIs above ESLs. Therefore, additional soil sampling was not recommended. However, during a previous investigation by Brown and Caldwell, a soil sample was collected at a depth of 5 feet bgs from a trench (B154TR007). The trench sample detected gasoline at a concentration of 1,150 mg/kg. The RWQCB requested an additional soil sample near the former trench to delineate the extent of the gasoline in soil. A soil sample was collected in boring B154SB001, located approximately 15 feet north of B154TR007. Total petroleum hydrocarbons as gasoline was reported at 26 mg/kg, which is below the ESL of 400 mg/kg. The results on Figure 6-14 show that the extent of fuels and lead are laterally and vertically defined in soil. A risk assessment is recommended at the former Building 154 UST for the soil impacted with gasoline range organics.

Groundwater sampled during the tank excavation was impacted with gasoline range organics and lead above the ESLs. Isomers of DCE were detected in groundwater samples, likely the result TCE degradation. Maximum concentrations of cis-1,2 DCE, benzene, diesel fuel, motor oil and gasoline near the former 154 UST are listed in Table 6-36. Plate 1 and Plate 3 show the concentrations of diesel fuel and cis-1,2 DCE detected in groundwater. Figure 6-15 and Figure 6-16 show gasoline and motor oil detected in groundwater above analytical method limits.

**Table 6-36. Maximum concentrations of cis-1,2 DCE, benzene, diesel fuel, motor oil and gasoline near the former UST 154.**

| Analyte | Concentration (µg/L) | Sample ID |
|---|---|---|
| Diesel fuel | 66,000/8,300* | B154HP001 |
| Gasoline | 16,200 | B154TR002 |
| Motor Oil | 7,200 | B154HP001 |
| Benzene | 120 | B154TR003 |
| Cis-1,2 DCE | 1,300 | B154HP001 |

- split sample result
µg/L = micrograms per liter

During the Expanded SI, groundwater samples downgradient of the former UST reported hydrocarbons, PAHs and solvents. Analysis of samples collected from B154HP002 approximately 40 feet southeast, detected diesel fuel at 98 µg/L but gasoline was below detection limits. Southwest of the former excavation (approximately 225 feet) hydrocarbons were not detected in groundwater samples above MDLs. Hydrocarbon contaminants detected downgradient of the excavation delineate the hydrocarbon plume related to the former USTs. The solvents reported downgradient of the former UST are related to a different source area and are discussed in Section 6.5.13. A risk assessment is recommended for the remaining groundwater hydrocarbon impact due to the former 154 UST.

6.5.19 Former Locomotive House (Building 156).

**No further DoD Action is Indicated at Building 156**

Built in 1945, Building 156 was a locomotive house and contained pits installed for servicing diesel locomotives. The locomotive pits were filled in and concrete is exposed at grade. There are no drawings that indicate the construction of these pits. Two borings (B156HP001 and B156HP002) were advanced downgradient of Building 156 to determine the presence or absence of fuels and solvents in groundwater from a suspected release from former DoD degreasing activities in the building (Figure 6-11).

CPT boring logs for B156HP001 and B156HP002 indicate that sandstone is approximately 7 feet to 8 feet bgs in this area. No groundwater was encountered. Soil gas samples were collected at 3 feet to 4 feet bgs and no VOCs were detected above MDLs. Therefore, no further DoD action is indicated.

6.5.20 Former Motor Cleaning Building/Steam Cleaning/Paint Spray/Fuel Storage (Building 161).

**Groundwater contains low concentrations of metals at Building 161. A UST was found but could not be removed due to refusal of right of entry by the landowner.**

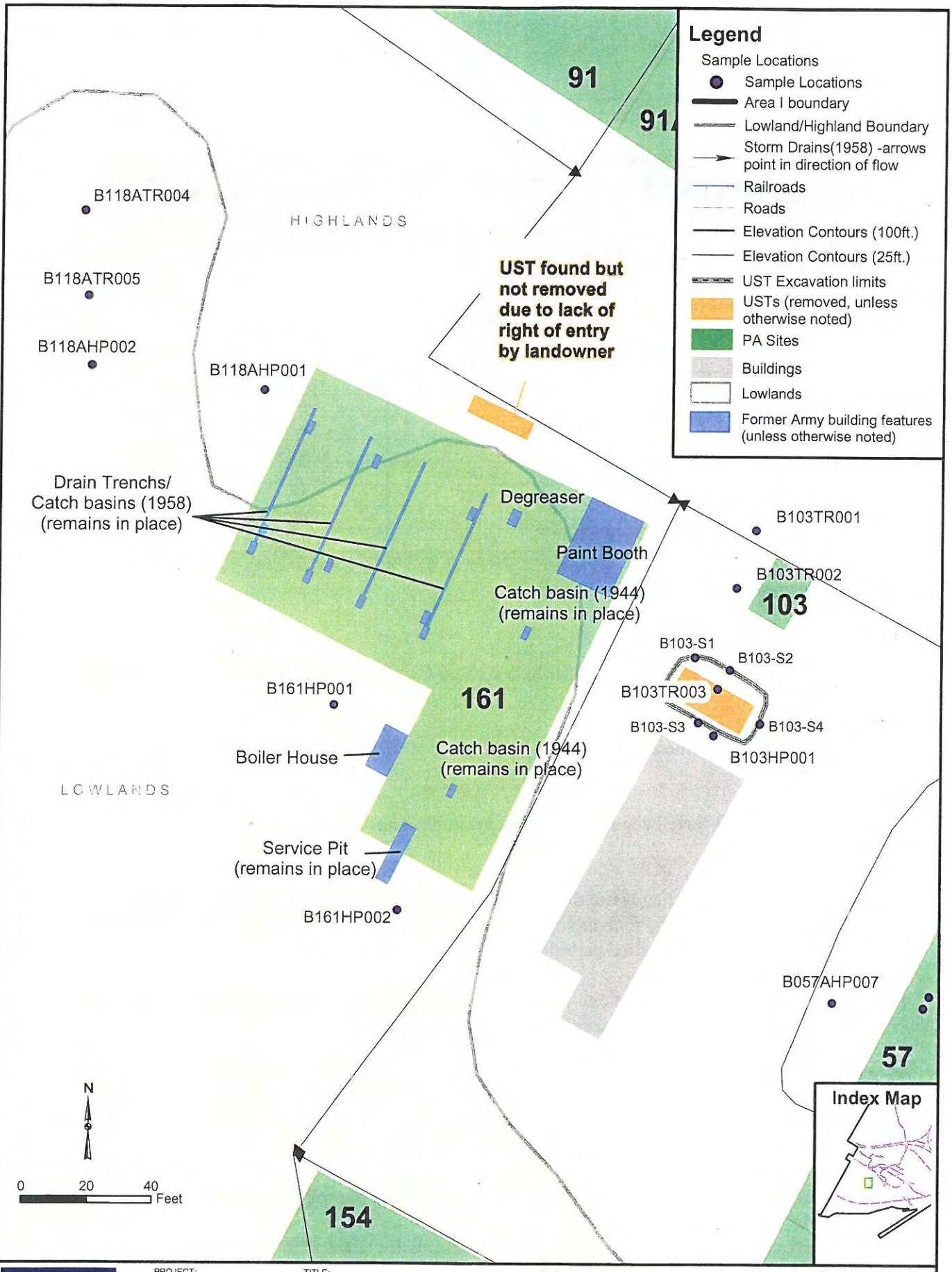
Operations in this building included motor cleaning, steam cleaning, and spray painting. Drawings of the building shows the location of a kerosene storage tank, a paint spray booth, a degreaser, a steam cleaner, a service pit, a boiler house, four drain trenches, and six catch basins (Figure 6-18). Other historic records indicate that the building contained a dip tank line, stripping tank, two acid dip tanks, two water dip tanks, and a neutralizer tank. Locations of these structures are unknown. The service pit measures 10 feet long by 3.5 feet wide and has a 6-inch drain connecting to the storm drain. In 1952, the building operations included steam cleaning of large components, dipping and painting (FA/BC, 2004a). The building had been constructed in a temporary-type manner on reclaimed tidelands without pilings. The building was later demolished after the Army left the Arsenal in 1964.

According to historic records, temporary construction of buildings resulted in uneven settling, creating excessive stresses in trussed members to the extent that numerous failures occurred. Floors sank so badly that the floor drains could not operate (FA/BC, 2004a). In 1952, there was sewer system deficiencies noted at Building 161, such that frequently rodding was needed to keep the sewage lines open (FA/BC, 2004a). Currently, the building foundation with the drain trenches, catch basins and service pit remain.

As part of the Fuel Storage Tank Removal Action (BC, 2005), a tank fill pipe was located and waste oil found in the UST. The tank limits were not determined due to interference of a concrete surface during the geophysical survey. The property owner did not grant access to the property to remove this UST.

As part of the Expanded SI, two borings (B161HP001 and B161HP002) were advanced downgradient of Building 161 to determine the presence or absence of fuels, metals and solvents in groundwater from a suspected release from former DoD cleaning activities in the building and from a possible release of fuels from the fuel storage UST. B161HP001 was advanced downgradient of the drain trenches with catch basins and the kerosene UST. B161HP002 was advanced downgradient of the service pit (Figure 6-18). A total of three groundwater samples were collected: one sample from shallow groundwater in B161HP001 at 9 to 13 feet bgs and two samples from deeper groundwater (49 to 56 feet bgs at B161HP001 and 19 to 23 feet bgs at B161HP002). An attempt was made to collect a shallow groundwater sample at B161HP002 but the hole remained dry to 10 feet bgs. This building is located in the lowlands (Figure 6-18).

Several metals were reported above MDLs in groundwater samples in CPT borings B161HP001 and B161HP002 (Table 6-37). Cobalt and nickel were identified above their respective ESLs (Table 6-37).

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DATE: 4/4/2005

TITLE: Former Building 161 Army Features
SITE: Benicia Arsenal, Benicia, California

Figure 6-18

**Table 6-37. Detected Groundwater Concentrations of Metals at Former Building 161**

Concentrations in mg/L

| Metal | B161HP001 (at 9 to 13 feet bgs) | B161HP001 (at 49 to 56 feet bgs) | B161HP002 (at 19 to 23 feet bgs) | ESL |
|---|---|---|---|---|
| Antimony | <0.0005 | 0.00265 | <0.0005 | 0.030 |
| Arsenic | 0.00681 | <0.0036 | <0.0036 | 0.036 |
| Barium | 0.131 | 0.213 | 0.417 | 1 |
| Calcium | 201 | 456 | 610 | NE |
| Cobalt | <0.005 | **0.012** | **0.021** | 0.003 |
| Iron | 9.13 | 7.77 | 0.0908 | NE |
| Magnesium | 139 | 1590 | 959 | NE |
| Manganese | 2.74 | 5.43 | 12.5 | NE |
| Molybdenum | <0.01 | 0.0445 | 0.0214 | 0.24 |
| Nickel | <0.01 | **0.0372** | **0.0345** | 0.0082 |
| Potassium | 2.35 | 219 | 115 | NE |
| Sodium | 329 | 11950 | 6850 | NE |
| Zinc | 0.0249 | <0.005 | <0.005 | 0.081 |

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
NE = not established
**Bolded** values exceed ESLs.

According to the International Agency for Research on Cancer (1991), cobalt has the following origins and uses.

- Cobalt has been obtained primarily as a by-product of the mining and processing of copper and nickel ores.
- Cobalt compounds have been used as pigments in glass and ceramics in many countries for thousands of years.
- Since the beginning of the twentieth century, the major uses of cobalt have been in the production of metal alloys, such as superalloys and magnetic alloys, as well as high-strength steels and hard-metal cemented carbides.
- At the end of the 1980s, about one-third of the cobalt used was in the production of cobalt chemicals, which are used primarily as catalysts and pigments.

As stated for former battery charge building (Building 101) (Section 6.5.13), cobalt has been used in the development of longer lasting rechargeable lithium ion, nickel-cadmium, and nickel-metal hydride batteries since the 1990s. The source of cobalt in groundwater at concentrations that exceed ESLs is unknown based on the DoD activities in this building.

According to the Work Health Organization (1991), nickel has the following characteristics.

- Nickel is a ubiquitous trace metal and occurs in soil, water, air, and in the biosphere.

- Levels in natural waters have been found to range from 2 µg/L to 10 µg/L (fresh water) and from 0.2 µg/L to 0.7 µg/L (marine).

- Most of the nickel is used for the production of stainless steel and other nickel alloys with high corrosion and temperature resistance.

- Nickel alloys and nickel platings are used in vehicles, processing machinery, armaments, tools, electrical equipment, household appliances, and coinage. Nickel compounds are also used as catalysts, pigments, and in batteries.

- It is resistant to alkalis, but generally dissolves in dilute oxidizing acids. Nickel carbonate, nickel sulfide, and nickel oxide are insoluble in water, whereas nickel chloride, nickel sulfate, and nickel nitrate are water soluble.

According to Nickel Institute (2005), nickel is used in the auto industry as part of stainless steel, nickel-based alloys, nickel-containing alloy steels, nickel powders, and nickel plating. These metals and powders are used to form catalyst supports, exhaust systems, spark plugs, diesel valves, thermostats, gears, drive shafts, coatings, anti-corrosion treatment for under hood components, piston/cylinder coatings, electronic cans, and connectors.

The source of nickel in groundwater at concentrations that exceed its ESL is not clearly understood. The following is one possible scenario. Nickel from nickel-based alloys or coatings were washed from the vehicles or parts plated in Building 120 and the nickel-ladened wash water entered the catch basins. This water leaked from the catch basins into the brackish groundwater. The nickel dissolved into groundwater forming a nickel compound, such as nickel sulfate, where it was detected in the groundwater samples. The concentrations at the site are low based on typical concentrations of nickel expected in marine waters. Therefore, a risk assessment is recommended for the nickel found in groundwater.

Petroleum hydrocarbons were not reported above ESLs in groundwater (Table 6-38). Diesel fuel concentrations in groundwater for this building and the industrial area are shown on Plate 1.

**Table 6-38. Detected Petroleum Hydrocarbon Concentrations in Groundwater at Former Building 161**

| | | | | | |
|---|---|---|---|---|---|
| Diesel fuel | 390 | 95 | 96 | <24 | 640 |
| Gasoline | 23 | <20 | <20 | <25 | 500 |
| Motor Oil | 91 | 160 | 110 | <230 | 640 |
| Benzene | <0.18 | <0.18 | 0.51 | 0.68 | 460 |
| Toluene | <0.12 | <0.12 | 0.22 | <0.42 | 130 |
| Ethylbenzene | <0.11 | <0.11 | <0.11 | <0.27 | 290 |
| Xylenes | <0.24 | <0.24 | <0.24 | <0.69 | 100 |

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
**Bolded** values exceed ESLs.

TCE and its daughter products were detected in groundwater (Table 6-39). TCE and cis-1,2-DCE concentrations for this building and the industrial area are shown on Plate 2 and Plate 3. TCE and vinyl chloride exceed their respective ESLs (Table 6-39). The occurrence of TCE and its daughter products is part of a larger plume that is discussed further in Section 6.5.27. As stated above for Building 91, there are several primary sources of TCE at other locations in the industrial area. There is no documented DoD use of solvents at Building 161.

**Table 6-39. TCE, cis-1,2-DCE, trans-1,2-DCE, and Vinyl Chloride Concentrations in Groundwater at Former Building 161**

| | Concentrations in µg/L | | | | |
|---|---|---|---|---|---|
| Analyte | B161HP001 (at 5 to 13 feet bgs) | B161HP001 (at 49 to 56 feet bgs) | B161HP002 (at 5 to 10 feet bgs) | B161HP002 (at 49 to 52 feet bgs) | ESL |
| TCE | <0.15 | 2 | 0.41 | **460** | 360 |
| Cis-1,2-DCE | 0.85 | 110 | 1.2 | 230 | 590 |
| Trans-1,2-DCE | <0.15 | 3.3 | <0.15 | 12 | 590 |
| Vinyl chloride | <0.25 | 0.27 | 0.61 | **5.1** | 3.8 |

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
**Bolded** values exceed ESLs.
bgs = below ground surface
µg/L = micrograms per liter

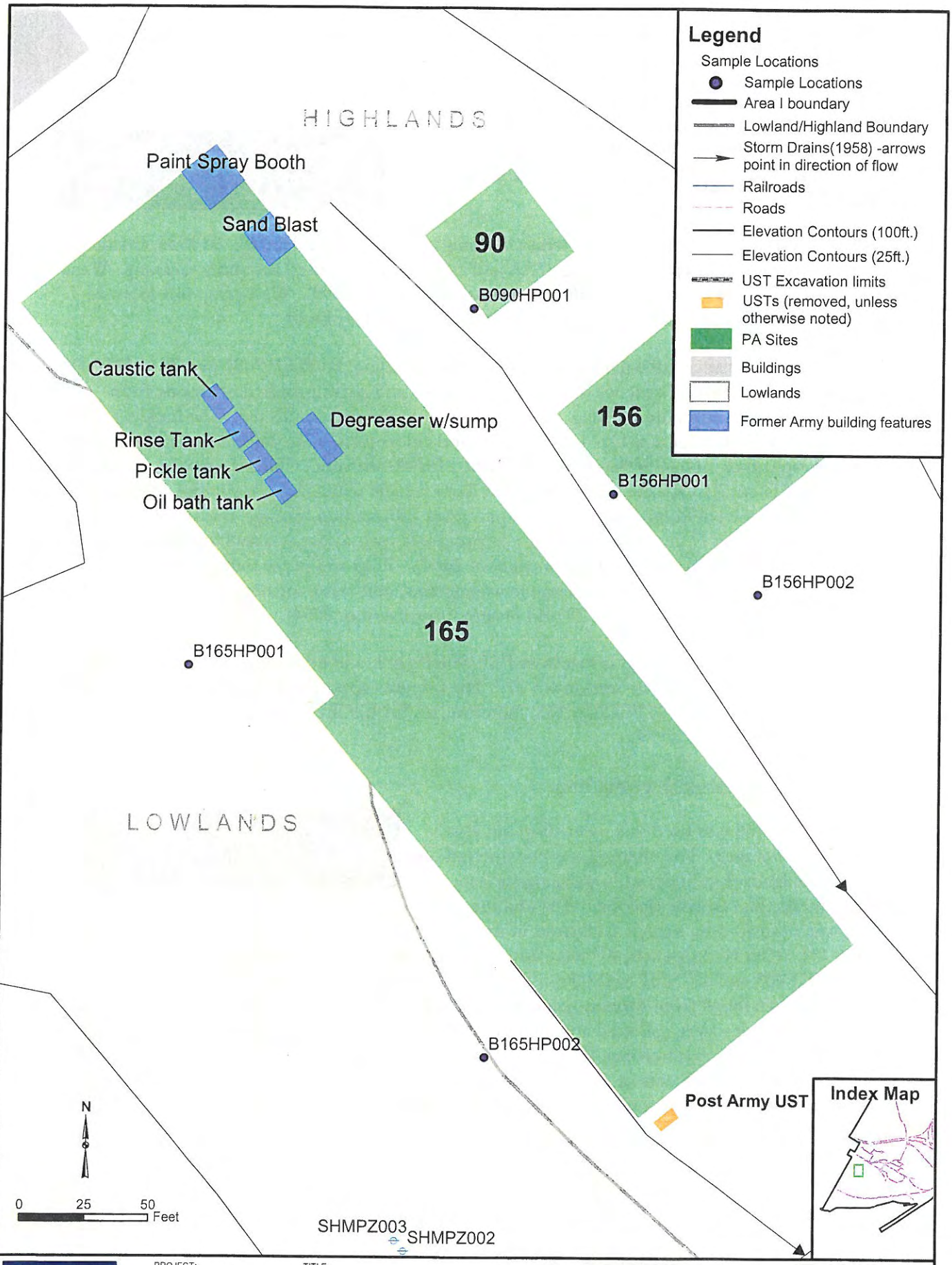
Once access to the kerosene UST is granted, the UST should be removed and samples should be collected to determine if there was a release from the fuels to soil and groundwater. No further action by USACE cannot be done until access is provided.

### 6.5.21 Former Reclamation Building/Transport Vehicle Shop (Building 165)

**A risk evaluation is recommended for Building 165**

Built in 1945, Building 165 was used for vehicle repairs and contained two gas-fired boilers and caustic, rinse, pickle, oil bath, and degreaser processing tanks (Figure 6-19). All the dip tanks have been removed and the current business has divided the building into hundreds of storage areas. Between 1966 and 1981, the building was used for office space an as a facility for the manufacture and storage of equipment for pumps, water systems, swimming pools, automobile wheels and accessories. Operations were similar to the aluminum wheel manufacturing at nearby Building 90 which included manufacturing aluminum wheels for automobiles and installing fiberglass truck beds on pick-up trucks. The aluminum wheel process included pouring the aluminum into a form then grinding and cleaning the wheel. The location and the types chemicals used in the cleaning are unknown. Building 165 is located in the on the border between the highlands and the lowlands (Figure 6-19).

Five downgradient Hydropunch™ samples were collected (B165HP001, B165HP002, B165HP003, B165HP004, B165HP005) to determine if there was a release of metals, VOCs, and petroleum hydrocarbons from former DoD maintenance and cleaning activities in the building. TCE, cis-1,2 DCE, and vinyl chloride contained concentrations of 32,000, 46,000, and 4,600 µg/L, respectively. The occurrence of the TCE and its degradation products are part of a larger plume and is discussed further in Section 6.5.27.

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PROJECT: 24785-007
DATE: 4/4/2005

TITLE: Former Building 165 Army Features
SITE: Benicia Arsenal, Benicia, California

Figure 6-19

6.5.22 Former Steam Cleaning Building (Building 165A)/ Former Maintenance Building, Body and Radiator Shop (Building T199).

**No further DoD Action is Indicated at former Building 165A/T199**

Building 165A was used for most of the steam cleaning activities at the Arsenal. In 1953, Building T199 was constructed to replace Building 165A and continued to be used for steam cleaning. Weak alkali soap was injected into the steam during operations (Jacobs, 1999). Waste disposal or waste management activities are unknown. The building was removed by DoD.

Two borings were advanced downgradient of the former building, B165AHP001 and B165AHP002 to determine the presence or absence of a release of VOCs and petroleum hydrocarbons from former cleaning activities in the building. Groundwater samples were collected. The building is located in the lowlands (Figure 6-11). Cis-1,2 DCE and chloroform were detected at 4.9 µg/L and 0.38 µg/L, respectively. No ESL has been established for chloroform. Chloroform was detected at trace levels and is not a COI expected to be found from vehicle maintenance activities. Chloroform can be released to the environment from direct processes (production, storage, transit, or use) or as a result of its formation from other substances, in processes such as paper bleaching with chlorine and water chlorination (World Health Organization, 2004). Pulp and paper mills, municipal wastewater treatment plants, chemical manufacturing plants, and waste incinerators represent anthropogenic sources of chloroform (World Health Organization, 2004).

The concentration of cis-1,2 DCE is below its ESL of 6.0 µg/L and its occurrence is part of a larger plume and is discussed further in Section 6.5.27. The solvents appear to have originated upgradient from activities that occurred in Building 165, therefore, no further investigation is recommended at the former Building 165A/T199.

6.5.23 Former Paint Shop (Building 166).

**No further DoD Action is Indicated at Building 166**

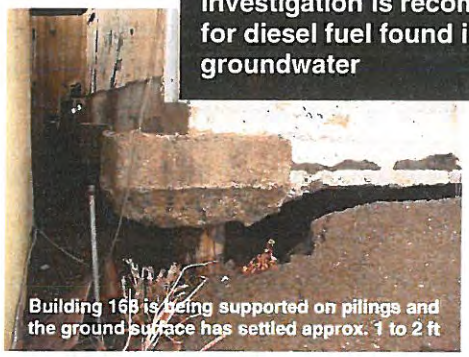
Former Building 166 was used as a paint shop but also contained a grease rack. The building was constructed on reclaimed tide lands (lowlands) without pilings, it had settled 12 inches on one side (Jacobs, 1999) and the building was destroyed by Benicia Industries in the 1970's. It was located south of Building 4 (Figure 6-11). Two Hydropunches™ were advanced downgradient of the building (SWAMPAHP003 and SWAMPAHP006) to determine if there was a release of VOCs and petroleum hydrocarbons from former maintenance (grease rack) activities in the building. Groundwater samples were collected and analyzed for fuels and solvents to determine if there was a release of former DoD maintenance (grease rack) activities. MtBE was detected at a concentration of 2.4 µg/L. No other solvents or fuels were detected. The MtBE indicates a post-army release, therefore, no further DoD action is indicated at former Building 166.

6.5.24 Former Bar Stock Building/Storage/Vehicle Shops for Motor Pool (Building 167 and Building 168).

**Building 167: No further DoD Action is Indicated**

**Building 168: Additional investigation is recommended for diesel fuel found in shallow groundwater**

Both of these building were built in 1945 during the World War II expansion at the former Arsenal. The buildings are located on the former marshland and are supported by pilings that have been driven to the top of the underlying sandstone. The land surface around these buildings has sunk several feet as shown in the photo at left.


Building 168 is being supported on pilings and the ground surface has settled approx. 1 to 2 ft

Historical records identify both buildings as vehicle shops but records did not indicate whether maintenance work was performed. Four borings (B167HP001, B167HP002, B168HP001, and B168HP002) were advanced downgradient of both buildings to determine the presence or absence of fuels and solvents in groundwater from possible DoD vehicle maintenance activities (Figure 6-11).

The only contaminates detected above MDLs were diesel fuel and naphthalene reported in samples collected from shallow groundwater (5 to 10 feet bgs) in borings B167HP002 and B168HP002 (Table 6-40). Both of these analytes are less than their respective ESLs.

**Table 6-40. Detected Contaminates in Shallow Groundwater at Buildings 167 and Building 168**

| | Concentration (µg/L) | | |
|---|---|---|---|
| Analyte | B167HP002 | B168HP002 | ESL |
| Diesel fuel | <24 | 100 | 640 |
| Naphthalene | 0.61 | <0.47 | 24 |

ESL = Environmental Screening Level. Groundwater is not a current to potential drinking water source (RWQCB, 2005).
µg/L = micrograms per liter

However, the decision criteria used for this investigation required that if a key indicator, like diesel fuel, was reported in a sample with no known source, that additional sampling would be required to determine if there is a source area upgradient of the location. At B168HP002, diesel fuel was reported in shallow groundwater at 100 µg/L and approximately 100 feet west of this location, SWAMPBHP002, diesel fuel was detected at 270 µg/L in shallow groundwater (Plate 1). The nearest upgradient water samples, SWAMPAHP007 and SWAMPAHP008, are approximately 250 to 280 feet, north to north-northwest of this location. These upgradient samples were non-detect for diesel fuel. Other diesel fuel plumes in the industrial area have been delineated with smaller lateral distances than the distance from the nearest upgradient groundwater samples to the detections at SWAMPBHP002 and B168HP001. Therefore, it is possible that the source of the diesel fuel in this area may not have been found and maybe related to a release on the north side of Building 168. Therefore, additional groundwater sampling is recommended to determine if there is an upgradient source of diesel fuel in this area.

There were distinct peaks identified on the diesel fuel chromatogram for sample B168HP001 that did not match a typical diesel pattern and may indicate non fuel-related compounds. In attempt to identify these peaks, the groundwater sample was sent for additional analysis by EPA Method 8270. Bis(2-ethylhexyl)phthalate was found in the sample at a concentration of 190 µg/L, which exceeds its ESL of 32 µg/L. The compounds could not be definitely linked with peaks on the fuel chromatogram. As stated for the Salvage Yard, the presence of phthalates indicates a post Army source.

In summary, a trace concentration of naphthalene was reported in groundwater at Building 167. This concentration does not exceed its RWQCB ESLs (Table 6-40). There is no evidence of a significant DoD impact. Therefore, no further DoD action is indicated for Building 167. Phthalates found in groundwater are associated with a post Army source. Diesel fuel was found in shallow groundwater near Building 168 with no known source area. Therefore, additional investigation is recommended to determine if there is a source of diesel fuel in shallow groundwater upgradient of Building 168 and CPT location SWAMPBHP002.

Based on the data for Building 167, there is no threat to human health and the environment from any DoD release from this building. Therefore, no further DoD action is indicated.

6.5.25 Fillsite 1.

The fillsite was first identified on a 1918 map of the Arsenal and labeled "dump". The area was reclaimed marshland and was filled when Building 71 was constructed over the filled area in 1920. Building 71 was demolished in the 1980s, like the other buildings on the former marshland due to severe structural settling of the foundation. Fillsite 1 was in operation at about the turn of the century. Research indicates that burning took place at this location.

In 2000, a geophysical survey was performed in the area to determine if the dump existed. Nine test pits were dug at anomalous areas indicated by the geophysical survey. No refuse was found. One of the concrete pilings for former Building 71 was found. Soil and groundwater samples were collected from the test pits. Fuels were reported in soil at a maximum concentration of 2,900 mg/kg motor oil. Methylene chloride (20 µg/L), MtBE (0.64 µg/L, cis-12,DCE (18 µg/L), TCE (21 µg/L), diesel fuel (56 µg/L) and motor oil (450 µg/L) were reported in groundwater. The fuels in soil and groundwater may be attributed to the burn dump but the source of the solvents was unknown. Further information about this investigation can be found in Section 1.5.3. Fillsite 1 is located in the lowlands, east of the 50 Series Complex (Figure 6-11).

Thirteen CPT borings (FS1HP001 through FS1HP013) were advanced at the fillsite to determine the source of previously identified solvents and to delineate the solvents in groundwater (Figure 6-11). The maximum concentrations of TCE and its daughter products were reported in FS001HP007 and FS001HP001 (Table 6-41). TCE and vinyl chloride were reported at concentrations that exceed their respective ESLs (Table 6-41). As stated in previous sections, the presence of TCE and its daughter products at Fillsite 1 are part of a larger plume in the industrial area. This is discussed further in Section 6.5.27.

**Table 6-41. Maximum Concentrations of TCE, cis,1-2-DCE, trans-1,2-DCE, and Vinyl Chloride in Groundwater at Fillsite 1**

| Concentrations in µg/L | | | | | |
|---|---|---|---|---|---|
| **Location** | **Depth (ft bgs)** | **TCE** | **Cis-1,2-DCE** | **Trans-1,2-DCE** | **Vinyl Chloride** |
| FS001HP007 | 18-27 | **3,400** | 420 | 140 | **6** |
| FS001HP001 | 3.6-10 | <0.31 | 4.8 | <0.33 | **6.8** |
| ESL | | 360 | 590 | 590 | 3.8 |

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
**Bolded** values exceed ESLs
µg/ = micrograms per liter

In summary, the groundwater data in the industrial area indicates that the primary sources of the TCE are from other locations. The presence of TCE in the area of Fillsite 1 is likely due to the transport of contaminated groundwater through the storm drain system to this area. There is no evidence of a disposal site at this location based on the 2001 test pits. Solvents were not disposed of on the ground because the area was filled and covered with asphalt by the 1920s and solvents were not available until World War II. Therefore, there is no evidence of a DoD release at Fillsite 1 and no further DoD action is indicated.

### 6.5.26 Former Storehouse/Shop (Building TO131).

**No further DoD Action is Indicated at former Building TO131**

Looking east at the CPT Rig Setup at TO131

TO131's use as shop began when it was built in the 1940s on top of a hill, called Bottle Hill (Figure 6-11). Bottle Hill is comprised of Vine Hill Sandstone. The building was later renovated in the 1950s to house a new-link operation for ammunition. Drawings show that the building contained several above ground processing tanks (i.e. "hot", "cold", rinse, alkali and acid tanks), a shallow degreaser pit, and an oil-fired boiler. The degreaser pit was 3 feet deep. Activities in this building were noted in a 1952 sewer survey report for the industrial area and included degreasing, dipping, preserving and painting (Brown and Caldwell, 1952). The building was torn down between 1958 and 1964.

A soil boring (TO131HP001) was placed next to the former concrete building pad (Figure 6-11) to determine the possible impact of fuels and solvents from the former DoD degreasing operations. A soil gas sample was planned and sampled in this boring since it was expected that no groundwater would be present on this hill. As suspected, no groundwater was encountered and competent sandstone is present at 6.5 feet bgs. The soil gas was analyzed for VOCs. No VOCs were detected in the sample collected at 4 to 5 feet bgs. Based on the soil gas concentrations, there is no evidence of a release at this building. Therefore, no further DoD action is indicated.

6.5.27 Industrial Area Groundwater.

The following subsection summarizes the results of groundwater samples collected in the industrial area for petroleum hydrocarbons, MtBE, chlorinated solvents, and PAHs.

Petroleum Hydrocarbons in Groundwater.

Diesel fuel was commonly detected in groundwater. The second most common petroleum hydrocarbon detected in groundwater was motor oil. Gasoline also was detected in groundwater; however, less frequently than diesel and motor oil. Maximum petroleum hydrocarbon concentrations detected during the Expanded SI are listed in the following Table 6-42.

**Table 6-42. Maximum Petroleum Concentrations in Groundwater**

| Location | Depth (feet bgs) | Diesel Fuel (µg/L) | Motor Oil (µg/L) | Gasoline (µg/L) |
|---|---|---|---|---|
| B120HP004 | 5 | **510,000** | <230 | <25 |
| B154HP001 | 5 | **66,000** | **7,200** | 250 |
| FS001HP001 | 3.6 | **30,000** | <230 | 130 |
| FS001HP008 | 5 | 160 | **710** | <500 |
| B059HP001 | 2.5 | **13,000** | **26,000** | 130 |
| B120HP002 | 34 | <100 | <230 | **500** |
| ESL | -- | 640 | 640 | 500 |

ESL = Environmental Screening Level. Groundwater is not a current to potential drinking water source (RWQCB, 2005).
**Bolded** concentrations exceed or equal their respective ESLs.
bgs = below ground surface
µg/L = micrograms per liter

There are 11 areas where petroleum hydrocarbons are detected in groundwater at concentrations that exceed ESLs within the industrial area (Figure 6-20). The location of these areas (in a clockwise direction) and type of petroleum hydrocarbon in exceedance are the following:

1. at the former Building 31 UST (diesel fuel and gasoline),
2. at the former Building 103 UST (gasoline),
3. at the southeast corner of Building 98 at B073TR001 (gasoline),
4. northwest corner of Building 120 (motor oil)
5. beneath and south of Building 120 (diesel fuel),
6. northwest corner of Building 89 at FS1HP012 (diesel fuel),
7. south of Building 55 at B057AHP002 (gasoline),
8. south and east of Building 59 (motor oil),
9. at the former Building 53 UST (diesel fuel and gasoline),
10. at the former Building 154 UST (diesel fuel, motor oil and gasoline), and
11. at the former Building 118A ASTs (diesel fuel and motor oil).

These areas were identified based on data from this investigation and previous investigations.

- Three of the seven petroleum hydrocarbon areas are located at former UST sites Building 31, Building 53, Building 103, and Building 154. The USTs from Buildings 53, 103, and 154 were

removed in March 2002 and the UST at Building 31 was removed in May 2004. During the removal it was found that the USTs were not intact. These USTs are the likely sources for the TPH impacted groundwater at these locations. Motor oil was found only in the area of former Building 154 USTs (Figure 6-20).

- Gasoline was detected at a concentration of 1,370 µg/L in groundwater during the excavation of trench B073TR001 at the southwest corner of Building 98. The location of the trench was dug based on results from a geophysical survey in an attempt to locate a suspected 1,000-gallon gasoline UST at a former service station (Building 73). Building 73 was located beneath the southwest corner of Building 98. The UST was not found and assumed to have been removed.

- Motor oil, diesel fuel, and gasoline were detected in shallow groundwater north of Building 120 and diesel fuel was also detected in groundwater samples south of Building 120. USTs were suspected in this area, although no conclusive geophysical evidence was obtained and if they were present they were likely removed when Building 120 was constructed. Plate 1, Figure 6-15, and Figure 6-16 illustrate the detections and lateral extent of diesel fuel, gasoline, and motor oil in shallow groundwater.

- Diesel fuel was detected in groundwater exceeding its ESL at the northwest corner of Building 89, east of Fillsite 1 (Plate 1). Concentrations at Fillsite 1 do not exceed ESLs. Therefore, the source of the diesel fuel at this location (FS1HP012) is not known.

- Gasoline and diesel fuel were detected at concentrations of 2,300 µg/L and 380 µg/L, respectively in groundwater sample B057AHP002, located south of Building 55 (Figure 6-14 and Plate 1). Fuels were used in Building 55 to fuel equipment. These fuels may have been from activities conducted in Building 55.

- Motor oil was also detected in shallow groundwater samples collected near Building 59 (Figure 6-16). This building was used as a tool house. In 1951, a degreaser pit was installed. After the Army left, the building was used as a machine shop where cutting oils may have been used. After the Army left in 1964, the building was also used as machine shop. The source of the motor oil is unknown

- Diesel fuel and motor oil was reported in B118ATR005 at a concentration of 2,700 µg/L and 860 µg/L, respectively, during a previous investigation (FA/BC, 2002b) (Plate 1 and Figure 6-16). The lateral extent is defined within the area of the boring (Figure 6-20) based on concentrations of diesel fuel and motor oil that are less than ESLs at B118ATR004 and B118AHP002 step-out samples. The source may be attributed to a small release from the former ASTs.

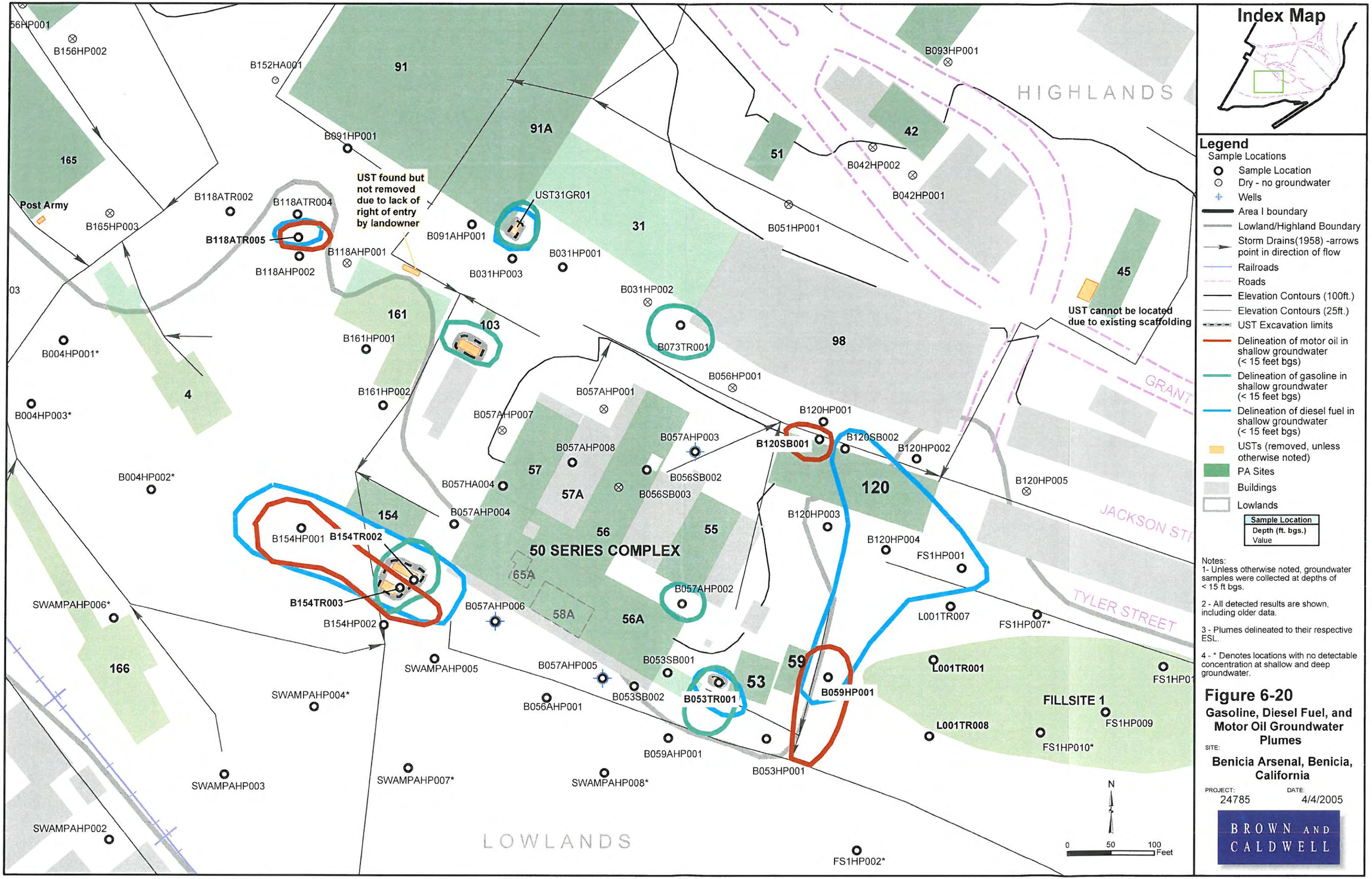



**Figure 6-20**

**Gasoline, Diesel Fuel, and Motor Oil Groundwater Plumes**

SITE: **Benicia Arsenal, Benicia, California**

PROJECT: 24785 DATE: 4/4/2005

BROWN AND CALDWELL

- Diesel fuel was also found in three borings along Bayshore Road, SWAMPBHP002 (270 µg/L at 5 to 10 feet bgs, B168HP001 (100 µg/L at 5 to 10 feet bgs) and SWAMPAHP003 (25 µg/L at 91 feet bgs) (Plate 1). The shallow groundwater sample at SWAMPAHP003 was reported at less than 25 µg/L. The discussion of diesel fuel found at SWAMPBHP002 and B168HP001 is included in the description of Building 167 and Building 168. The presence of diesel fuel in the deeper groundwater sample at SWAMPAHP003 is not understood. The nearest upgradient water samples collected from the deeper water-bearing unit, at FS001HP003 was non-detect for diesel fuel. In this case the distance to the nearest upgradient water sample is approximately 120 feet. Since the detected value is very low (<25 µg/L) and less than the ESL of 640 µg/L and there are no known source areas in the area, no further DoD action is indicated.

A risk assessment for the fuels found in groundwater is recommended for the industrial area.

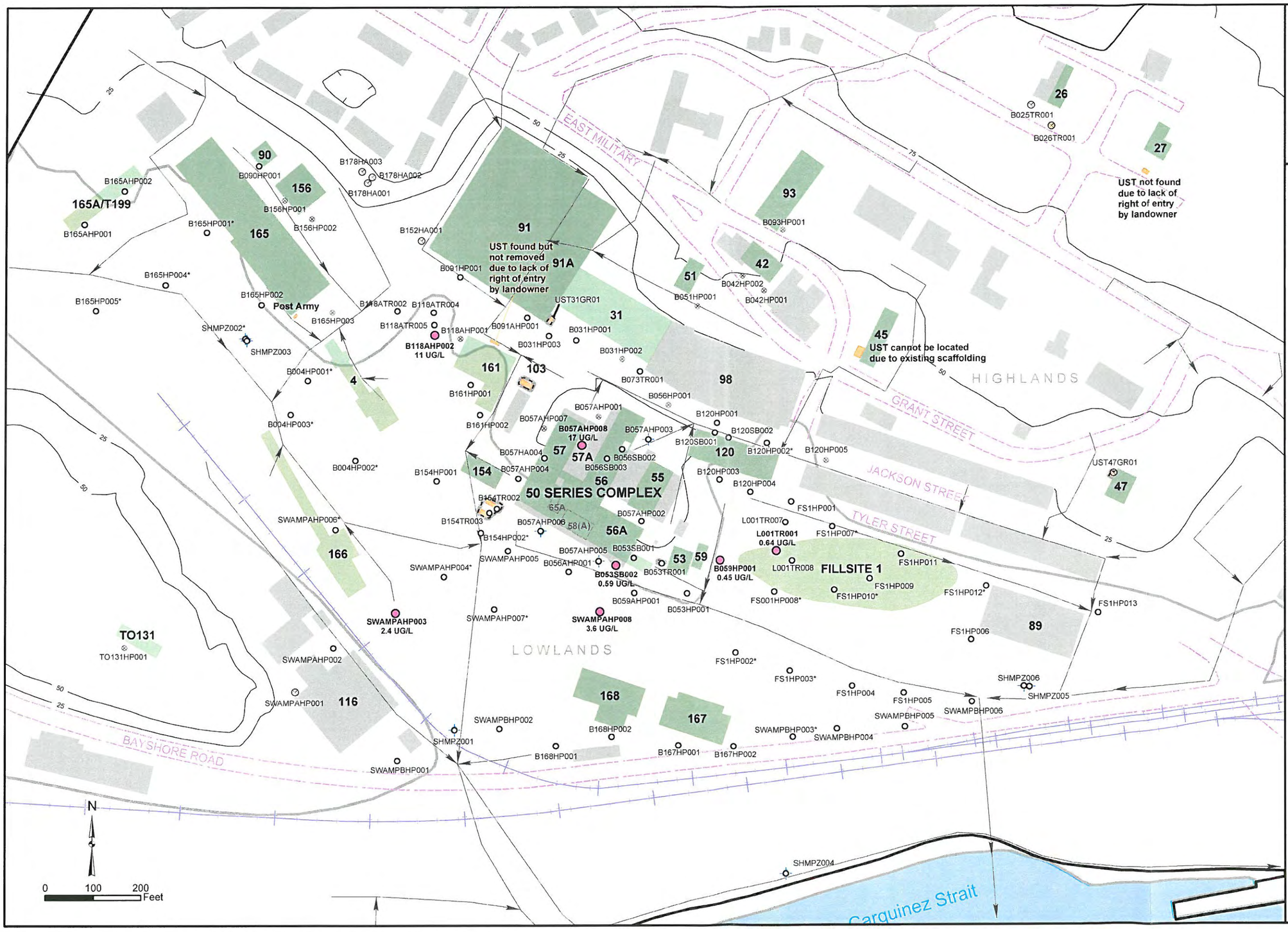
MtBE and Oxygenated Gasoline in Groundwater.

MtBE has been detected in shallow groundwater in the industrial area since investigation began in 1999. These detections of MtBE indicate a post-Army gasoline release. MtBE was found in groundwater samples collected beneath Building 57A (B057AHP008), near former Building 118A ASTs (B118AHP002), south of the 50 Series Complex (SWAMPAHP003, SWAMPAHP008, B053SB002 and B057AHP005), and east of Building 59 (B059HP001) (Table 6-43 and Figure 6-21). Comparisons were made to MCLs and ESLs. MtBE reported in groundwater beneath Building 57A (B057AHP008) is the only detected value that exceeds the MCL of 13 µg/L and all of the results do not exceed the ESL of 1,800 µg/L (Table 6-43).

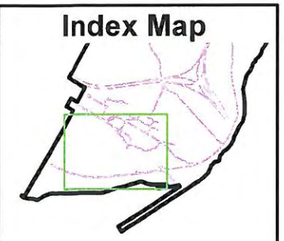
**Table 6-43. Detected MtBE Concentrations in Groundwater**

| [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|
| B057AHP008 | 9/16/99 | 8-10 | **17** |
| B118AHP002 | 5/5/04 | 5-10 | 11 |
| SWAMPAHP008 | 5/18/04 | 5-10 | 3.6 |
| SWAMPAHP003 | 5/10/04 | 5-10 | 2.4 |
| B053SB002 | 9/10/99 | 4-8 | 0.59 |
| L001TR001 | 2/13/01 | 3 | 0.64 |
| B059HP001 | 4/29/04 | 2.5-4.5 | 0.45 |
| MCL | | | 13 |
| ESL | | | 1,800 |

ESL = Environmental Screening Level. Groundwater is not a current to potential drinking water source (RWQCB, 2005).
MCL = Maximum Contaminant Level (California Department of Health Services, 2004)
**Bolded** concentrations exceed or equal their respective ESL or MCL.
bgs = below ground surface
µg/L = micrograms per liter




## Index Map



## Legend

Sample Locations
- Non-Detections
- With Detections
- Dry - no groundwater
- Wells
- Area I boundary
- Lowland/Highland Boundary
- Storm Drains(1958) -arrows point in direction of flow
- Railroads
- Roads
- Elevation Contours (100ft.)
- Elevation Contours (25ft.)
- UST Excavation limits
- USTs (removed, unless otherwise noted)
- PA Sites
- Buildings
- Lowlands

Notes:
1- Unless otherwise noted, groundwater samples were collected at depths of < 15 ft bgs.

2 - All detected results are shown, including older data.

3 - * Denotes locations with no detectable concentration at shallow and deep groundwater.

# Figure 6-21

**MtBE Detected in Groundwater**

SITE:

**Benicia Arsenal, Benicia, California**

PROJECT: 24785

DATE: 4/4/2005

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According to the World Health Organization (1998), these are the following characteristics of MtBE.

- MtBE is not known to occur naturally in the environment and the major source of MTBE is associated with the distribution, storage and use of oxygenated gasoline.
- It has been produced in several countries in increasing volumes since the late 1970s to solely provide both octane enhancement and an increase in the oxygen content of gasoline.
- Approximately 25% of gasoline in the United States of America is blended with MtBE. MtBE has been added to gasoline in concentrations up to 17% by volume.
- It biodegrades very slowly, such that the hydrocarbon components of gasoline blended with MTBE were readily degraded even though the MtBE remained. However, the solubility of oxygenated gasoline with 10 percent MtBE by weight is 5,000 milligrams per liter at 25°C. In contrast, the solubility of non-oxygenated gasoline is about 120 milligrams per liter.

Therefore, the presence of MtBE in groundwater means it is the one of the first contaminants to be detected and one of the last contaminants to degrade.

Concentrations for gasoline and benzene were compared with the locations with MtBE detections (Table 6-44). All of the locations, except B059HP001, indicate that MtBE is the only contaminant remaining from the oxygenated gasoline release. This may indicate that the release occurred some time ago. At B059HP001, gasoline concentrations (130 µg/L) are higher than MtBE concentrations (0.45 µg/L). This may indicate a more recent release. However, these are comparisons and the there are many factors that affect the biodegradation of these contaminants, like solubility, distribution, movement of the water itself, and adsorption.

**Table 6-44. Detected MtBE with associated Gasoline Concentrations in Groundwater**

| | | | |
|---|---|---|---|
| B057AHP008 | 8-10 | 17 | 16.5 |
| B118AHP002 | 5-10 | 11 | <25 |
| SWAMPAHP008 | 5-10 | 3.6 | <25 |
| SWAMPAHP003 | 5-10 | 2.4 | <25 |
| B053SB002 | 4-8 | 0.59 | <12 |
| L001TR001 | 3 | 0.64 | <19 |
| B059HP001 | 2.5-4.5 | 0.45 | 130 |

bgs = below ground surface
µg/L = micrograms per liter

In summary, the presence of MtBE in groundwater indicates that oxygenated gasoline was released into the subsurface after the Army left the Arsenal in 1964. The highest concentrations of MtBE were found in Building 57A at B057AHP008. Degradation of the oxygenated gasoline has occurred to concentrations below method detection limits in most of the areas. However, oxygenated gasoline is present near Building 59 and may indicate a more recent release.

Chlorinated Solvents in Groundwater.

Chlorinated solvents, primarily TCE and its degradation products cis-1,2-DCE and vinyl chloride, are present in shallow and deeper groundwater in the industrial area. During the Expanded SI fieldwork, as the data from the mobile lab was being plotted and analyzed, it became apparent that TCE had degraded to non detect in areas leaving daughter products behind, like cis-1,2-DCE. As such, cis-1,2-DCE became the primary solvent to delineate laterally and vertically.

Table 6-45 represents the highest detections of TCE and cis-1,2-DCE in groundwater (greater than 1,000 µg/L). These areas are south of Building 165 (B165HP001), beneath and south of Building 57 (B057HA004, B057AHP004 and B154HP001), northern portion of Fillsite 1 (FS001HP007), north of Building 120 (B120HP002), and at the northern portion of Building 56 (B056SB003). These areas are illustrated on Plate 2 and Plate 3 using TCE and cis-1,2-DCE groundwater concentrations.

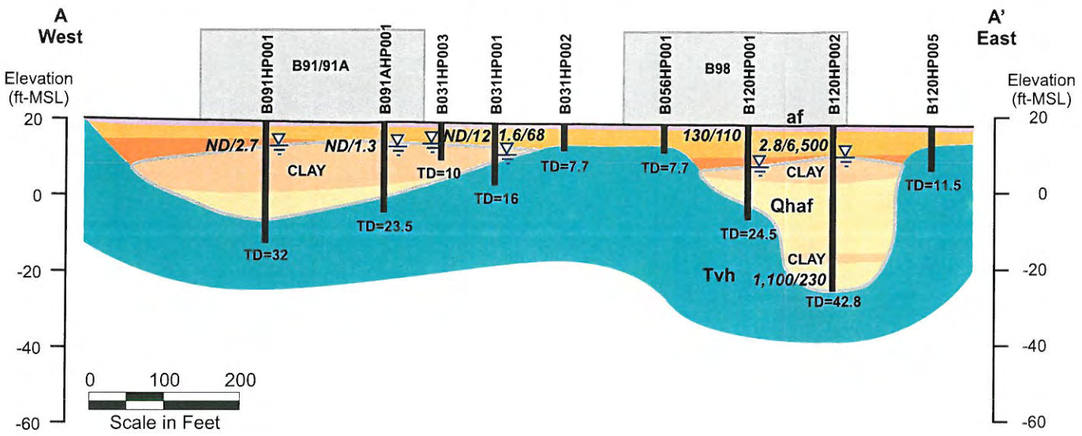
**Table 6-45. Maximum TCE and cis-1,2-DCE Concentrations in Groundwater in the Industrial Area**

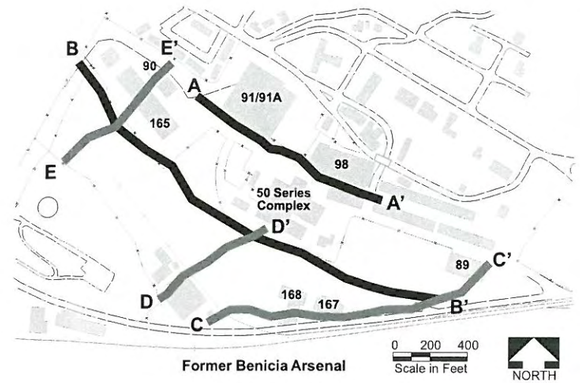
| Boring | Date Collected | Depth (feet bgs) | TCE Concentration (µg/L) | cis-1,2-DCE Concentration (µg/L) |
|---|---|---|---|---|
| B165HP001 | April 2004 | 6 | 32,000 | 46,000 |
| B057HA004 | September 1999 | 0.5 | 8,500 | 2,000 |
| B057AHP004 | September 1999 | 6 | 3,800 | 1,200 |
| FS001HP007 | May 2004 | 18 | 3,400 | 420 |
| B120HP002 | May 2004 | 34 | 1,100 | 6,500 |
| B056SB003 | September 1999 | 7 | 2,200 | 700 |
| B154HP001 | May 2004 | 30 | <0.31 | 1,300 |

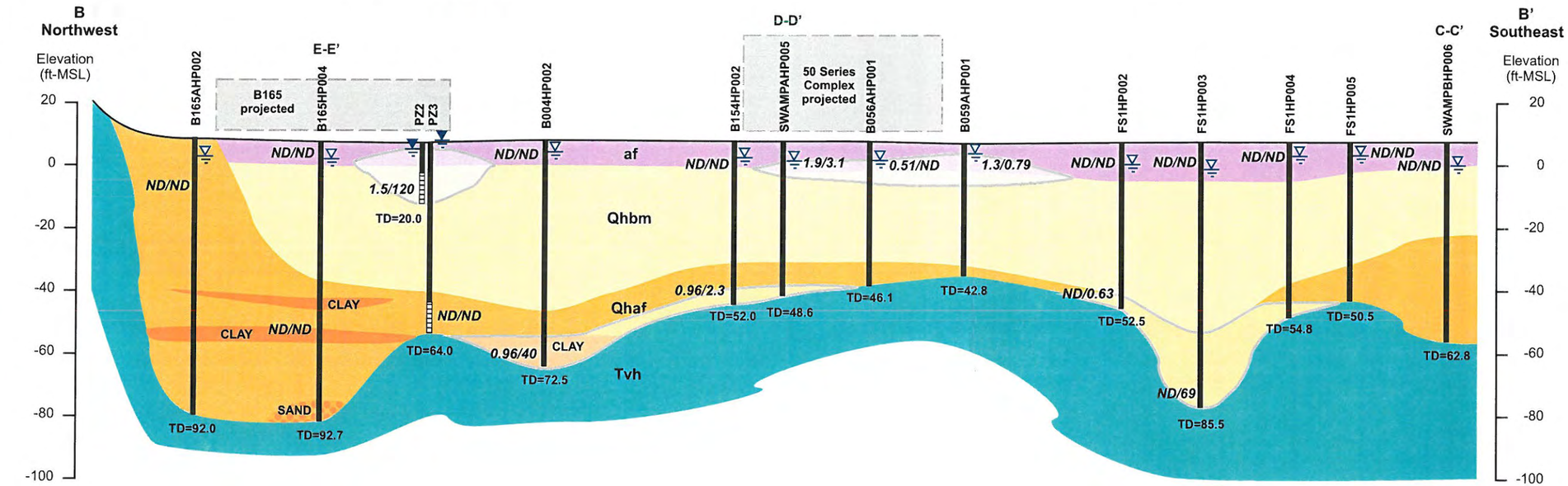
bgs = below ground surface
µg/L = micrograms per liter

The lateral extent of cis-1,2-DCE in shallow groundwater extends from Building 165 to Fillsite 1 to to a line south of Building 165, 50 Series Complex and Fillsite 1 (Plate 3). In deeper groundwater, cis-1,2-DCE is found south of Building 165 at B165HP001, south of former Building 4 to the 50 Series Complex, and south of Fillsite 1. These locations coincide with several valleys within the Vine Hill sandstone that have been partially filled with alluvium. The source of the solvent discharge is upgradient where the solvents can intercept the older alluvium, like at Building 165, and then travels deeper along the sandstone contact beneath the Bay Mud in these valleys, like the occurrence of solvents south of Building 4 to the 50 Series Complex and south of Fillsite 1.

Concentrations of TCE and cis-1,2-DCE were plotted on geologic cross sections, these are the same cross sections provided in Section 4.0 but with contaminant concentrations added (Figure 6-22 and Figure 6-23). The shaded areas on the cross sections represent impacted groundwater and illustrate the vertical extent of solvents in the area.



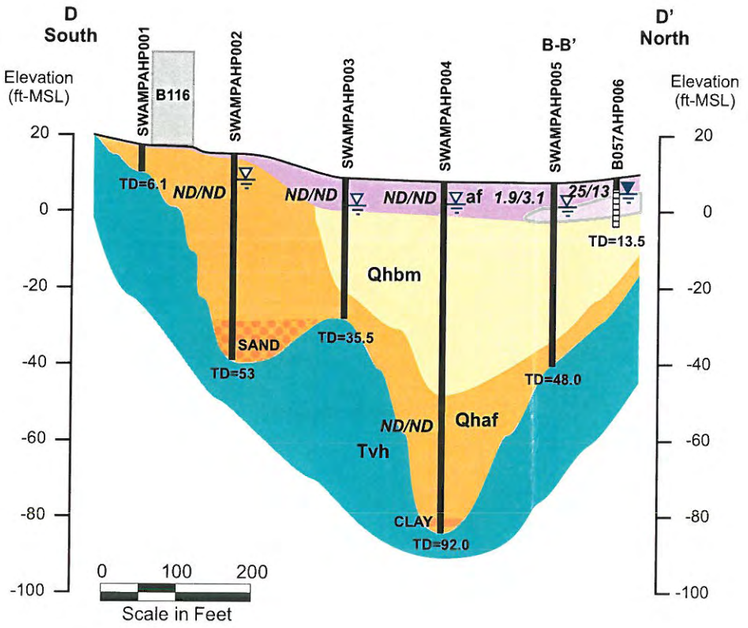



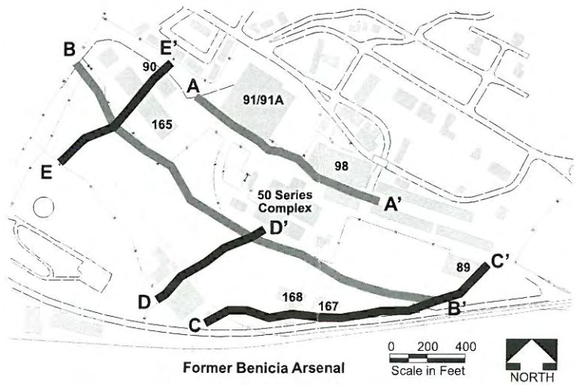

| Hydrostratigraphic Units | Geologic Units |
|---|---|
| Relatively Permeable Units | Artificial Fill (af) |
| | Alluvium (Qhaf) -fining upwards sequences of silt to silty clay with some lenses of sand or clay |
| Relatively Non Permeable Units | Bay Mud (Qhbm) - clays and sensitive fines |
| | Bedrock (Tvh) - Vine Hill Sandstone |

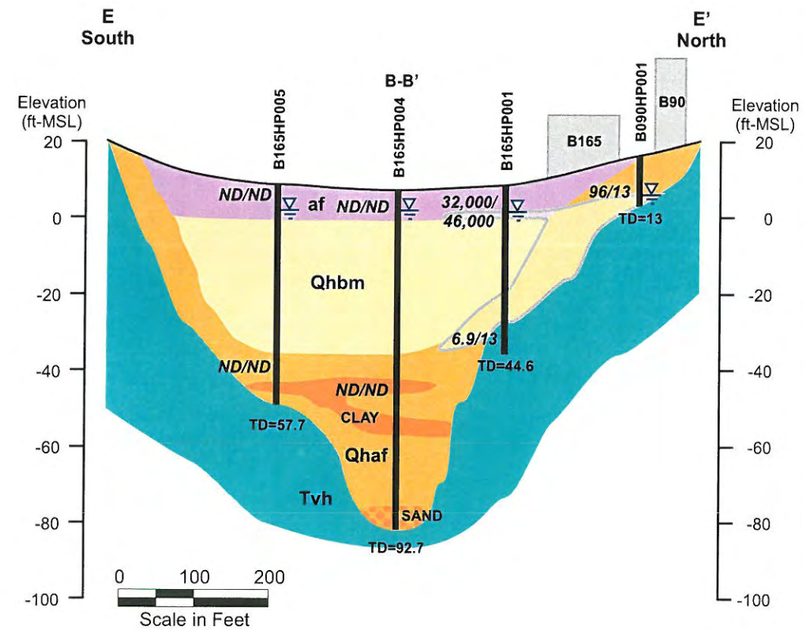
Explanation

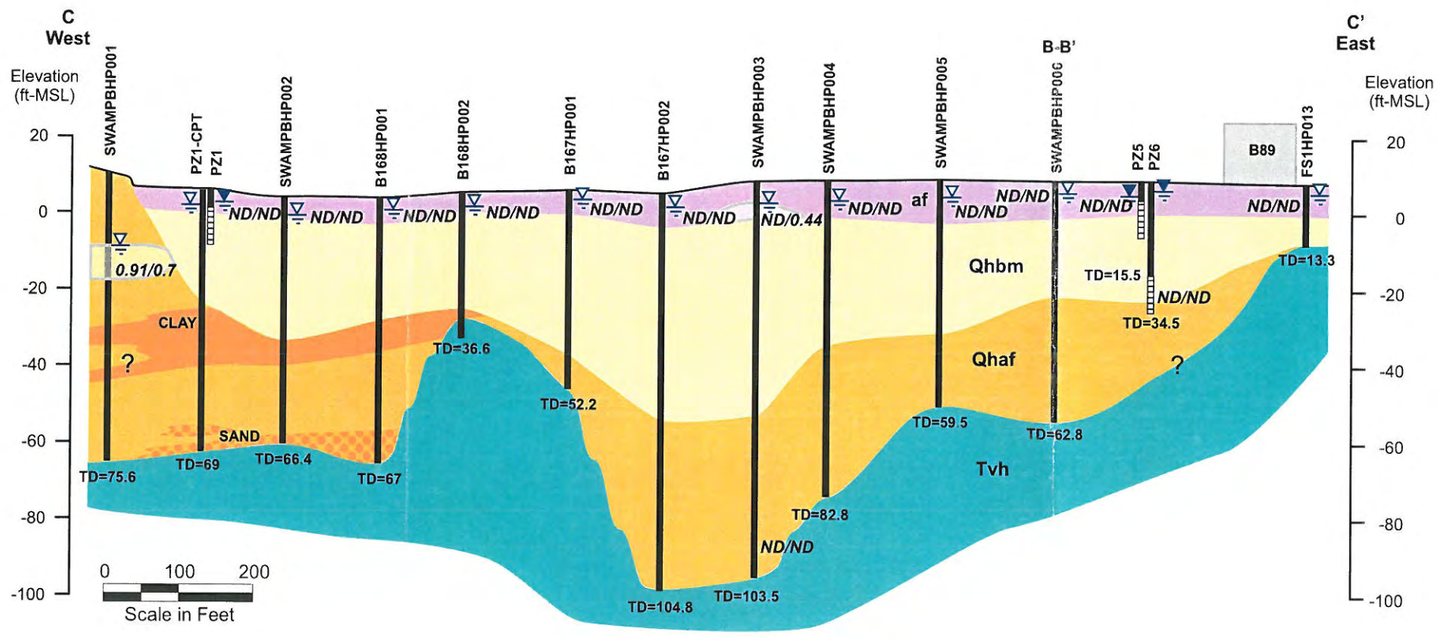
| | |
|---|---|
| PZ-3 | Piezometer |
| | Boring |
| | Screen Interval |
| TD=30 | Total Depth, Feet Below Ground Surface |
| | Depth to First Water |
| | Depth to Static Water (measured May 2004) |
| TCE/cis1,2-DCE | Trichloroethene (ug/L)/ cis1,2-Dichloroethene (ug/L) |
| ND | Non-detectable Result |
| | Approximate Extent of TCE/cis1,2-DCE |

**Figure 6-22**
**Geologic Cross Sections A-A' and B-B' Showing TCE and cis1,2-DCE Results**
Expanded Site Inspection Report
*Former Benicia Arsenal*




| Hydrostratigraphic Units | Geologic Units |
|---|---|
| Relatively Permeable Units | Artificial Fill (af) |
| | Alluvium (Qhaf) -fining upwards sequences of silt to silty clay with some lenses of sand or clay |
| Relatively Non Permeable Units | Bay Mud (Qhbm) - clays and sensitive fines |
| | Bedrock (Tvh) - Vine Hill Sandstone |

Explanation

| | |
|---|---|
| PZ-3 | Piezometer |
| | Boring |
| | Screen Interval |
| TD=30 | Total Depth, Feet Below Ground Surface |
| | Depth to First Water |
| | Depth to Static Water (measured May 2004) |
| TCE/cis1,2-DCE | Trichloroethene (ug/L)/cis1,2-Dichloroethene (ug/L) |
| ND | Non-detectable Result |
| | Approximate Extent of TCE/cis1,2-DCE |

**Figure 6-23**
**Geologic Cross Sections C-C', D-D', and E-E' Showing TCE and cis1,2-DCE Results**
Expanded Site Inspection Report
*Former Benicia Arsenal*

The alluvial material north of the 50 Series Complex on section A-A' (Figure 6-22) is impacted with solvents from the shallow water table (approximately 3 feet bgs) to the contact of the underlying sandstone. Concentrations in this area are the greatest north of Building 120 (or south of Building 98 as shown on the figure) but do not extend to the west because of a sandstone divide separating the plumes. Between B031HP002 to B056HP001, the sandstone is near the surface. Historic photos, like the one to the right, indicate that there was a small ridge and that the Army subsequently excavated to build Jackson Street. In this area of shallow sandstone there is no groundwater. As a result, the plume has spilt in two.

An early 1900s photo of the northern side of Buildings 55 through 57 (from left to right). The photographer taking the picture is standing on a sandstone ridge, now since dug out to form Jackson Street.

As the solvent impacted groundwater intersects the alluvial fill, the plume can split into two primary directions vertically: one within the groundwater in the alluvial fill and the other staying within the alluvium as it mantles the steeply dipping sandstone. Both of these units are more permeable than the Bay Mud; therefore, water is flowing more freely in these units than in the Bay Mud.

This split distribution of solvent-impacted groundwater is shown on Section E-E' (Figure 6-23). Solvent-impacted groundwater at Building 90 (TCE detected at 96 µg/L) is traveling beneath Building 165 within the artificial fill and the underlying alluvium along the sandstone, which is represented by 6.9 µg/L TCE at 36 feet in B165HP001. Complicating this scenario is the presence of a secondary source found at B165HP001 (32,000 µg/L). Since the concentrations are so high in the shallow groundwater within the artificial fill, it is not known if TCE is dispersing vertically through the Bay Mud and reaching the underlying alluvium.

TCE source areas are based on the highest concentrations found in shallow groundwater (Table 6-45). There appears to be four source areas that have resulted in a co-mingled plume. These four source areas are:

- Building 165 - represented by the detections in B165HP001 of 32,000 µg/L TCE and 46,000 µg/L cis-1,2-DCE
- 50 Series Complex – represented by TCE found in soil in the area of the Building 57A vat and high concentrations of TCE at B057AHP004, B057HA004, B056SB003 and B154HP001 (maximum TCE concentration is 8,500 µg/L)
- Building 120 – represented by 1,100 µg/L TCE at B120HP002 and 3,400 µg/L TCE at FS001HP007

The release mechanism for the TCE is not well understood at Building 165. The Army's use of the building was a reclamation building and a transport vehicle shop. Information about the layout of processes is limited to a 1945 drawing that locates caustic, rinse, pickle, oil bath, and degreaser above ground dipping tanks. These tanks were located in the northern portion of the building across from CPT boring B165HP001. The type of degreaser used is unknown. After the decommissioning of the Arsenal in 1964, the new landowner used Building 165 and the adjacent Building 90 to

manufacture aluminum wheels in the 1970s. Building 90 was used as the pour room, where the aluminum wheels were casted. Other activities included grinding and cleaning of the wheels. A similar practice was occurring at the same time at 4186 Park Road. A description of the environmental clean-up activities occurring at 4186 Park Road is discussed in Section 1.5.4. The location of cleaning activities and types of cleaning compounds are not known at Building 165.

At the 50 Series Complex, the data indicate a possibility of an Army and post-Army release. The sources of TCE used by the Army were confined to the vapor degreaser tanks in Building 57 and Building 56A. In the 1970s, a transmission shop occupied Building 57A. Transmission parts were reportedly found in the bottom of the vat indicating poor housekeeping practices.

The source of TCE north of Building 120 may be attributed to a leak of process water from an underground neutralizer tank on the north side of the building or a leak from the storm drain lines that carried the process water. TCE is also detected in the area of Fillsite 1 at FS001HP007 (3,400 µg/L TCE) at 18 feet bgs. The shallow groundwater sample at this location reported 5.1 µg/L TCE at 5.5 feet bgs. The source of TCE at FS001HP007 is from Building 120. Building 120 is located on the edge of the highlands and the lowlands (Figure 6-11). The TCE released into shallow groundwater at Building 120 traveled through shallow groundwater until a buried alluvial valley on the east side of 50 Series Complex (see Section 4.2) intercepted shallow groundwater and forced the TCE into the deeper groundwater. This is evident by the higher TCE detections in the deep groundwater (3,400 µg/L TCE) than shallow groundwater (5.1 µg/L) at FS001HP007. Based on the data presented, a risk assessment is recommended for the solvents found in groundwater.

PAHs in Groundwater.

After CPT Hydropunch® samples were collected, four locations were selected for PAH analysis. These locations were chosen based on the highest diesel fuel or motor oil detections that also exceeded the delineation limit of 640 µg/L in the initial CPT Hydropunch® samples. A total of four locations (B059HP001, B154HP001, FS001HP001 and FS001HP012) met this criterion. No PAHs were detected above method detection limits for boring B059HP001. The detected results for PAHs and their diesel fuel and motor oil range concentrations for the other three borings with PAH detections are shown in Table 6-46. ESLs were used as comparison criterion because the locations are within the lowlands (Table 6-46). Most of the PAHs reported above MDLs also exceed their respective ESL.

PAHs are part of the chemical composition of diesel fuel hydrocarbons. According to a study by the Environmental Technology Centre in Ottawa, Canada, PAHs commonly present in diesel fuel are naphthalene, phenanthrene, dibenzothiophene, fluorene, and chrysene (Wang et. al., 2003). Other PAHs found in lesser concentrations are biphenyl, acenaphthalene, anthracene, fluoranthene, pyrene and benz(a)anthracene (Wang et. al., 2003). These PAHs were found in the groundwater samples collected from B154HP001, FS001HP001 and FS001HP012 (Table 6-46). However, PAHs were not identified above MDLs in the groundwater sample collected from B059HP001 even though a concentration of 13,000 ug/L of diesel range organics was reported. This sample contains primarily lighter end (gasoline) and heavier end (motor oil) hydrocarbons. Although a small amount of mid-range (diesel) hydrocarbons appear to be present in the sample, the reported result of 13,000 µg/L is primarily due to the presence of the lighter and heavier end hydrocarbons.

**Table 6-46. PAH Groundwater Concentrations in the Industrial Area**

| | | | | |
|---|---|---|---|---|
| Diesel fuel | **66,000 (split result 8,300)** | **30,000** | **1,000** | 640 |
| Motor oil | **7,200** | <460 | <230 | 640 |
| Acenaphthene | **110** | <0.49 | <0.55 | 23 |
| Benzo(a)anthracene | **87** | <0.025 | **5.3** | 0.027 |
| Benzo(a)pyrene | <0.052 | <0.053 | **3.9** | 0.014 |
| Benzo(b)flouranthene | **29** | <0.053 | **5.3** | 0.029 |
| Benzo(g,h,i)perylene | <0.1 | <0.085 | **4.6** | 0.1 |
| Benzo(k)flouranthene | **10** | <0.041 | **3.9** | 0.4 |
| Chrysene | <0.029 | <0.03 | **5.5** | 0.35 |
| Dibenz(a,h)anthracene | <0.047 | <0.066 | **2.6** | 0.25 |
| Fluoranthene | <0.055 | <0.056 | **18** | 8 |
| Fluorene | **37** | 0.24 | <0.094 | 3.9 |
| Indeno(1,2,3-c,d)pyrene | <0.035 | <0.05 | **4.8** | 0.029 |
| Phenanthrene | **35** | 0.21 | 4.2 | 4.6 |
| Pyrene | <0.087 | <0.09 | **12** | 2 |

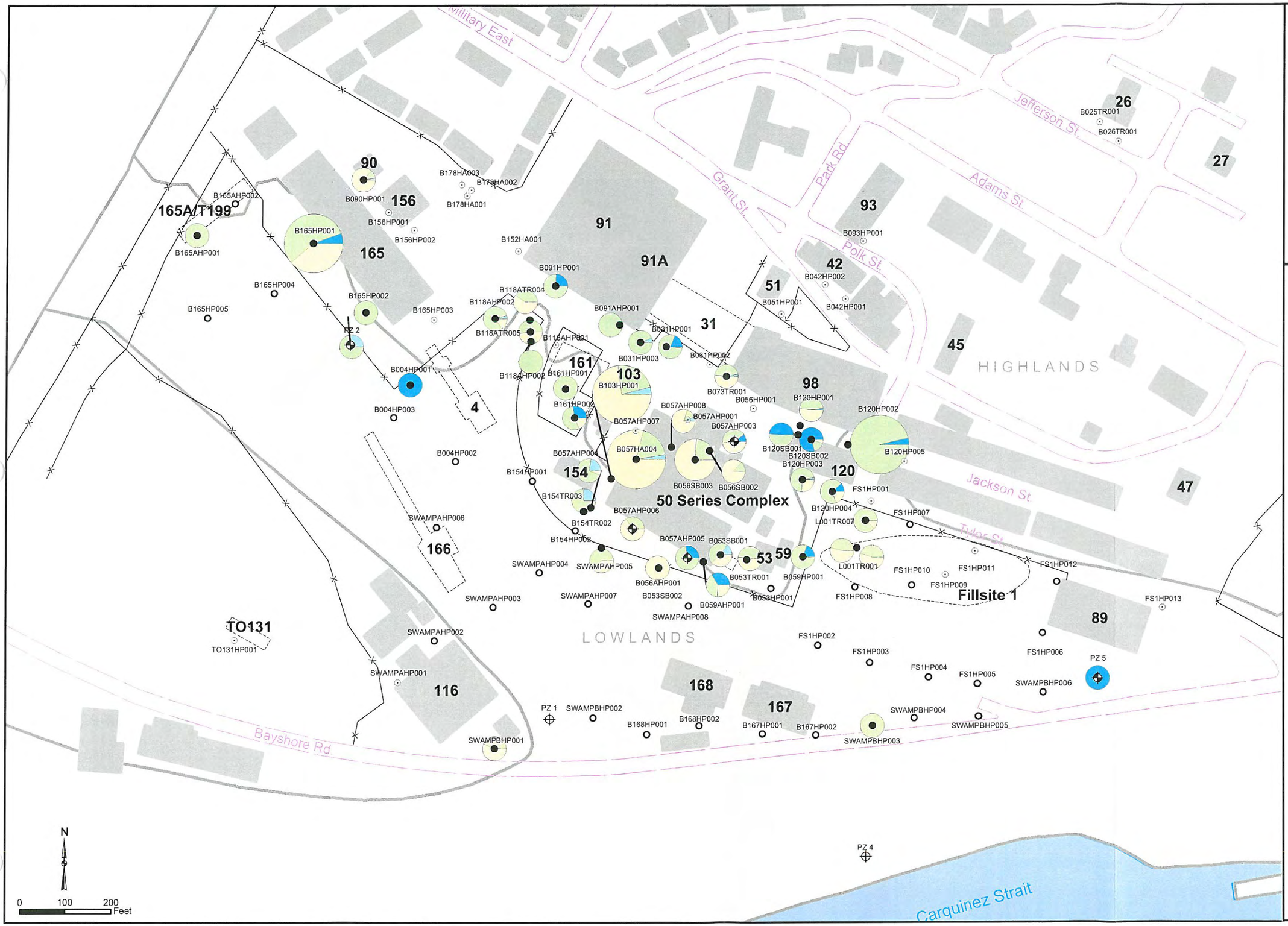
µg/L – micrograms per liter
ESL = Environmental Screening Level. Groundwater is not a current to potential drinking water source (RWQCB, 2005).
PAH – Polynuclear Aromatic Hydrocarbon
**Bolded** concentrations exceed or equal their respective ESL.

Based on the data presented, a risk assessment is recommended for the PAHs found in groundwater.

### 6.5.28 Distribution of TCE and Degradation Products in Groundwater

Figure 6-24 is a graphical representation of groundwater concentration of TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride (VC) for groundwater samples collected at less than 15 feet bgs, which represents samples collected within the artificial fill and the alluvium north of the Complex. Figure 6-25 illustrates the same concentrations except for samples collected at greater than 15 feet bgs. These deeper samples were collected from the alluvium beneath the Bay Mud and at the contact between the alluvium on the north side of the Complex and the sandstone. All of the historic data and the Expanded SI data are included in these figures.

Sample location symbols filled in black indicate a detection of one or more of the four compounds and sample location symbols that are clear indicate no detections. At sample locations with detections, a pie chart is shown that illustrates both the sample composition and the relative magnitude of each compound. The pie is subdivided into four colored sections for each compound: TCE in yellow, cis-1,2-DCE in green, trans-1,2-DCE in teal, and VC in blue. The size of a given pie section is proportional to the concentration of the compound relative to the sum of all detected compounds for that location. If a compound was not detected, the corresponding pie section is not shown. For example, at location B056AHP001, TCE was the only compound detected and the pie is yellow and undivided. At location B091HP001, only cis-1,2-DCE at 2.7 µg/L and VC at 0.87 µg/L were detected and the pie is primarily green with some blue. Note that the green section is three quarters of the pie because the 2.7 µg/L concentration is 76% of 3.57 µg/L, which is the sum of the two concentrations.




## Index Map

## Legend

Total VOCs: (µg/l)

500 - 5,000

<500

TCE
DCE12C
DCE12T
VC

Sample Locations

- Non-Detections
- With Detections
- Dry - No Water

Buildings
Former Buildings
Lowlands
Wells
Fences
Roads

# Figure 6-24

**Distribution of TCE and Degradation Products (<15 feet bgs.)**

SITE:

**Benicia Arsenal, Benicia, California**

PROJECT: 24785

DATE: 4/4/2005

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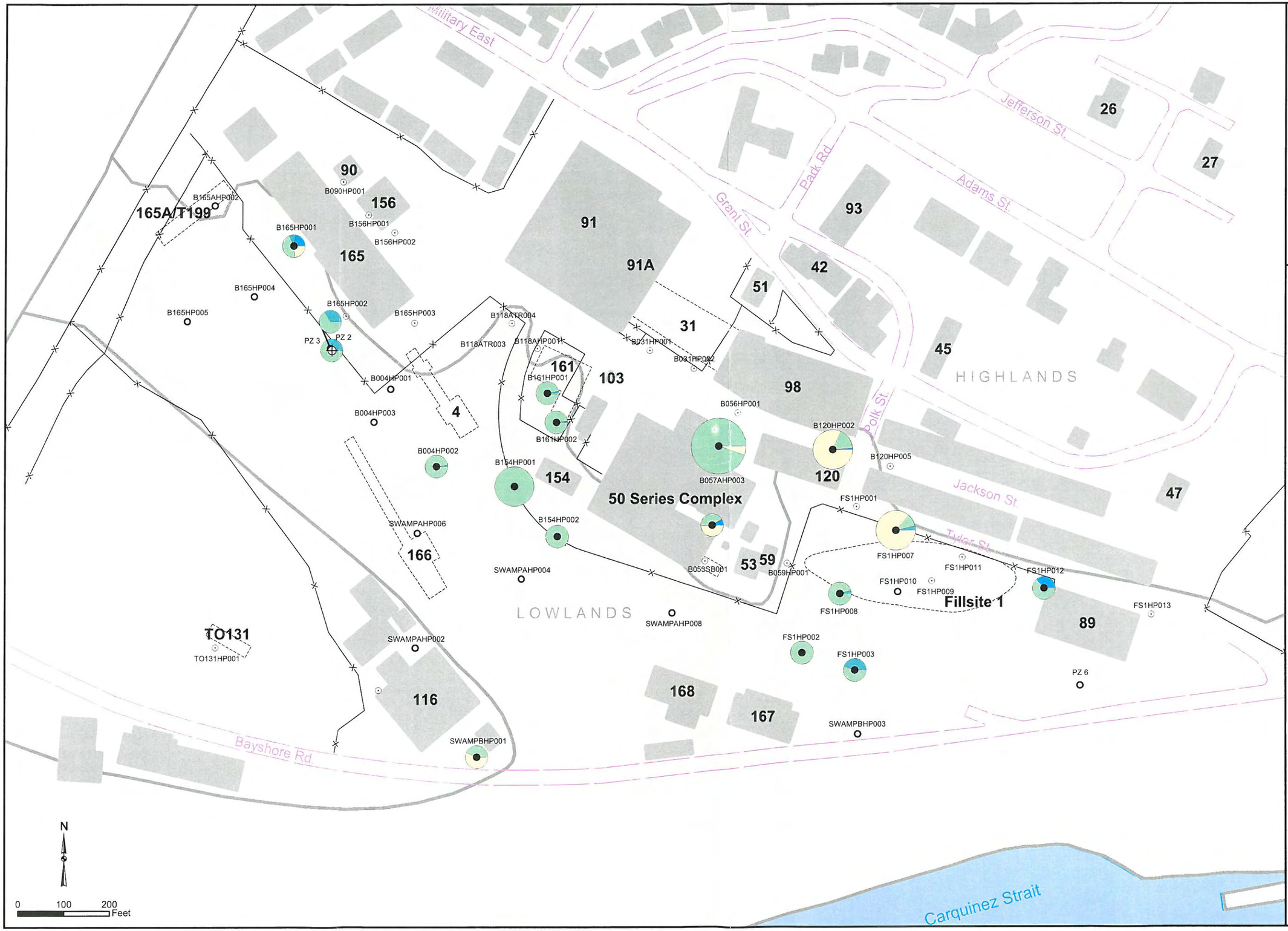
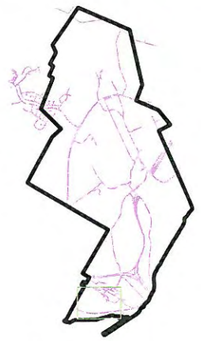



## Index Map



## Legend

Total VOCs: (µg/l)

- > 5,000
- 500 - 5,000
- <500

- TCE
- DCE12C
- DCE12T
- VC

Sample Locations

- Non-Detections
- With Detections
- Dry - No Water

- Buildings
- Former Buildings
- Lowlands
- Wells
- Fences
- Roads

# Figure 6-25

**Distribution of TCE and Degradation Products (>15 feet bgs.)**

SITE:

**Benicia Arsenal, Benicia, California**

PROJECT: 24785

DATE: 4/4/2005

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The significance of Figures 6-24 and 6-25 is that they can provide insight into the composition of contaminants in groundwater at various locations on the industrial area. This graphical technique can provide evidence of biodegradation or "fingerprint" a plume and distinguish it from other plumes. In the industrial area, TCE was used and released into soil. TCE can be degraded anaerobically by naturally occurring microorganisms in the subsurface. The biodegradation of TCE occurs primarily through reductive dechlorination whereby one or more chlorine atoms are removed from the compound under reducing conditions. TCE has three chlorine atoms and typically degrades into daughter products cis-1,2-DCE and trans-1,2-DCE which have two chlorine atoms. These compounds further degrade into VC with one chlorine atom.

The presence of TCE daughter products in most locations where TCE is found provides strong evidence that anaerobic degradation (reductive dechlorination) is occurring across the industrial area. Cis-1,2-DCE concentrations in some locations exceed TCE concentrations considerably. Trans-1,2-DCE is reported at concentrations that are less than those for cis-1,2-DCE, as is typically the case for a TCE release. Vinyl chloride is reported to a lesser extent. It is not unusual that little vinyl chloride is formed. At some environmental sites, the microorganism required to reductively dechlorinate cis-1,2-DCE is not present or populations are not sufficient to play a significant role.

Furthermore, the reduction of TCE requires modestly reduced oxidation/reduction potentials. The subsequent conversion of cis-1,2-DCE to vinyl chloride requires more reducing conditions. Thus, at some sites conditions result in what has been referred to as "DCE stall." However, cis-1,2-DCE and vinyl chloride may undergo oxidative degradation under aerobic, iron reducing, and manganese reducing conditions. Thus, it is possible that TCE is converted to cis-1,2-DCE and the latter is then converted to carbon dioxide, water, and chloride ion through other microbial processes.

The composition of samples shown on Figure 6-24 reinforces that there were separate releases of TCE and distinct plumes near Building 165, the 50 Series Complex, and Building 120 as described in Section 6.5.27.3. The groundwater samples near Building 165 indicate a relatively small plume with a source area near B165HP001 that extends downgradient to approximately B004HP001 near Building 4. This distinct group of samples illustrates a typical TCE plume with primarily TCE at the head of the plume (i.e., source area), biodegradation products cis-1,2-DCE with some trans-1,2-DCE near the middle of the plume, and primarily VC at the toe of the plume. Note that the concentration of total VOCs decreases along the plume axis several orders of magnitude. A different pattern (i.e., "fingerprint") of contaminant composition appears in Figure 6-24 near the 50 Series Complex. Samples near the 50 Series Complex, which is perched on a highland knoll, are composed predominantly of TCE with some cis-1,2-DCE. Samples in the surrounding lowlands downgradient of the 50 Series Complex are composed primarily of biodegradation products of cis-1,2-DCE and vinyl chloride. The presence of TCE with few daughter products or cis-,2-DCE at relatively low concentrations underneath the 50 Series Complex may indicate a more recent TCE release or inherent subsurface conditions that are less conducive to anaerobic biodegradation. Near Building 120, the pattern differs from the 50 Series Complex with a composition of primarily cis-1,2-DCE and VC with lesser concentrations of TCE. The plume near Building 120 is unlikely to be from a source area at the 50 Series Complex because detections in between are orders of magnitude less in concentration.

The composition of samples shown on Figure 6-25 indicates deep groundwater solvent contamination in the same three source areas as identified in Figure 6-24. The composition of

samples is primarily cis-1,2-DCE which suggests that condition in deep groundwater are conducive to reductive dechlorination of TCE to cis-1,2-DCE. The two samples at B120HP002 and FS1HP007 near Building 120 contain primarily TCE at significant concentrations which suggests a deep groundwater release of TCE such as a leak from the underground neutralizing tank (Figure 6-25). Downgradient of sample B120HP002 and FS1HP007 and along a buried alluvial valley, FS1HP002, FS1HP003 and FS1HP008 are composed of typical biodegradation products cis-1,2-DCE and vinyl chloride (Figure 6-25). This reinforces the theory of a separate release originating near Building 120.

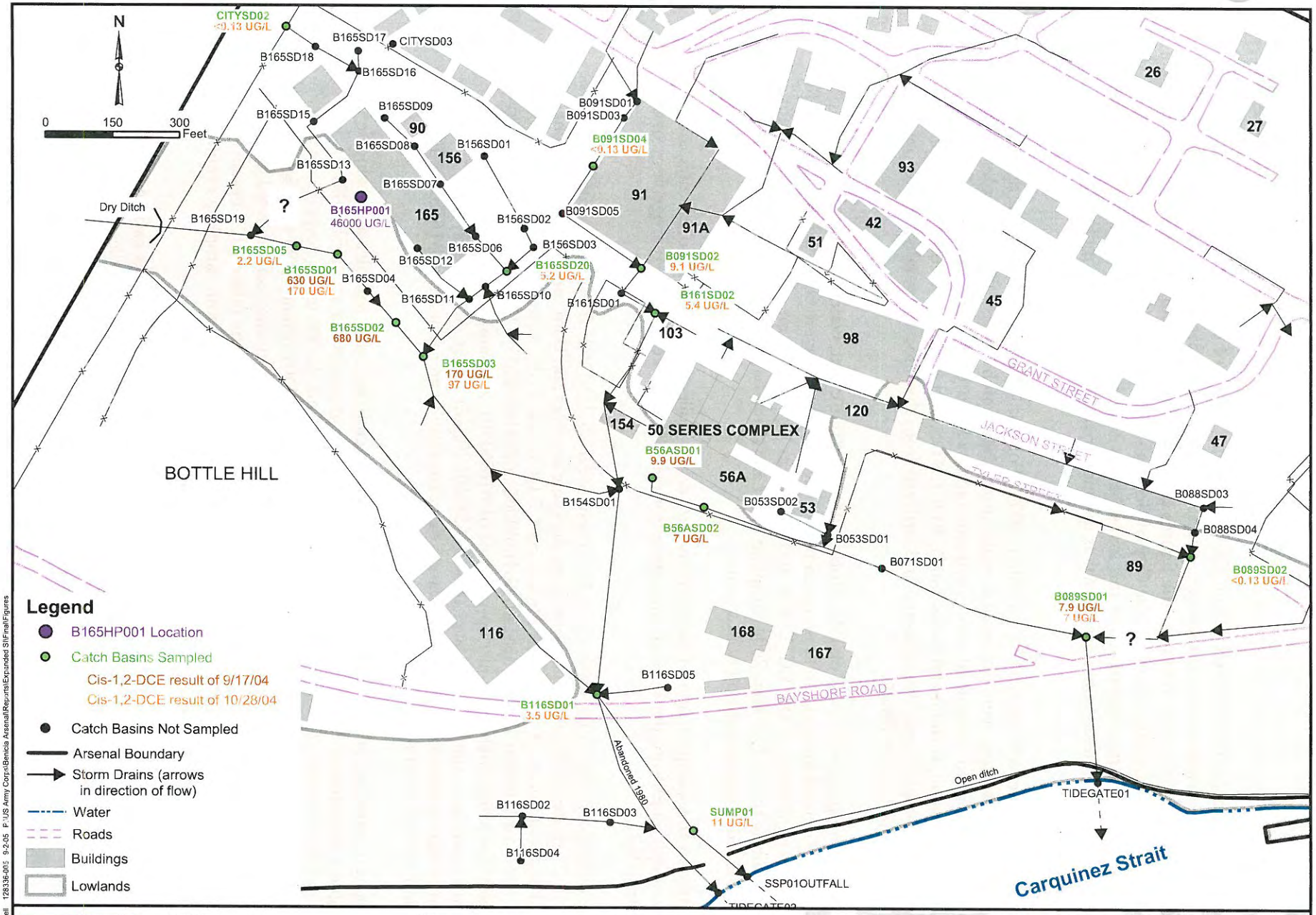
6.5.29 Storm Water Drain Sampling

**The storm water drain system is intercepting shallow groundwater**

The following text summarizes an investigation that took place in September 2004 and October 2004. A complete description of the events that took place for this investigation is included in this report as Appendix E. This investigation included six tasks: 1) an evaluation of the route of storm water discharge from the Arsenal industrial area, 2) a quick inspection of selective storm drain catch basins in the Arsenal industrial area; 3) a review the City of Benicia's National Pollutant Discharge Elimination System (NPDES) permit for the discharge of storm water, 4) measurements and an evaluation of these measurements in selected piezometers and catch basins; 5) samples collected from selective piezometers and storm water catch basins that are upstream, within, and downstream from the Arsenal industrial area; and 6) an evaluation if storm water upstream, within, and downstream of the Arsenal industrial area is contaminated.

Analysis of the data gathered so far in this report shows that shallow (<15 feet bgs) groundwater contamination does not extend past a line just south of the 50 Series Complex and Building 165 (Plate 2 and Plate 3). The data indicate that the storm water drain system intercepts shallow groundwater in the industrial area, and contaminated groundwater is infiltrating into the storm drain system.

The catch basins for the storm drains were first mapped on the Army General Storm Drainage Map, dated 1958. After the decommissioning of the Arsenal in 1964, the new landowner of the storm water drain system, the City of Benicia, adopted this map. In the Industrial area, the Army storm water drain system included a series of concrete catch basins connected with corrugated steal pipe and then drained into the Carquinez Strait through two tide gates. These tide gates are labeled "TIDEGATE01" and "TIDEGATE02" on Figure 6-26. The City of Benicia changed the original system by abandoning a line in 1980 that once connected to TIDEGATE02. A new line was installed with a sump labeled as "SUMP01" and the outfall is labeled "SSP01OUTFALL" on Figure 6-26. Arrows on the storm drain lines indicate the direction of water flow.

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PROJECT: 124785-005

DATE: 3/10/2005

TITLE: Cis-1,2-DCE Concentrations in Storm Drain Catch Basins (September/October 2004)

SITE: Benicia Arsenal, Benicia, California

**Figure 6-26**

Several measurements were collected from the catch basins: depth of the basin, the number of inlet/outlet pipes visible, depth to the pipes, and the general orientation of each pipe. Although the storm water catch basins are shown on the figures as connecting, these connections are not certain. There are some uncertainties between the City of Benicia's storm water drain map and the 1958 Army map; however, the information in this investigation is believed to be accurate based on field observations. These uncertainties are shown as question marks on the figures included in this subsection.

The first sampling event was on 17 September, 2004. For this event, water levels and the number of inflow and outflow pipes were observed in eight storm drain catch basins. Water samples were collected and analyzed for general water chemistry (anions [nitrate, chloride, sulfate] and cations [calcium, magnesium, sodium and potassium]), VOCs, TDS, and EC in six of the catch basins. Groundwater samples were also collected and analyzed from three local groundwater piezometers (PZ-2, PZ-5 and B057AHP005).

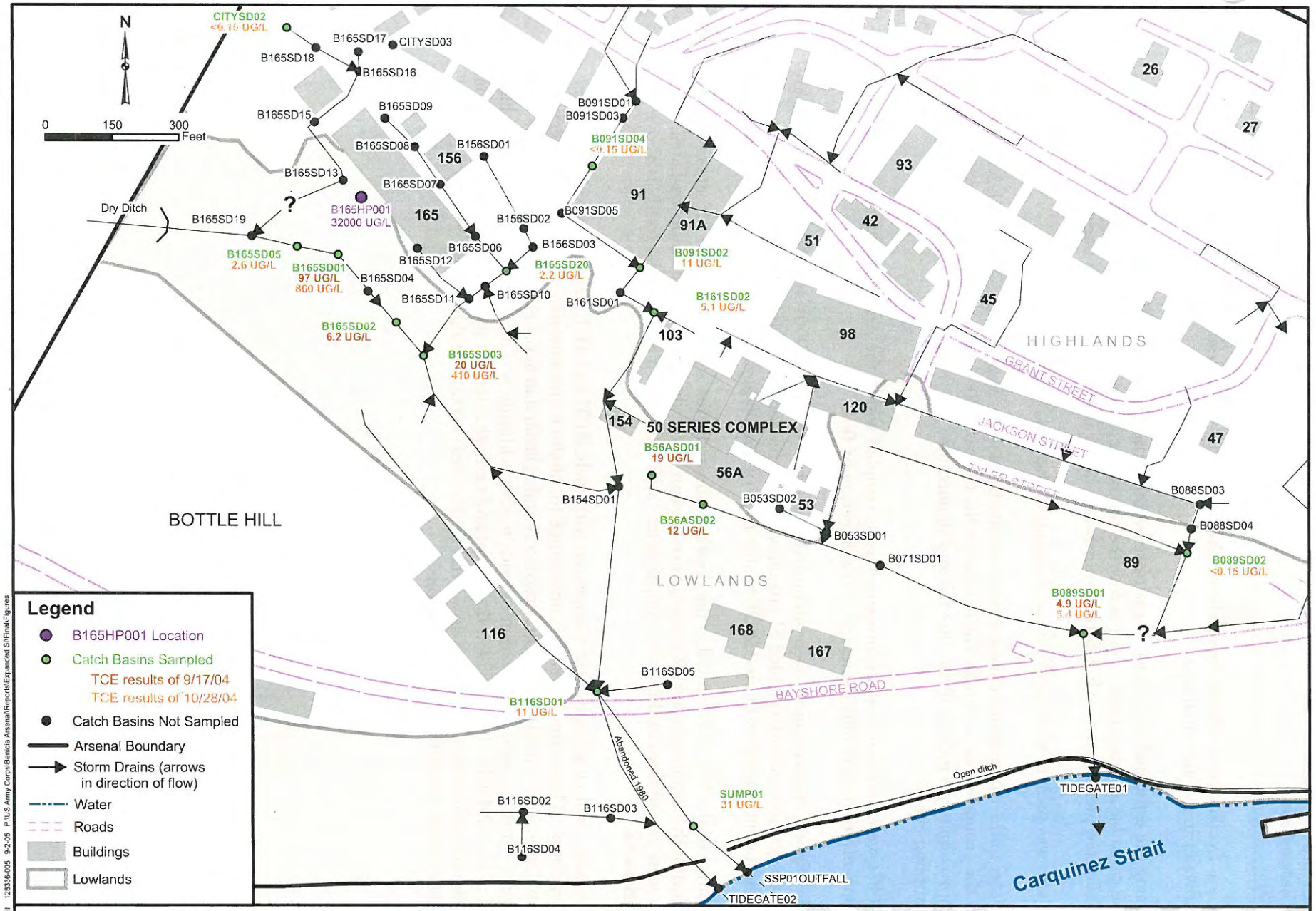
The second sampling event was on 28 October, 2004. For this event, water levels and numbers of pipes were observed in 43 storm drain catch basins. Water samples were collected and analyzed for general water chemistry, TDS, EC, VOCs, and SVOCs in 12 catch basins. Piezometers were not sampled during the 28 October, 2004 sampling event and catch basins B089SD01, B165SD01, and B165SD03 were sampled during both events.

Presentation and interpretation of the TDS and EC results collected from the storm water catch basins samples and from the selected piezometers is described in Section 4.3 Hydrogeology of the Industrial Area.

Figure 6-26 shows the storm water catch basin results for cis-1,2-DCE from both sampling events. Figure 6-27 shows TCE concentrations from the same samples and both sampling events. The highest concentrations of VOCs, specifically cis-1,2-DCE and TCE, were reported in the catch basins south of Building 165 (B165SD01, B165SD02 and B165SD03). During the October 2004 sampling event, the catch basin just up-gradient of B165SD01 was sampled (B165SD05) and concentrations were significantly lower than B165SD01 (Figure 6-26). Additionally, VOC concentrations in the storm drain catch basins decrease away from catch basin B165SD01 in the direction of flow (west to east).

The highest detection of cis-1,2-DCE and TCE in the catch basin water samples also coincide with the highest detection of cis-1,2-DCE and TCE identified in groundwater at B165HP001. Concentrations of cis-1,2-DCE and TCE were 46,000 µg/L and 32,000 µg/L, respectively at B165HP001. This location is just up-gradient (north) of B165SD01 (Figure 6-26 and Figure 6-27). Therefore, it is possible that the storm drain catch basins are intercepting contaminated groundwater in the area of Building 165. VOC concentrations were much less in the other catch basins. VOC concentrations in all of the piezometers and the other catch basins for both sampling events were below 25 µg/L.

SVOCs were only reported in the water sample from catch basin B161SD02 as caffeine, ibuprofen, and hexadecanoic acid (a saturated fatty acid that is the major fat in meat and dairy products). These compounds are not commonly found in groundwater or storm drains but can be a common constituent in sewer water. The sewer system in this area may be leaking and the storm drain system may be collecting some of that leakage.

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PROJECT: 124785-005

DATE: 3/24/2005

TITLE: TCE Concentrations in Storm Drain Catch Basins (September/October 2004)

SITE: Benicia Arsenal, Benicia, California

**Figure 6-27**

There are five lines of evidence that indicate that the storm water drain system intercepts shallow groundwater in the industrial area.

1) Using the estimated elevations, it was observed that the elevation of the top of the water in all the catch basins was about 1 foot below the top of the water table that was measured in the associated piezometers. Therefore, groundwater could flow into the catch basins.

2) Water was present in most of the catch basins at the end of the dry season.

3) Water in the catch basins changed from mostly brackish in September 2004, which was similar to the groundwater, to mostly fresh water in the October 2004 sampling event because of approximately 3 inches of rain that fell and drained into the storm water drain system between sampling events.

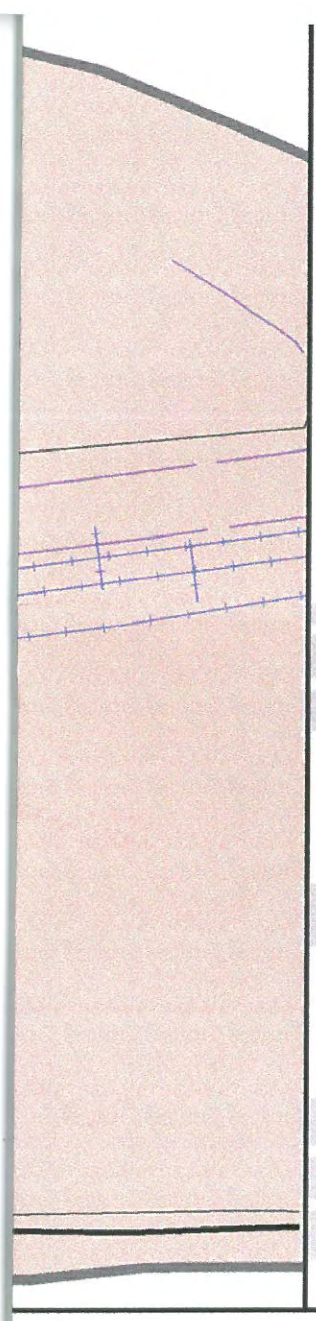
4) VOCs were detected in all of the catch basins sampled within the Arsenal industrial area, and concentrations generally decreased in the direction of flow.

5) The highest concentrations were identified in catch basins B165SD01 and B165SD02, which are down-gradient of an Expanded SI groundwater sample location, B165HP001, and had the highest concentrations of cis-1,2-DCE and TCE of 46,000 µg/L and 32,000 µg/L, respectively.

The source of the VOCs is located in the Arsenal industrial area and not from an off-site source based on both sampling events. Water was not present in the ditch west of the industrial area, and VOCs were not present in the water sample from catch basin CITYSD02 in the foothills above the industrial area.

In summary, shallow groundwater is impacted with fuels, TCE and TCE daughter products in the industrial area. The storm drains is a conveyance for shallow groundwater. Deeper groundwater is impacted with TCE and TCE daughter products and is limited in aerial extent. Degradation is occurring. In some areas, degradation extends to vinyl chloride and in other areas degradation has stalled at cis-1,2-DCE. In any event, the lateral and vertical extent of the impacted groundwater has been delineated to concentrations below MDLs. The next section of this report, Section 7, will provide conclusions with recommendations.

# See Arsenal Binder 4 in the City Attorney's Office.



| Value | Value |
|---|---|

Notes:
1- Unless otherwise noted, groundwater samples were collected at depths of < 15 ft bgs.

2 - All detected results are shown, including older data.

3 - Plumes delineated to the ESL of 640 UG/L.

4 - * Denotes locations with no detectable concentration at shallow and deep groundwater.

## Plate 1

### Diesel Fuel Detected in Groundwater

SITE:

**Benicia Arsenal, Benicia, California**

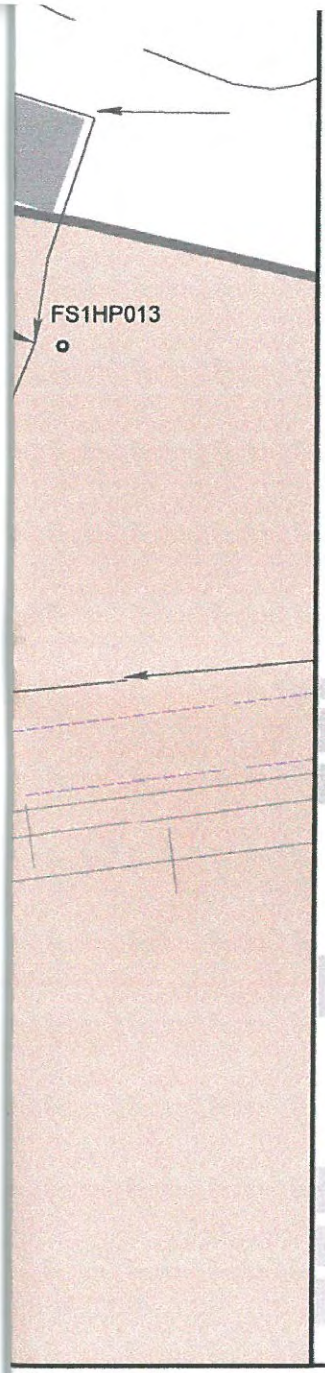
PROJECT: 24785

DATE: 4/7/2005

BROWN AND CALDWELL

Expanded Site Inspection Report

# See Arsenal Binder 4 in the City Attorney's Office.




| Depth (ft. bgs.) | Depth (ft. bgs.) |
|---|---|
| Value | Value |

Notes:
1- Unless otherwise noted, groundwater samples were collected at depths of < 15 ft bgs.

2 - All detected results are shown, including older data.

3 - Plumes delineated to non-detect

4 - * Denotes locations with NO detectable concentration at shallow and deep groundwater.

## Plate 2

**Trichloroethene Detected in Groundwater**

SITE:

**Benicia Arsenal, Benicia, California**

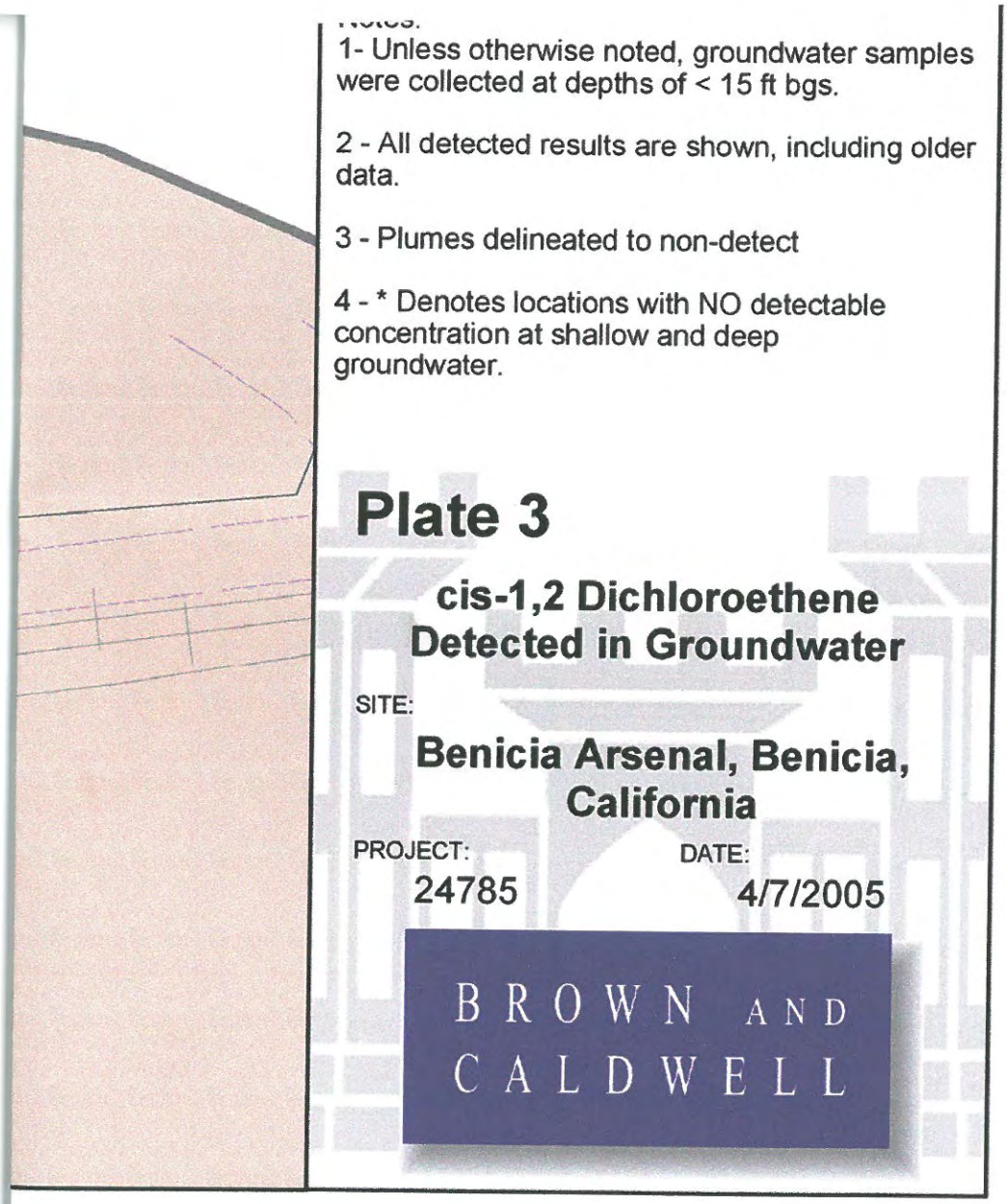
PROJECT: 24785

DATE: 4/12/2005

BROWN AND CALDWELL

Expanded Site Inspection Report

# See Arsenal Binder 4 in the City Attorney's Office.




Expanded Site Inspection Report