



A Report Prepared For:

California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, California 94612

Attention: Mr. Alec W. Naugle, P.G.

**SUMMARY OF REMEDIAL INVESTIGATIONS,
FEASIBILITY STUDY AND REMEDIAL ACTION PLAN
NAPA PIPE FACILITY
1025 KAISER ROAD
NAPA, CALIFORNIA**

**VOLUME 4
SITE 6 – FORMER MACHINE SHOP, FORMER DRUM STORAGE AREA,
AND SOUTHEASTERN PORTION OF FABRICATION BUILDINGS**

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1.0 INTRODUCTION

This Volume 4 of this Summary of Remedial Investigations, Feasibility Study and Remedial Action Plan (RI/FS/RAP) has been prepared by PES Environmental, Inc. (PES) on behalf of Napa Redevelopment Partners, LLC (NRP) to address soil and groundwater affected primarily by petroleum hydrocarbons and volatile organic compounds (VOCs) at Site 6 (the Site). Site 6 is located in the northwestern portion of the Napa Pipe Facility, located at 1025 Kaiser Road in Napa, California (hereafter, the Facility). The Site and Facility locations are shown on Plate 1. The Facility is divided into seven environmental sites (refer to Plate 2): Site 1, Site 2/3, Site 4, Site 5, Site 6, Site 7 and Other Areas. As noted on Plate 2, Volumes 2, 3, and 5 of this RI/FS/RAP address cleanup of soil and groundwater at Site 2/3, Site 4, and Other Areas, respectively. Volume 1 provides an overview of the RI/FS/RAP for the Facility, including an executive summary.

As discussed in Volume 1, soil and groundwater investigations at Site 5, Site 7, and portions of Site 2/3 (the former Pipe Storage Areas) have indicated that these areas are absent of substantial environmental impacts. Accordingly, active remedial action measures are not anticipated for those portions of the Facility at this time. Nor are those portions of the Facility subject to on-going regulatory oversight. Site 7 is hydrogeologically upgradient of the other six sites and was previously chosen as a “background” site (James M. Montgomery, Consulting Engineers, Inc. [JMM], 1990a). Site 1 is permitted and maintained as a Class II Waste Management Unit (WMU).

Site 6 includes, on the west, the former Machine Shop and vicinity; on the east, the former Drum Storage Area (including the former Assembly Bay and the Warehouse and Electrical/Plumbing Shop buildings areas); and on the north, portions of the Fabrication Buildings area (see Plates 2 and 3).

The area encompassing the southeastern portion of the Fabrication buildings was not included as part of Site 6 in the *Supplemental Remedial Investigation Workplan, Site 6* (PES, 2006a). However, based on the results of the investigations conducted in this area and at the former Drum Storage Area in September through November 2006 (refer to Section 3.0), it became apparent that commingling groundwater plumes exist in these areas (see discussion in Section 4.0). Therefore, it was decided to include the southeastern portion of the Fabrication Buildings in this Volume 4. The remainder of the Fabrication Buildings Area is addressed in Volume 5 of the RI/FS/RAP (Plate 2).

The Facility contains both former and current steel pipe fabricating buildings. The tenant that leases the Fabrication Buildings and adjoining buildings, which are located in the northwestern portion of Facility (Plate 2), is currently conducting steel pipe fabrication. The previous Facility owner (i.e., Napa Pipe Corporation, a wholly-owned subsidiary of Oregon Steel Mills, Inc.) removed equipment and materials from the remaining buildings after the purchase of the Facility by NRP.

The primary remedial action objective for Site 6 was previously defined as prevention of migration of chemicals of interest (COI) in groundwater in the vicinity of the former Machine Shop area (Montgomery Watson [MW], 1996). This objective has been accomplished over the past 9 years via a groundwater extraction trench located on the north side of the former Machine Shop.

When remedial action plans were developed in 1996, the Facility was an active industrial site. At this time, plans are underway to redevelop the Facility for mixed residential, commercial and open space uses; consequently the remedial action objectives are being modified via this RI/FS/RAP to remediate soil and groundwater to levels consistent with intended land uses. This report presents new data collected to further characterize Site 6, and develops and evaluates remedial alternatives for cleanup in accordance with the remedial action objectives, and recommends a cleanup alternative for Site 6.

1.1 Regulatory Context and Cleanup Level Selection

This document has been prepared in accordance with: (1) discussions between NRP representatives and staff of the California Regional Water Quality Control Board – San Francisco Bay Region (RWQCB) and (2) the existing RWQCB orders for the Facility, Order No. 90-147 and Order No. R2-2205-0012. The RWQCB's Environmental Screening Levels (ESLs) (RWQCB, 2005) have been used as screening tools (with modifications discussed below) and are proposed in this RAP as cleanup levels for the Site/Facility. The ESLs are intended to provide conservative screening values such that the presence of chemicals in soil, soil gas, or groundwater at concentrations below the corresponding ESL can be assumed not to pose a significant, long-term (chronic) threat to human health and the environment.

ESLs were developed by the RWQCB to address environmental protection goals presented in the Water Quality Control Plan for the San Francisco Bay Basin ("Basin Plan"). These goals include:

Surface Water and Groundwater:

- Protection of drinking water resources;
- Protection of aquatic habitats;
- Protection against vapor intrusion into buildings; and
- Protection against nuisance conditions.

Soil:

- Protection of human health (direct-exposure);
- Protection against vapor intrusion into buildings;

- Protection against leaching and subsequent impacts to groundwater;
- Protection of terrestrial biota; and
- Protection against adverse nuisance conditions.

Through the use of standard risk assessment assumptions and methodology, the RWQCB's ESLs are protective of each of the above factors. Because the soil and groundwater data for the Site were compared to the conservative and protective ESLs, and because cleanup to those levels is proposed in this RAP, a site-specific risk assessment is not included in this RI/FS/RAP¹.

The final ESLs defined in the RWQCB's ESL document were adjusted to account for two site specific factors: (1) shallow groundwater is not a current or potential source of drinking water²; and (2) groundwater gradients are relatively flat, and groundwater plumes are stable and do not show migration; consequently, there is no pathway for discharge of groundwater plumes to the aquatic resources of the Napa River. Because of these factors, ESLs protective of drinking water and aquatic habitats do not apply and the next lowest default ESLs were used³. A summary of the ESLs used for the Facility is provided in Table 1. Note that some of the constituents listed on the table were not detected at Site 6. The table is intended to be comprehensive and inclusive of all of the constituents detected in soil and groundwater at Sites 2/3, 4, 6, and the Other Areas. As discussed in Section 6.0, only a few chemicals at the Site are chemicals of concern that require soil and groundwater remediation. The final cleanup levels for these chemicals are listed in Section 6.1.4 and are the same as the ESLs for these chemicals.

In applying ESLs for the Site, since residential land use is anticipated for the Site, soils data are compared to the residential ESLs (see Table 1). Shallow soil samples (collected from less than 3 meters, about 10 feet) are compared to the Shallow Soil ESLs. Deep soil samples (greater than 3 meters) are compared to the Deep Soil ESLs.

¹ See the RWQCB's ESL website (<http://www.swrcb.ca.gov/rwqcb2/esl.htm>) for complete discussion of the ESL development process. As noted in the ESL document, additive risk due to the potential presence of multiple chemicals with similar target health effects are addressed through the use of conservative exposure assumptions and target risk levels. Also, while the ESLs do not specifically address potential synergistic effects, as noted in the ESL document, "Synergistic effects are primarily of concern for exposure to multiple chemicals at concentrations significantly higher than those expressed in the direct-exposure ESLs. Conservative target risk goals (e.g., target excess cancer risk of 10⁻⁶) and exposure parameters used to develop screening levels further reduce this concern." Note also that the bulk of the soil and groundwater contamination is from relatively low toxicity petroleum hydrocarbons with only a few carcinogenic compounds present.

² The average Facility-wide electrical conductivity (EC) of water samples collected from wells screened within the shallow and deep aquifers (see Section 2.3 for definitions of these aquifers) is 5,114 microSiemens/cm (µS/cm). By the State Water Resources Control Board Resolution 88-63 definition of sources of drinking water (i.e., water with EC less than 5,000 µS/cm), the two shallowest groundwater aquifers at the Facility are not considered sources of drinking water. As such, the non-drinking water ESLs are applicable to the Facility.

³ The specific pathway is the protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water.

As indicated on Table 1, two Shallow Soil ESLs exist for the total petroleum hydrocarbons (TPH) middle distillates and TPH residual fuels parameters. For the shallowest soils (0 to 3 feet below ground surface [bgs]⁴) the lower of the two values (100 milligrams per kilogram [mg/kg] for TPH middle distillates and 500 mg/kg residual fuels) is selected to conservatively address nuisance odor issues.

1.2 Objectives of RI/FS/RAP

The objectives of the RI/FS/RAP are to: (1) identify remediation strategies that will meet the Remedial Action Objectives (prevent adverse impact to human health and avoid further degradation of groundwater quality); and (2) present a program for remediation of soil and groundwater affected by VOCs and petroleum hydrocarbons at the Site. The RI/FS/RAP:

1. Summarizes previous environmental investigations conducted at the Site;
2. Presents the results of the supplemental remedial investigation conducted by PES in September through November 2006;
3. Summarizes the chemicals of concern, specifies the chemicals to be remediated and associated Site cleanup levels, and defines the extent of soil and groundwater media that will require remediation;
4. Identifies and evaluates applicable remedial technologies and alternatives;
5. Recommends a preferred remedial alternative; and
6. Outlines the tasks to implement the recommended remedial action.

1.3 Organization

The RI/FS/RAP includes the following sections:

Section 1.0 – Introduction. The introduction presents a general explanation of the objectives and organization of the RI/FS/RAP.

Section 2.0 – Site Background. This section provides a description of the Site, summarizes current and historical Site uses, discusses the geology and hydrogeology of the Site, and summarizes previous remedial investigations conducted at the Site.

⁴ To be conservative, samples collected from 3-3.5 feet bgs are considered “shallowest soil” in this report because the laboratory may have analyzed soil from the very top of the soil liner, which would be more representative of 3 feet bgs rather than 3.5 feet bgs.

Section 3.0 – Supplemental Remedial Investigation. This section presents the methodologies and results of the supplemental remedial investigation recently conducted at the Site by PES.

Section 4.0 – Nature and Extent of Contamination. This section discusses the nature and extent of soil and groundwater contamination at the Site and presents a conceptual site model (CSM).

Section 5.0 – Contaminant Fate and Transport. This section discusses contaminant fate and transport including a discussion of potential routes of migration, degradation mechanisms, and transport mechanisms.

Section 6.0 – Chemicals of Concern and Remediation Extent. This section summarizes the chemicals of concern identified during the numerous investigations conducted at Site 6, specifies the chemicals to be remediated and associated Site cleanup levels and defines the extent of soil and groundwater media that will require remediation.

Section 7.0 – Feasibility Study Scoping. This section defines the scope of the feasibility study, the applicable and relevant and appropriate requirements, the remedial action objectives, and specifies the proposed cleanup levels.

Section 8.0 – Identification and Screening of Remedial Technologies. This section identifies and screens potentially applicable technologies for remediating soil and groundwater to meet the remedial action objectives.

Section 9.0 – Development of Remedial Alternatives. This section assembles technologies into remedial alternatives, describes them, and presents costs to implement the alternative.

Section 10.0 – Evaluation of Remedial Alternatives. This section evaluates each alternative individually and comparatively, in terms of the remedial action objectives and regulatory evaluation criteria. A preferred remedial alternative is identified.

Section 11.0 – Remedial Action Plan Implementation. This section presents the procedures for implementation of the preferred remedial alternative for the Site and presents a schedule for remedial action implementation and reporting.

2.0 SITE BACKGROUND

A physical description of the Site and discussion of current and historical Site uses are presented below.

2.1 Site Description

Site 6 is located in the northwestern portion of the Facility, and is bounded to the east by the railroad right-of-way that bisects the Facility and to the west by a seawall along the Napa River (see Plates 2 and 3). As discussed above, the Site includes, on the west, the former Machine Shop area; on the east, the former Drum Storage Area (including the former Assembly Bay and the Warehouse and Electrical/Plumbing Shop buildings areas); and on the north, the southeastern portions of the Fabrication Buildings (see Plates 2 and 3). Site 6 slopes slightly eastward toward the railroad tracks, and is paved with asphalt to support vehicular traffic and to control stormwater runoff. Four drydocks (Drydock #1 through Drydock #4) are located along the Napa River in the southwest corner of Site 6. The drydocks are typically kept dry and are not currently in service.

All that remains of the former Machine Shop, which was approximately 24,000 square feet in size, is the concrete floor slab and subgrade foundations. The remainder of this building was demolished in September and October 2006.

No remnants of the former Drum Storage Area are evident at the Site. This area is paved with asphalt and is currently used to park trucks. The current uses of the remaining buildings at Site 6 are listed below:

- TransBay Steel, a steel fabricating company, is currently leasing Fabrication Bays 1 and 2. TransBay Steel also stores equipment and materials outside the Fabrication Bays;
- The former Assembly Bay is currently leased by Precast Vault Engineered Structures, a concrete vault manufacturer;
- Specialized Storage, a company that leases portable storage structures, is currently leasing the eastern-half of the Electrical/Plumbing Shop; and
- The Warehouse and the western-half of the Electrical/Plumbing Shop are currently vacant.

2.2 Site History

The Basalt Rock Company (Basalt), which constructed steel ships and barges during World War II, first used the former Machine Shop, Fabrication Bays, and drydocks to support those efforts. At the end of World War II, Basalt had a well-equipped facility that included four drydocks, machine shops, and plate shops (Montgomery Watson Harza [MWH], 2005). Beginning in the late 1940s, the fabrication equipment was used for the construction of heavy plate components, including pressure vessels, bridge girders, and offshore platform components (MW, 1996).

The historical uses of the various buildings and areas within Site 6 include:

- **Former Machine Shop:** Used to repair and maintain equipment and machinery used in pipe fabrication. Prior to its demolition in 2006, portions of the building were leased to TransBay Steel (MWH, 2005). Equipment involved in the operations at the former Machine Shop is shown on the diagram included in Appendix A.
- **Former Drum Storage Area:** According to JMM (JMM, 1990a), cutting oils and solvents were stored in this area prior to their use in the Pipe Mill Building.
- **Fabrication Bays:** Historically, these buildings have been used for cutting, welding, bending, rolling, and general fabrication of steel products (MWH, 2005).
- **Assembly Bay:** This area has been used to fabricate and repair pipe mill machinery parts, assemble equipment, test new pipe mill equipment, and cut test coupons from pipe rings for processing in the test lab (MWH, 2005).
- **Electrical/Plumbing Shop:** These shops supported the plumbers and electricians that provided upkeep and maintenance for the Facility operations (MWH, 2005).
- **Warehouse:** Historically, this building was used for the receipt, storage, and shipment of parts and supplies for operations in the former Pipe Mill Building (MWH, 2005).

According to MW (MW, 1996), the U.S. Army Corps of Engineers constructed the seawall along the Napa River during the 1940s as an improvement for the Basalt Rock Company facility. MW indicated that the seawall was constructed east of the course of the Napa River. At the completion of construction, the area between the Napa River and the new seawall was dredged to bring the river water up against the wall. The total depth of the seawall is not known, but it is believed that the wall extends at least to the soft river bottom, which is at a depth of 16 feet bgs (MW, 1996). MW performed geophysical testing of the wall in the mid-1990s that suggested the wall extends to a depth of approximately 20 feet bgs (MW, 1996). The testing also suggested that the wall may be built on top of pilings or caissons that extend at least to the total depth tested (37 feet bgs). The approximate location of the seawall is shown on Plate 3.

The drydocks in the southwestern corner of Site 6 were constructed when Basalt became active in the shipbuilding program for the United States Navy prior to World War II (MWH, 2005). The docks were constructed with concrete walls and bottoms that are approximately 13.5 feet bgs. As indicated above, the docks are typically kept dry and are not currently in service.

A 45-foot long groundwater extraction trench was installed on the north side of the former Machine Shop in October 1997 to hydraulically control groundwater flow and to prevent migration of chemicals of concern in groundwater (MW, 1996). Interim remedial actions at Site 6 are discussed in more detail in Section 2.5.

2.3 Geology and Hydrogeology

The following sections discuss the Facility-wide and Site 6-specific geology and hydrogeology. Some of the information presented in this section was obtained from MW's *Site 6 Characterization and Remedial Action Plan* report (MW, 1996).

2.3.1 Facility-Wide Hydrostratigraphy

Hydrostratigraphic units present at the Facility include, from youngest (structurally shallowest) to oldest (structurally deepest), fill, younger alluvium, older alluvium, and the bedrock volcanics (MW, 1996). These units are described below.

2.3.1.1 Fill

According to MW, fill material placed in many low-lying areas along the Napa River floodplain have ranged from dredging spoils to imported engineered fill (MW, 1996).

2.3.1.2 Younger Alluvium

Younger alluvium is characterized as a thin veneer of unconsolidated clay, silt, sand, and gravel that locally may yield water to wells if a sufficient thickness of the unit is saturated (Kunkel and Upson, 1960).

2.3.1.3 Older Alluvium

The older alluvium overlies the bedrock volcanics and is characterized by poorly sorted mixtures of clays, silts, sands, and gravels. At this Facility, a hardpan (cemented) horizon is commonly found in the uppermost part of this unit. Regionally, the older alluvium yields good quality water and is considered a source of potable groundwater (Kunkel and Upson, 1960).

2.3.1.4 Bedrock Volcanics

Tuff, breccia, and agglomerate, with locally interbedded volcanic flows characterize the bedrock volcanics. Depth to bedrock beneath the Facility is greater than approximately 380 feet bgs. Aquifers within tuff and breccia zones are usually confined and typically yield good quality water; wells completed in these zones are used for domestic, agricultural, and industrial water supply (Kunkel and Upson, 1960).

2.3.2 Site-Specific Hydrogeology

Site-specific geologic and hydrogeologic information was compiled based on data obtained during previous investigations, the Facility-wide groundwater monitoring program (see Section 2.4.6), and PES's investigations conducted in September through November 2006

(discussed in Section 3.0). Lithologic logs for PES's investigations are included in Appendix B.

Plates 4 and 5 are geologic cross sections A-A' and B-B' for the Site; the locations of these cross sections are shown on Plate 3. Geologic cross sections prepared by MW as part of the *Site 6 Characterization and Remedial Action Plan* report (MW, 1996) are included in Appendix C.

Lithologic logs and monitoring well completion diagrams from previous Site 6 investigations are included in Appendix D. Appendix D also includes a lithologic log for a boring completed by J.H. Kleinfelder & Associates (J.H. Kleinfelder & Associates, 1981) during a geotechnical investigation associated with the expansion of Fabrication Bays 1 and 2. The geotechnical lithologic log included in this appendix was used on cross section B-B' (Plate 5).

MW previously identified three hydrostratigraphic units in the vicinity of Site 6 (MW, 1996). From uppermost (youngest) to lowermost (oldest), these units are:

- Fill Unit;
- Silt/Clay Unit (Younger Alluvium); and
- Partially Cemented Silt/Sand Unit (Older Alluvium).

The results from PES's September through November 2006 investigations confirmed the presence of these units at the Site. The following sections describe each of these units.

2.3.2.1 Fill Unit

The fill is the uppermost unit encountered at the Site and is heterogeneous. As shown on the cross sections, the thickness of the fill varies across Site 6, but is generally 3 to 6 feet thick. According to MW, fill thickness varies according to the original surface topography and proximity to the drydocks and seawall. Fill thickness of up to 8 feet are found near the seawall based on the lithologies encountered in wells MW-49 and MW-50.

The fill unit at Site 6 can be characterized as heterogeneous mixture of predominantly sand and gravel with various proportions of silt and clay. Typically, the fill is varying shades of gray and brown, dry to wet, loose to dense, with occasional debris such as concrete, asphalt, and brick (MW, 1996). MW indicated that the origin of the fill is believed to be materials dredged from the Napa River, material from quarry operations, and miscellaneous material from construction activities. The fill unit is generally non-water-bearing at depths above 4 feet. However, in areas where the fill unit extends to deeper depths it can be saturated across larger intervals.

As shown on cross section B-B' (see Plate 5), a hydrocarbon sheen or staining was encountered in the fill unit in the vicinity of the former Drum Storage Area. The presence of separate-

phase product or hydrocarbon sheens and staining in borings and wells completed at Site 6 is discussed in detail in Section 4.2.1 of this RI/FS/RAP.

2.3.2.2 Silt/Clay Unit

The silt/clay unit, which correlates with the younger alluvium, is located stratigraphically below the fill unit and is underlain by the partially cemented silt/sand unit (i.e., the older alluvium). As shown on cross sections A-A' and B-B' (Plates 4 and 5), the silty clay unit is present beneath much of Site 6. However, it appears to be thinner in the eastern portion of the Site, and also thins to the north in the direction of the Fabrication Buildings (see cross section B-B', Plate 5, compared to cross section A-A', Plate 4).

The silt/clay unit is heterogeneous, but consists mainly of silts and clays that are mottled blue/greenish gray to black (organic rich), moist to wet, and soft to medium stiff. The unit contains plant fragments, rootlets, and wet fibrous peat stringers of varying thicknesses. Also, organic clay lenses and peat horizons, and clayey to silty sand lenses or layers are present in this unit. As shown on cross section A-A' and the cross sections in Appendix C, numerous sand lenses/layers with thicknesses of up to 10 feet are present in the vicinity of the former Machine Shop area. In the eastern portion of the Site, this unit contains more organic material and peat stringers and very few sand lenses (see cross-section B-B' and cross sections in Appendix C). In general, the interbedded sand lenses and wet fibrous peat stringers are the groundwater producing zones in this unit, which lies within the Shallow Groundwater Zone discussed in Section 2.3.3.1.

MW interpreted the silty clay unit as floodplain and tidal marsh deposits and the interbedded sand stringers as likely representing deposits by small stream channels that drained the area (MW, 1993). The greater prevalence of sand deposits on the west side of the Site, in the Machine Shop area, is consistent with the higher energy environment near the Napa River Channel.

2.3.2.3 Partially Cemented Silt/Sand Unit

This unit is located stratigraphically below the silty clay unit and correlates with the older alluvium. The unit typically consists of weakly to moderately cemented silt and sand layers interbedded with softer silt and clay. In places, the silts and clays contain varying amounts of sand and gravel. Lenses of non-cemented sands and gravels are also present in the unit. The non-cemented sand and gravels within the unit are generally water-bearing and were considered by MW to comprise the Deep Groundwater Zone discussed in Section 2.3.3.2.

As shown on the cross section A-A' (see Plate 4) and the cross sections in Appendix C, the depth to the top of the partially cemented silt/sand unit is approximately 20 to 25 bgs in the vicinity of the former Machine Shop area. In the eastern portion of the Site, this unit was encountered in the vicinity of the Assembly Bay and Fabrication Buildings at depths ranging

between 8 and 13 feet bgs (see Plate 5). The depth to this unit in the eastern portion of the Site appears to increase to the south (see Plate 5).

As discussed by MW (MW, 1996), the uppermost portion of this unit in the vicinity of the former Machine Shop area is characterized by a partially cemented layer that is significantly more dense or stiff than overlying sediment. In the eastern portion of the Site, this unit generally consists of a weakly cemented silt to gravelly sandy silt, olive to olive brown or greenish gray, moist (silt) to wet (gravelly sandy silt), and medium stiff to stiff or medium dense. According to geotechnical boring B3 presented on cross section B-B' (see Plate 5), this unit consists of water-bearing sands and gravels from approximately 11 feet bgs to the total depth of the boring (45.5 feet bgs).

2.3.3 Site 6 Groundwater Occurrence and Flow Directions

The occurrence of groundwater beneath Site 6 can generally be divided into two groundwater zones:

- The Shallow Groundwater Zone (beginning approximately 3 to 7 feet bgs) – Encompasses water-bearing soils within the fill and silt/clay units; and
- The Deep Groundwater Zone (beginning approximately 20 to 25 feet bgs in the former Machine Shop area and 8 to 13 feet bgs in the eastern portion of the Site) – Encompasses water-bearing soils within the partially cemented silt/sand unit.

2.3.3.1 Shallow Groundwater Zone

Water level measurements at Site 6 are conducted on a semiannual basis as part of the Facility-wide groundwater monitoring program discussed in Section 2.4.6 of this document. Groundwater within the Shallow Zone at Site 6 is unconfined, and generally occurs at a depth of approximately 3 to 7 feet bgs. Water levels vary seasonally. As expected, groundwater elevations were generally higher in the May 16, 2006 water level measurement event (end of wet season) than in the October 3, 2006 event (end of dry season). The exception is in well MW-11, which is located on the north side of the former Machine Shop close to the extraction trench (see Plate 3), where the water level was 2.34 feet higher in the October 3, 2006 event. This higher water level is likely the result of the extraction trench being temporarily shut down due to electric power interruption during demolition of the Machine Shop. Water levels in the remainder of Site 6 ranged from 0.46 to 1.24 feet higher in the May 16, 2006 event.

As discussed in the *Site 6 Characterization and Remedial Action Plan* (MW, 1996), the seawall barrier and drydocks appear to have a major influence on groundwater conditions and flow at Site 6. Based on the absence of tidal influence in shallow wells located adjacent to the seawall (see discussion in Section 2.3.5), MW concluded that the seawall “acts as a nearly impermeable barrier to water flow, effectively prohibiting groundwater flow between the Shallow Groundwater Zone and the Napa River.” MW also indicated that “the drydock

structures also act as a barrier to groundwater flow, given that they are believed to have been constructed similarly to the seawall.”

Flow directions in the Shallow Groundwater Zone at Site 6 are shown on the potentiometric surface maps for May 16, 2006 and October 3, 2006 (see Plates 6 and 7, respectively). These water-level measurement events are intended to show variations in groundwater elevation and flow direction between the end of the wet and end of dry seasons, respectively. The water level survey data for the May 16, 2006 and October 3, 2006 events are summarized on Tables 2 and 3, respectively.

Based on these potentiometric surface maps, a review of historic water-level data for Site 6, and discussions presented in the *Groundwater Monitoring Program Report Number 67, April – June 2006, Former Napa Pipe Facility, 1025 Kaiser Road, Napa, California* report (PES, 2006b), groundwater flow in the eastern portion of the Site during the May 2006 event was south to southwest, in a direction away from to the Napa River. In the western portion of the Site, groundwater flow direction in the May 2006 event was generally radially toward the extraction trench on the north side of the former Machine Shop (see Plate 6); the extraction trench was operational at the time of this monitoring event. As shown on Plate 6, a groundwater depression is present in the vicinity of the extraction trench. Based on the water level data presented on Plate 6, groundwater flow is away from the seawall and drydocks.

Groundwater flow in the October 2006 monitoring event (PES, 2007) is very similar to that described for the May 2006 event (see Plate 7). The biggest difference between these events is the presence of a groundwater mound in the immediate vicinity of well MW-11, which is located close to the extraction trench. As shown on Plate 7, a groundwater depression is present just west of this mound. The groundwater extraction trench was not operational at the time of the October 2006 water level measurement event. The absence of this mound in the May 2006 event can likely be explained by the influence of the extraction trench on the shallow groundwater.

MW discussed the groundwater conditions at the Site prior to the installation of the extraction trench in their *Site 6 Characterization and Remedial Action Plan* (MW, 1996). In this report, MW indicated that “the groundwater high along the northern wall of the Machine Shop is consistent with historic groundwater conditions measured during the quarterly monitoring program. This high has typically been most pronounced in the late summer or early autumn, but persists throughout the year.” Possible sources were attributed to differential groundwater recharge caused by the concentration of surface water runoff from building downspouts or from ponding in natural depressions.

The horizontal gradients for the May 16, 2006 measurement event were approximately:

- 0.010 feet/foot (ft/ft) in the eastern portion of the Site; and

- 0.013 ft/ft on the northwest side of the former Machine Shop in the vicinity of monitoring wells MW-10 and MW-49. Gradients are considerably steeper in the vicinity of the groundwater depression induced by the extraction trench.

The horizontal gradients for the October 3, 2006 measurement event were approximately:

- 0.009 ft/ft in the eastern portion of the Site; and
- 0.013 ft/ft on the northwest side of the former Machine Shop in the vicinity of monitoring wells MW-10 and MW-49.

2.3.3.2 Deep Groundwater Zone

Groundwater in the Deep Zone at Site 6 is encountered in sand and gravel lenses within the partially cemented silt/sand unit. Two Deep Groundwater Zone wells, wells DW-3 and DW-7, are located at Site 6 on the north side of the former Machine Shop (see Plate 3 for well locations). Wells DW-3 and DW-7 are screened at 26 to 31 feet bgs (see Tables 2 and 3). The groundwater in each well is confined, rising to approximately 4 to 6 feet bgs. Potentiometric surface maps have not historically been prepared for this zone because of the limited number of data points.

MW (MW, 1996) used co-located wells MW-3 and DW-3 (located approximately 5 feet apart) and wells MW-11 and DW-7 (located approximately 5 feet apart) to give an indication of the gradient between the two zones on the north side of the former Machine Shop. Based on groundwater data collected on December 5, 1995, downward gradients existed in the vicinity of both well pairs. MW calculated a vertical gradient of 0.02 ft/ft for wells MW-3 and DW-3 and a vertical gradient of 0.2 ft/ft for wells MW-11 and DW-7. For the purpose of calculating these vertical gradients, MW assumed a separation of approximately 10 feet between the shallow and deep groundwater zones. The December 5, 1995 measurement event was conducted prior to the installation of the extraction trench.

An indication of the vertical gradient between the Shallow and Deep Groundwater Zones in the vicinity of co-located wells DW-3 and MW-3 for the two most recent groundwater measurement events is summarized below.

- **May 16, 2006 Measurement Event (see Table 2):** Elevations for wells DW-3 and MW-3 were 3.38 and 3.56 feet mean sea level (MSL), respectively, indicating a slight downward gradient of 0.02 ft/ft using the same assumptions discussed above; and
- **October 3, 2006 Measurement Event (see Table 3):** Elevations for wells DW-3 and MW-3 were 2.60 and 2.71 feet MSL, respectively, indicating a slight downward gradient of 0.01 ft/ft using the same assumptions discussed above.

The groundwater extraction trench located along the north side of the former Machine Shop lowers the water table in its vicinity. Therefore, vertical gradient estimates using wells DW-7

and DW-11 (located close to the extraction trench) would not be representative of the general conditions in the area and are not estimated.

2.3.4 Aquifer Testing

Results for limited aquifer testing conducted at Site 6 are presented in the *Site 6 Characterization and Remedial Action Plan* (MW, 1996). The aquifer testing involved slug withdrawal (rising head) method slug tests at shallow wells MW-12 (2 slug tests), MW-49 (2 slug tests), and MW-52 (1 slug test). A short-duration pumping test was also performed at well MW-12 to confirm slug testing results. The results of these tests are summarized on a table included in Appendix H. As shown on this table, results of the slug and pumping tests indicated the following hydraulic conductivities:

- **MW-49:** 3.9×10^{-3} to 8.0×10^{-4} centimeters per second (cm/sec) range;
- **MW-52:** 4.6×10^{-2} to 2.8×10^{-2} cm/sec range; and
- **MW-12:** 1.4×10^{-4} cm/sec for the slug test, and 2.3×10^{-4} to 3.5×10^{-4} cm/sec range for pumping test.

MW indicated that the hydraulic conductivity results from wells MW-49 and MW-52 represented the fill unit because both of these wells are screened across the interface of the fill and silt/clay unit. Well MW-12 is screened within a silty sand layer in the silt/clay unit. MW indicated that this well yields more groundwater than other Site 6 wells screened within the silt/clay unit.

MW also calculated an approximate groundwater flow velocity (pre-extraction trench) for the Shallow Groundwater Zone beneath the former Machine Shop of 9×10^{-6} cm/sec (i.e., 0.024 feet per day or 9 feet per year) to the south to southeast using a groundwater gradient of 0.015 ft/ft, an average hydraulic conductivity of 2×10^{-4} cm/sec, and an effective porosity of 0.33.

2.3.5 Tidal Influence

MW conducted a systematic water level survey on December 5, 1995 to evaluate the influence of tidal fluctuations in the Napa River on groundwater elevations at Site 6, including the effect of the seawall on groundwater conditions in the Shallow Groundwater Zone. The details of this survey are presented in the *Site 6 Characterization and Remedial Action Plan* (MW, 1996).

The survey involved measuring depth-to-water in 20 wells over approximately 12 hours. The wells included 13 shallow wells and two deep wells at Site 6, and four wells (MW-2, MW-14, MW-15, and MW-32) located over 1,000 feet inland from the Napa River that were monitored for control purposes.

A summary of the results and conclusion for the survey are presented below:

- The Napa River fluctuated 7.46 feet between high and low tidal crests;
- Groundwater fluctuations in the wells used for control purposes ranged between 0.02 and 0.08 feet. MW did not believe that these wells were tidally influenced;
- Groundwater elevations during the survey typically fluctuated less than 0.08 feet in shallow wells and less than 0.34 feet in the deep wells. Also, no pattern between the magnitude of fluctuation in wells and distance from the river was apparent. MW concluded that the effect of the fluctuating water level in the Napa River on the groundwater zones beneath Site 6 is limited;
- Groundwater elevation changes in well DW-7 appear to be influenced by river level fluctuations more than any other well that was evaluated. However, only 0.34 feet of fluctuation in the groundwater elevation was observed in this well; and
- The seawall is an effective barrier to groundwater flow in the Shallow Groundwater Zone as evidenced by only 0.05 feet of groundwater elevation change in wells MW-49 and MW-50 located less than 10 feet inland from the river.

2.4 Previous Investigations

The following section discusses the previous investigations conducted at Site 6. Pertinent tables and plates associated with these investigations are presented in the appendices referenced below. The results for each investigation are compared to the applicable residential ESLs discussed in Section 1.0 and presented on Table 1. The TPH soil results and selected groundwater results from these investigations, along with the current data presented in Section 3.0, are incorporated into the nature and extent of contamination discussion presented in Section 4.0. The results of these investigations are also discussed in Section 6.0 (Chemicals of Concern and Remediation Extent).

The analytical method for the TPH results discussed in Sections 2.4.1 and 2.4.2 did not specifically identify the type of petroleum hydrocarbon; the reported concentration for these results are for TPH as diesel (TPH-d) and TPH as motor oil (TPH-mo) combined. The borings associated with these TPH results are in the areas of Site 6 where samples collected during subsequent investigations indicated that the petroleum hydrocarbons present are generally characteristic of heavier-end compounds that fall within the TPH-mo range (MW, 1996). Therefore, the TPH results discussed in Sections 2.4.1 and 2.4.2 are compared to the ESLs for motor oil (i.e., TPH residual fuels; see Table 1).

The following information is provided to clarify which ESLs presented on Table 1 are used as screening tools for the various petroleum hydrocarbon soil and groundwater results discussed below:

- TPH gasoline ESLs are used for TPH as gasoline (TPH-g) results;
- TPH middle distillates ESLs are used for TPH-d results; and
- TPH residual fuels ESLs are used for TPH-mo, TPH-d/TPH-mo combined, and Oil & Grease (O&G) results.

2.4.1 Soil and Groundwater Testing at the Kaiser Steel Corporation Pipe Mill and Fabrication Facility in Napa California (1987)

In September 1987 JMM conducted Facility-wide a soil and groundwater investigation for Kaiser Steel Corporation. The results of this investigation are documented in the *Report of Soil and Groundwater Testing at the Kaiser Steel Corporation Pipe Mill and Fabrication Facility in Napa California* (JMM, 1987). A small portion of the investigation was conducted in what is now called Site 6.

As part of the investigation, four soil borings (BH-2, BH-28, BH-40, and BH-41; see Plate 3 and the plate in Appendix E for boring locations) were drilled to depths ranging between 3 and 10 feet bgs. The lithologic logs are included in Appendix D. Borings BH-28 and BH-40 are located on the north side of the former Machine Shop, boring BH-2 is in the former Drum Storage Area, and boring BH-41 lies southwest of the former Drum Storage Area. Soil and grab groundwater samples were collected from borings BH-28 and BH-40 and grab groundwater samples were collected from the remaining borings. The soil samples were analyzed for VOCs and TPH⁵ and the grab groundwater samples were analyzed for VOCs. In addition, the grab groundwater sample from boring BH-28 was analyzed for TPH⁵ and the sample from boring BH-41 was analyzed for Base/Neutral/Acid Extractables (i.e., semivolatile organic compounds [SVOCs]). The analytical results for the soil and groundwater samples are included in Appendix E.

In summary, TPH in soil was detected at 17 mg/kg in boring BH-28 and at 12 mg/kg in boring BH-40. The groundwater sample collected from boring BH-28 contained TPH at 1.3 milligrams per liter (mg/l). All of the TPH soil and groundwater results from this investigation are below the applicable ESLs. The TPH soil results from this investigation are incorporated into the nature and extent of contamination discussion presented in Section 4.0.

The only VOCs detected in the soil sample from boring BH-40 were trichloroethylene (TCE) and cis-1,2-dichloroethane (DCA) at concentrations of 23 and 41 micrograms per kilogram (µg/kg), respectively. The concentrations for these constituents are below ESLs. No VOCs were detected in the soil sample collected from boring BH-28.

A number of VOCs were detected in the grab groundwater samples collected during this investigation. With the exception of the TCE results of 1,600 micrograms per liter (µg/l) in boring BH-40, the VOC concentrations in groundwater are below ESLs. The highest VOC

⁵ The sum of TPH-d and TPH-mo combined.

concentrations detected in groundwater during this event were in boring BH-40, including benzene at 100 µg/l, chloroform at 200 µg/l, 1,2-DCA at 100 µg/l, 1,1-dichloroethene (DCE) at 200 µg/l, xylenes at 100 µg/l, and cis-1,2-DCE at 3,100 µg/l⁶. SVOCs were not detected in the groundwater sample collected from boring BH-41. The groundwater results from this investigation are shown on the tables and laboratory reports in Appendix E.

2.4.2 Site Investigation Report for the Napa Pipe Corporation Facility (1990)

From August to November of 1989 JMM conducted an extensive Facility-wide soil and groundwater investigation for Napa Pipe Corporation. The results of this investigation are documented in the *Site Investigation Report for the Napa Pipe Corporation Facility Report* (JMM, 1990a). As part of this investigation, five soil borings (6A, 6B, 6C, 6D, and 6E; see the plate in Appendix F and Plate 3 for boring locations) were drilled at Site 6 in the vicinity of the former Machine Shop area (borings 6C, 6D) and former Drum Storage Area (borings 6A, 6B, 6E). The lithologic logs are included in Appendix D. According to the lithologic logs, borings 6C, 6D, and 6E were completed in unpaved areas and borings 6A and 6B were completed in areas with a 0.25 feet thick asphalt cover. Samples collected from various depths in each boring ranged from 0 to 7 feet bgs. These samples were analyzed for VOCs, TPH⁵, and O&G.

In summary, TPH and O&G were detected in many of the soil samples. Results for the following samples were at concentrations above ESL values:

- O&G Results: Samples from boring 6B at 0.5 to 1 feet bgs (850 mg/kg) and 2.75 to 3.25 feet bgs (1,800 mg/kg); boring 6C at 0 to 0.5 feet bgs (1,300 mg/kg); boring 6D at 0 to 0.5 feet bgs (3,000 mg/kg); and boring 6E at 0 to 0.5 feet bgs (9,200 mg/kg) and 2.5 to 3 feet bgs (1,100 mg/kg); and
- TPH Results: Samples from boring 6B at 2.75 to 3.25 feet bgs (1,200 mg/kg); boring 6D at 0 to 0.5 feet bgs (1,700 mg/kg); and boring 6E 0 to 0.5 feet bgs (6,600 mg/kg) and 2.5 to 3 feet bgs (1,000 mg/kg).

The TPH and O&G results are summarized on the tables in Appendix F. The TPH soil results from this investigation are incorporated into the nature and extent of contamination discussion presented in Section 4.0.

Five different VOCs were detected in the 15 soil samples analyzed (see the tables in Appendix F). However, none of the detected VOCs exceeded their respective ESL values. The VOC soil results are summarized on the tables in Appendix F.

⁶ Groundwater sampling probe MS1, sampled in 1989 (see Section 2.4.2) and located adjacent to Boring BH-40, did not confirm these VOC detections. Only trans-1,2-DCE was detected, at a concentration of 70 µg/l. The presence of VOCs at BH-40 appears to be an isolated occurrence.

In an effort to determine the extent of the contamination before monitoring wells were installed, a groundwater screening program was implemented by JMM in August of 1989. Groundwater sampling probes were advanced to depths of approximately 6 to 7.5 feet bgs at ten (10) locations surrounding the former Machine Shop area (MS-1 through MS-10; see the plates in Appendix F for locations). Location MS-6 did not produce groundwater, and therefore was not sampled. Groundwater samples were collected from the remaining locations and analyzed for VOCs. Groundwater from location MS-2 contained TCE (540 µg/l) above its corresponding ESL values. The remaining VOCs were detected at concentrations below ESLs. The results for the groundwater sampling probes are summarized on the tables in Appendix F.

Based on the findings of the groundwater screening program, shallow wells MW-3, MW-10, MW-11, MW-12, and MW-13 and deep well DW-3 were installed (see the plates in Appendix F and Plate 3 for well locations). The lithologic and well completion logs for these wells are included in Appendix D. During the installation, soil samples were collected at various depths between 9 and 28 feet bgs in each well, except well MW-3, and analyzed for VOCs. VOCs were detected in many of the samples; however, none of the detected concentrations exceed ESL values. The VOC results for the soil samples are summarized on the tables in Appendix F.

Groundwater samples collected from wells MW-3, MW-10, MW-11, MW-12, MW-13, and deep well DW-3 were analyzed for metals, VOCs, TPH, and O&G. The results are summarized on tables included in Appendix F. TCE was detected at a concentration of 1,400 µg/l in well MW-11, which is above the ESL. The remaining VOCs detections from these wells are below ESLs. TPH and O&G were not detected in the groundwater samples and none of the metals results exceeded ESLs.

2.4.3 June and July 1990 Investigation

From June to July, 1990 JMM conducted a Facility-wide soil and groundwater investigation for Napa Pipe Corporation. This investigation was a follow up to the 1989 investigation discussed above. The results for this investigation are included in the *Corrective Action Plan for the Napa Pipe Mill* (JMM, 1990b). As part of this investigation, four soil borings (6F, 6G, 6H, and 6I; see the plates in Appendix G and Plate 3 for boring locations) were advanced in the former Drum Storage Area. In addition, shallow monitoring wells MW-36, MW-37, and deep well DW-7 were installed at the former Machine Shop area, and MW-38 was installed in the former Drum Storage Area (see Plate 3 for well locations). Lithologic and well completion diagrams are included in Appendix D.

Twelve soil samples were collected from the borings at depths ranging from 2.5 to 7.5 feet bgs. Soil samples were collected during the installation of wells MW-37 (at 3.0 and 6.5 feet bgs), MW-38 (at 5.0 feet bgs), and DW-7 (at 2.5, 5.0, and 7.5 feet bgs). The soil samples were analyzed for VOCs, TPH-d, and TPH-mo. As indicated in the *Corrective Action Plan*, “metals contamination in the soil at Site 6 was not investigated because operations conducted at the site have not posed a threat of metals contamination” (JMM, 1990c). The new monitoring

wells were included in a groundwater monitoring event conducted in July of 1990 that also included sampling existing Site 6 wells MW-11 and MW-36. The groundwater samples from the wells were analyzed for VOCs.

In summary, the only VOC detected at a concentration above its ESL in groundwater samples collected from the Site 6 wells included in the July 1990 monitoring event was TCE in well MW-11 at 760 $\mu\text{g/l}$ (see the tables in Appendix G).

Soil samples collected during this sampling event with concentrations above TPH-mo ESLs, included:

- 5 feet bgs sample from MW-38 at 5,000 mg/kg;
- 5 feet bgs sample from boring 6F at 1,200 mg/kg;
- 2.5 feet bgs sample from boring 6G at 1,900 mg/kg; and
- 2.5 feet bgs sample from boring 6I at 1,200 mg/kg.

The only TPH-d soil result above ESLs was the 3 feet bgs sample collected from well MW-37 at a concentration of 640 mg/kg. The analytical results for the soil samples collected during this investigation are summarized on the tables in Appendix G. The TPH soil results from this investigation are incorporated into the nature and extent of contamination discussion presented in Section 4.0.

2.4.4 Site 6 Characterization and Remedial Action Plan (May 1996)

In December of 1995 MW conducted a soil and groundwater investigation at Site 6 for Napa Pipe Corporation. The results of this investigation are documented in the *Site 6 Characterization and Remedial Action Plan* (MW, 1996).

As part of the investigation, three soil borings (6J, 6K, and 6L; see the plates in Appendix H and Plate 3 for boring locations) were advanced to depths between 6 and 10 feet bgs. Borings 6J and 6K were intended to assess the extent of TPH in the vadose zone soil near the former Drum Storage Area. Boring 6L was intended to verify the extent of TPH and VOC contamination in the soil along the north side of the former Machine Shop. In addition, four shallow monitoring wells were installed (MW-49, MW-50, MW-51, and MW-52; see Plate 3 for boring locations) across the Site to assess the extent of TPH and VOC groundwater contamination. Six soil samples were obtained during the installation of these monitoring wells. Soil samples during this event were analyzed for TPH-d, TPH-mo, VOCs, and the soil samples from the installation of MW-50 and MW-52 were also analyzed for total organic carbon (TOC). The four monitoring wells installed during this investigation and five existing Site 6 wells (MW-10, MW-11, MW-12, MW-38, and DW-7) were sampled in December 1995. Samples from these wells were analyzed for TPH-d, TPH-mo, and VOCs. The lithologic logs and monitoring well completion diagrams for these borings and wells included

in Appendix D. The results of this investigation are summarized on the tables and plates included in Appendix H.

In summary, TPH-d was detected in 2 of the 7 soil samples analyzed for this constituent. The highest concentration was 15 mg/kg, which is below the ESL. TPH-mo was detected in 5 of the 7 soil samples analyzed for this constituent. The results for the 4 feet bgs samples from borings 6J (3,100 mg/kg) and 6K (6,700 mg/kg) exceed the ESL for TPH-mo. VOCs were not detected in the soil samples. The TPH soil results from this investigation are incorporated into the nature and extent of contamination discussion presented in Section 4.0.

None of the VOCs detected in the monitoring wells during the groundwater sampling event conducted in December 1995 exceeded ESLs. Both TPH-d (at 4,400 $\mu\text{g/l}$) and TPH-mo (at 4,500 $\mu\text{g/l}$) were detected at concentrations above the ESL in well MW-38, and TPH-d (at 3,200 $\mu\text{g/l}$) was detected at a concentration above the ESL in well MW-52 (see the tables in Appendix H).

2.4.5 Phase II Site Investigation by Shaw Environmental Inc.

In 2005, Shaw Environmental Inc. (Shaw) conducted a Phase II site investigation of the Facility prior to NRP's acquisition of the Facility. The results were documented in the report: *Phase II Site Investigation at Napa Pipe Facility, 1025 Kaiser Road in Napa, CA* (Shaw, 2005). As part of this investigation, soil boring MS-01 was drilled within the former Machine Shop near the machinery pit (see the plate in Appendix I and Plate 3 for boring location). The lithologic log for the boring is included in Appendix D.

Two soil samples were collected from boring MS-01 at depths of 3 and 7 feet bgs and a grab groundwater sample was collected. The soil samples were analyzed for TPH-mo and polychlorinated biphenyls (PCBs). The grab groundwater sample was analyzed for TPH-mo, VOCs, and PCBs. The soil and groundwater analytical results tables are included in Appendix I.

In summary, TPH and PCBs were not detected in the soil and grab groundwater. Five VOCs (1,1-DCA, 1,1-DCE, bromomethane, cis-1,2-DCE, and TCE) were detected in the groundwater sample at concentrations below ESL values. The TPH soil results, from this investigation are incorporated into the nature and extent of contamination discussion presented in Section 4.0.

2.4.6 Facility-Wide Groundwater Monitoring Program

A Facility-wide groundwater monitoring program has been ongoing at the Facility since April 1989. The scope of the sampling has been revised and updated with approval from the RWQCB several times since its inception. To date, sixty-eight monitoring events have been conducted at the Facility (PES, 2007). Facility-wide groundwater monitoring events are conducted semi-annually during the second and fourth quarters of each year. Water-level

measurements are collected from all monitoring wells during these events, but only selected wells are sampled. Currently, 48 of the 71 monitoring wells that exist at the Facility are sampled as part of this program; some of these wells are sampled semi-annually and others annually. Groundwater sample analyses vary, but one or more of the following analyses are performed on the samples: VOCs; TPH-d; TPH-extractables (TPH-E); or metals (including aluminum, arsenic, barium, chromium, copper, lead, selenium, and zinc). In addition, selected wells at Site 4 are analyzed for a variety of monitored natural attenuation parameters.

At Site 6, 8 of 14 on-site monitoring wells are sampled; 3 wells (MW-11, MW-51, and DW-7) are sampled semi-annually and 5 wells (MW-10, MW-12, MW-13, MW-37, and DW-3) are sampled annually. Monitoring wells at Site 6 are sampled for VOCs. However, as indicated on Table 4, well MW-49 in the area of the former Machine Shop, and wells MW-38 and MW-52 at the former Drum Storage Area were analyzed for TPH-mo and TPH-d during the fourth quarter 2006 event (i.e., sampling conducted in October 2006) to assess TPH groundwater concentrations in these areas. The VOC groundwater results for the second and fourth quarter 2006 monitoring events are summarized on Table 5. TPH-mo, TPH-d, and TCE results for the October 2006 monitoring event are included on the groundwater concentration maps discussed in Section 4.0 (nature and extent of contamination).

Based on the results from the Facility-wide groundwater monitoring program, the only area at Site 6 with elevated VOC concentrations in groundwater is in the vicinity of the extraction trench located on the north side of the former Machine Shop. Well MW-11, located close to the extraction trench (see Plate 3), has historically had the highest concentrations of VOCs (specifically TCE) in groundwater. The TCE concentration in this well at the time of its installation in 1989 was 1,400 µg/l. TCE concentrations steadily declined in this well through 1997. Concentrations of TCE in quarters 1 through 4 in 1997 were 77, 89, 55, and 260 µg/l, respectively. However, TCE concentrations sharply increased after the installation of the extraction trench in October 1997. Concentrations of TCE in quarters 1 through 4 in 1998 were 1,600, 3,000, 2,500, and 2,000 µg/l, respectively. After 1998, TCE concentrations began to decline again. As indicated on Table 5, TCE concentrations in well MW-11 were 380 and 300 µg/l during the second and fourth quarter 2006 sampling events.

Wells MW-38 and MW-52 have historically had the highest concentrations of petroleum hydrocarbons in groundwater at Site 6. However, very few petroleum hydrocarbon analyses have been performed on the groundwater samples collected from these wells. The concentration of TPH-d in well MW-38 at the time of its installation in 1990 was 3,600 µg/l; hydraulic oil and kerosene were not detected and TPH-mo was not analyzed. In December 1995, TPH-d and TPH-mo concentrations in this well were 4,500 and 4,400 µg/l, respectively. In the 4th quarter 2006 sampling event, TPH-d and TPH-mo concentrations in well MW-38 were 9,000 and 16,000 µg/l, respectively. In well MW-52, TPH-d and TPH-mo concentrations were 3,200 and 2,000 µg/l, respectively, in December 1995 (i.e., just after its installation). In the 4th quarter 2006 sampling event, TPH-d and TPH-mo concentrations in well MW-52 were 16,000 and 12,000 µg/l, respectively. These results suggest that petroleum

hydrocarbon concentrations in groundwater in the vicinity of the former Drum Storage Area have increased since this analysis was last performed in 1995.

2.5 Summary of Interim Groundwater Remedial Actions

Interim remedial actions have been ongoing at Site 6 since October 1997. The primary objective of the interim remedial actions at Site 6 was previously defined as prevention of migration of COI in groundwater in the vicinity of the former Machine Shop area (MW, 1996). Interim remedial actions at the Site have included installation (in October 1997) and operation of a 45-foot long groundwater extraction trench on the north side of the former Machine Shop (see Plate 3 for location of the trench). The extracted groundwater is discharged under permit to the Napa Sanitation District (NSD) via the sanitary sewer connection located on the western side of the former Machine Shop. The volume of groundwater extracted through time has been presented in the reports generated for the groundwater monitoring program (PES, 2007). In addition, separate-phase product recovery in well MW-52 has been ongoing since 2001.

Information regarding product recovery from the well MW-52 and volume of groundwater extracted from the trench have been presented in the reports generated for the Facility-wide groundwater monitoring program.

Historically, well MW-52 has contained varying levels of separate-phase product. However, a review of the groundwater monitoring reports indicated that separate-phase product was last detected (at 0.09 feet thick) in well MW-52 in June 2001. Separate-phase product was not detected in this well during the recent water level measurement events (i.e., May and October 2006). A sheen was observed. Product recovery efforts at this location are ongoing, and, as indicated on Tables 2 and 3, an oil absorbent sock is kept in this well and changed out on a regular basis. Based a review of the Facility-wide groundwater monitoring reports, separate-phase product was first detected in well MW-52 in May 2000 at a thickness of 0.45 feet. Separate-phase product was also detected in this well in December 2000 at a thickness of 0.11 feet and in June 2001 as indicated above. According to the monitoring reports, an oil absorbent sock was placed in this well between the December 2000 and June 2001 measurement events.

As of December 27, 2006, the totalizer reading for the Site 6 groundwater extraction system was 482,401 gallons. A total of 49,440 gallons was pumped between January and August 2006, representing an average flow rate of 0.15 gallons per minute (gpm). The extraction of groundwater from the trench temporarily ceased in mid-August 2006 when electrical power to the Machine Shop was cut off in preparation for demolition activities. Groundwater extraction from the trench resumed in mid-October 2006. A total of 42,260 gallons was pumped between October and December 2006, representing an average flow rate of 0.52 gpm. The power supply to the extraction system has been re-routed from the former Machine Shop and is directly connected to the groundwater extraction system.

3.0 SUPPLEMENTAL REMEDIAL INVESTIGATION

The following sections present the field activities and methods (Section 3.1) and analytical results (Section 3.2) for the supplemental remedial investigation conducted by PES in September through November 2006.

3.1 Field Activities and Methods

Prior to conducting the supplemental remedial investigation, PES reviewed historical Site documents and prepared a workplan that was submitted to RWQCB staff for review. The RWQCB approved the work plan in early September 2006. The workplan, titled *Supplemental Remedial Investigation Workplan, Site 6* (PES, 2006a), recommended that a subsurface investigation be conducted to address the following data gaps:

- The lateral extent of VOC contamination in soil and groundwater beneath the former Machine Shop;
- The lateral extent of hydrocarbon contamination in soil at the former Drum Storage Area;
- The source of VOC groundwater contamination at the former Machine Shop area;
- Whether the source of TPH-mo at the former Drum Storage Area represented a surface release or a subsurface release from some other feature, such as nearby storm drain lines;
- The source of the TPH-d and TPH-mo in groundwater at well MW-52 is not clear; it was postulated that the hydrocarbons may be related to the soil contamination at the former Drum Storage Area or from some other source location, such as the nearby Pipe Mill to the south; and
- The purpose of the subsurface investigation in the southeastern portion of the Fabrication buildings was to assess the presence or absence of soil and groundwater contamination (PES, 2006c).

As discussed in the *Supplemental Remedial Investigation Workplan, Other Areas* (PES, 2006c), no previous environmental investigations had been conducted in the southeastern portion of the Fabrication buildings. Therefore, the purpose of the subsurface investigation in this area was to assess the presence or absence of soil and groundwater contamination.

During the initial phase of work for the supplemental remedial investigation, PES completed the following borings (see Plate 3 for boring locations):

- Two borings in the vicinity of the former Machine Shop area (MS1 and MS2); eight borings located within or immediately adjacent to the former Machine Shop could not be completed because the building was being demolished;
- Seven borings in the vicinity of the former Drum Storage Area (DS1 through DS7); and
- Ten borings in the vicinity of the former Assembly Bay, Warehouse, Electrical/Plumbing Shop area and the southeastern portion of the Fabrication Buildings (TB2, TB3, TB18 through TB21, TB24, TB25, TB48, and TB49); boring TB1 could not be completed because multiple layers of concrete were encountered in the subsurface that the direct-push rig and coring equipment could not penetrate.

A summary of the samples collected from these borings and the analyses performed on the samples is provided in Table 6. As indicated on this table, soil and groundwater samples were collected from each of these borings.

Based on the results of the September 2006 investigation, a second phase of work was conducted beginning in late October and continuing into the early part of November 2006. The purpose of this investigation and the work completed are summarized below:

- Nine borings were advanced that were not completed during the initial phase for reasons discussed above. These borings included MS3 through MS10 beneath the floor slab of the former Machine Shop and boring TB1 in the former Assembly Bay;
- Boring TB50 was advanced to further delineate the extent of TPH soil contamination in the vicinity of boring TB20, located in the eastern portion of Fabrication Bay 2; and
- Borings TB50, TB51, and TB52 were advanced to delineate the extent of TPH groundwater contamination in the vicinity of the former Assembly Bay and southeastern portion of the Fabrication buildings.

A summary of the samples collected from these borings and the analyses performed on the samples is provided in Table 6.

A third phase of work, which involved drilling boring TB55 (and other borings discussed in Volume 5 of the RI/FS/RAP), was conducted on November 20, 2006. The purpose of this boring was to assess the eastern extent of elevated TPH in groundwater found in the eastern portion of the Assembly Bay (i.e., at boring TB1). A summary of the samples collected from this boring and the analyses performed on the samples is provided in Table 6.

The pre-field activities, and sampling and analytical methods used for the supplemental remedial investigation are discussed in Sections 3.1.1 through 3.1.3. All drilling and sampling activities were conducted with oversight by a California Professional Geologist.

3.1.1 Pre-Field Activities

Drilling permits were obtained from the Napa County Department of Environmental Management prior to all phases of drilling. PES contacted Underground Service Alert more than 48 hours before beginning exterior drilling activities, and retained California Utility Surveyors, a private utility locating company, to clear all boring locations for subsurface utilities. A site-specific Health and Safety Plan was prepared for all sampling activities.

3.1.2 Sampling Methods

RSI Drilling (RSI) of Woodland, California, under subcontract to PES, utilized a direct-push drilling rig to advance the borings to the desired depth, which ranged between 11 and 16 feet bgs. Either a single- or dual-walled sampling system equipped with a clear acetate liner was used to collect continuous soil cores from the borings. Soil samples for VOC analysis were collected with an Encore™ sampling device.

A PES geologist observed the borehole drilling and prepared a lithologic log of the borings using the Unified Soil Classification System (USCS). The soil cores were screened for VOCs using a photoionization detector (PID) and the results were recorded on the lithologic log. Lithologic logs are presented in Appendix B. A lithologic log was not created for borings DS11 and DS12 because these locations were sampled for groundwater only. Therefore, soil cores for logging and sampling purposes were not collected.

To facilitate groundwater sampling, a 1-inch diameter schedule 40 polyvinyl chloride (PVC) well casing fitted with a 10- to 15-foot section of factory-slotted PVC well screen was lowered into the boring selected for groundwater sampling. Groundwater samples were collected from the PVC casing with a peristaltic pump. New tubing was used at each sampling location. The samples were collected in appropriate laboratory-provided sample containers.

Sample containers were labeled to indicate project location, job number, boring number, sample number, and time and date collected. The samples were immediately placed in a thermally-insulated cooler containing ice. The samples were picked up daily by a courier who transported them under chain of custody protocol to Curtis & Tompkins, LTD (C&T) of Berkeley, California. C&T is certified by the State of California for the requested analyses.

Downhole drilling and sampling equipment was cleaned via pressure washing or using a non-phosphate detergent and double-rinsed with potable water prior to use. Borings were backfilled with cement grout. Drill cuttings, equipment rinsate, and purged groundwater were containerized and stored at the Facility pending proper disposal.

3.1.3 Analytical Methods

All soil and groundwater samples delivered to C&T were accompanied by a completed sampler's chain of custody form. The following test methods were used to perform the analyses indicated in Table 6:

- VOCs by United States Environmental Protection Agency (USEPA) Test Method 8260B; and
- Total extractable hydrocarbons (i.e., reported as diesel [C10-C24] and motor oil [C24-C36]) by USEPA Test Method 8015B; a silica gel cleanup was included with this analysis.

3.2 Analytical Results

Analytical results for soil matrix and groundwater samples are presented in Tables 7 through 14. Analytical results for the former Machine Shop area are presented on separate tables because the contamination in this area is separate and associated with different sources than the contamination in the eastern portion of the Site (i.e., the former Drum Storage Area and the southeastern portion of the Fabrication Buildings). Laboratory analytical reports and chain of custody forms for samples analyzed by C&T are presented in Appendix J.

Plates 8 through 11 provide a graphical presentation of soil sampling results for TPH-mo and TPH-d. Selected groundwater-sampling results from the October 2006 monitoring event and the results from Shaw's 2005 investigation (Shaw, 2005) are shown on Plates 12 through 14. The nature and extent of contamination shown on these soil and groundwater plates, which also show selected results from previous investigations conducted at Site 6, are discussed in Section 4.0.

The soil and groundwater results presented on Tables 7 through 14 are compared to the residential ESLs discussed in Section 1.0 and presented on Table 1.

3.2.1 Soil Results

3.2.1.1 Petroleum Hydrocarbons

Former Drum Storage Area and Southeastern Portion of Fabrication Buildings

As shown in Table 7, TPH-d was detected in 50 of 60 soil samples analyzed for this constituent. Detected concentrations of TPH-d ranged from 1.0 mg/kg (3 to 3.5 feet sample from boring TB1) to 4,600 mg/kg (2 to 2.5 feet sample from boring DS1). Results for the following six samples were at concentrations greater than ESLs:

- Boring TB21 at 2 to 5.5 feet = 120 mg/kg;

- Boring DS4 at 2 to 2.5 feet = 420 mg/kg;
- Boring DS5 at 5 to 5.5 feet = 780 mg/kg;
- Boring TB20 at 1.75 to 2.25 feet = 1,000 mg/kg;
- Boring DS5 at 2 to 2.5 feet = 3,200 mg/kg; and
- Boring DS1 at 2 to 2.5 feet = 4,600 mg/kg.

TPH-mo was detected in 48 of 60 soil samples analyzed for this constituent (Table 7). Detected concentrations of TPH-mo ranged from 5.1 mg/kg (2 to 2.5 feet sample from boring DS7) to 9,800 mg/kg (1.75 to 2.25 feet sample from boring TB20). Results for the following three samples are at concentrations greater than ESLs:

- Boring DS5 at 2 to 2.5 feet = 3,200 mg/kg;
- Boring DS1 at 2 to 2.5 feet = 9,700 mg/kg; and
- Boring TB20 at 1.75 to 2.25 feet = 9,800 mg/kg.

Former Machine Shop Area

As shown in Table 8, TPH-d was detected in 11 of 20 soil samples analyzed for this constituent. Detected concentrations of TPH-d ranged from 1.0 mg/kg (7 to 7.5 feet sample from boring MS7) to 51 mg/kg (7 to 7.5 feet sample from boring MS5). None of the results are at concentrations greater than ESLs.

TPH-mo was detected in 10 of 20 soil samples analyzed for this constituent (Table 8). Detected concentrations of TPH-mo ranged from 5.5 mg/kg (7 to 7.5 feet sample from boring MS7) to 200 mg/kg (7 to 7.5 feet sample from boring MS5). None of the results are at concentrations greater than ESLs.

3.2.1.2 Volatile Organic Compounds

Former Drum Storage Area and Southeastern Portion of Fabrication Buildings

Acetone, methylene chloride, and 2-butanone were the only VOCs detected in soil in the southeastern portion of the Fabrication Buildings (Table 9). The maximum concentrations of these constituents were detected in the 7 to 7.5 feet bgs sample from boring TB1 at 440, 310, and 37 µg/kg, respectively. None of the detected VOCs are above ESL values.

Former Machine Shop Area

VOCs detected in soil at the former Machine Shop area include acetone, cis-1,2-DCE, TCE, and vinyl chloride (Table 10). These constituents, with the exception of acetone in boring MS9, were detected in the borings MS3, MS4, and MS5, which are located near the machinery pit in the northwestern portion of the former Machine Shop. The maximum concentrations of cis-1,2-DCE, TCE, and vinyl chloride were detected in boring MS5 at 82 µg/kg (7 to 7.5 feet bgs sample), 130 µg/kg (7 to 7.5 feet bgs sample), and 15 µg/kg (3 to 3.5 feet bgs sample), respectively. Vinyl chloride is the only VOC are above its ESL value of 6.7 µg/kg (Table 10).

3.2.2 Groundwater Results

3.2.2.1 Petroleum Hydrocarbons

Former Drum Storage Area and Southeastern Portion of Fabrication Buildings

TPH-d was detected in 20 of 27 groundwater samples analyzed for this constituent (Table 11). Detected concentrations of TPH-d ranged from 52 µg/l (boring DS7) to 58,000 µg/l (boring TB2). Results from the following three borings were at concentrations greater than the ESL of 2,500 µg/l:

- Boring DS10 = 4,600 µg/l;
- Boring DS5 = 9,700 µg/l; and
- Boring TB2 = 58,000 µg/l.

TPH-mo was detected in 11 of 27 groundwater samples analyzed for this constituent (Table 11). Detected concentrations of TPH-mo ranged from 540 µg/l (boring DS3) to 160,000 µg/l (boring TB2). Results from the following four borings were at concentrations greater than ESL of 2,500 µg/l:

- Boring TB1 = 3,000 µg/l
- Boring DS10 = 6,200 µg/l;
- Boring DS5 = 13,000 µg/l; and
- Boring TB2 = 160,000 µg/l.

Former Machine Shop Area

TPH-d was detected in 4 of 10 groundwater samples analyzed for this constituent (Table 12). Detected concentrations of TPH-d ranged from 62 µg/l (boring MS9) to 1,300 µg/l (boring MS5). None of the results are at concentrations greater than ESLs.

TPH-mo was detected in 3 of 7 groundwater samples analyzed for this constituent (Table 12). Detected concentrations of TPH-mo ranged from 320 µg/l (boring MS2) to 7,300 µg/l (boring MS5). The result from boring MS5 is above the ESL of 2,500 µg/l.

3.2.2.2 Volatile Organic CompoundsFormer Drum Storage Area and Southeastern Portion of Fabrication Buildings

Eleven (11) different VOCs were detected at low concentrations in the grab groundwater samples collected in the southeastern portion of the Fabrication buildings during the supplemental remedial investigation. VOCs were not detected in 8 of the 13 groundwater samples collected from the borings in this area and none of the detected VOCs are above ESL values (Table 13).

Former Machine Shop Area

At the former Machine Shop area, twenty (20) different VOCs were detected in the ten (10) grab groundwater samples collected during the supplemental remedial investigation (Table 14). As summarized below, only TCE and vinyl chloride were detected at concentrations above their respective ESLs:

- **TCE:** Detected above the ESL (530 µg/l) in boring MS4 (930 µg/l); and
- **Vinyl Chloride:** Detected above the ESL (3.8 µg/l) in boring MS5 (15 µg/l).

4.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of TPH and VOCs in soil and groundwater at Site 6 as identified from the various investigations is summarized below. TPH and VOCs have regularly been detected at Site 6 and are considered to be the chemical parameters of interest.

4.1 Nature and Extent of Contamination in Soil

The soil distribution maps presented on Plates 8 through 11 incorporate TPH data from the previous investigations discussed in Section 2.4, and from the recently conducted supplemental remedial investigation by PES. The following discussion of the nature and extent of petroleum

hydrocarbon contamination in soil has been divided into separate discussions for TPH-mo and TPH-d.

4.1.1 Petroleum Hydrocarbons

4.1.1.1 TPH as Motor Oil

The distribution of TPH-mo in soil beneath Site 6 is shown in the 0 to 4 feet bgs interval on Plate 8 and in 4 to 10 feet bgs interval on Plate 9. In general, results posted for the shallow depth interval correlate with the fill unit and those posted for the deeper depth interval correlate either with lower portions of the fill unit or the silt/clay unit. As shown in the explanation for each plate, the posted color dots represent various concentration ranges for TPH-mo, relative to the ESL and order of magnitude factors of the ESL.

In addition, the presence of a petroleum hydrocarbon sheen, staining, or separate-phase product in borings and wells completed at Site 6 is indicated on Plates 8 and 9 and cross section B-B' (Plate 5); this information was obtained from the lithologic logs created during PES's investigation and by others during previous investigations at Site 6 (see Appendices B and D, respectively). This information is presented on the TPH-mo soil plates rather than the TPH-d soil plates (i.e., Plates 10 and 11) because the borings containing sheens, staining, or separate-phase product are all located in the eastern portion of the Site 6 where TPH-mo concentrations are higher in soil and groundwater than TPH-d concentrations. The extent of petroleum hydrocarbon sheen, staining, or separate-phase product at Site 6 is discussed in Section 4.2.1.

As shown on Plates 8 and 9, areas where TPH-mo was detected in soil at concentrations above ESL values include:

- In boring 6D on the north side of the former Machine Shop;
- In various borings in the vicinity of the former Drum Storage Area; and
- In boring TB20 located in the easternmost portion of Fabrication Bay 2.

In general, the highest concentrations of TPH-mo in soil and the greatest extent of this constituent at concentrations above the ESL are found in the 0 to 4 feet bgs interval (Plate 8). As shown on Plates 9, TPH-mo concentrations generally decrease with depth. However, concentrations of TPH-mo above the ESL are found in the 4 to 10 feet bgs interval on the west and south sides of the former Drum Storage Area.

Based on the locations where elevated concentrations of TPH-mo occur in soil at Site 6, suspected sources include:

- North Side of Former Machine Shop: Possible releases of TPH in this area may have been associated with poor housekeeping and/or chemical handling practices. As

indicated by JMM (JMM, 1990a), solvent spills to the ground outside the Machine Shop in the vicinity of borings 6C and 6D were confirmed during the initial site reconnaissance conducted in September 1987 (JMM, 1987). This suggests that poor chemical handling practices occurred in this area in the past;

- Former Drum Storage Area: The source of TPH is likely associated with releases from the former Drum Storage Area. According to JMM (JMM, 1990a), cutting oils and solvents were stored in this area prior to use in the pipe mill; and
- Easternmost Portion of Fabrication Bay 2: The source in this area is not known.

4.1.1.2 TPH as Diesel

The distribution of TPH-d in soil at Site 6 is shown on Plates 10 through 11 using the same depth intervals as previously described for the distribution of TPH-mo. In general, TPH-d concentrations in soil are lower than the concentrations of TPH-mo.

As shown on Plates 10 and 11, areas where TPH-d was detected in soil at concentrations above ESL values include:

- In well MW-37 located on the south side of the former Machine Shop;
- In boring TB21 located on the south side of Fabrication Bay 2;
- In a few borings west and north of the former Drum Storage Area; and
- In boring TB20 located in the easternmost portion of Fabrication Bay 2.

With the exception of the elevated concentration in boring DS5, concentrations of TPH-d above the ESL are found in the 0 to 4 feet bgs interval (see Plates 10 and 11). The source of TPH-d in soil at well MW-37, and borings TB20 and TB21 is are not known. The source in the vicinity of the Former Drum Storage Area is believed to be the same as discussed for TPH-mo.

4.1.2 Volatile Organic Compounds

As discussed in Sections 2.4 and 3.2, the only VOC detected in soil at a concentration above ESLs was vinyl chloride at 3 to 3.5 feet bgs in boring MS5. The only area at Site 6 where VOCs were frequently detected in soil is in the vicinity of the machinery pit at the former Machine Shop and just north of this pit where boring MS5 is located. As indicated by JMM (JMM, 1990a), solvent spills to the ground outside the Machine Shop in the vicinity of borings 6C and 6D were confirmed during the initial site reconnaissance conducted in September 1987 (JMM, 1987). Boring MS5 is located between these borings (see Plate 3).

4.2 Nature and Extent of Contamination in Groundwater

The posted TPH-mo, TPH-d, TCE groundwater concentrations shown on Plates 12 through 14 are results obtained from the more recent investigations conducted at Site 6. The posted results were obtained from either: (1) the site assessment conducted by Shaw (Shaw, 2005) in October 2005 (i.e., boring MS-01 at the former Machine Shop area); (2) the supplemental remedial investigation conducted by PES in September through November 2006 (i.e., the MS, DS, and TB designated borings); or (3) the most recent Facility-wide groundwater monitoring event conducted by PES in October 2006 (i.e., monitoring well results). Groundwater results for samples collected from borings completed during investigations in the late 1980s and 1990s (see Section 2.4 for discussions of these investigations) were taken into consideration when drawing the concentration contours. However, because of natural attenuation processes, these historical results likely do not represent current conditions.

4.2.1 Petroleum Hydrocarbons

The following sections discuss the extent of separate-phase product and dissolved petroleum hydrocarbons in groundwater.

4.2.1.1 Separate-Phase Product

As discussed in Section 2.5, separate-phase product has historically been detected in well MW-52. The maximum thickness of separate-phase product detected in this well was 0.45 feet in May 2000. Separate-phase product was also detected in this well in December 2000 (0.11 feet thick) and in June 2001 (0.09 feet thick). Separate-phase product was not detected in this well during recent water level measurement events (see Tables 2 and 3). However, Jim Swindle, who oversees the operation and maintenance of interim remedial activities at Site 6, indicated (by personal communication, 2006) that product continues to accumulate on the oil absorbent sock placed in this well.

The presence of a petroleum hydrocarbon sheen, staining, or separate-phase product in borings and wells completed at Site 6 is indicated on Plates 8 and 9 and cross section B-B' (Plate 5). Based on the information obtained from the lithologic logs, a petroleum hydrocarbon sheen, staining, or separate-phase product was observed in the following borings, which are all located in the eastern portion of Site 6:

- **0 to 4 feet bgs interval (see Plate 8):** TB2, TB3, DS1, and 6K; and
- **4 to 10 feet bgs interval (see Plate 9):** TB51, DS3, DS6, 6K, MW-38, and MW-52.

4.2.1.2 Dissolved-Phase Petroleum Hydrocarbons

The distribution of TPH-mo in groundwater in the Site is shown on Plate 12. As shown on this plate, concentrations greater than the ESL of 2,500 µg/l are found: (1) in a small area on

the north side of the former Machine Shop; (2) in an area that extends westward from the former Drum Storage Area toward well MW-52; and (3) between borings TB1 and TB2 in the former Assembly Bay.

The distribution of TPH-d in groundwater is similar to TPH-mo, but is generally detected at lower concentrations (see Plates 12 and 13). Concentrations of TPH-d are 50% to 75% that of TPH-mo in the vicinity of the former Drum Storage Area, but are 3 to 5-times lower on the north side of the former Machine Shop and in the former Assembly Bay.

The highest concentrations of TPH-mo and TPH-d in groundwater are found in the former Assembly Bay as defined by the 50,000 µg/l contours on Plates 12 and 13. As shown on these plates, the distributions of TPH-mo and TPH-d in groundwater in the former Drum Storage Area shows a decreasing trend westward towards boring DS10, but then increases in the vicinity of well MW-52 before dropping off significantly in boring DS12. This trend suggests separate source areas for the TPH contamination in the eastern and western portions of this plume. The only detections of TPH-mo and TPH-d in groundwater at the former Machine Shop area occur in boring MS5, suggesting that the extent of these constituents are very limited in this area (see Plates 12 and 13).

Based on the locations where elevated concentrations of TPH-mo and TPH-d occur in groundwater at Site 6, suspected sources include:

- North Side of Former Machine Shop: Possible releases of TPH in these areas may have been associated with poor housekeeping and/or chemical handling practices. As indicated by JMM (JMM, 1990a), solvent spills to the ground outside the Machine Shop in the vicinity of borings 6C and 6D were confirmed during the initial site reconnaissance conducted in September 1987 (JMM, 1987). This suggests that poor chemical handling practices occurred in this area in the past;
- Former Drum Storage Area: The source of TPH in groundwater in the eastern portion of the TPH plume is likely associated with releases from the former Drum Storage Area where the plume appears to originate (see Plates 12 and 13). According to JMM (JMM, 1990a), cutting oils and solvents were stored in this area prior to use in the pipe mill. As mentioned above, a second source area may exist in the vicinity of well MW-52. A specific source in the vicinity of this well is not known, but activities associated with the adjacent railroad track are a possibility; and
- Former Assembly Bay: According to Jim Swindle (personal communication, 2006), who has worked at the Facility since the mid-1960s, a large machinery pit previously existed in the Assembly Bay in the vicinity of boring TB2. The source of petroleum hydrocarbons in groundwater may be related to releases from the former machinery pit or equipment associated with the pit. However, the exact location of this former pit is not known so it is not shown on the Site 6 plates.

4.2.2 Volatile Organic Compounds

As discussed in Section 3.2 and indicated on Table 5, the only constituents detected in groundwater at concentrations above ESLs during recent sample events are:

- **TCE:** Detected above the ESL (530 µg/l) in boring MS4 (930 µg/l); and
- **Vinyl Chloride:** Detected above the ESL (3.8 µg/l) in boring MS5 (15 µg/l) and well MW-11 (6.0 µg/l in the second quarter 2006 sampling event; below the ESL in the fourth quarter 2006 sampling event).

The distribution of TCE in groundwater is shown on Plate 14. The estimated extent of the area where TCE in shallow groundwater is above the ESL is also shown on this plate and is limited to the immediate vicinity of boring MS4. Boring MS5 and well MW-11 are located immediately north of boring MS4, which suggests that the TCE and vinyl chloride in groundwater may be from the same source. The vinyl chloride may be present as a degradation by-product of the parent product TCE. Possible sources of VOCs in this area are the solvent spills discussed above and potential releases from the machinery pit located inside the former Machine Shop (see Plate 14).

TCE was detected at concentrations significantly below the ESL during the second and fourth quarter 2006 monitoring events in deep well DW-7 (detected at a maximum concentration of 8.9 µg/l; see Table 5). This compound has historically been detected at low concentrations in this well. As discussed in Section 2.3.3, downward vertical gradients have generally been observed on the north side of the former Machine Shop.

4.3 Conceptual Site Model

Based on the data from Site 6 investigations to date, various suspected sources exist for the TPH and VOC contamination at Site 6, including (see Plate 3 for location of sources):

- **North Side of Former Machine Shop:** Releases in this area may have been associated with poor housekeeping and/or chemical handling practices as discussed above;
- **Former Drum Storage Area:** The source of the petroleum hydrocarbons in the eastern portion of this area are likely associated with releases from the former Drum Storage Area where cutting oils and solvents were stored in this area prior to use in the pipe mill (JMM, 1990a). As mentioned above, a second source area may exist in the vicinity of well MW-52. A specific source in the vicinity of well MW-52 is not known, but activities associated with the adjacent railroad track are a possibility; and
- **Former Assembly Bay:** A large machinery pit previously existed in the former Assembly Bay in the vicinity of boring TB2. The source of petroleum hydrocarbons in groundwater may be related to releases from the former machinery pit or equipment associated with the pit.

Surface releases at Site 6 likely migrated vertically through the more permeable fill unit and then laterally outward along the water-bearing portions of the fill unit and along the contact between the fill and silt/clay units. Some of this migration is likely due to smearing of the petroleum product via water table fluctuations. Secondary porosity features such as root holes, and more permeable lenses of peat and sands within the silt/clay unit likely also contributed to the migration of TPH and VOCs. However, based on the deeper TPH soil results (see Plates 9 and 11), the silt/clay unit appears to have generally impeded the downward migration of TPH-mo and TPH-d.

Once released to groundwater, the TPH and VOC constituents have generally not migrated significantly based on the distribution of contaminants in groundwater (see Plates 12 through 14). The lack of plume migration is attributed to generally flat gradients, the low permeable nature of the silt/clay unit, and natural attenuation. In addition, the seawall and drydocks act as a nearly impermeable barrier to water flow between the Shallow Groundwater Zone and the Napa River.

Results of groundwater monitoring activities since installation of the extraction trench in October 1997 indicate that the trench has been effective in controlling the migration of TCE and other VOCs groundwater contaminants in the vicinity of the former Machine Shop area. Based on the low concentrations of TCE historically detected in well DW-7, the Deep Groundwater Zone has been minimally impacted by the shallow groundwater contamination on the north side of the former Machine Shop despite the slight downward gradients.

5.0 CONTAMINANT FATE AND TRANSPORT

As part of the *Site 6 Characterization and Remedial Action Plan* (MW, 1996), MW discussed chemical fate and transport for the compounds of interest (i.e., VOCs in the vicinity of the former Machine Shop area and TPH in the eastern portion of Site 6). PES has reviewed the chemical fate and transport section of this report (i.e., Section 4.5 – Migration of Compounds of Interest in Groundwater) and generally concurs with the information presented. Therefore, Section 4.5 of MW's report is included in Appendix K because it is considered applicable to the current conditions at the Site 6, including the southeastern portion of the Fabrication Buildings.

In summary, MW indicated that constituent migration beneath Site 6 is induced primarily in the downgradient direction by the convective flow of groundwater (i.e., the natural movement of groundwater as represented by the average groundwater velocity). They also indicated constituent migration is slower than the groundwater because their migration is retarded by mechanisms of adsorption and natural attenuation. MW listed adsorption, hydrolysis, oxidation, reduction, and biodegradation as mechanisms of natural attenuation that retard migration.

Based on their analysis, MW indicated that adsorption may reduce constituent migration rates at Site 6 by the following retardation factors (e.g., a retardation factor of 5 indicates that the migration of constituents is occurring at one-fifth of the groundwater velocity):

- VOCs: An estimated retardation factor of 2 was considered reasonable for the migration of VOCs in the silty clays at Site 6; and
- TPH: MW selected xylene, a compound present in TPH, as an indicator compound to model the retardation factor for TPH. The estimated retardation factor for xylenes is 8.

Using a retardation factor of 2 and a groundwater flow rate of 9 feet per year (ft/yr), MW calculated a migration rate for cis-1,2-DCE (degradation product of TCE) of 4.5 ft/yr in the Shallow Groundwater Zone. They indicated that considering only the retardation from adsorption, it would take approximately 330 years for the VOC groundwater plume in the vicinity of the former Machine Shop area to migrate around the drydocks and discharge into the Napa River approximately 1,500 feet downgradient. Because TPH is less mobile than VOCs (i.e., retardation factor of 8), the potential for TPH to migrate from the eastern portion of the Site to the Napa River is considered low.

The migration estimate discussed above was done prior to the installation of the extraction trench on the north side of the former Machine Shop. Since the installation of the extraction trench in October 1997, the plume has been generally confined to the immediate vicinity of the former Machine Shop. As discussed in Section 2.4.6, concentrations of TCE in well MW-11, which is located close to the extraction trench, have been declining since an initial increase after the installation of the extraction trench.

6.0 CHEMICALS OF CONCERN AND REMEDIATION EXTENT

This section summarizes the chemicals of concern (COC) identified during the previous investigations conducted at Site 6, specifies the chemicals to be remediated and associated Site cleanup levels and defines the extent of soil and groundwater media that will require remediation (i.e., the areas that exceed the cleanup levels).

6.1 Chemicals of Concern

Chemicals of concern for soil and groundwater were selected on the basis of the following primary factors:

- Chemicals previously identified in cleanup plans (e.g., MW, 1996) as COCs were retained;
- Frequency of detection. Chemicals detected at a frequency greater than 5% were further evaluated for possible retention as a COC; and

- Exceedance of ESLs. If a chemical was frequently detected and soil or groundwater concentrations were above an ESL, the chemical was retained as a COC.

6.1.1 Soil

As noted above and in MW's *Site 6 Characterization and Remedial Action Plan* (MW, 1996) petroleum hydrocarbons are the primary chemicals of concern in soil. For soil, TPH-mo and TPH-d are considered the primary petroleum hydrocarbon parameters requiring remediation. Table 15 summarizes the occurrence of petroleum hydrocarbons detected in soil samples, including their frequency of detection and number of detections above ESLs, separately for (1) the former Machine Shop area; and (2) the former Drum Storage Area and southeastern portion of the Fabrication Buildings. Although other petroleum hydrocarbon compounds were tested for in prior investigations (i.e., TPH⁵ and O&G), these chemicals are not specifically treated as COC because either: 1) the analytical method did not specifically identify the type of petroleum hydrocarbon (TPH and O&G); or 2) they were infrequently tested for and their presence is likely an artifact of chromatogram overlap of TPH-d or TPH-mo. For TPH and O&G, the results were considered to represent TPH-mo results and were compared to TPH-mo ESL values, as noted on Table 15. TPH-d and TPH-mo are retained as COC throughout the Site.

For VOCs, the following compounds were frequently detected (i.e., using a 5% frequency of detection as the criterion; see Table 16):

- Former Machine Shop Area: 2-butanone, acetone, methylene chloride, TCE, tetrahydrofuran, and cis-1,2-DCE; and
- Former Drum Storage Area and Southeastern Portion of the Fabrication Buildings: Acetone.

Of these, none exceeded its respective ESL value. Therefore, no VOCs in soil are retained as a COC.

6.1.2 Groundwater

Tables 17 through 18 summarize the detections, frequency of detection and number of detections above ESLs for petroleum hydrocarbons and VOCs in groundwater, respectively. Again, these tables summarize the data separately for (1) the former Machine Shop area; and (2) the former Drum Storage Area and southeastern portion of the Fabrication Buildings. The groundwater results summarized in the tables are for the most recent groundwater sampling results from the fourth quarter 2006 monitoring event and recent grab groundwater sampling investigations.

Both TPH-d and TPH-mo are frequently detected in groundwater in these areas (Table 17). Both TPH-mo and TPH-d exceeded their respective ESLs in the former Drum Storage Area

and southeastern portion of the Fabrication Buildings. Therefore, these constituents are retained as COCs in these areas. At the former Machine Shop area, only TPH-mo exceeded its ESL value. Therefore, TPH-mo is retained as a COC in this portion of the Site.

Numerous VOCs including both chlorinated VOCs, methyl-tert-butyl ether (MTBE), and the BTEX (benzene, toluene, ethylbenzene, and xylenes) compounds were detected in groundwater (Table 18). However, only vinyl chloride and TCE were detected both frequently and exceeded their ESL values; these compounds were detected in groundwater at the former Machine Shop and are retained as COCs in this area. In the former Drum Storage Area and southeastern portion of the Fabrication Buildings, ten VOCs were detected frequently in groundwater (see Table 18), but none were at concentrations that exceed ESL values. Therefore, VOCs are not retained as a COC in this portion of the Site.

A summary table for metals in groundwater was not prepared because they were not analyzed in the samples recently collected at the Site. However, as discussed in Section 2.4, none of the groundwater metals results during past investigation exceeded ESL values. Therefore, metals are not retained as COC in groundwater.

6.1.3 Summary of Chemicals of Concern

Using the sorting process described above, the following chemicals were retained as chemicals of concern for soil and groundwater. As an indication of the relative importance of each COC, a summary of the number of samples exceeding the ESLs is also included.

Former Machine Shop Area

- Soil
 - TPH-mo: 3 samples (includes TPH and O&G results treated as TPH-mo); and
 - TPH-d: 1 sample.
- Groundwater
 - TPH-mo: 1 sample;
 - TCE: 1 sample; and
 - Vinyl chloride: 1 sample.

Former Drum Storage Area and Southeastern Portion of Fabrication Buildings

- Soil
 - TPH-mo: 16 samples (includes TPH and O&G results treated as TPH-mo); and
 - TPH-d: 6 samples.
- Groundwater
 - TPH-mo: 6 samples; and
 - TPH-d: 5 samples.

6.1.4 Cleanup Levels for Chemicals of Concern

As described in detail in Section 1.1, the ESLs were selected for use as cleanup levels for the Site. For the soil and groundwater COCs at the Site, the cleanup levels are as follows:

Soil:

<u>Parameter</u>	<u>Residential ESL Shallow Soil (0-3 feet bgs) (mg/kg)</u>	<u>Residential ESL Shallow Soil (3 to 10 feet bgs) (mg/kg)</u>	<u>Residential ESL Deep Soil (> 10 feet bgs) (mg//kg)</u>
TPH-d	100	400	5,000
TPH-mo	500	1,000	5,000

Groundwater:

<u>Parameter</u>	<u>Nondrinking Water ESL (µg/l)</u>
TPH-d	2,500
TPH-mo	2,500
TCE*	530; 360
Vinyl Chloride	3.8

* Currently, both the presence of the seawall and functioning of the groundwater extraction trench mitigate potential threats to the river posed by the TCE plume in the vicinity of the former Machine Shop. Because the extraction trench is planned for removal (see Section 11.1.3), the ESL for protection of aquatic habitat (360 µg/l) will apply to cleanup of the TCE plume. The 530 µg/l value applies to all other areas outside of the former Machine Shop area.

6.2 Areas Requiring Remediation

This section identifies the portions of the Site where soil or groundwater concentrations exceed the applicable cleanup levels and are therefore the target of remedial actions.

6.2.1 Areas and Volumes of Soil Exceeding Cleanup Levels

As described in Section 6.1.1, only TPH-d and TPH-mo were detected above their respective cleanup levels in soil. The areal extent and volume of soil requiring remediation is defined by the soil samples that exceed the cleanup levels for TPH (see Plates 15 and 16).

Former Machine Shop Area

Unsaturated Soil. For unsaturated soils, the TPH data results presented on Plates 8 and 10 were used to delineate the area where it is likely that TPH concentrations exceed the cleanup levels; this area is shown on Plate 15. As shown on Plate 15, there are only three relatively small and isolated areas totaling approximately 2,800 square feet (sf) in size. Assuming an unsaturated zone thickness of 4 feet, the in-place volume of unsaturated soil that exceeds the cleanup levels in this area is approximately 400 cubic yards (cy).

Saturated Soil. For saturated soils, the TPH data presented on Plates 9 and 11 were used to delineate the area where it is likely that TPH concentrations exceed the cleanup levels. In addition to this soil data, information presented on these plates regarding the estimated extent of the separate-phase/sheen area was used to delineate the area where saturated soil likely exceeds the soil cleanup levels; this area is shown on Plate 16. Based on the available data, there are no areas in the Former Machine Shop area that exceed the soil cleanup levels in the saturated zone.

Former Drum Storage Area and Southeastern Portion of Fabrication Buildings

Unsaturated Soil. For unsaturated soils, the TPH data results presented on Plates 8 and 10 were used to delineate the area where it is likely that TPH concentrations exceed the cleanup levels; this area is shown on Plate 15. This area is primarily located around the former Drum Storage Area with two smaller areas located in the Assembly Bay and totals approximately 38,000 sf in size. Assuming an unsaturated zone thickness of 4 feet, the in-place volume of unsaturated soil that exceeds the cleanup levels in this area is approximately 5,600 cy.

Saturated Soil. For saturated soils, the TPH data presented on Plates 9 and 11 were used to delineate the area where it is likely that TPH concentrations exceed the cleanup levels. This area is focused in the area located just south of the former Drum Storage Area and also one isolated area located around monitoring well MW-52. These areas are shown on Plate 16 and include a total area of approximately 18,600 sf in size. Based on the available data, it is assumed that the impacted saturated soil zone extends from 4 to 10 feet bgs. Therefore, assuming a saturated thickness of 6 feet, the in-place volume of saturated soil that exceeds the cleanup levels in this area is approximately 4,100 cy.

Summary of Site 6 Soil Volumes

The total volume of soil exceeding cleanup level for all of Site 6 (i.e., the Former Machine Shop area and Former Drum Storage Area and Southeastern Portion of Fabrication Buildings) is estimated to be:

- **Unsaturated Soil:** 6,000 cy; and
- **Saturated Soil:** 4,100 cy.

6.2.2 Areas and Volumes of Groundwater Exceeding Cleanup Levels

Former Machine Shop Area

As described in Section 6.1.2, the primary groundwater COCs that exceed their respective cleanup levels are TPH-mo, TCE, and vinyl chloride. The elevated TPH concentration is limited to boring MS5 and the elevated VOC concentrations are limited to the area around the nearby boring MS4.

As shown on Plate 16, a total area of approximately 2,900 sf has TPH and/or VOC concentrations exceeding the cleanup levels; as noted above, there is no area where saturated soil exceeds the soil cleanup levels. Assuming the same 6 feet thick saturated thickness as for the saturated soils, the total in-place volume of saturated soil in the area exceeding groundwater cleanup levels is 700 cy.

Former Drum Storage Area and Southeastern Portion of Fabrication Buildings

As shown in Plates 12 through 14, the primary groundwater COCs that exceed their respective cleanup levels are TPH-mo and TPH-d. The elevated TPH is concentrated in two main areas, one located south of the former Drum Storage Area extending southwest towards MS-52 and the other area in the eastern Assembly Bay area.

As shown on Plate 16, a total area of approximately 77,600 sf has TPH concentrations exceeding the cleanup levels that includes: (1) the 18,600 sf where saturated soil exceeds the cleanup levels; and (2) an additional 59,000 sf where only groundwater concentrations exceed the cleanup levels. Assuming the same 6 feet thick saturated thickness as for the saturated soils, the total in-place volume of saturated soil in the area exceeding groundwater cleanup levels is 13,100 cy.

7.0 FEASIBILITY STUDY SCOPING

7.1 Scope of the Feasibility Study

This feasibility study is focused on developing remedial actions that address soil and groundwater affected by COCs identified at the Site, primarily petroleum hydrocarbons and VOCs. As defined in Section 6.2, the areas where soil and groundwater exceed applicable cleanup levels are shown in Plates 15 and 16. For soils, there is approximately 6,000 cy of unsaturated soil and approximately 4,100 cy of saturated soil that exceed the applicable soil the cleanup levels (primarily TPH-d and TPH-mo). Contaminants in groundwater not only exceed groundwater cleanup levels in the area where saturated soils exceed soil cleanup levels, but also exceed groundwater cleanup levels (primarily for TPH compounds) in an area approximately 59,000 sf in size adjacent to the contaminated soil areas (see Plate 16). This

area where only groundwater cleanup levels are exceeded encompasses another approximately 13,800 cy (i.e., 700 cy + 13,100 cy) of saturated soil.

This feasibility study specifically addresses the Site, and the conclusions and recommended remedial action can be implemented independently of other remedial actions being considered elsewhere at the Facility. It is important to recognize, however, that the remediation of the Site will potentially be conducted concurrent with the other areas of contamination (e.g., Site 2/3, Site 4) and that although some differences do exist between the various sites, the contaminant types are generally similar from site to site. This similarity in contaminant types leads to the possibility that certain remediation technologies will likely have applicability to more than one site and economies of scale may be recognized. See Volume I for a more detailed discussion of how the remediation activities of the different sites may be integrated.

7.2 Applicable or Relevant and Appropriate Requirements and “To Be Considered” Factors for Impacted Soil and Groundwater

In developing remedial action objectives, Applicable or Relevant and Appropriate Requirements (“ARARs”) must be considered. ARARs are described in 40 CFR Paragraph 300.430(e)(2)(i) and derived from the National Oil and Hazardous Substances Contingency Plan (“NCP”), set forth in 40 CFR Part 300. The selected remedial alternative must comply with the ARARs. It should also, to the extent practicable, reflect and account for other regulatory policy and criteria that while not necessarily legally applicable, are “to be considered” (TBC) during the development of remedial actions. ARARs and TBCs can be subdivided into three categories:

- **Chemical specific ARARs and TBCs** are health-based or risk-based standards that define the allowable limits of specific chemical constituents detected in or discharged to the environment. Cleanup and discharge levels that determine Site remedial goals can be provided by chemical specific ARARs. The RWQCB’s ESLs are examples of potential chemical specific TBCs;
- **Location-specific ARARs and TBCs** can apply to natural features located on a site, such as the presence of endangered species, seasonal wetlands, or flood plains and to man-made features and institutional factors, including zoning requirements, landfills, and locations of archaeological or historical significance. Location-specific ARARs restrict the types of remedial actions that can be implemented based on the site-specific characteristics or location; and
- **Action-specific ARARs and TBCs** are activity-based or technology-based limitations that can set design and performance restrictions. These ARARs specify engineering controls and permit requirements that must be instituted during site activities, or restrict specific activities. The Federal Occupational Safety and Health Administration (OSHA) regulations regarding worker health and safety requirements, and California OSHA (Cal-OSHA) requirements for noise control and dust control during construction are examples of action specific ARARs.

7.2.1 Potential Chemical-Specific ARARs and TBCs

The primary potential chemical-specific ARARs for the Site are as follows:

- Federal Drinking Water Standards (40 CFR Part 141) and California Drinking Water Standards (22 CCR Section 64435) or MCLs;
- Porter-Cologne Water Quality Control Act, California Water Code, Division 7, Section 13000 et seq.; and
- National Pretreatment Standards (40 CFR Part 403).

The following are the identified potential chemical-specific TBCs for the property:

- RWQCB's Screening For Environmental Concerns at Sites With Contaminated Soil and Groundwater (4th edition, February 2005).

7.2.2 Potential Location-Specific ARARs and TBCs

The National Archeological and Historic Preservation Act (16 USC Section 469, 36 CFR Part 65) is the only location-specific ARAR identified for the Site. Although wetlands are located south and west of the Site, they are not located within or near the areas requiring remediation.

7.2.3 Potential Action-Specific ARARs and TBCs

Identified action-specific ARARs and TBCs for the property are presented below. The following are potential action-specific ARARs for the Site:

- Resource Conservation and Recovery Act (RCRA) regulations (40 CFR Parts 261 through 268; and California Code of Regulations [CCR] Sections 66261 through 66268);
- Land Disposal Unit Criteria (40 CFR Part 264.221, et seq., 22 CCR Section 66264.221, et seq.);
- Clean Water Act (40 CFR Parts 100-149), including National Pollutant Discharge Elimination System (NPDES) Permit Requirements;
- Safe Drinking Water and Toxics Enforcement Act of 1986 (Proposition 65), State of California;
- Hazardous Materials Transportation Regulations (49 CFR Part 107, 171-177);
- Clean Air Act (42 USC Section 7401, et seq.);

- Applicable Napa County Codes and Ordinances;
- Bay Area Air Quality Management District (BAAQMD) Rules and Regulations: Organic Compounds, Regulation 8; and Hazardous Pollutants, Regulation 11;
- Occupational Safety and Health Administration (29 CFR Part 1910.120 et seq.); and
- Cal-OSHA (Title 8).

The following are potential action-specific TBCs for the property:

- San Francisco Bay Basin Plan, Region 2, Water Quality Control Plan.

7.3 Additional Factors for Remedial Action Objective Development

In addition to the regulatory requirements summarized above in Section 7.2, there are several significant non-regulatory considerations that play a role in the evaluation of remedial technologies and alternatives, and ultimately in the selection of a recommended remedial action plan for Site 6. These additional factors include:

- **Unrestricted Land Use.** Napa County is currently updating its General Plan. Use of substantial portions of the Site for residential purposes is within the range of plans currently being studied. Accordingly, to maximize the long-term protectiveness of remedial alternatives relative to the foreseeable land uses, remedial actions at the Site should, to the extent practicable, achieve cleanup levels without extensive use of institutional or engineering controls to control or limit exposure. In other words, cleanups should remediate soil and groundwater to below risk-based cleanup levels and leave the Site with no, or as few as possible, restrictions or long-term remedial actions (e.g., deed restrictions, monitoring, maintenance of engineering controls) as possible;
- **Need for Clean Imported Soil.** Remedial actions that result in soils being transported off-site will likely require the importing of the same volume of clean soil back onto the Site. In addition, the conceptual redevelopment plan for the Facility includes raising the ground surface approximately 2 to 3 feet using imported soil. This presents an opportunity for soils excavated from one remedial site to be treated, as necessary, and placed as fill in other portions of the Facility in order to achieve final grade requirements;
- **Timeframe to Achieve Cleanup.** In light of the County's on-going planning process and currently anticipated redevelopment proposals, remedial actions should be completed, and the cleanup objectives for the Site met, in a relatively short timeframe; and
- **Available Area for Remedial Actions.** The Facility is quite large (approximately 150 acres), the majority of which is not known to be contaminated and is available for

use in the various remedial actions, including the remediation of the Site. This available land can be used for soil stockpiling, used to locate treatment systems (e.g., thermal treatment systems for soil) or processing areas (e.g., open areas for use as “landfarms”), or as a final location for placement of treated soils. Portions of the Facility, especially the southern portion, are to be zoned commercial within the Napa County Airport flyover zone. Therefore, cleanup standards in those commercially-zoned areas are proposed to be consistent with those uses.

These additional factors will influence the remedial strategies to be considered. For example, use of containment technologies such as capping, slurry walls, or hydraulic control (groundwater extraction) will not meet cleanup levels for groundwater or soil in a timely fashion and thereby would require extensive institutional and engineering controls.

7.4 Remedial Action Objectives

Remedial Action Objectives (RAOs) are goals specific to a facility, area, or to an affected medium (e.g., soil or groundwater) that are developed for protection of the environment and human health. RAOs for affected soil and groundwater are intended to guide remedial actions that mitigate the identified potential threats to human health and the environment. These objectives should be developed in a manner consistent with reasonably foreseeable future Site uses (i.e., residential and commercial uses). RAOs can address both chemical concentrations and potential exposure pathways. The RAOs for soil and groundwater, described in Sections 7.4.1 and 7.4.2, respectively, were developed based on the conceptual model described in Section 4.3, the cleanup levels defined for the site in Section 6.1.4, the ARARs listed in Section 7.2, and the additional factors described above in Section 7.3.

7.4.1 RAOs for Soil

The following RAOs have been developed for soil:

- Reduce concentrations of COCs in soil to below the lowest applicable cleanup level listed in Section 6.1.4 to the maximum extent practicable; and
- Minimize the use of and reliance on institutional and/or engineering controls to the extent practicable.

7.4.2 RAOs for Groundwater

The following RAOs have been developed for groundwater:

- Reduce concentrations of COCs in groundwater to below the lowest applicable cleanup levels listed in Section 6.1.4 to the maximum extent practicable; and
- Minimize the use of and reliance on institutional and/or engineering controls to the extent practicable.

7.5 General Response Actions

General response actions (GRAs) are broad categories of remedial actions that may be used alone or in combination with other GRAs to achieve the RAOs for the site. The GRAs that are potentially applicable to the remediation of the Site include:

- **No Action:** A “no action” alternative is required to be evaluated as a baseline alternative against which other remedial alternatives are compared. No other remedial action would be conducted;
- **Institutional Controls:** Institutional controls, such as deed restrictions on land or resource restrictions (e.g., water use restrictions), can be used to supplement engineering controls or in conjunction with active remedial alternatives to reduce or limit exposure to hazardous substances. As discussed in Section 10.0, even though institutional controls are in general not as protective of human health and the environment as active remediation, they will be retained as a GRA;
- **Engineering Controls:** Engineering controls are physical measures that prevent or minimize exposure to hazardous substances or reduce the mobility or migration of hazardous substances and can be combined with institutional controls, as required, to achieve protection of human health and the environment. Although engineering controls typically require long-term maintenance and, as mentioned above for institutional controls, tend to be somewhat less protective than active remediation, they will be retained as a GRA; and
- **Active Remediation:** These remedial actions include a broad range of technologies designed to remove or destroy contaminants in specific media. Active remedial actions typically are more protective of human health and the environment compared to the no action alternative as well as institutional and engineering controls. Active remedial actions are generally preferred because they: (1) provide the best long-term protection of human health and the environment; (2) result in the reduction of the mobility, toxicity, and volume of contaminants; and (3) restore the property to its highest productive use. In this feasibility study, active remedial actions are evaluated for soil and groundwater and each of these categories is further subdivided into: (1) in situ remediation options; and (2) ex situ remediation options. Active remediation for soil utilizing on-site treatment and off-site disposal are also evaluated.

8.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

Remedial technologies are actions that can be implemented at the site to address one or more of the RAOs. There may be more than one technology and associated processes that could be appropriate for any portion of a remedial site. Once identified, the potentially applicable technologies are screened based on specific criteria to determine if they should be retained for

use in development of remedial alternatives. This section describes the process and the results of identifying and screening remedial technologies potentially applicable to achieving the RAO requirements at the Site.

8.1 Preliminary Technology Identification and Screening

8.1.1 Technology Identification

Potentially applicable conventional and innovative remedial technologies and cleanup processes were identified and evaluated to address the RAOs. A preliminary list of potential applicable technologies were identified based on the physical and chemical nature of the Site contaminants (primarily TPH-mo, TPH-d, VOCs), the impacted media (soil and groundwater), the Site conditions (shallow groundwater table, extent of contamination, subsurface lithology), and the RAOs. Tables 19a and 19b list the potentially applicable remediation technologies and processes for soil and groundwater, respectively, that were evaluated to identify those that would be retained for development of the remedial alternatives.

In addition to chemical-specific technology limitations, implementing a remedy at the Site is limited by several constraints including:

- **Buildings and Structures.** Buildings or structures currently occupy a significant portion of the Site. For purposes of this FS, it is assumed that existing structures, including building foundations, will be removed prior to initiating remedial actions;
- **Subsurface Utilities.** Subsurface utilities, including water, gas, electric, and product lines, are likely located throughout the affected area. Because of the age of the Facility, the location and depth of some subsurface piping and utilities is not known with certainty. For purposes of this FS, it is assumed that subsurface utilities will be removed or deemed insignificant for remedial implementation purposes, prior to initiating remedial actions; and
- **Existing Monitoring Well and Extraction System Abandonment** – Existing monitoring wells and the extraction system that are within, or adjacent to, areas where remedial activities could damage the wells, or monitoring wells that will no longer be needed, will be abandoned as part of demolition and site preparation activities prior to initiating remedial actions.

8.1.2 Technology Screening

Screening of the potentially applicable technologies used the following criteria to determine whether a potential remediation technology and process was appropriate for achieving the site RAOs:

- **Effectiveness** – the ability to treat the Site contaminants and meet the RAOs;

- **Implementability** – constraints or difficulties in implementing the technology and verifying effectiveness; and
- **Cost** – estimated costs for construction, operation, and maintenance of the technology to meet the RAOs. Cost is used primarily to differentiate between technologies or process options that had similar effectiveness and implementability but significantly different costs.

Based on the screening criteria, technologies were either retained for use in development of remedial alternatives or eliminated from consideration. The screening process for soil and groundwater technologies is summarized in Tables 19a and 19b, respectively, including the rationale for retaining or eliminating particular technologies. The technologies retained for use in development of remedial alternatives are described in more detail in the sections below.

8.2 Soil Treatment Technologies

The affected soil area and volume at the Site are specified in Section 6.2.1 and shown in Plates 15 and 16. As noted in Section 6.1.1, the primary COCs in the soil at the Site are TPH-mo and TPH-d, which are present in concentrations that exceed cleanup levels in the unsaturated and saturated zones. Potentially applicable technologies include those that are capable of effectively destroying or removing the contaminants in either zone. The soil remediation technologies can destroy the contaminants *in situ* within the subsurface or *ex situ* following excavation. Reducing contaminant concentrations in the soil will also reduce the potential for migration of contaminants to groundwater, thereby increasing the efficiency of subsequent groundwater cleanup.

Fourteen preliminary soil treatment technologies were identified and screened against the criteria defined above. These include conventional as well as alternative and innovative technologies. The results of the screening process are shown in Table 19a. Of the 14 technologies that were identified, six were retained for further evaluation after initial screening and are described in more detail below.

8.2.1 Excavation

Contaminated soils can be excavated using standard construction techniques and equipment, such as excavators, bulldozers, and scrapers. Excavated soils can then be managed using other remediation technologies depending on contaminant type and concentration, cleanup levels, and regulatory requirements. Limiting factors related to excavation include:

- Excavation of impacted soils may expose potentially volatile contaminants to the atmosphere and may require respiratory protection for workers or other nearby receptors as well as special excavation techniques to limit emissions;
- Excavation of saturated soils may require dewatering with subsequent management of the impacted groundwater generated by the dewatering activities;

- Shoring or other slope stabilization techniques (e.g. lay backs) will likely be required for excavations greater than 4 feet depth, and especially for excavations below the groundwater table; and
- Backfilling of excavations in the saturated zone may require importing engineered fill.

Because excavation is an implementable technology that would effectively remove the contaminated soil from the subsurface thereby eliminating the potential for future exposures and eliminating the potential for the soil to act as a source of groundwater contamination, and because it is a required first step when using *ex situ* treatment and soil management approaches, excavation will be retained for further evaluation.

8.2.2 *Ex Situ* Low Temperature Thermal Desorption

Low Temperature Thermal Desorption (LTTD) is an *ex situ* remedial technology that uses heat to increase the volatility of the contaminants and physically separate them from the soil. The impacted soil is excavated and placed in a thermal desorption unit where it is heated. The system is designed to separate contaminants from the soil rather than destroy them. A vacuum system is used to convey the volatilized products to a vapor treatment system where the contaminants are treated prior to atmospheric discharge. There are two common thermal desorption types: the rotary dryer and thermal screw.

Rotary dryers are horizontal cylinders that can be indirect or direct fired. Most rotary systems use an inclined rotating metallic cylinder where the soil is heated. For the thermal screw systems, hollow augers transport the soil through a jacketed trough and the soil is indirectly heated. All thermal desorption systems require treatment of the volatilized vapors to remove particulates and contaminants. Particulates are removed by wet scrubbers or fabric filters, and contaminants are removed by carbon adsorption or destroyed in a secondary combustion chamber or catalytic oxidizer.

The maximum temperature is limited by the material properties of the heated components. For LTTD, the soil is heated to between 200 and 600°F. Target contaminants are VOCs and fuels with destruction efficiencies in the vapor phase treatment system of greater than 95 percent. The treated soil retains its physical properties, and unless heated to the higher end of the temperature range, natural organic components are not damaged. Limiting factors include:

- Large particles and debris – adversely impacts material handling, pre-feed requirements, and destruction efficiencies;
- Moisture – adversely impacts material handling, residence time, heating requirements, and destruction efficiencies. At moisture concentrations greater than 20 percent, drying the soil prior to the LTTD is highly recommended;
- Highly abrasive feed (e.g., large gravel and rocks) - adversely impacts desorber operation (may result in damage);

- High contaminant concentrations – adversely impacts desorber operation (may result in overheating and damage), handling requirements (may require blending), and disposal options;
- Heavy metals - adversely impacts treated soil (potentially requiring stabilization) and disposal options; and
- Clay and silty soils - adversely impacts reaction time as a result of contaminant binding or soil sticking to the cylinder.

Because the primary contaminants in soil (TPH-d, TPH-mo) are effectively treated using this technology, and the soil type and overall contaminant concentrations are suitable, and because it is implementable, *ex situ* LTTD was retained for further evaluation.

8.2.3 Biopiling

Biopiles are an *ex situ* remediation technology that involves stockpiling excavated soils into aboveground cells with interlayered process piping and systems to introduce fresh air, nutrients, and moisture as needed to stimulate aerobic biodegradation of the target contaminants. Biopiles are specifically constructed to optimize conditions for aerobic activity. The soils can be blended as needed to increase air permeability, homogeneity, and microbial population and ensure sufficient oxygen, moisture, and nutrients can be supplied throughout the pile. Measures are required to prevent contaminated vapors from being released into the atmosphere or liquids from draining into previously clean soil and groundwater. Additionally, regular monitoring is necessary to ensure optimization of biodegradation rates, track contaminant concentration reductions, and ensure ambient air and groundwater quality are not impacted. Limiting factors include:

- Soils with high percentage of fines and a high degree of saturation – adversely impacts air flowrates;
- Separate-phase product – adversely impacts contaminant biodegradation rates (may be toxic to the microorganisms);
- Low contaminant concentrations – adversely impacts contaminant biodegradation rates due to less substrate for the microorganisms;
- High molecular weight compounds – adversely impacts contaminant biodegradation rates;
- Colder, wet climates – adversely impacts contaminant biodegradation rates (may require climate control measures); and
- High contaminant volatility – impacts system operation (may require treatment technology).

Because the primary contaminants in soil (TPH-d, TPH-mo) may be effectively treated using this technology, the treatment costs may be less when compared to *ex situ* LTTD, and it can be implemented in the available space, biopiling was retained for further evaluation.

8.2.4 Landfarming

The technology is the same as described for biopiles except the excavated soils are spread in a thin layer on the ground. Soil aeration is generally accomplished by tilling or plowing rather than by engineered measures such as process piping and air introduction systems. Because of the larger area of the land farm as compared to the biopiles, additional measures may be necessary to prevent soil and wind erosion and control surface water runoff and dust generation.

Because the primary contaminants in soil (TPH-d, TPH-mo) may be effectively treated using this technology, the treatment costs may be less when compared to *ex situ* LTTD or biopiling, and there may be sufficient available space to implement this technology, landfarming was retained for further evaluation.

8.2.5 *In Situ* Chemical Oxidation

This is an *in situ* remedial technology where chemical oxidants are injected into the subsurface to chemically convert contaminants into non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. For *in situ* soil treatment, this technology is almost exclusively applied to saturated soil; unsaturated soils (i.e., vadose zone) are very difficult to treat *in situ* using this technology due to problems associated with chemical delivery, distribution and contact in the soil.

The chemical oxidants most commonly used include hydrogen peroxide, persulfate, ozone, and permanganate. These oxidants have been able to cause rapid and complete chemical destruction of toxic organic compounds, and other organics have become amenable to subsequent bioremediation. The technology can achieve destruction efficiencies greater than 90% for unsaturated aliphatic compounds (e.g., TCE), aromatic compounds (e.g., benzene), and fuel-related organics with fast reaction rates. Matching the oxidant and delivery method to the contaminants and site conditions is critical to successful implementation and achieving performance goals. Limiting factors include:

- Soils with high percentage of fines – can adversely impact distribution of chemical oxidants within the target treatment zone;
- Soils with highly stratified lithology – adversely impacts the uniform delivery of chemical oxidants;
- The quantities of chemical oxidants required to ensure that target contaminants are oxidized can be large which may adversely impact handling and safety requirements;

- Indiscriminant and rapid reactions with other oxidant-consuming substances (natural organic matter, reduced minerals, carbonate, and other free radical scavengers) increase oxidant demand and can adversely impact contaminant destruction; and
- Inadvertent oxidation induced effects – adversely impacts soil properties (may decrease pH, generate colloids that result in reduced permeability, mobilize sorbed metals, form toxic byproducts, and increase temperatures and contaminated vapors).

Because the primary contaminants for the Site (TPH-d and TPH-mo) are amenable to treatment using this technology, chemical oxidation was retained for further evaluation. Site soils are not ideal for *in situ* technologies such as chemical oxidation, but the relatively shallow distribution of contaminants and thin treatment zone may make implementation of oxidants feasible.

8.2.6 Off-Site Disposal

Impacted soil can be excavated and then disposed of at a permitted off-site landfill. The specific landfill that soil may be taken to will depend in part on the characterization of the soil with respect to state and federal hazardous waste regulations. Given the relatively high cost of off-site disposal, and the additional cost associated with replacing all soils taken off-site with imported fill, it is not anticipated that off-site disposal will be used as the primary approach for managing excavated soil. There may be situations, however, when unusual soil conditions and/or the presence of other contaminant types not currently identified (e.g., metals) are encountered. In these situations, other on-site treatment technologies may not be suitable and off-site disposal may be required. Therefore, off-site disposal was retained for further evaluation.

8.3 Groundwater Treatment Technologies

The affected groundwater area at the Site and volume of saturated soil associated with this affected groundwater are specified in Section 6.2.2 and shown on Plate 16. As noted in Section 6.1.2, the primary COCs in the groundwater at the Site are TPH-mo, TPH-d, TCE, and vinyl chloride. The only area where VOCs define the extent of groundwater exceeding a cleanup level (i.e., in areas where TPH do not exceed the cleanup level) is the small area around boring MS4; TCE and vinyl chloride exceed their cleanup levels (see Plate 16). Other VOCs and several SVOCs are also present in groundwater in the Site at concentrations below their ESLs, but at much lower concentrations than the primary COCs and are generally co-located with the primary COCs that are present at much higher concentrations.

Identified potentially applicable technologies include those that are capable of effectively destroying or removing the contaminants. The groundwater remediation technologies can destroy the contaminants *in situ* within the subsurface or *ex situ* following extraction or excavation of the saturated soil.

Ten preliminary groundwater treatment technologies were identified and screened against the criteria defined above. These included conventional as well as alternative and innovative technologies. The results of the screening process are shown in Table 19b. Of the ten technologies that were identified, two *ex situ* technology and two *in situ* technologies were retained for further evaluation after initial screening and are described in more detail below.

8.3.1 *In Situ* Enhanced Bioremediation

This *in situ* technology refers to the addition of oxygen, nutrients, co-substrates, and/or other amendments to the groundwater to increase whatever natural aerobic and/or anaerobic biodegradation rates that may be ongoing. The existing microorganisms are used to metabolize the organic contaminants in the groundwater. Limiting factors include:

- Soils with high percentage of fines – can adversely impact distribution of oxygen, nutrient, co-substrates, and other amendments within the target zone;
- Excessive localized microorganism growth – adversely impacts system operation (may result in clogging nutrient and water injection wells);
- Soils with highly stratified lithology – adversely impacts delivery of oxygen, nutrients, co-substrates, and other amendments to the microorganisms;
- High contaminant concentrations/separate-phase product – adversely impacts contaminant biodegradation rates (may be toxic to the microorganisms);
- Very low contaminant concentrations – adversely impacts contaminant biodegradation rates due to less substrate for the microorganisms;
- High molecular weight compounds – adversely impacts contaminant biodegradation rates; and
- The possible need for both aerobic and anaerobic conditions/processes to effectively treat the range of contaminants present (e.g., TPH compounds via aerobic processes and chlorinated VOCs via anaerobic processes).

The primary COCs in groundwater at the Site (TPH-d and TPH-mo) would be effectively treated using enhanced biodegradation and the technology can be readily implemented at the Site. Saturated Site soils are not ideal for *in situ* technologies such as enhanced bioremediation, but relatively shallow distribution of contaminants makes effective application of amendments more feasible.

8.3.2 *In Situ* Chemical Oxidation

This *in situ* technology uses oxidizing agents to oxidize and destroy organic contaminants. This is a direct chemical reaction involving the application or injection of oxidants into the

target zone to destroy or chemically transform the contaminants. Efficient oxidation depends on the reaction potential and the effective contact between oxidant and contaminant. Subsurface heterogeneities, preferential flow paths, and poor mixing in the subsurface may result in inefficient treatment. Additionally, oxidation is non-specific, and the oxidant will be consumed not only by the contaminant, but also by natural demands within the target zone. These include other organic material and reduced-state metals.

There are a number of oxidants that are potentially usable, including ozone, persulfate, hydrogen peroxide, and permanganate. Of these, ozone, persulfate, peroxide, and permanganate are the most widely used and are generally commercially available. Some oxidants (e.g., ozone and peroxide) are very strong and effective, but also rapidly decompose which can limit the ability to distribute them in the subsurface. Permanganate and persulfate are also strong oxidants and do not decompose as readily as peroxide and ozone and therefore can be easier to distribute in the subsurface. Matching the oxidant and delivery method to the contaminants and site conditions is critical to successful implementation and achieving performance goals. Limiting factors include:

- Saturated soils with high percentage of fines can adversely impact distribution of chemical oxidants within the target treatment zone;
- Saturated soils with highly stratified lithology may present preferential flow pathways that can adversely impact the uniform delivery of chemical oxidants;
- The quantities of chemical oxidants required to ensure target contaminants are oxidized can be large which may adversely impacts handling and safety requirements;
- Indiscriminant and rapid reactions with other oxidant-consuming substances (natural organic matter, reduced minerals, carbonate, and other free radical scavengers) increase oxidant demand and can adversely impact contaminant destruction; and
- Inadvertent oxidation induced effects – adversely impacts soil properties (may decrease pH, generate colloids that result in reduced permeability, mobilize sorbed metals, form toxic byproducts, and increase temperatures and contaminated vapors).

Because chemical oxidation would effectively treat the primary contaminants for the Site (TPH-d and TPH-mo and to a lesser extent VOCs), it was retained for further evaluation. Site conditions are not ideal for *in situ* technologies such as chemical oxidation, but the relatively shallow distribution of contaminants and thin treatment zone may make implementation of oxidants feasible.

8.3.3 Saturated Soil Excavation

This is an *ex situ* technology that involves physically removing the contaminated groundwater by excavating the saturated soil within the groundwater plume boundaries and dewatering, as necessary. Excavation for removal of contaminated soils (i.e., with COCs exceeding soil

cleanup levels) is discussed in Section 8.2.1. Excavated saturated soil would be managed on-site through drying, treatment, or other appropriate methods and used as fill. Provisions are necessary to remove and control groundwater within the excavation boundaries. The excavation boundaries will overlap into clean areas to ensure the entire volume of the groundwater plume is removed. Limiting factors include:

- Excavation of saturated soil becomes increasingly more difficult and expensive the deeper contamination extends below the water table;
- High permeability saturated soils may result in excessive amounts of groundwater being generated by dewatering of the excavation, significantly increasing difficulty and cost; and
- Large excavations may require phased implementation.

Because contamination is relatively shallow at the Site and the soils are generally low permeability, excavation of saturated soils is an effective and implementable approach and will quickly remove the groundwater plume.

8.3.4 Existing Wastewater Treatment System

Excavation would require management of contaminated groundwater generated during dewatering activities. The Facility has an existing wastewater treatment system that discharges into the sanitary sewer under a permit with the Napa County Sanitation District. This system includes storage tanks, chemical injection systems (flocculant injection), settling tanks, an oil/water separator, and is maintained and periodically sampled to meet discharge requirements. Groundwater generated during dewatering can be treated using this existing wastewater treatment system and discharged to the sanitary sewer under the existing permit. If additional treatment is required to remove dissolved organic constituents (TPH, VOCs) to below permit limits, a series of granular activated carbon vessels can be added as a polishing step prior to discharge.

8.4 Summary of Retained Remedial Technologies

The technologies retained for use in alternative development include:

- **Soil Technologies**
 - Excavation;
 - *Ex Situ* Low Temperature Thermal Desorption;
 - Biopiling;
 - Landfarming;
 - Off-Site Disposal; and
 - *In Situ* Chemical Oxidation.

- **Groundwater Technologies**
 - *In Situ* Enhanced Bioremediation;
 - *In Situ* Chemical Oxidation;
 - Saturated Soil Excavation; and
 - Existing Wastewater Treatment System.

These technologies include *in situ* and *ex situ* technologies for both soil and groundwater. All of the retained technologies are likely to be effective at treating the Site contaminants, are implementable, have costs that are not disproportionate to other retained technologies, and will likely meet the RAOs, but optimizing the manner in which these technologies may be utilized most effectively (and therefore most cost-effectively) will likely require limited treatability studies during the design process. Based on the results of these treatability studies and the variability in contaminant concentrations present at the Site, it is likely that one technology may be most effective at treating soil and/or groundwater with lower contaminant concentrations whereas another technology may be most effective for higher concentrations.

9.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Remedial alternatives are combinations of technologies designed to meet the RAOs. The technologies retained from the screening process were assembled into the three remedial alternatives described below that could treat the contaminants in soil and groundwater and protect public health. Each remedial alternative is described in the following sections with respect to conceptual design, implementation, effectiveness and performance, estimated cleanup time, and estimated cost. The conceptual design is developed in sufficient detail to conduct the detailed comparative evaluation of the alternatives (Section 10.0).

The duration of remedy alternatives was estimated using engineering judgment and general knowledge of the remediation technologies. Depending on the nature of the alternative, the duration of the cleanup can be difficult to predict because numerous site conditions and processes impact the effectiveness of the remediation technologies that make up an alternative. Therefore, the alternatives were compared on the basis of the estimated relative effectiveness of the technologies and the likelihood that cleanup could be achieved in a timeframe consistent with the reasonably foreseeable future land use.

The costs of the remedial alternatives discussed below were developed by accounting for capital costs as well as recurring and future costs. Capital costs include workplans, design reports, other agency-required documents, and construction to implement the remedy. Recurring and future costs include groundwater monitoring, operation and maintenance, and reporting.

A contingency of 30 percent was added to each alternative to reflect a level of uncertainty in the estimated costs. The contingency on capital cost reflects uncertainty in construction costs. The contingency on recurring and future costs generally reflects uncertainty of the operation

and maintenance costs and the duration of the remedy. These cost estimates should be considered accurate in the range of minus 30 percent to plus 50 percent of the estimated cost. Consistent with regulatory guidance for preparation of feasibility studies. The cost estimates are rounded to the nearest \$10,000.

9.1 Approach to Developing Remedial Alternatives

The approach to developing remedial alternatives for the Site is based both on the requirements of the RAOs and on the technologies retained based on the screening conducted in Section 8.0. The RAOs require that the remediation achieve cleanup levels minimizing the use of institutional or engineering controls after remediation is completed. These requirements are consistent with the general policies of state and federal cleanup regulations and guidance that favor remedial strategies that clean up and restore contaminated sites and that accommodate the range of reasonably foreseeable land uses. Since the anticipated future use of the Site includes residential development, remedial approaches relying on containment or risk-management approaches were not preferred.

The NCP requires a “no action” alternative be evaluated, and one is included in the development and evaluation of alternatives below. Typically, where existing remedial measures have occurred or are ongoing, an alternative is included in the feasibility study that, to varying degrees, maintains the existing remedial actions. At the Site, the existing RWQCB orders (Order No. 90-147 and Order No. R2-2205-0012) require, among other things, the ongoing operation of the groundwater extraction trench located on the north side of the Former Machine Shop (see Section 2.5 for details) and groundwater monitoring to document groundwater contaminant levels (refer to Section 2.4.6 for details). While these existing engineering and institutional controls would not, either by themselves or in conjunction with other similar measures, meet the RAOs for the Site, a remedial alternative based on the existing measures is included for evaluation in the FS.

9.1.1 General Remediation Approaches

Rather than developing separate remedial alternatives to evaluate each of the technologies individually, both the *in situ* and *ex situ* technologies will be retained and evaluated together as separate “tool boxes” for soil and groundwater remediation. The specific “tools” to be used in an alternative are defined in the alternative descriptions below. If an alternative is selected for implementation, the manner in which the tool box technologies would be applied may be optimized during design and in conjunction with the other remedial actions being conducted at other sites within the Facility.

With respect to developing remedial alternatives that meet the RAOs, this tool box approach leads to the following two general remedial alternatives that will be evaluated:

- An *in situ* approach for groundwater and some soils, excluding the primary source area. Unsaturated soil exceeding the ESLs and highly contaminated soils within the primary source area will be addressed using *ex situ* technologies; and
- An all *ex situ* approach that involves excavation of all soil and groundwater (i.e., saturated soil) exceeding cleanup levels and managing the excavated soils using one of more of the *ex situ* treatment technologies, as needed.

An *in situ* approach for all saturated soil and groundwater, including the primary source area, is not deemed feasible due to the uncertainties about effectively treating the source area soil where separate-phase product may be present and the associated very high costs in attempting this type of treatment.

Additional development of the tool box approach for *in situ* and *ex situ* remediation is provided below, followed by a detailed description of the remedial alternatives to be evaluated in the FS.

9.1.2 *In Situ* Tool Box

The retained technologies for *in situ* remediation of soil and groundwater consists of enhanced bioremediation and chemical oxidation. These technologies can be implemented separately or, depending on the chemistry utilized, together in a complimentary way.

For purposes of this FS, the *in situ* approach would consist of injecting a combination of sodium persulfate and calcium peroxide. Sodium persulfate is a stable, highly soluble, crystalline material, which upon activation generates the sulfate radical, a very strong oxidant, capable of oxidizing a broad range of compounds including fuel hydrocarbons. The calcium peroxide has a dual activating effect on the persulfate by the release of peroxide and by creating alkaline conditions. The degradation of the calcium peroxide would also provide a longer term source of oxygen, which would enhance the biodegradation of the petroleum-related contaminants. Finally, the sulfates generated by the reaction of persulfate can be also utilized by sulfate bacteria. These sulfate bacteria can assist in the bioremediation of the contaminants when the aquifer is converted from an aerobic system to an anaerobic system following consumption of oxygen by bacteria that aerobically degrade the petroleum hydrocarbons.

This dual chemical blend would be introduced to the subsurface through a series of injections. Geoprobe technology would be used to advance injection rods to the maximum depth of the vertical contaminant treatment zone (e.g., 10 feet bgs). The chemicals will be injected through the bottom of the rods into the surrounding formation as the rods are retracted upwards through the entire length of the vertical contamination zone. The rate and total volume of treatment chemistry injected into the formation would be monitored to ensure an even distribution of treatment chemistry throughout the entire length of the vertical contamination zone. Once injected, the chemicals will disperse into the saturated zone through advective transport and dispersion.

As noted above, this *in situ* approach is best suited to saturated soil and groundwater outside of the primary source area and is not readily applicable to the primary source area or unsaturated soil. The source area and unsaturated soils will be addressed by *ex situ* technologies in all remedial alternatives developed below.

9.1.3 *Ex Situ* Tool Box and Soil Management Protocol

The first step in any *ex situ* remediation approach is removing the affected media from the subsurface so it can be managed using other technologies. For both soil and groundwater, excavation would be the approach used, with groundwater being “excavated” by removing the saturated soil (including the groundwater) as well as by the incidental dewatering that might be required as part of excavating below the water table.

Once removed from the subsurface, the soil would be segregated and managed using the tool box of *ex situ* treatment technologies consistent with a soil management protocol that will be developed during remedial design and documented in a Remedial Design and Implementation Plan (RDIP). The RDIP will be a document that presents a detailed protocol for managing all soil excavated not only at the Site, but for all remedial actions at the Facility. Included in the protocol will be requirements for confirmation sampling and analysis to confirm excavated (and treated, if necessary) soils have met cleanup levels. With respect to the soils from the Site, the soil management protocol would utilize the *ex situ* treatment technologies retained in Section 8.0. Based on analytical testing results, soil would be segregated into the general categories listed below and managed by category as follows:

- 1) **Clean Overburden** – Unsaturated soil with contaminant concentrations below the cleanup levels that has to be excavated to access contaminated saturated soils or groundwater below. This soil would be stockpiled near the excavation and then reused as backfill (assuming it is suitable from a geotechnical perspective) after remedial activities are completed.
- 2) **Soil Exceeding Residential ESLs but Below Commercial Cleanup Levels** – Unsaturated or saturated soil that has concentrations of COCs in excess of the residential cleanup levels but below the commercial cleanup levels would be transported to commercially-zoned areas (e.g., the areas south of the ECB), dried as necessary, and used as fill in these areas without further treatment.
- 3) **Soil Exceeding both Residential and Commercial Cleanup Levels** – Unsaturated or saturated soil that has concentrations of COCs in excess of both residential and commercial cleanup levels would be transported to a central stockpile area for contaminated soil and treated using one or more of the treatment technologies in the “tool box.” Soil falling in this general category would likely be further segregated (e.g., unsaturated vs. saturated, total TPH concentrations greater than 30,000 mg/kg) to facilitate effective treatment. Once treated to below cleanup levels (verified through confirmation sampling and analysis), the soil would be used as fill at the Facility.

- 4) Saturated Soil from Groundwater Plume Areas** – Saturated soils located in areas where concentrations of COCs in groundwater exceed groundwater cleanup levels, but COC concentrations in soil are below soil cleanup levels, would be transported to a stockpile area, dried as necessary, and used as fill at the Facility (residential or commercially-zoned areas) without further treatment.

Three of the four categories (1, 2, and 4) defined above would not require that the excavated soil be treated prior to use as fill at the Facility. For the third category, some treatment of the soil would be required before the soil can be used as fill. One or more of the following retained *ex situ* treatment technologies would be used:

- Biopiling;
- Landfarming; and
- *Ex Situ* Low Temperature Thermal Desorption.

All of these technologies are able to effectively treat the Site contaminants and the manner in which they would be utilized are defined in the alternative descriptions below. During development of the soil management protocol and the RDIP, the implementation approach will be optimized based on a variety of factors including contaminant concentrations of specific soil, the type and quantity of soil being remediated elsewhere at the Facility, the results of treatability studies, and refined cost estimates based on a detailed design.

Finally, off-site disposal is also retained for use as part of the soil management protocol for those situations when unusual soil conditions and/or the presence of other contaminant types not currently identified (e.g., metals) are encountered. In these situations, other on-site treatment technologies may not be suitable and off-site disposal may be required.

9.2 Alternative 1 – No Action

9.2.1 Alternative Description

The “no action” alternative is required by the NCP. In this alternative, no cleanup of soil or groundwater would be conducted and no additional groundwater monitoring would be conducted (the existing groundwater monitoring wells are assumed to be decommissioned during demolition activities).

9.2.2 Cost

There is little or no cost associated with implementing the no action alternative.

9.3 Alternative 2 – Maintain Existing Remedial Actions

9.3.1 Alternative Description

In this alternative, the status quo is maintained via continued groundwater monitoring and operation of the existing extraction system as specified in the existing RWQCB orders, and the existing remedial plan (MW, 1994). For cost estimating purposes, the extraction system is assumed to be operated for another 20 years. The groundwater monitoring program is also assumed to continue for 20 years.

9.3.3 Cost

The annual costs for implementing Alternative 2 (i.e., continued groundwater monitoring) is estimated to be \$50,000. The net present value of the O&M costs for this alternative over the durations defined above, and assuming a discount rate⁷ of 5%, is \$620,000.

9.4 Alternative 3 – Ex Situ Source Area Soil and Groundwater Treatment and In situ Groundwater Plume Remediation

9.4.1 Alternative 3 Description

Alternative 3 consists of two major components: (1) excavation and *ex situ* treatment of source area saturated and unsaturated soils and groundwater; and (2) *in situ* treatment of groundwater exceeding cleanup levels but outside of the source area. The excavation of the source area would be conducted first in order to both remove the source contaminants and also to induce hydraulic gradients from the surrounding plume areas toward the excavation through dewatering activities. The dewatering would not only remove some of the contaminated groundwater for treatment, but the increased hydraulic gradients may assist in the distribution of the chemical oxidants to be used in the *in situ* treatment phase of the remediation.

Excavation and Ex Situ Treatment of Source Area Soil and Groundwater. For purposes of this FS, the source area of the Site is defined as including: (1) unsaturated soils exceeding the cleanup levels (see Plate 15); and (2) the saturated soil and groundwater located in the area where saturated soils exceed the soil cleanup levels (Plate 16). As described in Section 6.2, these two areas include 6,000 cy and 4,100 cy of soil, respectively, for a total excavation volume of approximately 10,100 cy.

The approach for managing the excavated soil is described above in Section 9.1.3, with the soil being segregated into categories based on contaminant levels and managed consistent with a soil management protocol. Where treatment is required to achieve cleanup levels, technologies in the “tool box” would be utilized as defined below. The initial excavation would be the unsaturated soils exceeding cleanup levels and the clean overburden required to be removed to

⁷ Discount rate equals interest rate minus inflation rate.

access the underlying saturated zone soils. The clean overburden would be stockpiled nearby for later use as backfill, and the soil exceeding the cleanup levels would be segregated by contaminant level and taken to the appropriate stockpile and/or treatment area for processing as defined below.

Next, the source area saturated zone would be excavated. Excavating the saturated zone would involve some form of dewatering. Groundwater generated during excavation dewatering, which will contain elevated contaminant levels, would be collected and transported to the existing wastewater treatment system for pretreatment prior to discharging to the sanitary sewer under the Facility's existing permit. It is assumed that granular activated carbon (GAC) adsorption vessels would be added to the existing treatment system to reduce the dissolved organic level prior to discharge. As with the unsaturated soils, the excavated saturated soils would be segregated by contaminant level and taken to the appropriate stockpile and/or treatment area for processing. If these saturated soils require the additional step of drying before they can be further treated, they would be spread and dried in a separate area designed such that water draining from the soil can be collected and treated on site.

The technologies retained in the "tool box" for managing soil *ex situ* include biopiling, landfarming, low temperature thermal desorption, and off-site disposal. Based on the available information and for purposes of developing a cost estimate for this FS, it is assumed that excavated soils would be managed as follows:

- Approximately 1,000 cy (10 percent) would have contaminant levels below commercial cleanup levels (verified through confirmation sampling and analysis) and can be used directly as fill in the commercially-zoned areas (after drying if necessary);
- Approximately 5,100 cy of the soil (50 percent), generally those with low to moderate contaminant levels, would be treated directly using biopiling techniques to at least commercial cleanup levels (verified through confirmation sampling and analysis) and used as fill in the commercially-zoned areas;
- Approximately 3,000 cy of the soils (30 percent), generally those with moderate to high contaminant levels, would be treated using low temperature thermal desorption, sampled to confirm cleanup levels have been met, and then used as fill; and
- Approximately 1,000 cy of the soil (10 percent) would require off-site disposal.

The above percentages are based on general technology limitations and available contaminant distribution information and are intended to be representative of technologies retained in the "tool box." As noted above, during development of the soil management protocol and the RDIP, the implementation approach will be optimized based on a variety of factors as well as detailed analysis of COC concentrations or specific requirements for individual technologies.

Verification soil samples would be collected from the excavation areas using a hand sampler and earthmoving equipment to evaluate whether the target cleanup levels have been met.

Verification sample analyses would likely be performed utilizing an expedited laboratory turn-around schedule, or an on-site mobile laboratory, in order to reduce the likelihood for significant delays to affect the remedial action schedule. In addition to verification soil sampling, it is anticipated that soil gas samples would be collected from shallow soil to confirm that residual contamination that may be present at depth, although below applicable soil or groundwater ESL values, is not causing an exceedance of a soil gas ESL. Should laboratory analytical results indicate that the cleanup level has not been attained, additional excavation will be performed.

Once the excavation is completed, it would be backfilled using a combination of recycled concrete (generated during demolition of the existing Facility building foundations) and imported granular fill to the approximate elevation of the water table and then using clean overburden, clean imported fill, or potentially soils treated to below the residential ESLs. In order to prevent the recontamination of the clean backfill in the saturated zone, amendments may be added to the backfill to promote enhanced biodegradation of contaminants in groundwater that flow back into the former excavation.

In Situ Treatment of Groundwater Outside of the Source Area. The area where groundwater exceeds cleanup levels outside the source area is shown on Plate 16. As described in Section 6.2, this area comprises approximately 1.5 acres and contains an estimated 13,800 cy of saturated soil. The general approach to the *in situ* treatment of the groundwater in this area is described above in Section 9.1.2 and consists of *in situ* chemical oxidation and enhanced bioremediation using a sodium persulfate/calcium peroxide blend. For cost estimating, it is assumed that the blend would consist of a 5 to 1 mix of 25 percent sodium persulfate and 25 percent calcium peroxide.

Based on the existing information, the sodium persulfate/calcium peroxide mixture would be injected using Geoprobe technology. For cost estimating, it is assumed the injection points would be spaced approximately 10 feet apart, and with an assumed average radius of influence of approximately 6 feet, this should provide overlap of the coverage provided by each injection point. With this assumed spacing, it would take approximately 590 injection locations to effectively treat the target area.

Monitoring the effectiveness of the *in situ* treatment would be accomplished through a network of monitoring wells installed in the treatment area before the injections occur. Several pre-injection monitoring events would be conducted to establish pre-treatment baseline concentrations. Post-treatment monitoring would be conducted to confirm that cleanup levels have been achieved and that no “rebound” of contaminant concentrations is occurring. A typical post-treatment monitoring program would consist of a round of sampling 2 weeks after injection, 6 weeks after injection, 3 months after injection, and then quarterly for three events to provide a year of monitoring data. If cleanup levels in certain areas are not met initially, or concentrations “rebound,” additional injections of oxidant would be required.

In addition to the groundwater monitoring described above, it is anticipated that soil gas samples would be collected from shallow soil to confirm that residual groundwater contamination, although below their respective soil or groundwater cleanup levels, is not causing an exceedance of a soil gas ESL.

9.4.2 Cost

The costs associated with implementing Alternative 3 are shown in Table 20. The capital costs for Alternative 3 include excavation and treatment of soils, *in situ* treatment of groundwater, placing treated soil as fill, amending the backfill to promote biodegradation of residual contaminants, and managing groundwater generated during dewatering. Operations and maintenance (O&M) costs associated with Alternative 3 are limited to short-term post-treatment monitoring of the *in situ* treatment area.

The estimated capital costs for Alternative 3 range from a low of \$1.27 million to a high of \$2.30 million, with an average capital cost of \$1.79 million. Average O&M costs are estimated at \$147,000 assuming one year of post-treatment monitoring. Total remediation costs for Alternative 3, using the average capital and O&M costs, are estimated at \$1.94 million. It is assumed that implementation of Alternative 3 would begin in 2008 and that all capital costs will be incurred during 2008, although some *ex situ* soil treatment activities could extend into 2009. O&M costs (groundwater monitoring) would extend into 2009.

9.5 Alternative 4 – Ex Situ Soil and Groundwater Remediation

9.5.1 Alternative Description

Alternative 4 consists of the excavation and *ex situ* treatment of all saturated and unsaturated soils and groundwater that exceed their respective cleanup levels. The areas that would be excavated are defined in Plates 15 and 16. As described in Section 6.2, the estimated volume of soil exceeding cleanup levels includes 6,000 cy of unsaturated soil and 4,100 cy of saturated soil. The area where only groundwater exceeds cleanup levels (Plate 16) contains an additional 13,800 cy of saturated soil. The total estimated volume of soil to be excavated in Alternative 4 is 23,900 cy.

The approach for managing the excavated soil is described above in Section 9.1.3, with the soil being segregated into categories based on contaminant levels and managed consistent with a soil management protocol. Where treatment is required to achieve cleanup levels, technologies in the “tool box” would be utilized as defined below. The initial excavation would be the unsaturated soils exceeding cleanup levels and the clean overburden required to be removed to access the underlying saturated zone soils. The clean overburden would be stockpiled nearby for later use as backfill, and the soil exceeding the cleanup levels would be segregated by contaminant level and taken to the appropriate stockpile and/or treatment area for processing as defined below.

Next, the saturated zone would be excavated as described above for Alternative 3, with dewatering activities used as necessary and the generated groundwater would be collected and treated onsite using the existing wastewater treatment system prior to discharging to the sanitary sewer under the Facility's existing permit. The excavated saturated soils would be segregated by contaminant level and taken to the appropriate stockpile, dried as necessary prior to reuse or treatment, and then managed as defined below.

Similar to Alternative 3, the "tool box" of *ex situ* soil treatment technologies would be used to manage the excavated soil. Based on the available information and for purposes of developing a cost estimate for this FS it is assumed that excavated soils would be managed as defined in Alternative 3 with the exception that all of the 13,800 cy of soil being excavated to remove the areas where groundwater exceeds cleanup levels (but soil concentrations are below cleanup levels), would have soil concentrations below residential cleanup levels and could be used as fill without additional treatment beyond drying. With these assumptions, the excavated soil in Alternative 4 would be managed as follows:

- Approximately 14,800 cy (62 percent) would have contaminant levels below commercial cleanup levels (verified through confirmation sampling and analysis) and could be used directly as fill in the commercially-zoned areas (after drying if necessary);
- Approximately 5,100 cy of the soil (21 percent), generally those with low to moderate contaminant levels, would be treated directly using biopiling techniques to at least commercial cleanup levels (verified through confirmation sampling and analysis) and used as fill in the commercially-zoned areas;
- Approximately 3,000 cy of the soils (13 percent), generally those with the highest contaminant levels, would be treated using low temperature thermal desorption sampled to confirm cleanup levels have been met and then could be used as fill; and
- Approximately 1,000 cy of the soils (4 percent) would require off-site disposal.

Once the excavation is completed, it would be backfilled using a combination of recycled concrete (generated during demolition of the current building foundations) and imported granular fill to the approximate elevation of the water table and then using clean overburden, clean imported fill, or potentially soils treated to below the residential cleanup levels. In order to prevent the recontamination of the clean backfill in the saturated zone, amendments may be added to the backfill to promote enhanced biodegradation of contaminants in groundwater that flow back into the former excavation.

As described above for Alternative 3, verification soil and soil gas samples would be collected to evaluate whether the target cleanup levels have been met. Should verification results indicate that the cleanup level has not been attained, additional excavation would be performed.

9.5.2 Cost

The costs associated with implementing Alternative 4 are shown in Table 21. The capital costs for Alternative 4 would include excavation and treatment of soils, placing treated soil as fill, amending the backfill to promote biodegradation of residual contaminants, and managing groundwater generated during dewatering. There are no ongoing O&M costs associated with Alternative 4.

The estimated capital costs (and total remediation costs since there are no O&M costs) for Alternative 4 range from a low of \$1.30 million to a high of \$2.42 million, with an average capital cost of \$1.86 million. It is assumed that implementation of Alternative 4 would be conducted in 2008 and that all capital costs will be incurred during 2008, although some *ex situ* soil treatment activities could extend into 2009.

10.0 EVALUATION OF REMEDIAL ALTERNATIVES

The following section: (1) summarizes the criteria for evaluation of remedial alternatives; (2) evaluates the four remedial alternatives against the evaluation criteria and RAOs; (3) presents a comparative evaluation of the four alternatives against each other with respect to the evaluation criteria and RAOs; and (4) recommends a preferred remedial alternative for implementation to address soil and groundwater contamination at the Site.

10.1 Criteria for Evaluation

In addition to the RAOs developed in Section 7.4, each remedial alternative will be evaluated against the nine evaluation criteria set forth in the NCP and accompanying USEPA guidance documents (NCP, 1990 and USEPA, 1998). These nine criteria are divided into three categories: “Threshold Criteria,” “Primary Balancing Criteria,” and “Modifying Criteria.”

In accordance with USEPA guidance in the NCP, the selected alternative is required to meet the two threshold criteria. The five primary balancing criteria provide comparisons between the alternatives and identify tradeoffs between them. The two modifying criteria consider acceptance by the State and by the local community. The nine evaluation criteria are described below.

10.1.1 Threshold Criteria

1. **Overall Protection of Human Health and the Environment.** This criterion addresses whether a remedial alternative is protective of human health and the environment considering long-term and short-term site-specific characteristics. The remedy’s short-term effectiveness, long-term effectiveness and permanence, and ability to reduce chemical toxicity, mobility, and volume affect the evaluation under this criterion. This

criterion considers the degree of certainty that an alternative can meet the site-specific remedial action levels.

2. **Compliance with Applicable or Relevant and Appropriate Requirements.** RAOs for the Site are developed by considering, among other things, ARARs. The remedial alternatives must comply with ARARs, which are presented in Section 7.2.

10.1.2 Balancing Criteria

1. **Long-Term Effectiveness and Permanence.** This criterion addresses how well a remedy maintains protection of human health and the environment after the site-specific remedial levels have been met to the extent feasible. Components to be addressed include the magnitude of residual risk, the adequacy and long-term reliability of institutional controls and containment systems, and potential consequences should the remedy or some portion of it fail.
2. **Reduction of Mobility, Toxicity, or Volume.** Under this criterion, the anticipated amount of the chemical of concern destroyed or treated and the amount remaining at the site are assessed, along with the degree of expected reduction in chemical mobility, toxicity, or volume.
3. **Short-Term Effectiveness.** This criterion concerns protection of human health and the environment during construction and implementation of the remedy.
4. **Implementability.** Implementability considers both the technical and administrative feasibility of implementation. The criterion also considers the ability to construct and operate remedial facilities, ease of undertaking additional remedial actions, ability to monitor remedial effectiveness, and the ability to obtain necessary approvals and permits.
5. **Cost.** The costs to be assessed include the capital cost, annual operation and maintenance costs.

10.1.3 Modifying Criteria

1. **State Acceptance.** The State Acceptance criterion incorporates input from state agencies to modify the alternative selection process. This input can be obtained via formal comments received during the project comment period.
2. **Community Acceptance.** This criterion addresses reaction from the local citizenry.

The NCP requires that an environmental evaluation of sensitive or critical habitats be conducted. In this Site 6 setting, there are no sensitive or critical habitats requiring environmental evaluation. Furthermore, through stormwater controls implemented during the rainy season, surface water runoff from the excavation area and/or ex-situ treatment or

stockpile areas would be controlled to prevent contaminants from being released to sensitive environmental receptors.

10.2 Detailed Evaluation of Alternatives

The evaluation of the remedial alternatives against the NCP criteria and the RAOs is presented in Table 22, and summarized below for each alternative.

10.2.1 Alternative 1 – No Action

There is little or no cost associated with Alternative 1.

Alternative 1 does not meet either of the threshold NCP criteria – (1) protection of human health and the environment, and (2) compliance with ARARs. It does not meet the RAOs described in Section 7.4. Therefore, Alternative 1 is judged not to be acceptable.

10.2.2 Alternative 2 – Maintain Existing Remedial Actions

Alternative 2 has an estimated cost of \$620,000.

In light of the range of foreseeable land uses for the Site, Alternative 2 does not meet either of the threshold NCP criteria – (1) protection of human health and the environment, and (2) compliance with ARARs. It does not meet the RAOs described in Section 7.4. Therefore, Alternative 2 is judged not to be acceptable and active remediation is required.

10.2.3 Alternative 3 – *Ex Situ* Source Area Soil and Groundwater Treatment and *In Situ* Groundwater Remediation

Because it reduces contaminant concentrations to below risk-based cleanup levels, Alternative 3 is protective of human health and the environment and meets the first threshold requirement. This alternative should also comply with ARARs. In general, Alternative 3 also performs well on the five balancing criteria, with the possible exception of technical implementability. Specifically, potential difficulties associated with uniformly distributing the chemical oxidant throughout the relatively low permeability soils of the treatment zone would need to be addressed prior to implementation. Treatability studies can be conducted to help address this issue.

Alternative 3 has an estimated cost of \$1.94 million, almost all of which are capital costs related to treatment of the soil and groundwater during the first year this alternative is implemented. The major uncertainties associated with this cost are related to unit costs for soil and groundwater treatment. Information developed during treatability studies conducted during design would help refine these unit costs and reduce the cost uncertainty.

10.2.4 Alternative 4 – *Ex Situ* Soil and Groundwater Remediation

The evaluation of Alternative 4 is very similar to that of Alternative 3, except there are no implementability concerns related to *in situ* chemical oxidation for Alternative 4. This alternative meets all of the NCP criteria with a relatively high degree of certainty.

Alternative 4 has an estimated cost of \$1.86 million, all of which are capital costs related to treatment of the soil and groundwater during the first year this alternative is implemented. As with Alternative 3, the major uncertainties associated with this cost are related to unit costs for soil and groundwater treatment, which can be refined based on treatability studies conducted during design.

10.3 Summary of Comparison of Remedial Alternatives

The comparative evaluation of the alternatives against each of the criteria is also shown in Table 22. Alternatives 1 and 2 compare poorly against the other two alternatives in all criteria (except cost) and, as such, are not acceptable alternatives for meeting the RAOs.

Comparing Alternatives 3 and 4, they are very similar in their ability to meet the cleanup objectives. Both compare favorably to the evaluation criteria, and both meet the RAOs for the Site. These alternatives have very similar costs. The only significant difference between the two alternatives is related to the *in situ* chemical oxidation component of Alternative 3. As described in Table 22, given the relatively low permeability and potentially stratified nature of the soils in the saturated zone, there may be some difficulties in effectively distributing the chemical oxidant throughout the treatment zone. Uniform distribution of treatment chemicals is critical to effectively treat the entire affected area. Failure to uniformly distribute the oxidant could lead to partially treated, or even untreated, areas that could lead to a “rebound” effect for contaminant levels in groundwater. If post-treatment monitoring indicated that a rebound in concentrations was occurring, supplemental injections of oxidant would be required to polish the residual contaminants and meet cleanup levels.

10.4 Recommended Remedial Alternative

Based on the evaluation of the three alternatives against the NCP criteria and the RAOs, Alternative 4 is superior in terms of long-term effectiveness, permanence, and implementability. Although Alternative 3 would also likely achieve the cleanup objectives in a timely manner, the higher level of certainty associated with Alternative 4 at essentially the same cost as Alternative 3 leads to the recommendation of Alternative 4.

11.0 REMEDIAL ACTION PLAN IMPLEMENTATION

This section discusses the conceptual design of the recommended remedial action. A preliminary schedule for remedial action implementation and reporting is also presented.

11.1 Conceptual Remedial Design

Alternative 4 is described in Section 9.5 and generally consists of the excavation of a total of approximately 23,900 cy of saturated and unsaturated soils and groundwater that exceed their respective cleanup levels. The excavated soil would be segregated into categories and managed consistent with a soil management protocol. Where treatment is required to achieve cleanup levels prior to use of the soil as fill, technologies in the “tool box” would be utilized. The soil management protocol would be prepared as part of the RDIP and would document the detailed protocol for managing all soil excavated not only at the Site, but for remedial actions at Site 2/3, Site 4 and Other Areas at the Facility.

11.1.1 Remediation Procedures and the Soil Management Protocol

The detailed approach for conducting the excavation at the Site will be developed during design in consultation with potential remediation contractors. In general, the initial excavation would be the unsaturated soils exceeding residential cleanup levels and the clean overburden followed by the saturated zone. Groundwater generated during required dewatering activities would be collected and treated onsite using the existing wastewater treatment system prior to discharging to the sanitary sewer under the Facility’s existing permit. The overall approach for handling the excavated soil is described above in Section 9.1.3, with the soil being segregated into categories based on contaminant levels and managed consistent with the soil management protocol.

Soil samples would be collected and submitted for chemical analysis to evaluate which category specific soil falls into and therefore how it will be managed. Soil samples to characterize the soil would be collected at a frequency specified in the RDIP. For soils requiring treatment prior to being used as backfill, the technologies retained in the “tool box” for treating soil *ex situ* include biopiling, landfarming, low temperature thermal desorption, and off-site disposal.

Following completion of excavation activities and confirmation, via sampling and analysis, that cleanup levels have been met, backfilling would proceed using a combination of recycled concrete and imported granular fill to the approximate elevation of the water table and then using clean overburden, clean imported fill, or potentially soils treated to below the residential cleanup levels. Note that per the RWQCB, soils proposed for reuse within 5 feet of the ground surface in residential areas must meet the residential nuisance ESLs for TPH (middle distillates) and TPH (residual fuels) of 100 and 500 mg/kg, respectively. Amendments may be added to the backfill to promote enhanced biodegradation of contaminants in groundwater that flows back into the former excavation to prevent the recontamination of the clean backfill in the saturated zone.

11.1.2 Permitting and Contractor Health and Safety

The work will be conducted in accordance with applicable federal, state and local regulations. These include, but are not limited to:

- National Fire Protection Association (NFPA) NFPA 30 Flammable and Combustible Liquids;
- Occupational Safety and Health Administration (OSHA), Title 29 Code of Federal (CFR) 1910.120. Regulations applicable to hazardous waste site operations (HAZWOPER);
- Health and Safety Code Division 20, Chapters 6.5 and 6.8;
- Title 8 California Code of Regulations (CCR) General Industry Safety Orders (GISO) 5192 Hazardous Materials Storage Ordinance, and Title 8 CCR 1532.1;
- Title 22, CCR Sections 66261.2 and 66261.3;
- Napa County Grading and Construction Ordinances;
- Napa Sanitation District Discharge Limitations;
- Napa County Ordinance No. 1240, Stormwater Management and Discharge Control;
- Napa County Code, Section 13.12 (specifies that permits must be obtained prior to drilling and installing certain soil borings and groundwater wells); and
- Bay Area Air Quality Management District (BAAQMD) Rules and Regulations: Organic Compounds, Regulation 8; and Hazardous Pollutants, Regulation 11.

The excavation and soil handling would be conducted by a qualified, HAZWOPER-trained, contractor using conventional earthwork equipment. The contractor would prepare a Site Specific Health and Safety Plan (HSP), which will address identification of hazards, hazard mitigation, safe work practices and emergency response procedures for the project. The site-specific HSP would be prepared to comply with 29 CFR 1910.120 and Title 8 CCR GISO 5192. Additionally, any remediation subcontractors selected to perform remedial work on-Site would be required to prepare a HSP for its activities.

11.1.3 Site Preparation

Prior to conducting the proposed remedial activities, it is assumed that all structures including buildings, foundations and floor slabs, paving, and materials stored or stockpiled in or near the Site would be demolished and/or removed. In addition, it is assumed underground utilities (including the groundwater extraction trench) would be removed or abandoned as appropriate.

In addition to removing the structures, foundations, utilities, and existing groundwater monitoring wells in and near the excavation, areas of the Facility that would be utilized to implement the remedial action would be cleared of obstructions and otherwise prepared for use. This would include preparation of equipment lay down and staging areas, soil stockpile areas, soil treatment areas, and areas where treated soil will be used as fill. Because soil stockpiling, soil treatment, and overall site filling would also be conducted at the other areas of the Facility, these activities would be coordinated with the remedial actions proposed for the other sites.

11.1.4 Verification Sampling

Verification soil samples will be collected from the excavation areas using a hand sampler and earthmoving equipment to evaluate whether the cleanup levels have been met. Detailed descriptions of the verification sampling procedures and analytical program will be provided in the Verification Sampling and Analysis Plan (VSAP) that will be included as part of the RDIP. The VSAP will specify the number of sidewall and excavation bottom soil samples that will be collected and the depth intervals where samples are to be collected. Sample locations and the number of samples collected may be adjusted in the field if necessary. Verification sample analyses will likely be performed utilizing an expedited laboratory turn-around schedule, or an on-site mobile laboratory, to reduce the likelihood for significant delays to affect the remedial action schedule.

In addition to verification soil sampling, it is anticipated that soil gas samples will be collected from shallow soil to confirm that residual contamination that may be present at depth, although below their respective soil or groundwater cleanup levels, is not causing an exceedance of a soil gas ESL. Should laboratory analytical results indicate that the cleanup level has not been attained, additional excavation will be performed.

11.1.5 Dust and Odor Control

During shallow excavation activities, depending on soil conditions, there is potential to generate airborne dust. Therefore, as required, the contractor would apply a water mist to the excavation and soil handling and haul routes to reduce the potential for dust generation. Soil would be wetted as needed to reduce the occurrence of visible dust. Air monitoring would be conducted in accordance with local air quality management regulations as described in the RDIP and/or the contractor's HSP.

11.1.6 Decontamination

Equipment used to excavate, transport, and manage the affected soil would be decontaminated prior to leaving the site. The equipment will first be decontaminated by removing visible soil by sweeping or brushing. Soil that cannot be removed by this procedure would be removed from equipment by washing in a prepared decontamination area. The decontamination area would be constructed in a central location that would be utilized for all remediation activities at

the site. Decontamination wash water will be collected, characterized, treated on site using the existing wastewater treatment system, and discharged to the sanitary sewer.

11.1.7 Excavation Backfilling

The excavations would be backfilled once verification soil sampling confirms that cleanup levels are met throughout the excavation area. The specific backfill requirements would be determined during remedial design and will incorporate geotechnical considerations for future residential and commercial construction. Procedures and specifications would be included in the RDIP. For portions of the excavation below the water table, backfilling would typically utilize recycled concrete and asphalt in the bottom of the excavations to bridge over the wet, fined-grained soils and then utilize imported granular fill to bring the grade back up to above the water table elevation. Above the water table, backfill will likely consist of clean overburden, other excavated soils where COC concentrations are below the applicable cleanup levels, or treated soil, as appropriate.

11.2 Schedule of Remedial Action Implementation and Reporting

It is anticipated that the soil excavation would be completed during the 2008 construction season, approximately April through October, pending approval of this RI/FS/RAP, preparation of the RDIP, and issuance of the needed permits by the County and associated approvals. Approval of this document does not limit the County's normal environmental review associated with such permit(s) and related approvals. Depending on the total volume of soil requiring treatment from all the remediation areas (e.g., Sites 4 and 6), and the specific type of treatment utilized (e.g., biopiling, LTDD), treatment of excavated soils may extend beyond 2008 into 2009.

Treatability studies to develop design information for select technologies would be implemented during 2007. Initiation of these treatability studies is expected in the first quarter of 2007.

11.3 Performance Criteria

Evaluation of the progress of the soil and groundwater remediation program would be conducted throughout its implementation. The laboratory analytical results of the soil verification samples would be compared to the proposed target cleanup levels. If these compounds are detected in verification soil sampling above the proposed target cleanup levels and further excavation is not feasible, PES will consult with RWQCB staff to evaluate the appropriateness of instituting additional remedial measures, if warranted.

11.4 Reporting

Following completion of remediation activities, a remedial action implementation report will be prepared and submitted to RWQCB for review and approval. The report will summarize the

work that was performed, verification soil and soil gas sample analytical results, and document that the cleanup levels have been achieved. Performance monitoring results for soil treatment will be reported and the final disposition of excavated soils will be documented. Copies of laboratory reports and chain-of-custody forms will be included.

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TABLES

Table 1
Environmental Screening Levels
Napa Pipe Facility
Napa, California

SOIL					GROUNDWATER	
Nondrinking Water Resource					Nondrinking Water Resource	
Parameter	ESL	ESL	ESL	ESL	Parameter	ESL
	Shallow Soil (<3m)	Shallow Soil (<3m)	Deep Soil (>3m)	Deep Soil (>3m)		
	Residential	Commercial	Residential	Commercial		(µg/l)
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		
TPH (gasoline)	100	500 ⁰	5000 ³	5000 ³	TPH (gasoline)	5000 ^{8,11}
TPH (middle distillates)	100/400 ¹	500/750 ²	5000 ³	5000 ³	TPH (middle distillates)	2500 ^{8,11}
TPH (residual fuels)	500/1000 ⁴	2500 ⁵	5000 ⁶	5000 ⁷	TPH (residual fuels)	2500 ⁸
Benzene	0.18	0.38	0.18	0.51	Benzene	540 ⁹
Naphthalene	0.46	1.5	0.46	1.5	Naphthalene	210 ¹⁰
TCE	0.26	0.73	0.26	0.73	TCE	530 ⁹
1,1-DCE	8.9 ¹²	2.1 ¹²	8.9 ¹²	21	1,1-DCE	6300 ⁹
cis-1,2-DCE	1.6	3.6	1.6	3.6	cis-1,2-DCE	6200 ⁹
Chloroethane	0.63	0.85	0.63	0.85	Chloroethane	160 ¹⁰
1,1-DCA	0.32	0.89	0.32	0.89	1,1-DCA	1000 ⁹
Vinyl Chloride	0.0067	0.019	0.0067	0.019	Vinyl Chloride	3.8
trans-1,2-DCE	3.1	7.3	3.1	7.3	trans-1,2-DCE	2600 ¹⁰
1,2-DCA	0.025	0.07	0.025	0.07	1,2-DCA	200
PCE	0.087	0.24	0.087	0.24	PCE	120 ⁹
1,1,1-TCA	98 ¹²	230 ¹²	98 ¹²	230 ¹²	1,1,1-TCA	50000 ¹⁰
1,1,2-TCA	0.032	0.089	0.032	0.089	1,1,2-TCA	350
Styrene	450 ¹²	1000 ¹⁴	450 ¹²	1100 ¹²	Styrene	110 ¹⁰
Methylene Chloride	0.52	1.5	0.52	1.5	Methylene Chloride	2400 ⁹
1,2-Dichlorobenzene	8.9 ¹²	21 ¹²	8.9 ¹²	21 ¹²	1,2-Dichlorobenzene	100 ¹⁰
1,4-Dichlorobenzene	0.046	0.13	0.046	0.13	1,4-Dichlorobenzene	110 ¹⁰
Chlorobenzene	2.7 ¹²	6.2 ¹²	2.7 ¹²	6.2 ¹²	Chlorobenzene	500 ¹⁰
Bromodichloromethane	0.014	0.039	0.014	0.039	Bromodichloromethane	170
Chloroform	0.88	1.9	78 ¹³	78 ¹³	Chloroform	330
Dibromochloromethane	0.019	0.054	0.019	0.054	Dibromochloromethane	170
Bromomethane	0.22	0.51	0.22	0.51	Bromomethane	580 ⁹
MTBE	2	5.6	2	5.6	MTBE	1800
Ethylbenzene	390 ¹²	390 ¹²	390 ¹²	390 ¹²	Ethylbenzene	300 ¹⁰
Xylenes	310 ¹²	420 ¹²	310 ¹²	420 ¹²	Xylenes	5300 ¹⁰
Toluene	100 ¹³	310 ¹²	130 ¹²	310 ¹²	Toluene	400 ¹⁰
2-Butanone	490 ¹²	1000 ¹⁴	490 ¹²	1300 ¹²	2-Butanone	50000 ¹⁰
Acetone	500 ¹⁴	1000 ¹⁴	1000 ¹⁴	2500 ¹⁴	Acetone	50000 ¹⁰
1,4-Dioxane	18	30	30	30	1,4-Dioxane	50000
Anthracene	6.1 ¹⁵	6.1 ¹⁵	6.1 ¹⁵	6.1 ¹⁵	Anthracene	22 ¹⁰
Fluorene	160 ¹⁵	160 ¹⁵	160 ¹⁵	160 ¹⁵	Fluorene	950 ¹⁰
Methylnaphthalene (total 1- & 2-)	110 ¹⁵	110 ¹⁵	110 ¹⁵	110 ¹⁵	Methylnaphthalene (total 1- & 2-)	100 ¹⁰
Phenanthrene	40 ¹⁶	40 ¹⁶	1000 ¹⁷	2500 ¹⁷	Phenanthrene	410 ¹⁰
Bis(2-ethylhexyl)Phthalate	160	570 ¹³	1000 ¹⁷	2500 ¹⁷	Bis(2-ethylhexyl)Phthalate	650 ¹⁰
Chrysene	3.8	13	150 ¹³	150 ¹³	Chrysene	0.8 ¹⁰
Fluoranthene	40	390 ¹⁵	1000 ¹⁷	2500 ¹⁷	Fluoranthene	130 ¹⁰
Pyrene	85	85 ¹⁵	85 ¹⁵	85 ¹⁵	Pyrene	68 ¹⁰
Antimony	6.1	40	280	280	Antimony	50000 ¹⁰
Arsenic	5.5	5.5	5.5	5.5	Arsenic	50000 ¹⁰
Barium	750	1500	2500	2500	Barium	50000 ¹⁰
Beryllium	4	8	36	36	Beryllium	50000 ¹⁰
Cadmium	1.7	7.4	38	38	Cadmium	50000 ¹⁰
Chromium	58	58	58	58	Chromium	50000 ¹⁰
Chromium VI	1.8	1.8	1.8	1.8	Chromium VI	50000 ¹⁰
Cobalt	10	10	10	10	Cobalt	50000 ¹⁰
Copper	230	230	2500	5000	Copper	50000 ¹⁰
Lead	150	750	750	750	Lead	50000 ¹⁰
Molybdenum	40	40	2500	3600	Molybdenum	50000 ¹⁰

**Table 1
Environmental Screening Levels
Napa Pipe Facility
Napa, California**

SOIL					GROUNDWATER	
Nondrinking Water Resource					Nondrinking Water Resource	
Parameter	ESL	ESL	ESL	ESL	Parameter	ESL (µg/l)
	Shallow Soil (<3m) Residential (mg/kg)	Shallow Soil (<3m) Commercial (mg/kg)	Deep Soil (>3m) Residential (mg/kg)	Deep Soil (>3m) Commercial (mg/kg)		
Mercury	3.7	10	98	98	Mercury	50000 ¹⁰
Nickel	150	150	1000	1000	Nickel	50000 ¹⁰
Selenium	10	10	2500	3400	Selenium	50000 ¹⁰
Silver	20	40	2500	3600	Silver	50000 ¹⁰
Thallium	1	13	47	47	Thallium	50000 ¹⁰
Vanadium	110	200	2500	5000	Vanadium	50000 ¹⁰
Zinc	600	600	2500	5000	Zinc	50000 ¹⁰

Notes:

- ESL = Environmental Screening Level (RWQCB, February 2005)
 TPH (middle distillates) includes TPH as diesel
 TPH (residual fuels) includes TPH as motor oil and TPH as hydraulic oil
- 0 = The final ESL from Table B-2 (commercial/industrial) of RWQCB, 2005 is 400 mg/kg, based on protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water, Table G. This pathway does not apply and the cleanup value defaults to 500 mg/kg (gross contamination ceiling value) and with the recognition that confirmation soil gas testing may be required.
- 1 = The final ESL from Table B-1 of RWQCB, 2005 is 100 mg/kg, based on the Gross Contamination Ceiling Value (Odors, etc.), Table H-2. However, the MADEP screening values, (Appendix 7, RWQCB, 2005) on which Table H-2 is based, state that the nuisance ceiling value for C9 to C18 carbon range (equivalent to the lighter fraction of diesel is 1000 mg/kg (not 100 mg/kg). This value is higher than the next lowest value of 400 mg/kg (direct exposure) shown on Table B-1. For the shallowest soils (0-3 ft. bgs) the lower of the two values (100 mg/kg) is selected to conservatively protect for nuisance odor issues. For deeper soils (>3 ft bgs but <3 m), the proposed cleanup value is 400 mg/kg.
- 2 = The final ESL from Table B-2 of RWQCB, 2005 is 500 mg/kg, based on both the gross contamination ceiling value (odors, etc.) from Table H-2 and protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water, Table G. Note that the 500 mg/kg value for soil from Table G is already a non-drinking water number and is based on soil leaching protective of surface water discharge at 640 mg/l. This pathway would likely not apply. In addition, similar to footnote 1, the MADEP screening levels are listed as 1,000 mg/kg, not 500 mg/kg. The next highest value on Table B-2 is the direct contact value of 750 mg/kg. For the shallowest soils (0-3 ft. bgs) the lower of the two values (500 mg/kg) is selected to conservatively protect for nuisance odor issues. For deeper soils (>3 ft bgs but <3 m), the proposed cleanup value is 750 mg/kg. It also recognized that confirmation soil gas testing may be required.
- 3 = The final ESL from Table D-1 (residential) and Table D-2 (commercial/industrial) of RWQCB, 2005 is 400 for TPH(gasolines) and 500 mg/kg for TPH(middle distillates), based on protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water, Table G. This pathway does not apply and the cleanup value defaults to 5000 mg/kg (gross contamination ceiling value) and with the recognition that confirmation soil gas testing may be required.
- 4 = The final ESL from Table B-1 of RWQCB, 2005 is 500 mg/kg, based on the Gross Contamination Ceiling Value, Table H-2. However, the MADEP screening values, (Appendix 7, RWQCB, 2005) on which Table H-2 is based, states that the nuisance ceiling value for C19 to C36 carbon range (equivalent to motor oil and hydraulic oil) is 2500 mg/kg. This value is higher than the next lowest value of 1,000 (direct exposure) shown on Table B-1. As in footnotes 1 and 2, the lower value (in this case 500 mg/kg) is retained to conservatively protect for nuisance odor issues in the shallowest soils (0-3 ft bgs). For the deeper soils (>3 ft and <3m), the direct exposure number (1,000 mg/kg) is used.
- 5 = The final ESL from Table B-2 of RWQCB, 2005 is 1000 mg/kg, based on the Groundwater Protection (Soil Leaching), Non-Drinking Water Resource, Table G. However, the value listed follows the LARWQCB guidance, which is based on the protection of a drinking water resource. Shallow groundwater is not a drinking water resource; the drinking water resource is over 150 feet below ground surface. At this depth, the LARWQCB's soil screening level would be 50,000 mg/kg (see Table 4-1 of LARWQCB, 1996). This value is higher than the next lowest value of 2,500 mg/kg, based on the nuisance ceiling as shown on Table B-2; therefore the proposed cleanup goal defaults to 2500 mg/kg.
- 6 = The final ESL from Table D-1 of RWQCB, 2005 is 1000 mg/kg, based the Groundwater Protection (Soil Leaching), Non-Drinking Water Resource, Table G. However, the value listed follows the LARWQCB guidance (see footnote on Table D-1 and Section 5.3.2 text of RWQCB, 2005), which is based on the protection of a drinking water resource. Shallow groundwater is not a drinking water resource; the drinking water resource is over 150 feet below ground surface. At this depth, the LARWQCB soil screening level would be 50,000 mg/kg (see Table 4-1 of LARWQCB, 1996). This value is higher than the next lowest value of 5000 (gross contamination ceiling value) shown on Table D-1; therefore the proposed cleanup goal defaults to 5000 mg/kg.
- 7 = The final ESL from Table D-2 of RWQCB, 2005 is 1000 mg/kg, based the Groundwater Protection (Soil Leaching), Non-Drinking Water Resource, Table G. However, the value listed follows the LARWQCB guidance (see footnote on Table D-1 and Section 5.3.2 text of RWQCB, 2005), which is based on the protection of a drinking water resource. Shallow groundwater is not a drinking water resource; the drinking water resource is over 150 feet below ground surface. At this depth, the LARWQCB soil screening level would be 50,000 mg/kg (see Table 4-1 of LARWQCB, 1996). This value is higher than the next lowest value of 5000 (gross contamination) shown on Table D-2; therefore the proposed cleanup goal defaults to 5000 mg/kg.
- 8 = No aquatic habitat pathway. Defaults to gross contamination ceiling level value.
- 9 = No aquatic habitat pathway. Defaults to vapor intrusion pathway.
- 10 = No aquatic habitat pathway. Defaults to gross contamination ceiling value.
- 11 = Soil gas values to be used for verifying cleanup.
- 12 = Protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water does not apply; therefore, the cleanup value defaults to the vapor intrusion pathway.
- 13 = Protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water does not apply; therefore, the cleanup value defaults to the direct exposure pathway.
- 14 = Protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water does not apply; therefore, the cleanup value defaults to the gross contamination ceiling value.
- 15 = The final ESLs from Tables B-1 and D-1 (residential) and Tables B-2 and D-2 (Commercial/Industrial) of RWQCB, 2005 are based on protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water, Table G. This pathway does not apply and the cleanup value defaults to the vapor intrusion into buildings pathway.
- 16 = The final ESLs from Tables B-1 and D-1 (residential) and Tables B-2 and D-2 (Commercial/Industrial) of RWQCB, 2005 are based on protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water, Table G. This pathway does not apply and the cleanup value defaults to the Urban Area Ecotoxicity Criteria.
- 17 = The final ESLs from Tables D-1 (residential) and D-2 (Commercial/Industrial) of RWQCB, 2005 are based on protection of surface water resources via soil leaching to groundwater and discharge of groundwater to surface water, Table G. This pathway does not apply and the cleanup value defaults to the Gross Contamination Ceiling Value.

Table 2
Water Level Survey Data - May 16, 2006 Monitoring Event
Site 6 (Former Machine Shop and Drum Storage Areas)
Napa Pipe Facility
Napa, California

Well Identification	TOC Elevation (ft MSL)	Depth to Water (ft bTOC)	Depth to FPLH (ft bTOC)	FPLH Thickness (feet)	Groundwater Elevation (feet MSL)	Screened Interval (feet bgs)	Screened Interval (ft MSL)
Extraction Sump	8.94	9.66	--	--	-0.72	N/A	N/A
DW-3	8.08	4.70	--	--	3.38	26 to 31	-17.9 to -22.9
DW-7	8.75	5.30	--	--	3.45	26 to 31	-17.3 to -22.3
MW-10	8.63	6.17	--	--	2.46	7.5 to 12.5	1.1 to -3.9
MW-11	8.54	4.40	--	--	4.14	7.5 to 12.5	1.0 to -4.0
MW-12	8.24	4.65	--	--	3.59	7.5 to 12.5	0.7 to -4.3
MW-13	7.87	3.05	--	--	4.82	7 to 12	0.9 to -4.1
MW-3	7.83	4.27	--	--	3.56	10 to 15	-2.0 to -7.0
MW-36	8.43	6.35	--	--	2.08	5 to 10	3.4 to -1.6
MW-37	7.67	3.50	--	--	4.17	4 to 9	3.7 to -1.3
MW-38	4.49	3.06	--	--	1.43	3 to 8	1.5 to -3.5
MW-49	8.46	4.58	--	--	3.88	3 to 13	5.5 to -4.5
MW-50	8.46	5.08	--	--	3.38	3 to 13	5.5 to -4.5
MW-51	7.87	8.19	--	--	-0.32	4.5 to 14	3.4 to -6.1
MW-52 ^a	5.41	3.38	--	--	2.03	3 to 13	2.4 to -7.6

Notes:

TOC = Top of casing

ft bTOC = Feet below top of casing

ft MSL = Feet mean sea level

FPLH = Free Phase Liquid Hydrocarbons

N/A = Not applicable

-- = Not observed

^a = Oil absorbent sock in well

Table 3
Water Level Survey Data - October 3, 2006 Monitoring Event
Site 6 (Former Machine Shop and Drum Storage Areas)
Napa Pipe Facility
Napa, California

Well Identification	TOC Elevation (ft MSL)	Depth to Water (ft bTOC)	Depth to FPLH (ft bTOC)	FPLH Thickness (feet)	Groundwater Elevation (feet MSL)	Screened Interval (feet bgs)	Screened Interval (ft MSL)
Extraction Sump	8.94	0.0	--	--	8.94	N/A	N/A
DW-3	8.08	5.48	--	--	2.60	26 to 31	-17.9 to -22.9
DW-7	8.75	5.90	--	--	2.85	26 to 31	-17.3 to -22.3
MW-10	8.63	6.98	--	--	1.65	7.5 to 12.5	1.1 to -3.9
MW-11	8.54	2.06	--	--	6.48	7.5 to 12.5	1.0 to -4.0
MW-12	8.24	5.65	--	--	2.59	7.5 to 12.5	0.7 to -4.3
MW-13	7.87	4.29	--	--	3.58	7 to 12	0.9 to -4.1
MW-3	7.83	5.12	--	--	2.71	10 to 15	-2.0 to -7.0
MW-36	8.43	7.20	--	--	1.23	5 to 10	3.4 to -1.6
MW-37	7.67	4.23	--	--	3.44	4 to 9	3.7 to -1.3
MW-38	4.49	3.59	--	--	0.90	3 to 8	1.5 to -3.5
MW-49	8.46	5.40	--	--	3.06	3 to 13	5.5 to -4.5
MW-50	8.46	6.08	--	--	2.38	3 to 13	5.5 to -4.5
MW-51	7.87	8.65	--	--	-0.78	4.5 to 14	3.4 to -6.1
MW-52 ^a	5.41	4.22	--	--	1.19	3 to 13	2.4 to -7.6

Notes:

TOC = Top of casing

ft bTOC = Feet below top of casing

ft MSL = Feet mean sea level

FPLH = Free Phase Liquid Hydrocarbons

N/A = Not applicable

-- = Not observed

^a = Oil absorbent sock in well

**Table 4
 TPH as Diesel and TPH as Motor Oil in Groundwater Monitoring Wells
 Fourth Quarter 2006 Monitoring Event
 Site 6 (Former Machine Shop and Drum Storage Areas)
 Napa Pipe Facility
 Napa, California**

Well Identification	Quarter	TPH as Diesel (µg/l)	TPH as Motor Oil (µg/l)
MW-38	4th	9,000HY	16,000
MW-49	4th	62Y	ND [300]
MW-52	4th	16,000H	12,000L
Groundwater ESL¹		2,500	2,500

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

µg/l = Micrograms per liter

ND = Not detected at or above the indicated laboratory reporting limit

TPH = Total petroleum hydrocarbons

H = Heavier hydrocarbons contributed to the quantitation

Y = Sample exhibits chromatographic pattern which does not resemble standard

L = Lighter hydrocarbons contributed to the quantitation

Table 5
Volatile Organic Compounds in Groundwater Monitoring Wells
Second and Fourth Quarter 2006 Monitoring Events
Site 6 (Former Machine Shop and Drum Storage Areas)
Napa Pipe Facility
Napa, California

Well Identification	Quarter	1,1-DCA (µg/l)	1,1-DCE (µg/l)	cis-1,2-DCE (µg/l)	trans-1,2-DCE (µg/l)	TCE (µg/l)	Vinyl Chloride (µg/l)
DW-3	4th	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
DW-7	2nd	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	1.7	ND (0.5)
	4th	ND (0.5)	ND (0.5)	1.8	ND (0.5)	8.9	ND (0.5)
MW-10	4th	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
MW-11	2nd	6.6	2.7	140	ND (2.5)	380	6.0
	4th	7.5	2.9	160	2.7	300	2.2
MW-12	4th	ND (0.5)	ND (0.5)	14	ND (0.5)	3.9	ND (0.5)
MW-13	4th	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
MW-37	4th	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
MW-38	4th	4.1	ND (2.5)	ND (2.5)	ND (2.5)	ND (2.5)	ND (2.5)
MW-49	4th	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
MW-51	2nd	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	2.4
	4th	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	1.2
MW-52	4th	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)
Groundwater ESL¹		1,000	6,300	6,200	2,600	530	3.8

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

DCA = Dichloroethane

DCE = Dichloroethene

TCE = Trichloroethylene

ND = Not detected at or above the indicated laboratory reporting limit

Table 6
Summary of Analyses Performed on Soil and Groundwater Samples,
Supplemental Remedial Investigation
Site 6 (Former Machine Shop and Drum Storage Areas, and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Location	Soil Analyses		Groundwater Analyses		Comments
	TPH-d/mo	VOCs	TPH-d/mo	VOCs	
Former Machine Shop Area					
MS1	X	X	X	X	Soil samples collected at 2.5 and 6.5 feet bgs
MS2	X	X	X	X	Soil samples collected at 2.5 and 6.5 feet bgs
MS3	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
MS4	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
MS5	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
MS6	X	X	X	X	Soil samples collected at 2.5 and 7 feet bgs
MS7	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
MS8	X	X	X	X	Soil samples collected at 2.5 and 7 feet bgs
MS9	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
MS10	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
Former Drum Storage Area					
DS1	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS2	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS3	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS4	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS5	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS6	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS7	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS8	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS9	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS10	X	NR	X	NR	Soil samples collected at 2, 5 and 8 feet bgs
DS11	X	NR	X	NR	Groundwater only
DS12	X	NR	X	NR	Groundwater only

**Table 6
Summary of Analyses Performed on Soil and Groundwater Samples,
Supplemental Remedial Investigation
Site 6 (Former Machine Shop and Drum Storage Areas, and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California**

Location	Soil Analyses		Groundwater Analyses		Comments
	TPH-d/mo	VOCs	TPH-d/mo	VOCs	
Electrical/Plumbing Shop, Warehouse, Assembly Bay, and Southeastern Portion of Fabrication Buildings					
TB1	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
TB2	X	X	X	X	Soil samples collected at 3 and 5.5 feet bgs
TB3	X	X	X	X	Soil samples collected at 2.5 and 7 feet bgs
TB18	X	X	X	X	Soil samples collected at 3 and 6 feet bgs
TB19	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
TB20	X	X	X	X	Soil samples collected at 1.75 and 5.25 feet bgs
TB21	X	X	X	X	Soil samples collected at 2 and 6.5 feet bgs
TB24	X	X	X	X	Soil samples collected at 2 and 7 feet bgs
TB25	X	X	X	X	Soil samples collected at 3 and 6 feet bgs
TB48	X	X	X	X	Soil samples collected at 3 and 7 feet bgs
TB49	X	X	X	X	Soil samples collected at 2.5 and 7 feet bgs
TB50	X	NR	X	NR	Soil samples collected at 3 and 7 feet bgs
TB51	X	NR	X	NR	Soil samples collected at 3 and 7 feet bgs
TB52	X	NR	X	NR	Soil samples collected at 3 and 7 feet bgs
TB55	X	X	X	X	Soil samples collected at 3 and 6 feet bgs

Notes:

bgs = below ground surface

TPH-d/mo = Total petroleum hydrocarbons (TPH) as diesel/TPH as motor oil

VOCs = Volatile organic compounds

NR = Not requested

X = Analysis performed on sample

Table 7
TPH as Diesel and TPH as Motor Oil in Soil
Site 6 (Former Drum Storage Area and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Sample Location	Sample Identification	Sample Depth (Feet bgs)	Sample Date	TPH as Diesel (mg/kg)		TPH as Motor Oil (mg/kg)	
DS1	DS1-2'	2-2.5	9/7/2006	4,600	H	9,700	HL
	DS1-5'	5-5.5	9/7/2006	11	HY	58	H
	DS1-8'	8-8.5	9/7/2006	320	H	710	HL
DS2	DS2-2'	2-2.5	9/7/2006	1.6	HY	8.2	
	DS2-5'	5-5.5	9/7/2006	15	HY	88	
	DS2-8'	8-8.5	9/7/2006	52	HY	270	
DS3	DS3-2'	2-2.5	9/7/2006	44	HY	180	L
	DS3-5'	5-5.5	9/7/2006	260	H	510	L
	DS3-8'	8-8.5	9/7/2006	360	H	870	L
DS4	DS4-2'	2-2.5	9/7/2006	420	H	170	L
	DS4-5'	5-5.5	9/7/2006	14	HY	16	L
	DS4-8'	8-8.5	9/7/2006	2.5	Y	ND(5)	
DS5	DS5-2'	2-2.5	9/7/2006	3,200	HY	3,200	L
	DS5-5'	5-5.5	9/7/2006	780	HY	930	L
	DS5-8'	8-8.5	9/7/2006	180	HY	250	L
DS6	DS6-2'	2-2.5	9/7/2006	26	H	72	L
	DS6-5'	5-5.5	9/7/2006	84	H	420	HL
	DS6-8'	8-8.5	9/7/2006	39	HLY	150	L
DS7	DS7-2'	2-2.5	9/7/2006	3.4	HY	5.1	L
	DS7-5'	5-5.5	9/7/2006	46	HY	42	L
	DS7-8'	8-8.5	9/7/2006	2.7	HY	7.8	
DS8	DS8-2'	2-2.5	11/2/2006	39	H	150	L
	DS8-5'	5-5.5	11/2/2006	33	HY	160	H
	DS8-8'	8-8.5	11/2/2006	290	H	580	L
DS9	DS9-2'	2-2.5	11/1/2006	15	HY	42	HL
	DS9-5'	5-5.5	11/1/2006	2.1	HY	5.5	Y
	DS9-8'	8-8.5	11/1/2006	5.4	HY	23	H
DS10	DS10-2'	2-2.5	11/1/2006	32	HY	250	H
	DS10-5'	5-5.5	11/1/2006	7.9	HY	14	HL
	DS10-8'	8-8.5	11/1/2006	190	HY	240	L
TB1	TB1-3'	3-3.5	11/1/2006	1.0	HY	5.7	
	TB1-7'	7-7.5	11/1/2006	20	HY	150	L
TB2	TB2-3'	3-3.5	9/27/2006	20	HY	54	
	TB2-5.5'	5.5-6	9/27/2006	9.4	HY	35	
TB3	TB3-2.5'	2.5-3	9/19/2006	1.9	HY	7.9	
	TB3-7'	7-7.5	9/19/2006	1.2	HY	ND(5)	
TB18	TB18-3'	3-3.5	9/22/2006	ND(1)		ND(5)	
	TB18-6'	6-6.5	9/22/2006	ND(0.99)		ND(5)	

Table 7
TPH as Diesel and TPH as Motor Oil in Soil
Site 6 (Former Drum Storage Area and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Sample Location	Sample Identification	Sample Depth (Feet bgs)	Sample Date	TPH as Diesel (mg/kg)		TPH as Motor Oil (mg/kg)	
TB19	TB19-3'	3-3.5	9/22/2006	89	H	280	HL
	TB19-7'	7-7.5	9/22/2006	ND(1)		ND(5)	
TB20	TB20-1.75'	1.75-2.25	9/22/2006	1,000	HY	9,800	H
	TB20-5.25'	5.25-5.75	9/22/2006	23	HY	64	L
TB21	TB21-2'	2-2.5	9/21/2006	120	HY	450	H
	TB21-6.5'	6.5-7	9/21/2006	2.6	HY	19	
TB24	TB24-2'	2-2.5	9/22/2006	43	HY	92	L
	TB24-7'	7-7.5	9/22/2006	ND(0.99)		ND(5)	
TB25	TB25-3'	3-3.5	9/22/2006	11	HY	51	
	TB25-6'	6-6.5	9/22/2006	ND(1)		ND(5)	
TB48	TB48-3'	3-3.5	9/27/2006	ND(1)		ND(5)	
	TB48-7'	7-7.5	9/27/2006	ND(1)		ND(5)	
TB49	TB49-2.5'	2.5-3	9/27/2006	1.5	Y	16	H
	TB49-7'	7-7.5	9/27/2006	ND(1)		ND(5)	
TB50	TB50-3'	3-3.5	11/1/2006	6.4		6.5	H
	TB50-7'	7-7.5	11/1/2006	5.3	HY	24	HY
TB51	TB51-3'	3-3.5	11/1/2006	3.9	HY	23	H
	TB51-7'	7-7.5	11/1/2006	ND(1)		ND(5)	
TB52	TB52-3'	3-3.5	11/1/2006	3.3	HY	19	H
	TB52-7'	7-7.5	11/1/2006	ND(1)		ND(5)	
TB55	TB55-3'	3-3.5	11/20/2006	16	HY	21	HL
	TB55-6'	6-6.5	11/20/2006	10	HY	59	HL
Shallow (<3 meters bgs) Soil ESL¹				100²/400³		500²/1,000³	
Deep (>3 meters bgs) Soil ESL¹				5,000		5,000	

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) for residential land use where potentially impacted groundwater is not a current or potential drinking water resource, and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

² = 0 to 3 feet bgs interval, including samples collected from 3 to 3.5 feet bgs.

³ = 3 to 10 feet bgs interval, excluding soil samples collected from 3 to 3.5 feet bgs.

Results exceeding ESLs are shaded

bgs = Below ground surface

mg/kg = Milligrams per kilogram

ND = Not detected at or above the indicated laboratory reporting limit.

H = Heavier hydrocarbons contributed to the quantitation

Y = Sample exhibits chromatographic pattern which does not resemble standard

L = Lighter hydrocarbons contributed to the quantitation

**Table 8
TPH as Diesel and TPH as Motor Oil in Soil
Site 6 (Former Machine Shop Area)
Napa Pipe Facility
Napa, California**

Sample Location	Sample Identification	Sample Depth (Feet bgs)	Sample Date	TPH as Diesel (mg/kg)		TPH as Motor Oil (mg/kg)	
MS1	MS1-2.5'	2.5-3	9/21/2006	ND(1)		ND(5)	
	MS1-6.5'	6.5-7	9/21/2006	2.0	HY	ND(5)	
MS2	MS2-2.5'	2.5-3	9/21/2006	2.0	HY	6.8	
	MS2-6.5'	6.5-7	9/21/2006	ND(1)		ND(5)	
MS3	MS3-3'	3-3.5	10/31/2006	ND(1)		ND(5)	
	MS3-7'	7-7.5	10/31/2006	ND(1)		ND(5)	
MS4	MS4-3'	3-3.5	10/31/2006	ND(0.99)		ND(5)	
	MS4-7'	7-7.5	10/31/2006	ND(1)		ND(5)	
MS5	MS5-3'	3-3.5	10/31/2006	1.2	HY	18	H
	MS5-7'	7-7.5	10/31/2006	51	HLY	200	HL
MS6	MS6-2.5'	2.5-3	10/31/2006	49	HY	140	HL
	MS6-7'	7-7.5	10/31/2006	ND(1)		5.6	H
MS7	MS7-3'	3-3.5	10/31/2006	6.2	HY	41	H
	MS7-7'	7-7.5	10/31/2006	1.0	HY	5.5	H
MS8	MS8-2.5'	2.5-3	10/31/2006	9.8	HY	23	HL
	MS8-7'	7-7.5	10/31/2006	ND(1)		ND(5)	
MS9	MS9-3'	3-3.5	10/31/2006	ND(1)		ND(5)	
	MS9-7'	7-7.5	10/31/2006	22	HY	44	HL
MS10	MS10-3'	3-3.5	10/31/2006	1.1	YZ	ND(5)	
	MS10-7'	7-7.5	10/31/2006	1.2	HY	7.7	H
Shallow (<3 meters bgs) Soil ESL¹				100²/400³		500²/1,000³	
Deep (>3 meters bgs) Soil ESL¹				5,000		5,000	

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) for residential land use where potentially impacted groundwater is not a current or potential drinking water resource, and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

² = 0 to 3 feet bgs interval, including samples collected from 3 to 3.5 feet bgs

³ = 3 to 10 feet bgs interval, excluding soil samples collected from 3 to 3.5 feet bgs

Results exceeding ESLs are shaded

bgs = Below ground surface

mg/kg = Milligrams per kilogram

ND = Not detected at or above the indicated laboratory reporting limit

TPH = Total petroleum hydrocarbons

H = Heavier hydrocarbons contributed to the quantitation

Y = Sample exhibits chromatographic pattern which does not resemble standard

L = Lighter hydrocarbons contributed to the quantitation

Z = Sample exhibits unknown single peak or peaks

**Table 9
Volatile Organic Compounds in Soil
Site 6 (Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California**

Sample Location	Sample Identification	Sample Depth (Feet bgs)	Sample Date	Acetone (µg/kg)	Methylene Chloride (µg/kg)	2-Butanone (µg/kg)
TB1	TB1-3'	3-3.5	11/1/2006	ND(21)	46	ND(8.5)
	TB1-7'	7-7.5	11/1/2006	440	310	37
TB2	TB2-3'	3-3.5	9/27/2006	ND(19)	ND(19)	ND(9.4)
	TB2-5.5'	5.5-6	9/27/2006	20	ND(16)	ND(8.1)
TB3	TB3-2.5'	2.5-3	9/19/2006	ND(16)	ND(16)	ND(7.9)
	TB3-7'	7-7.5	9/19/2006	ND(16)	ND(16)	ND(8.2)
TB18	TB18-3'	3-3.5	9/22/2006	ND(22)	ND(22)	ND(11)
	TB18-6'	6-6.5	9/22/2006	ND(16)	ND(16)	ND(8.2)
TB19	TB19-3'	3-3.5	9/22/2006	ND(18)	ND(18)	ND(9.1)
	TB19-7'	7-7.5	9/22/2006	ND(16)	ND(16)	ND(7.8)
TB20	TB20-1.75'	1.75-2.25	9/22/2006	41	ND(16)	ND(11)
	TB20-5.25'	5.25-5.75	9/22/2006	ND(16)	ND(16)	ND(8.1)
TB21	TB21-2'	2-2.5	9/21/2006	ND(17)	ND(17)	ND(8.6)
	TB21-6.5'	6.5-7	9/21/2006	ND(17)	ND(17)	ND(8.6)
TB24	TB24-2'	2-2.5	9/22/2006	ND(16)	ND(16)	ND(7.9)
	TB24-7'	7-7.5	9/22/2006	ND(19)	ND(19)	ND(9.3)
TB25	TB25-3'	3-3.5	9/22/2006	ND(25)	ND(25)	ND(13)
	TB25-6'	6-6.5	9/22/2006	ND(17)	ND(17)	ND(8.3)
TB48	TB48-3'	3-3.5	9/27/2006	ND(23)	ND(23)	ND(12)
	TB48-7'	7-7.5	9/27/2006	ND(18)	ND(18)	ND(9.1)
TB49	TB49-2.5'	2.5-3	9/27/2006	ND(22)	ND(22)	ND(11)
	TB49-7'	7-7.5	9/27/2006	ND(18)	ND(18)	ND(8.9)
TB55	TB55-3'	3-3.5	11/20/2006	ND(22)	ND(22)	ND(11)
	TB55-6'	6-6.5	11/20/2006	35	ND(21)	ND(11)
Shallow (<3 meters bgs) soil ESL¹				500,000	520	490,000
Deep (>3 meters bgs) Soil ESL¹				1,000,000	520	490,000

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) for residential land use where potentially impacted groundwater is not a current or potential drinking water resource, and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

bgs = Below ground surface

µg/kg = Micrograms per kilogram

ND = Not detected at or above the indicated laboratory reporting limit.

**Table 10
Volatile Organic Compounds in Soil
Site 6 (Former Machine Shop Area)
Napa Pipe Facility
Napa, California**

Sample Location	Sample Identification	Sample Depth (Feet bgs)	Sample Date	cis-1,2-DCE (µg/kg)	Acetone (µg/kg)	TCE (µg/kg)	Vinyl Chloride (µg/kg)
MS1	MS1-2.5'	2.5-3	9/21/2006	ND(5.4)	ND(22)	ND(5.4)	ND(5.4)
	MS1-6.5'	6.5-7	9/21/2006	ND(4.4)	ND(18)	ND(4.4)	ND(4.4)
MS2	MS2-2.5'	2.5-3	9/21/2006	ND(4.5)	ND(18)	ND(4.5)	ND(4.5)
	MS2-6.5'	6.5-7	9/21/2006	ND(4.4)	ND(18)	ND(4.4)	ND(4.4)
MS3	MS3-3'	3-3.5	10/31/2006	10	ND(16)	ND(4)	ND(8.14)
	MS3-7'	7-7.5	10/31/2006	22	ND(17)	48	ND(8.3)
MS4	MS4-3'	3-3.5	10/31/2006	7.5	ND(18)	11	ND(8.8)
	MS4-7'	7-7.5	10/31/2006	14	ND(17)	24	ND(8.3)
MS5	MS5-3'	3-3.5	10/31/2006	ND(4.1)	ND(16)	ND(4.1)	15
	MS5-7'	7-7.5	10/31/2006	82	ND(16)	130	ND(8.2)
MS6	MS6-2.5'	2.5-3	10/31/2006	ND(4.3)	ND(17)	ND(4.3)	ND(8.6)
	MS6-7'	7-7.5	10/31/2006	ND(4)	ND(16)	ND(4)	ND(7.9)
MS7	MS7-3'	3-3.5	10/31/2006	ND(4)	ND(16)	ND(4)	ND(7.9)
	MS7-7'	7-7.5	10/31/2006	ND(4.2)	ND(17)	ND(4.2)	ND(4.2)
MS8	MS8-2.5'	2.5-3	10/31/2006	ND(4.8)	ND(19)	ND(4.8)	ND(9.6)
	MS8-7'	7-7.5	10/31/2006	ND(4.2)	ND(17)	ND(4.2)	ND(8.3)
MS9	MS9-3'	3-3.5	10/31/2006	ND(6)	ND(24)	ND(6)	ND(12)
	MS9-7'	7-7.5	10/31/2006	ND(4.9)	23	ND(4.9)	ND(9.8)
MS10	MS10-3'	3-3.5	10/31/2006	ND(6.3)	ND(25)	ND(6.3)	ND(13)
	MS10-7'	7-7.5	10/31/2006	ND(4.2)	ND(17)	ND(4.2)	ND(8.5)
Shallow (<3 meters bgs) soil ESL¹				1,600	500,000	260	6.7
Deep (>3 meters bgs) Soil ESL¹				1,600	1,000,000	260	6.7

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) for residential land use where potentially impacted groundwater is not a current or potential drinking water resource, and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

bgs = Below ground surface

µg/kg = Micrograms per kilogram

DCE = Dichloroethene

TCE = Trichloroethylene

ND = Not detected at or above the indicated laboratory reporting limit

Table 11
TPH as Diesel and TPH as Motor Oil in Groundwater
Site 6 (Former Drum Storage Area and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Sample Location	Sample Identification	Sample Date	TPH as Diesel		TPH as Motor Oil	
			(µg/l)		(µg/l)	
DS1	DS1-W	9/7/2006	280	HY	620	
DS2	DS2-W	9/8/2006	56	Y	ND(300)	
DS3	DS3-W	9/8/2006	200	HY	540	
DS4	DS4-W	9/8/2006	84	Y	ND(300)	
DS5	DS5-W	9/8/2006	9,700	HY	13,000	L
DS6	DS6-W	9/8/2006	120	Y	ND(300)	
DS7	DS7-W	9/8/2006	52	Y	ND(300)	
DS8	DS8-W	11/3/2006	60	Y	ND(300)	
DS9	DS9-W	11/2/2006	ND(50)		ND(300)	
DS10	DS10-W	11/2/2006	4,600	HY	6,200	
DS11	DS11-W	11/3/2006	ND(50)		ND(300)	
DS12	DS12-W	11/2/2006	130	Y	ND(300)	
TB1	TB1-W	11/2/2006	370	HY	3,000	H
TB2	TB2-W	9/27/2006	58,000	HY	160,000	L
TB3	TB3-W	9/18/2006	220	H	ND(300)	
TB18	TB18-W	9/22/2006	ND(60)		ND(300)	
TB19	TB19-W	9/22/2006	220	HY	730	
TB20	TB20-W	9/22/2006	2,000	HY	1,600	
TB21	TB21-W	9/21/2006	87	HY	ND(300)	
TB24	TB24-W	9/29/2006	52	Y	ND(300)	
TB25	TB25-W	9/22/2006	ND(50)		ND(300)	
TB48	TB48-W	9/27/2006	ND(50)		ND(300)	
TB49	TB49-W	9/27/2006	500	H	2,000	HL
TB50	TB50-W	11/1/2006	ND(50)		ND(300)	
TB51	TB51-W	11/1/2006	1,400	HY	2,100	HL
TB52	TB52-W	11/1/2006	110	HY	610	H
TB55	TB55-W	11/20/2006	ND(50)		ND(300)	
Groundwater ESL¹			2,500		2,500	

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

µg/l = Micrograms per liter

ND = Not detected at or above the indicated laboratory reporting limit

TPH = Total petroleum hydrocarbons

H = Heavier hydrocarbons contributed to the quantitation

Y = Sample exhibits chromatographic pattern which does not resemble standard

L = Lighter hydrocarbons contributed to the quantitation

**Table 12
 TPH as Diesel and TPH as Motor Oil in Groundwater
 Site 6 (Former Machine Shop Area)
 Napa Pipe Facility
 Napa, California**

Sample Location	Sample Identification	Sample Date	TPH as Diesel (ug/l)		TPH as Motor Oil (ug/l)	
MS1	MS1-W	9/21/2006	80	HY	ND(300)	
MS2	MS2-W	9/21/2006	79	HY	320	HY
MS3	MS3-W	11/1/2006	ND(50)		ND(300)	
MS4	MS4-W	10/31/2006	ND(50)		ND(300)	
MS5	MS5-W	10/31/2006	1,300	H	7,300	HL
MS6	MS6-W	11/1/2006	ND(50)		ND(300)	
MS7	MS7-W	10/31/2006	ND(50)		ND(300)	
MS8	MS8-W	10/31/2006	ND(50)		ND(300)	
MS9	MS9-W	10/31/2006	62	HY	380	H
MS10	MS10-W	10/31/2006	ND(50)		ND(300)	
Groundwater ESL¹			2,500		2,500	

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

µg/l = Micrograms per liter

ND = Not detected at or above the indicated laboratory reporting limit

TPH = Total petroleum hydrocarbons

H = Heavier hydrocarbons contributed to the quantitation

Y = Sample exhibits chromatographic pattern which does not resemble standard

L = Lighter hydrocarbons contributed to the quantitation

Table 13
Volatile Organic Compounds in Groundwater
Site 6 (Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Sample Location	Sample Identification	Sample Date	1,1-DCA (µg/l)	1,1,1-TCA (µg/l)	Acetone (µg/l)	Bromo-dichloromethane (µg/l)	Carbon Disulfide (µg/l)	Chloroform (µg/l)	MTBE (µg/l)	Xylenes (µg/l)	n-Butylbenzene (µg/l)	sec-Butylbenzene (µg/l)	Toluene (µg/l)
TB1	TB1-W	11/2/2006	2.3	3.9	ND(10)	ND(0.5)	0.9	ND(0.5)	2.6	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB2	TB2-W	9/27/2006	ND(0.5)	ND(0.5)	13	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	0.5	1.3	0.7	5.6
TB3	TB3-W	9/19/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB18	TB18-W	9/22/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB19	TB19-W	9/22/2006	ND(0.5)	ND(0.5)	17	0.8	0.7	10	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	0.5
TB20	TB20-W	9/22/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB21	TB21-W	9/21/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB22	TB22-W	9/21/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB24	TB24-W	9/29/2006	ND(0.5)	ND(0.5)	20	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	0.7	ND(0.5)	ND(0.5)	ND(0.5)
TB25	TB25-W	9/22/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB48	TB48-W	9/27/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB49	TB49-W	9/28/2006	1.1	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
TB55	TB55-W	11/20/2006	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
Groundwater ESL¹			1,000	50,000	50,000	170	NE	330	1,800	5,300	NE	NE	400

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

µg/l = Micrograms per liter

MTBE = methy-tert-butyl ether

TCA = Trichloroethane

DCA = Dichloroethane

ND = Not detected at or above the indicated laboratory reporting limit

NE = Not established

**Table 14
Volatile Organic Compounds in Groundwater
Site 6 (Former Machine Shop Area)
Napa Pipe Facility
Napa, California**

Sample Location	Sample Identification	Sample Date	1,1,1-TCA (µg/l)	1,1,2-TCA (µg/l)	1,2,4-TMB (µg/l)	1,1-DCA (µg/l)	1,1-DCE (µg/l)	Acetone (µg/l)	Benzene (µg/l)	Bromo-dichloromethane (µg/l)	Bromo-chloromethane (µg/l)	Chloroform (µg/l)	cis-1,2-DCE (µg/l)	Dibromo-methane (µg/l)	Dibromo-chloromethane (µg/l)	Xylenes (µg/l)	Toluene (µg/l)	PCE (µg/l)	TCE (µg/l)	Trichloro-fluoromethane (µg/l)	trans-1,2-DCE (µg/l)	Vinyl Chloride (µg/l)
MS1	MS1-W	9/21/2006	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(0.5)
MS2	MS2-W	9/21/2006	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(0.5)
MS3	MS3-W	11/1/2006	ND(0.5)	1.1	0.7	11	2.5	16	ND(0.5)	ND(0.5)	ND(0.5)	0.5	120	ND(0.5)	ND(0.5)	2.6	2.2	ND(0.5)	130	ND(1)	1.6	0.7
MS4	MS4-W	10/31/2006	ND(7.1)	ND(7.1)	ND(7.1)	27	ND(7.1)	ND(140)	ND(7.1)	ND(7.1)	ND(7.1)	ND(7.1)	330	ND(7.1)	ND(7.1)	ND(7.1)	ND(7.1)	ND(7.1)	930	ND(14)	8.5	ND(7.1)
MS5	MS5-W	10/31/2006	0.9	ND(0.5)	ND(0.5)	0.6	ND(0.5)	ND(10)	ND(0.5)	4.9	2.4	29	7.6	1.5	2.2	ND(0.5)	ND(0.5)	1.9	21	ND(1)	ND(0.5)	15
MS6	MS6-W	11/1/2006	ND(2)	ND(2)	ND(2)	ND(2)	ND(2)	ND(40)	ND(2)	ND(2)	ND(2)	ND(2)	23	ND(2)	ND(2)	ND(2)	ND(2)	ND(2)	290	ND(4.0)	ND(2)	ND(2)
MS7	MS7-W	10/31/2006	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	1.2	1.4	ND(0.5)	ND(0.5)	ND(1)	ND(0.5)	ND(0.5)
MS8	MS8-W	10/31/2006	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(10)	ND(0.5)	ND(0.5)	ND(0.5)	3.2	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	0.7	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)	ND(0.5)
MS9	MS9-W ²	10/31/2006	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(9.4)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)	ND(4.7)
MS10	MS10-W ²	10/31/2006	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(9.6)	6.1	ND(4.8)	ND(4.8)	5.1	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)	ND(4.8)
Groundwater ESL¹			50,000	350	NE	1,000	6,300	50,000	540	170	NE	330	6,200	NE	170	5,300	400	120	530	NE	2,600	3.8

Notes:
 ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

² = The 40 - ml VOAs for this sample contained abundant fines so the sample was analyzed as a sediment rather than water.

Therefore, the units are in micrograms per kilograms.

Results exceeding ESLs are shaded

µg/l = Micrograms per liter

TCA = Trichloroethane

TMB = Trimethylbenzene

DCA = Dichloroethane

DCE = Dichloroethene

PCE = Tetrachloroethylene

TCE = Trichloroethylene

ND = Not detected at or above the indicated laboratory reporting limit

NE = Not established

**Table 15
Summary of Petroleum Hydrocarbons in Soil
Site 6 (Former Machine Shop and Drum Storage Areas, and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California**

Constituent	Maximum Detection (mg/kg)	Minimum Detection (mg/kg)	Number of Samples	Number of Detections	Frequency of Detection	Shallow (<3 meters bgs) Soil ESL ¹ (mg/kg)	Deep (>3 meters bgs) Soil ESL ¹ (mg/kg)	# of Detections Above ESL
Former Machine Shop								
TPH ²	1,700	ND	10	4	40%	500 ⁴ /1,000 ⁵	5,000	1
O&G ³	3,000	ND	8	2	25%	500 ⁴ /1,000 ⁵	5,000	2
TPH-d	640	ND	29	15	52%	100 ⁴ /400 ⁵	5,000	1
TPH-mo	200	ND	31	13	42%	500 ⁴ /1,000 ⁵	5,000	0
Former Drum Storage Area and Southeastern Portion of Fabrication Buildings								
TPH ²	6,600	ND	12	5	42%	500 ⁴ /1,000 ⁵	5,000	3
O&G ³	9,200	ND	12	9	75%	500 ⁴ /1,000 ⁵	5,000	4
TPH-d	4,600	ND	75	51	68%	100 ⁴ /400 ⁵	5,000	6
TPH-mo	9,800	ND	75	62	83%	500 ⁴ /1,000 ⁵	5,000	9

Notes:
 ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) for residential land use where potentially impacted groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).
² = Results represent the sum of TPH-d and TPH-mo concentrations. The borings associated with these TPH results are areas of Site 6 where the petroleum hydrocarbons present are generally characteristic of heavier-end compounds that fall within the TPH-mo range (MW, 1996). Therefore, the results are compared the ESLs for TPH-mo.
³ = Compared to ESLs for residual fuels
⁴ = 0 to 3 feet bgs interval, including samples collected from 3 to 3.5 feet bgs
⁵ = 3 to 10 feet bgs interval, excluding soil samples collected from 3 to 3.5 feet bgs
 bgs = Below ground surface
 mg/kg = milligrams per kilogram
 ND = Not detected
 NE = No established ESL
 N/A = Not applicable
 O&G = Oil & grease
 TPH = Total petroleum hydrocarbons
 TPH-d = TPH as diesel
 TPH-mo = TPH as motor oil

Table 16
Summary of Volatile Organic Compounds in Soil
Site 6 (Former Machine Shop and Drum Storage Areas, and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Constituent	Maximum Detection (µg/kg)	Minimum Detection (µg/kg)	Number of Samples	Number of Detections	Frequency of Detection	Shallow (<3 meters bgs) Soil ESL ¹ (µg/kg)	Deep (>3 meters bgs) Soil ESL ¹ (µg/kg)	# of Detections Above ESL
Former Machine Shop								
2-Butanone (MEK)	110	ND	42	2	5%	490,000	490,000	0
Acetone	50	ND	42	3	7%	500,000	1,000,000	0
Methylene Chloride	8.8	ND	42	4	10%	520	520	0
TCE	240	ND	42	12	29%	260	260	0
Tetrahydrofuran	150	ND	42	2	5%	NE	NE	N/A
cis-1,2-DCE	130	ND	42	12	29%	1,600	1,600	0
Vinyl Chloride	15	ND	42	1	2%	6.7	6.7	1
trans-1,2-DCE	32	ND	42	1	2%	3,100	3,100	0
Former Drum Storage Area and Southeastern Portion of Fabrication Buildings								
2-Butanone (MEK)	37	ND	49	1	2%	490,000	490,000	0
Acetone	440	ND	49	14	29%	500,000	1,000,000	0
Ethylbenzene	170	ND	49	1	2%	390,000	390,000	0
Methylene Chloride	310	ND	49	2	4%	520	520	0
Toluene	1200	ND	49	1	2%	100,000	130,000	0
Xylenes	1100	ND	49	1	2%	310,000	310,000	0
TCE	6.5	ND	49	1	2%	260	260	0
Carbon Disulfide	10	ND	49	2	4%	NE	NE	N/A

Notes:

ESL¹ = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) for residential land use where potentially impacted groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

bgs = Below ground surface

µg/kg = Micrograms per kilogram

ND = Not detected

NE = No established ESL

N/A = Not applicable

DCE = Dichloroethene

MEK = Methyl ethyl ketone

TCE = Trichloroethylene

Table 17
Summary of Petroleum Hydrocarbons in Groundwater
Site 6 (Former Machine Shop and Drum Storage Areas, and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Constituent	Maximum Detection (mg/l)	Minimum Detection (mg/l)	Number of Samples	Number of Detections	Frequency of Detection	Groundwater ESL ² (mg/l)	# of Detections Above ESL
Former Machine Shop							
TPH as Diesel	1,300	ND	12	5	42%	2,500	0
TPH as Motor Oil	7,300	ND	12	3	25%	2,500	1
Former Drum Storage Area and Southeastern Portion of Fabrication Buildings							
TPH as Diesel	58,000	ND	29	22	76%	2,500	5
TPH as Motor Oil	160,000	ND	29	13	45%	2,500	6

Notes:

¹ = Unless otherwise noted, groundwater results from: (1) the fourth quarter 2006 monitoring event; (2) Shaw Environmental Inc.'s 2005 *Phase II Site Investigation*; and (3) PES's 2006 *Supplemental Remedial Investigation* were used to compile the information presented on this table.

ESL² = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

µg/l = Micrograms per liter

TPH = Total petroleum hydrocarbons

TPH-d = TPH as diesel

TPH-mo = TPH as motor oil

ND = Not detected

Table 18
Summary of Volatile Organic Compounds in Groundwater
Site 6 (Former Machine Shop and Drum Storage Areas, and Southeastern Portion of Fabrication Buildings)
Napa Pipe Facility
Napa, California

Constituent	Maximum Detection (µg/l)	Minimum Detection (µg/l)	Number of Samples	Number of Detections	Frequency of Detection	Groundwater ESL ² (µg/l)	# of Detections Above ESL
Former Machine Shop							
1,1-DCA	27	ND	20	5	25%	1,000	0
1,1-DCE	2.9	ND	20	3	15%	6,300	0
1,1,1-TCA	0.9	ND	20	1	5%	50,000	0
1,2,4-TMB	0.7	ND	20	1	5%	NE	N/A
Acetone	16	ND	20	1	5%	50,000	0
Benzene	6.1	ND	20	1	5%	540	0
cis-1,2-DCE	330	ND	20	8	40%	6,200	0
Toluene	2.2	ND	20	2	10%	400	0
Vinyl Chloride	15	ND	20	4	20%	3.8	1
Xylenes	2.6	ND	20	2	10%	5,300	0
trans-1,2-DCE	8.5	ND	20	3	15%	2,600	0
TCE	930	ND	20	8	40%	530	1
1,1,2-TCA	1.1	ND	20	1	5%	350	0
Bromodichloromethane	4.9	ND	20	1	5%	170	0
Bromochloromethane	2.4	ND	20	1	5%	NE	N/A
Chloroform	29	ND	20	4	20%	330	0
Dibromomethane	1.5	ND	20	1	5%	NE	N/A
Dibromochloromethane	2.2	ND	20	1	5%	170	0
PCE	1.9	ND	20	1	5%	120	0
Bromomethane	1.1	ND	20	1	5%	580	0
Former Drum Storage Area and Southeastern Portion of Fabrication Buildings							
1,1-DCA	4.1	ND	15	3	20%	1,000	0
1,1,1-TCA	3.9	ND	15	1	7%	50,000	0
Acetone	20	ND	15	3	20%	50,000	0
n-Butylbenzene	1.3	ND	15	1	7%	NE	N/A
Toluene	5.6	ND	15	2	13%	400	0
Xylenes	0.7	ND	15	2	13%	5,300	0
Carbon disulfide	0.9	ND	15	2	13%	NE	N/A
Bromodichloromethane	0.8	ND	15	1	7%	170	0
Chloroform	10	ND	15	1	7%	330	0
MTBE	2.6	ND	15	1	7%	1,800	0

Notes:

¹ = Unless otherwise noted, groundwater results from: (1) the fourth quarter 2006 monitoring event; (2) Shaw Environmental Inc.'s 2005 Phase II

Site Investigation; and (3) PES's 2006 Supplemental Remedial Investigation were used to compile the information presented on this table.

ESL² = San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Level (ESL) where

groundwater is not a current or potential drinking water resource and where the soil leaching to groundwater and discharge of groundwater to surface water pathway does not apply (i.e., no aquatic habitat pathway).

Results exceeding ESLs are shaded

µg/l = Micrograms per liter

DCA = Dichloroethane

DCE = Dichloroethene

TCA = Trichloroethane

TMB = Trimethylbenzene

TCE = Trichloroethylene

PCE = Tetrachloroethylene

MTBE = methy-tert-butyl ether

N/A = Not applicable

ND = Not detected

NE = Not established

Table 19a
Preliminary Screening of Remedial Technologies for Soil
Napa Pipe Facility, Napa, California

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Soil Vapor Extraction	Vacuum is applied to the subsurface to extract contaminant-laden soil gas. Induced concentration gradients result in desorption and mobilization of contaminants to fresh air pulled in from outside the target zone.	<p>Applicability. Applicable to volatile organics and some fuels (Henry's law constant greater than 0.01 or vapor pressure greater than 0.5 mm Hg). Moisture content, organic content, and air permeability of soil affect applicability. Aeration by SVE can promote <i>in situ</i> aerobic biodegradation but can also limit anaerobic biodegradation.</p> <p>Limitations. Performance is function of air permeability and contaminant volatility. High amount of fines and high degree of saturation limit airflow require higher vacuums. Stratified soils result in non-uniform airflow causing hot spots to remain. High sorption capacity can reduce removal rates. Off-gas and residual liquids may require treatment/disposal.</p>	<p>Low</p> <p>Primary site contaminants (TPH-mo and TPH-d) are not readily amenable to SVE. Unsaturated zone is not very thick and consists of low permeability silts and clays. Site lithology is not conducive to technologies relying on subsurface air flow. Potential for free product makes this technology even less viable.</p>	<p>Easy</p> <p>After all aboveground structures are removed, implementing this technology is fairly easy. The system is simple to operate and maintain, requiring no specialized skill level and experience. Equipment is readily available with numerous vendors.</p>	<p>Low ⑤</p> <p>SVE is a proven and relatively easy to operate remediation technology. System installation and operating costs are not excessive requiring no special equipment and consumables. High uncertainty since no data is available to determine long-term effectiveness and remediation duration, and contaminants are not prone to volatilization.</p>	No – due to low effectiveness.
Thermally Enhanced Soil Vapor Extraction	Hot air, steam, or soil heating is used to enhance desorption, volatilization and mobility. Vacuum is applied to subsurface to remove the volatilized contaminants.	<p>Applicability. Technology improves volatility of VOCs and SVOCs. Heating soil may increase air permeability by drying soils or interstitial pore space. Thermally enhanced SVE can improve conditions for biodegradation of residual contaminants.</p> <p>Limitations. Performance is function of attainable soil temperature, air permeability, and contaminant volatility. Same limitations as SVE. Offgas and residual liquids may be required treatment/disposal. Higher process temperatures require specialized equipment.</p>	<p>Low to Medium</p> <p>Thermal enhancement may provide limited improvement of contaminant extraction rates compared to SVE. Soils can become more permeable as they dry out. Motor oil range TPH contaminants will volatilize more when heated. Thin unsaturated zone, low permeability silts and clays, and heterogeneous lithology is not conducive to technologies relying on subsurface air flow. Potential for free product further reduces effectiveness.</p>	<p>Moderately Difficult</p> <p>Similar to SVE except specialized process equipment and higher temperature-rated components are needed. Also, specialized skills are required to operate and maintain the heat source systems. Boundary control becomes a challenge to ensure contaminated vapors and liquids do not contaminate previously clean areas.</p>	<p>Moderate to High ⑤</p> <p>Significantly higher costs than conventional SVE due to need for high temperature rated equipment and material. Also, electrical and/or fuel costs are significantly higher to supply the heat source. Shallow water table may require additional measures to ensure contaminated vapors are not released from the site. Maximum soil temperatures may be limited by low air permeability and shallow water table. High uncertainty since no data is available to determine long-term effectiveness and remediation duration. Site lithology not conducive to technologies relying on subsurface air flow.</p>	No – due to low effectiveness and relatively high cost

**Table 19a
Preliminary Screening of Remedial Technologies for Soil
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Excavation	Contaminated soils are excavated using standard construction techniques such as excavators, bulldozers, and scrapers. Excavation of saturated soils may require dewatering. Excavated soils are managed using other remediation technologies depending on contaminant type and concentration, cleanup levels, and regulatory requirements.	<p>Applicability. Excavation of soils above water table is a common remediation method. Relatively shallow unsaturated zone minimizes excavation volumes and limits need for shoring or slope stabilization. Excavation of soils below water table is less common, but limited depth of contamination below the water table makes this approach feasible.</p> <p>Limitations. Requires heavy construction equipment. Potential free phase product and high concentrations may present safety concerns requiring engineering controls to prevent exposure and fire/explosion. Silty/clayey soils may involve additional handling requirements.</p>	<p>High Impacted soil and contaminants are removed and no longer provide a potential source of exposure or secondary source of contamination to groundwater.</p>	<p>Moderately Easy After all aboveground structures are removed, excavation is fairly straightforward to implement using standard construction techniques. Large excavations below the water table will require dewatering and/or specialized excavation methods.</p>	<p>Moderate ① Large contaminated area and potential need to use respiratory equipment and handle contaminated soils and free phase product increase costs. Also, all contaminants are excavated and clean boundaries are confirmed via on-site sampling.</p>	Yes – effective and readily implemented at reasonable cost.
<i>Ex Situ</i> Low Temperature Thermal Desorption	Excavated soil is processed through an aboveground low temperature thermal desorption (LTTD) unit where it is heated to upwards of 600°F. Contaminants volatilize and are removed and treated in the vapor phase. Clean soils can be used as backfill material. Pre-processing of contaminated soils may be required to remove debris or oversize material, reduce moisture content to <20 to 30%, and reduce excessively high contaminant concentrations.	<p>Applicability. Site 6 contaminants will desorb at temperatures achievable by LTTD and are readily destroyed in standard vapor phase treatment systems (e.g., thermal oxidizers).</p> <p>Limitations. Moisture content of saturated soils and silty/clayey soils may involve additional handling requirements (e.g., drying). Large LTTD units require significant mobilization of equipment and access to large supplies of natural gas or propane. Operation of LTTD units will likely require air discharge permitting and associated emission limits.</p>	<p>High LTTD is a proven technology that has been shown effective at reducing contaminant concentrations to well below site cleanup levels. Effective operation results in soil suitable for reuse and destruction of contaminants in vapor phase treatment systems.</p>	<p>Moderately Difficult LTTD units of the size potentially required at Site 6 are large specialized systems and require significant mobilization and setup. Permitting requirements can be significant, but rarely prevent operations. Once set up, operations are relatively straightforward and involve providing a constant feed of contaminated soil to the LTTD unit, operation and monitoring of the unit itself, and managing the treated soils.</p>	<p>Moderate to High ③ Fuel requirements to run the LTTD unit increase operating costs. Contaminants are heated well above the boiling point, and soils can be blended to ensure soil is uniformly heated. Soils excavated from the capillary fringe will be wet and likely require drying. Although this is a proven technology for the site contaminants and confirmation sampling documents treatment effectiveness, moderate uncertainty associated with permitting requirements and exact nature of soil pre-processing requirements.</p>	Yes – effective and implementable for site contaminants at moderate cost.

**Table 19a
Preliminary Screening of Remedial Technologies for Soil
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Incineration	Excavated soil is processed through an aboveground incinerator unit where it is heated to high temperatures (upwards of 1,800°F). Contaminants are destroyed due to the high combustion temperatures. Clean soils can be used as backfill material.	<p>Applicability. Use of incinerator requires mobilizing a unit to the site (readily available technology). Contaminants are suitable for high temperature volatilization and removal/destruction.</p> <p>Limitations. Moisture content of saturated soils and silty/clayey soils may involve additional handling requirements. Large soil incineration units require significant mobilization of equipment and access to large supplies of natural gas or propane. Operation of incinerator unit will likely require air discharge permitting and associated emission limits.</p>	<p>High Incineration is a proven technology that has been shown effective at reducing contaminant concentrations to well below site cleanup levels. Effective operation results in soil suitable for reuse.</p>	<p>Moderately Difficult Incineration units of the size potentially required at Site 6 are large and specialized systems and require significant mobilization and setup. Permitting requirements can be significant.</p>	<p>High ③ Due to significantly higher operational temperatures, incinerators are more expensive to build and operate, with large fuel requirements increasing operating costs. Soils excavated from the capillary fringe will be wet and likely require drying. Although this is a proven technology for the site contaminants, the moderate uncertainty is associated with permitting requirements and exact nature of soil pre-processing requirements.</p>	No – Higher costs compared to LTDD with no benefit.
In-Pile Thermal Desorption	Excavated soil is stockpiled in engineered cells with embedded thermal desorption heaters and extractors. A heat source adds thermal energy to the pile to volatilize VOCs and SVOCs. Depending on the temperature (upwards of 1,600°F), contaminants can be destroyed or extracted and treated. Clean soils can be used as backfill material.	<p>Applicability. Contaminants are susceptible to high temperature volatilization and removal/destruction. Large available land area to set up cells.</p> <p>Limitations. Requires heavy construction equipment. Contaminant aeration is likely during excavation, potentially requiring respiratory protection for on-site workers. Potential free phase product and high concentrations present safety concerns due to exposure and fire/explosion. Desorbed vapors and drained liquids require containment measures and treatment systems.</p>	<p>High Thermal desorption is a proven technology that has been shown effective at reducing contaminant concentrations, although in-pile technique utilized less than continuous feed LTDD and incineration technologies. Effective operation results in soil suitable for reuse and destruction of contaminants in vapor phase treatment systems.</p>	<p>Moderately Difficult to Difficult Specialized skills and experience required to operate the IPTD system. If necessary, vapor treatment technologies are readily available for diesel and motor oil.</p>	<p>High ④ Large contaminated area and potential need to use respiratory equipment and handle contaminated soils and free phase product increase costs. Fuel or electrical requirements to provide the heat source increase operating costs. Uncertainty higher compared to LTDD due to difficulties ensuring uniform treatment and management of vapors and liquids from piles.</p>	No – higher cost and uncertainty compared to LTDD.
<i>In Situ</i> Thermal Desorption (ISTD)	ISTD is similar to In-Pile Thermal Desorption except heat is applied in-situ (without excavation) through heater wells and contaminant vapors extracted through heated extraction wells. The thermal energy is transmitted to the subsurface via thermal convection and radiant heating to volatilize VOCs and SVOCs. Temperatures of greater than 1,000°F can be achieved. Contaminants can be destroyed in situ or extracted and treated.	<p>Applicability. Site contaminants are susceptible to high temperature volatilization and removal/destruction.</p> <p>Limitations. Sites with thin contaminated zones less suited to technology due to cost considerations. Certain underground utilities can must be removed prior to treatment.</p>	<p>High Thermal desorption is a proven technology that has been shown effective at reducing contaminant concentrations.</p>	<p>Moderately Difficult to Difficult Specialized skills and experience required to operate the ISTD system. If necessary, vapor treatment technologies are readily available for diesel and motor oil.</p>	<p>High ④ Relatively thin contaminated zone significantly increases unit cost of ISTD compared to other thermal technologies. Uncertainty higher compared to LTDD due to difficulties ensuring uniform treatment and collection and treatment of vapors from subsurface.</p>	No – higher cost and uncertainty compared to <i>Ex Situ</i> LTDD.

Table 19a
Preliminary Screening of Remedial Technologies for Soil
Napa Pipe Facility, Napa, California

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Bioventing	Oxygen is delivered <i>in situ</i> by forced air movement to stimulate aerobic biodegradation.	<p>Applicability. Generally applies to aerobic biodegradation of contaminants sorbed to soil particles. Target contaminants are typically petroleum hydrocarbons, nonchlorinated solvents, and other organic chemicals.</p> <p>Limitations. Shallow water table, saturated soils, high concentrations and/or free phase product, and low permeability soils reduce bioventing performance.</p>	<p>Low Could enhance aerobic degradation in areas with lower contaminant concentrations. Unsaturated zone is not very thick and consists of low permeability silts and clays. Potential free product and high contaminant concentrations may be too toxic for effective biodegradation.</p>	<p>Easy After all aboveground structures are removed, implementing this technology is fairly easy. The system is easy to operate and maintain, requiring no specialized skill level and experience. Also, the equipment is readily available with numerous vendors.</p>	<p>Low ⑤ Adding oxygen to the subsurface involves easy-to-operate and fairly common equipment. High uncertainty since biodegradation rates adversely affected by high contaminant concentrations and potential free phase product. Also, site lithology not conducive to technologies relying on subsurface air flow.</p>	No – ineffective due to site conditions.
Bio-Piling	Excavated soils are stockpiled in engineered cells with embedded injectors to add oxygen, nutrients, and/or amendments as needed to stimulate biodegradation. Clean soils can be used as backfill material.	<p>Applicability. Similar to bioventing except <i>ex situ</i>. Target contaminants are typically petroleum hydrocarbons, nonchlorinated solvents, and other organic chemicals. Large available land area to set up cells.</p> <p>Limitations. Potential free phase product and high concentrations present safety concerns due to exposure, and may be toxic to bacteria. Potential vapors and drained liquids may require containment measures and treatment. Depending on biodegradation rates, cleanup levels, and quantity of soil requiring remediation, treatment can a significant amount of time (months or years).</p>	<p>Medium to High Could enhance aerobic degradation in areas with low to moderate contaminant concentrations. Silts and clays are low permeability, which would adversely affect airflow through the pile. Potential free product and high contaminant concentrations may inhibit bioactivity. These factors may improve with proper blending/mixing with cleaner more permeable soils.</p>	<p>Moderate Skill and experience requirements to construct and operate biopiles are relatively common. Equipment requirements are minimal, and equipment is readily available. Management of vapors and liquids increase complexity.</p>	<p>Low to Moderate ④ Large contaminated area and potential need to use respiratory equipment and handle contaminated soils and free phase product increase costs. Higher uncertainty since biodegradation rates are unknown and would need to be evaluated in treatability studies. Rates adversely affected by high contaminant concentrations and potential free phase product.</p>	Yes – effective and implementable treatment at moderate cost.
Landfarming	Excavated soil is spread in thin layers on the ground. Soil is aerated by tilling and/or plowing to stimulate biodegradation. Nutrients or amendments can be utilized if needed. Clean soils can be used as backfill material.	<p>Applicability. Similar to bio-piling, except land requirements are significantly higher in order to set up “landfarms”.</p> <p>Limitations. Similar to bio-piling, except more difficult to control moisture content since landfarms are not typically covered and are exposed to rainfall. Also more difficult to control vapors.</p>	<p>Medium Similar to bio-piling except it can be more difficult to control factors effecting biodegradation (e.g., moisture content, temperature). Technology may not be effective during wet season due to excessive rainfall.</p>	<p>Moderately Easy Skills, experience and equipment requirements to implement this technology are minimal. Because soil is treated in relatively shallow lifts, treatment of large volumes of soil require either very large areas to conduct treatment or longer treatment periods to process multiple lifts.</p>	<p>Low ④ Costs lower than bio-piling due to minimal equipment and operational requirements. Uncertainty similar to or slightly higher than bio-piling due to potential impacts of rainfall on performance.</p>	Yes – potentially effective treatment at low cost.

**Table 19a
Preliminary Screening of Remedial Technologies for Soil
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Monitored Natural Attenuation	Natural processes (volatilization, biodegradation, adsorption, and chemical reactions) are used to reduce contaminant concentrations to acceptable levels.	<p>Applicability. Natural attenuation is a common element of cleanup programs for fuel hydrocarbons and halogenated VOCs. Can be used to manage residual contamination following site stabilization and source control activities. Timeframe for cleanup not consistent with RAOs.</p> <p>Limitations. Extensive site characterization, modeling, and monitoring are required to document the natural attenuation of the contaminants. High contaminant concentrations and/or free phase product limit applicability of biodegradation. Similarly, higher molecular weight contaminants hinder volatilization.</p>	<p>Low</p> <p>As compared to other remedial technologies, use of MNA will take much longer (e.g., decades) to achieve cleanup levels. Diesel and motor oil are not amenable to volatilization, and areas of high concentrations and/or free phase product may be toxic to the bacteria.</p>	<p>Moderately Easy</p> <p>The required equipment, skills, and experience to implement monitored natural attenuation is minimal, although extensive sampling and analysis are needed to baseline the process and monitor ongoing progress.</p>	<p>Low ⑤</p> <p>Because there are no major equipment and construction requirements, the cost to implement this technology is low although long-term monitoring costs could be significant. The uncertainty of achieving the RAOs is high since contaminant concentrations have remained high after many years of potential bioactivity. High concentrations and free product inhibit natural biodegradation, and the site contaminants are not amenable to natural volatilization.</p>	No –not suitable to achieve cleanup goals.
<i>In Situ</i> Chemical Oxidation	Strong oxidizer is injected into subsurface to oxidize and destroy organic contaminants.	<p>Applicability. Chemical oxidation commonly applied to wide range of organic compounds including unsaturated aliphatic (i.e., TCE), aromatic compounds (i.e., benzene), and fuel hydrocarbons. Fast reaction rates can be achieved depending on oxidant type used.</p> <p>Limitations. Incomplete oxidation can result in intermediate contaminants. Some oxidizers can be explosive, particularly in high concentrations of high energy contaminants. Uniform application of oxidants required to ensure all contaminants are being treated can be difficult to achieve in stratified soils. Indiscriminant and rapid reactions with other oxidant-consuming substances (e.g., natural organic matter) reduce effectiveness.</p>	<p>Medium</p> <p>Heavier motor oil range TPH contaminants are amendable to treatment using chemical oxidation, but can require higher chemical dosing rates compared to lighter TPH compounds. Low soil permeability from silts and clays will make uniform distribution of the chemical oxidizer within the subsurface more difficult although relatively shallow and thin treatment zone will help this. Also, high contaminant concentrations and/or free phase product could require large amount of oxidizer.</p>	<p>Moderately Difficult</p> <p>After all aboveground structures are removed, injecting the oxidants would not be difficult, although effective distribution of oxidants through treatment zone may be challenging. Handling large quantities of strong oxidizers presents health and safety concerns.</p>	<p>Medium to High④</p> <p>Costs dependent on contaminant concentrations. High concentrations and the potential presence of free phase product could require large quantities and frequent applications of the oxidizer and result in much higher costs. Less contaminated soils will require less oxidant, fewer applications, and would cost less. Handling and safety requirements add additional costs. The uncertainty is moderate to high since the stratified lithology and low soil permeability could prevent oxidant from being uniformly distributed within the contaminated regions – treatability studies would be required to address uncertainty.</p>	Yes – although site soils not well suited for <i>in situ</i> approach, chemical oxidation retained as representative <i>in situ</i> remediation technology. May not be appropriate for treating source area soils.
<i>In Situ</i> Soil Washing	Water, or water containing an additive to enhance contaminant mobility, is applied to the soil surface or injected into the ground to flush contaminants into the groundwater. The groundwater is then extracted and treated.	<p>Applicability. Soil washing can be used to treat VOCs, SVOCs, and some fuels and enhance recovery of NAPL.</p> <p>Limitations. Different contaminants require different wash water mixtures. Clayey soil causes the contaminant to adhere more strongly to the soil, making it difficult to desorb. Also, the wash water may alter the physical and chemical properties of soil.</p>	<p>Low</p> <p>Contaminants are hydrophobic and soil washing would not mobilize the contaminants to the water table. Amendments may help, but there is significant uncertainty as to effectiveness. Soil washing could also result in contaminating previously clean areas.</p>	<p>Moderately Difficult</p> <p>Implementation requires uniform application of water and amendments through the contaminated region, which would be difficult given stratified and low-permeability soils.</p>	<p>Low to Medium⑤</p> <p>This technology involves a low-cost network of aboveground piping and systems to inject the wash water. The high uncertainty is a result of the stratified lithology, low soil permeability, and oleophobic contaminants.</p>	No – effectiveness uncertain

**Table 19a
Preliminary Screening of Remedial Technologies for Soil
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Off-Site Disposal	Excavated soil is disposed off-site at an approved and permitted facility.	<p>Applicability. Off-site disposal facilities are readily available that accept soils contaminated with fuels and VOCs.</p> <p>Limitations. None.</p>	<p>High Impacted soil is removed and no longer provides a potential source of contamination to groundwater.</p>	<p>Easy Off-site disposal facilities readily available and only require transportation of contaminated soils.</p>	<p>Moderate to High ① Costs for off-site disposal are moderate to high depending on waste classification of soils. Costs further increased due to need for importing of additional fill to site. Low uncertainty.</p>	Yes – retained for use with soils that may not be amenable for treatment with on-site technologies.
<p>NOTE: Uncertainty rating reflects additional data needs or technology development needed to demonstrate applicability, implementability, and cost uncertainty. ① = low degree of uncertainty. Site data generally available to determine applicability. ⑤ = high degree of uncertainty. Additional data, analysis, pilot testing, or technology development required to determine applicability to site.</p> <p>^a Preliminary effectiveness ratings of high, medium, and low reflect estimated relative effectiveness of the technology to treat the site contaminants and meet RAOs.</p> <p>^b Implementability rating of easy, moderately easy, moderately difficult, and difficult reflect estimated relative complexity and cost of implementing the technology.</p> <p>^c Cost reflects the relative overall costs (low, medium, high) of implementing the technology at the site.</p>						

**Table 19b
Preliminary Screening of Remedial Technologies for Groundwater
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Groundwater Extraction	Groundwater is pumped to extract contaminants and generate hydraulic gradients that can contain the plume and mobilize the contaminants to the extraction wells. Extracted groundwater is treated aboveground as needed and discharged.	<p>Applicability. Groundwater pumping is common for achieving hydraulic control and recovering contaminant mass. The contaminants are removed from the subsurface in the dissolved phase and then removed by the carbon. Technology is applicable to high contaminant concentrations in the dissolved phase in soils with high permeability and yields.</p> <p>Limitations. Groundwater extraction for contaminant removal is dependent on the hydraulic permeability of the formation.</p>	<p>Low Given low permeability and stratified soils at Site 6, achieving cleanup goals with groundwater extraction will be slow and may not affect residual free phase product (light or dense). Existing extraction trench has contained the groundwater plume/recovered contaminant mass, but has not cleaned up the contamination in the 9 years of operation.</p>	<p>Easy Groundwater extraction involves installing pumping systems to remove groundwater from the subsurface. These systems are relatively easy to install and operate. The required skills and experience for this technology is widely available. There are numerous vendors that can supply the equipment.</p>	<p>Medium to High ⑤ System installation costs are not excessive. Due to long cleanup timeframe, however, life-cycle costs for groundwater extraction and treatment systems are often high. Treatment costs could be high due to potentially significant contaminant mass. There is a high uncertainty regarding the timeframe required to achieve cleanup goals, if they can be achieved with this technology at all.</p>	No – low effectiveness due to site conditions (presence of free-phase product) and inability to meet RAOs.
Existing Wastewater Treatment System and Sanitary Sewer Discharge	The Napa Pipe facility currently maintains a wastewater treatment system that discharges into the sanitary sewer under a permit with the Napa County Sanitation District. This system includes storage tanks, chemical injection systems (flocculant injection), settling tanks, an oil/water separator. Groundwater generated during dewatering will be treated using this existing wastewater treatment system and discharged to the sanitary sewer under the existing permit. If additional treatment is required to remove dissolved organic constituents (TPH, VOCs) to below permit limits, a series of granular activated carbon (GAC) vessels will be added as a polishing step prior to discharge.	<p>Applicability. The existing wastewater treatment system appears to be suitable for use in treating groundwater with only minimal modification required, including the potential addition of GAC vessels to remove dissolved organics.</p> <p>Limitations. The existing wastewater treatment system must be operated within the requirements of the sanitary sewer discharge permit. Temporary transfer piping may be required to get groundwater from remediation areas to the system, or it can be moved using portable tanks or tanker trucks.</p>	<p>High The existing system has been demonstrated effective at meeting discharge requirements for the sanitary sewer and has the major treatment components needed to be treat groundwater, with the possible addition of GAC vessels.</p>	<p>Easy The existing facility is already constructed and permitted, and modifications necessary for use in treating groundwater are relatively straightforward to implement.</p>	<p>Low ③ The existing system will cost very little to modify for use as a groundwater treatment system, and operational costs are expected to be moderate. Uncertainty is associated with need to determine whether GAC adsorption vessels will be required and the means in getting the groundwater to the system.</p>	Yes – will be effective in managing groundwater extracted as part of excavation dewatering activities.
Permeable Reactive Barrier	Subsurface barrier allows passage of groundwater and controls movement of contaminants. The barrier is filled with reactive agents or microorganisms where the concentrated contaminants are either degraded or retained in the barrier material.	<p>Applicability. Reactive barriers apply to VOCs, SVOCs, and inorganics. A variety of media have been used to treat various classes of contaminants.</p> <p>Limitations. Requires heavy construction equipment. The reactive agents must be matched to the contaminants. Effectiveness is specific to barrier media and contaminants. Needs to be keyed into a confining layer. Barriers can lose hydraulic or reactive capacity over time. May be susceptible to fouling or excessive leakage if not designed and/or installed properly.</p>	<p>Low At the site, with the low groundwater flowrates, there may be limited effectiveness in achieving cleanup goals. Contaminant mass removal is a function of the flowrates through the wall. Unlikely to have efficiency for TPH compounds dissolved in groundwater.</p>	<p>Moderately Difficult Because of the shallow water table and relatively shallow depth to confining layer, installing the slurry wall barrier is straightforward. However, the extent of the contaminant boundary requires a large area to be contained and the plume would need to be more clearly delineated.</p>	<p>Medium to High ③ This technology involves excavating a large quantity of soil, but significantly less than the entire contaminated volume. Additional costs would be incurred. The medium uncertainty is associated with the determining the nature of the permeable barrier and evaluating the site hydraulics to effectively design the slurry wall/barrier system.</p>	No – not effective given site conditions and TPH contaminants.

**Table 19b
Preliminary Screening of Remedial Technologies for Groundwater
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
<i>In Situ</i> Enhanced Bioremediation	<p>Adding oxygen, nutrients, co-substrates, or amendments to the groundwater to increase the rate of biodegradation.</p> <p>Can also implement this technology by applying amendments to open excavations during backfilling for treatment of residual contamination.</p>	<p>Applicability. Bioremediation is applicable to petroleum hydrocarbons, some solvents, and other organic chemicals. Can be effective for remediating low level residual contamination in conjunction with source removal.</p> <p>Limitations. Applies to contaminants that can be biodegraded. Low permeability soils can hinder contact between contaminant, oxygen, and applied nutrients. Bio-fouling can result from biomass accumulation on well screens. Too low or too high contaminant concentrations adversely affect biodegradation rates.</p>	<p>Medium</p> <p>Could enhance aerobic degradation in areas with lower contaminant concentrations. Potential for free product and high contaminant concentrations in source areas may be too toxic for effective biodegradation. Can be effective in controlling residual contamination in excavations by adding amendments to backfill in the saturated zone.</p>	<p>Moderately Easy</p> <p>Implementing this technology is fairly easy, and skills, experience and equipment requirements are minimal. However, ensuring uniform application throughout the subsurface may be problematic due to the silty and clayey soils. This could result in hot spots continuing to contaminate the groundwater. Implementation as a backfill amendment is very simple.</p>	<p>Low ④</p> <p>Adding oxygen, nutrients, and amendments to the subsurface involves easy-to-operate and fairly common equipment. Moderate uncertainty associated with need to determine nature of amendments through treatability studies and uncertainty related to timeframe for achieving cleanup goals. Also, stratified lithology/ low permeability soils may prevent complete contact with all contaminant mass.</p>	<p>Yes – may be cost effective for lower concentration groundwater plumes but would require treatability studies to evaluate further.</p>
Monitored Natural Attenuation	<p>Natural processes (volatilization, biodegradation, adsorption, and chemical reactions) are used to reduce contaminant concentrations to acceptable levels.</p>	<p>Applicability. Natural attenuation is a common element of cleanup programs for fuel hydrocarbons and halogenated VOCs. Can be used to manage residual contamination following site stabilization and source control activities.</p> <p>Limitations. Extensive site characterization, modeling, and monitoring are required to document the natural attenuation of the contaminants. Typically involves long cleanup timeframe. High contaminant concentrations and/or free phase product limit applicability of biodegradation. Similarly, higher molecular weight contaminants hinder volatilization.</p>	<p>Low</p> <p>As compared to other remedial technologies, use of MNA will result in an extended cleanup timeframe. Diesel and motor oil are not amenable to volatilization, and areas of high concentrations and/or free phase product will be toxic to the bacteria. MNA has been a viable tool for VOC remediation at nearby Site 4.</p>	<p>Easy</p> <p>The skills and experience to implement monitored natural attenuation is minimal. Sampling and analysis are needed to baseline the process and monitor ongoing progress.</p>	<p>Low to Medium ⑤</p> <p>Because there are no major equipment and construction requirements, the cost to implement this technology is low, although long-term monitoring costs can be significant. The uncertainty of achieving the RAOs is high since contaminant concentrations have remained high after many years of potential bioactivity. High concentrations and free product inhibit natural biodegradation, and the site contaminants are not amenable to natural volatilization.</p>	<p>No –not effective in achieving cleanup goals in reasonable timeframe.</p>
Air Sparging	<p>Air is injected into groundwater to volatilize contaminants, and oxygen potentially increases biodegradation rates. Contaminants sparged from groundwater are recovered in the unsaturated zone by SVE.</p>	<p>Applicability. Target contaminants for sparging include VOCs and volatile fuels. Removal mechanisms can include volatilization and enhanced bioremediation.</p> <p>Limitations. Non-volatile contaminants not removed with this technology. Effectiveness requires uniform flow of air through saturated soil. Heterogeneous soils can result in non-uniform treatment and uncontrolled movement of contaminated vapors. High contaminant solubility limits transfer to the vapor phase. Addition of oxygen could cause oxidation and precipitation of iron and impact air permeability.</p>	<p>Low</p> <p>Diesel and motor oil are not readily amenable to this technology with lower volatilization rate. Silts and clays result in areas of low permeability, adversely affecting air flowrates. High contaminant concentrations and/or free phase product increase the potential for spreading contamination into previously clean areas.</p>	<p>Easy</p> <p>Equipment to implement this technology is readily available and easy to operate. Similarly, the necessary skills and experience are minimal.</p>	<p>Medium ④</p> <p>Air sparging equipment costs are relatively low due to minimal equipment, although operating costs would add to the total cost. The uncertainty is high due to low air permeability, high contaminant concentrations, and unknown design parameters. Site lithology not conducive to technologies relying on subsurface air flow.</p>	<p>No – technology ineffective with heavier contaminants and not suited to soil conditions.</p>

**Table 19b
Preliminary Screening of Remedial Technologies for Groundwater
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
Thermally Enhanced Air Sparging	Hot air, steam, or electric heating is used to enhance desorption and volatilization of the contaminants. Other potential benefits are increased contaminant mobility and biodegradation rates.	<p>Applicability. Heating improves the volatility of VOCs and SVOCs. Effective for subsurfaces with higher air permeability.</p> <p>Limitations. Performance is function of attainable temperature, air permeability, and contaminant volatility. Off-gas and residual liquids may be required treatment/disposal. Higher process temperatures require specialized equipment. Shallow water tables may allow contaminated vapors to escape.</p>	<p>Medium</p> <p>Thermal enhancement may improve volatilization. Diesel and motor oil contaminants will volatilize more when heated. Maximum groundwater temperatures are limited by low air permeability and shallow water table. Stratified lithology may result in cold spots where contaminants are not treated, thereby continuing to contaminate the groundwater above RAO requirements.</p>	<p>Moderately Difficult</p> <p>Similar to air sparging except process equipment rated for higher temperature may be needed. Also, specialized skills are required to operate and maintain the heat source systems. Vapor control becomes a challenge to ensure contaminated vapors and liquids do not contaminate previously clean areas.</p>	<p>Medium to High ⑤</p> <p>Costs are higher than conventional air sparging due to need for high temperature rated equipment and material. Also, electrical and/or fuel costs are significantly higher to supply the heat source. Shallow water table may require additional measures to ensure contaminated vapors are not released from the site. Maximum soil temperatures are limited by low air permeability and shallow water table. High uncertainty since no data is available to determine long-term effectiveness and remediation duration. Site lithology not conducive to technologies relying</p>	No – technology likely ineffective due to soil conditions
In Well Vapor Stripping	In this technology, a groundwater circulation cell is created around a circulation well. Contaminated groundwater is cycled through lower and upper screened intervals. The lower screened interval is below the water table, and the upper screened interval is across or above the water table. This causes the water to aerated as it discharges into the unsaturated zone, causing contaminants to volatilize.	<p>Applicability. Air stripping is applicable to VOCs with Henry's law constant greater than 0.01 or vapor pressure greater than 0.5 mm Hg. Some compounds that have been successfully separated from water using air stripping include BTEX, chloroethane, TCE, vinyl chloride, DCE, and PCE.</p> <p>Limitations. High solubility, low Henry's constant, and low permeability reduce the overall effectiveness. High iron and hardness or biomass accumulation can cause operational problems and reduce efficiency or require pretreatment. Similarly, presence of free phase product will coat the circulation well and significantly decrease performance.</p>	<p>Low</p> <p>For stripping, diesel and motor oil are not readily amenable for air stripping with low volatilization rates. Silts and clays and stratified lithology result in areas of low permeability, adversely vertical flow of groundwater through subsurface.</p>	<p>Moderately Difficult</p> <p>The shallow water table makes this an easy technology to implement. With the confining layer close to the water table, short-circuiting may occur.</p>	<p>Medium ④</p> <p>Costs are moderate because although readily available conventional equipment is used, shallow groundwater zone being treated would require numerous wells. The uncertainty is high due to soil conditions and since the contaminants are not amenable to vapor phase partitioning.</p>	No – not effective with site contaminants or soil conditions.

**Table 19b
Preliminary Screening of Remedial Technologies for Groundwater
Napa Pipe Facility, Napa, California**

Technology	Description	General Applicability/Limitations	Comments Specific to Site 6			Retained?
			Effectiveness ^a	Implementability ^b	Relative Cost ^c	
<i>In Situ</i> Chemical Oxidation	Strong oxidizer is injected into subsurface to oxidize and destroy organic contaminants.	<p>Applicability. Chemical oxidation commonly applied to wide range of organic compounds including unsaturated aliphatic (i.e., TCE), aromatic compounds (i.e., benzene), and fuel hydrocarbons. Fast reaction rates can be achieved depending on oxidant type used.</p> <p>Limitations. Incomplete oxidation can result in intermediate contaminants. Uniform application of oxidants required to ensure all contaminants are being treated can be difficult to achieve in stratified soils. Indiscriminant and rapid reactions with other oxidant-consuming substances reduce effectiveness.</p>	<p>Medium to High</p> <p>Diesel and motor oil amendable to treatment using chemical oxidation. Effectiveness largely dependent on ability to distribute oxidant through target zone and low soil permeability from silts and clays will make uniform distribution of within the subsurface more difficult. Relatively shallow and thin treatment zone may help overcome this difficulty. Also, high contaminant concentrations and/or free phase product could require large amount of oxidizer.</p>	<p>Moderately Difficult</p> <p>After all aboveground structures are removed, injecting the oxidants would not be difficult, although effective distribution of oxidants through treatment zone may be challenging. Handling large quantities of strong oxidizers presents health and safety concerns.</p>	<p>Medium ④</p> <p>Costs dependent on contaminant concentrations. High concentrations and the potential presence of free phase product could require large quantities and frequent applications of the oxidizer and result in much higher costs. Handling and safety requirements add additional costs. The uncertainty is moderate to high since the stratified lithology and low soil permeability could prevent oxidant from being uniformly distributed within the contaminated regions – treatability studies would be required to address uncertainty.</p>	<p>Yes – although site soils not well suited for in situ approach, may be cost effective for lower concentration groundwater plumes.</p>
Saturated Soil Excavation	The contaminated groundwater plume is physically removed by excavating the saturated soil within the groundwater plume boundaries. Excavated soil is managed on-site through treatment or other appropriate methods and used as fill.	<p>Applicability. Excavation of soils below water table as a means of groundwater plume remediation is not a common approach, although shallow depth to water, relatively thin contaminated zone, and need for a short remediation timeframe may make it applicable at this site.</p> <p>Limitations. Requires heavy construction equipment. Dewatering likely required as part of saturated zone excavation. Extent of excavation is fairly large to ensure removal of all contaminated material. Contaminant aeration is likely during excavation, potentially requiring respiratory protection for on-site workers.</p>	<p>High</p> <p>Impacted groundwater (and associated saturated soil) is physically removed and no longer provides a potential source of contamination to groundwater.</p>	<p>Moderately Difficult</p> <p>Although standard soil excavation techniques would likely be utilized, implementing this approach will be complicated by need for dewatering and by the relatively large area to be excavated.</p>	<p>Medium ①</p> <p>Large contaminated area may require dewatering and hydraulic control. Costs impacted by approach to managing soil and groundwater once excavated. Potential need to use respiratory equipment and possible exposure to contaminated soils and groundwater increase costs. Low uncertainty since all contaminants are excavated and confirmed via on-site sampling.</p>	<p>Yes – would quickly and effectively eliminate groundwater contamination</p>

NOTE: Uncertainty rating reflects additional data needs or technology development needed to demonstrate applicability, implementability, and cost uncertainty. ① = low degree of uncertainty. Site data generally available to determine applicability. ⑤ = high degree of uncertainty. Additional data, analysis, pilot testing, or technology development required to determine applicability to site.

^a Preliminary effectiveness ratings of high, medium, and low reflect estimated relative effectiveness of the technology to treat the site contaminants and meet RAOs.

^b Implementability rating of easy, moderately easy, moderately difficult, and difficult reflect estimated relative complexity and cost of implementing the technology.

^c Cost reflects the relative overall costs (low, medium, high) of implementing the technology at the site.

Table 20
Estimated Capital and O&M Costs - Alternative 3
Ex Situ Source Area Soil and Groundwater Treatment and In Situ Groundwater Plume Remediation
Site 6 - Former Machine Shop and Drum Storage Area, and Southeastern Portion of Fabrication Buildings
Napa Pipe Facility, Napa, California

Construction Costs							
ITEM	UNIT COST		UNITS	QUANTITY		COST	
	low	high		low	high	low	high
Construction Costs							
1. Mobilization/demobilization	\$ 50,000	\$ 100,000	LS	1	1	\$ 50,000	\$ 100,000
2. Excavate, stockpile, and replace clean overburden	\$ 11	\$ 14	CY	200	500	\$ 2,000	\$ 7,000
3. Excavate contaminated unsaturated soil >cleanup levels and stockpile for on-site treatment	\$ 4	\$ 7	CY	6,000	6,000	\$ 24,000	\$ 42,000
4. Excavate saturated source area soil >cleanup levels and stockpile for on-site treatment	\$ 6	\$ 9	CY	4,100	4,100	\$ 25,000	\$ 37,000
5. Excavation dewatering, treat groundwater on-site, and discharge to sewer	\$ 75,000	\$ 125,000	LS	1	1	\$ 75,000	\$ 125,000
6. <i>In situ</i> treatment of area where groundwater >cleanup levels	\$ 25	\$ 35	CY	13,800	13,800	\$ 345,000	\$ 483,000
7. Amend excavation bottom prior to backfill	\$ 40,000	\$ 80,000	acre	0.4	0.8	\$ 16,000	\$ 60,000
8. Treatment of contaminated soil on-site							
- Move and replace untreated in commercial area (10% of volume)	\$ 9	\$ 12	CY	1,000	1,000	\$ 9,000	\$ 12,000
- Biopile Treatment (50% of total volume)	\$ 20	\$ 60	CY	5,100	5,100	\$ 102,000	\$ 306,000
- Low Temperature Thermal Desorption (30% of total volume)	\$ 40	\$ 75	CY	3,000	3,000	\$ 120,000	\$ 225,000
- Off-Site Disposal (10% of total volume)	\$ 60	\$ 90	CY	1,000	1,000	\$ 60,000	\$ 90,000
9. Installation of monitoring wells	\$ 25,000	\$ 50,000	LS	1	1	\$ 25,000	\$ 50,000
10. Confirmation soil/soil gas sampling	\$ 25,000	\$ 50,000	LS	1	1	\$ 25,000	\$ 50,000
					Subtotal	\$ 878,000	\$ 1,587,000
					Engineering and Permitting (15%)	\$ 132,000	\$ 238,000
					Construction Cost Contingency (30%)	\$ 263,000	\$ 476,000
					Total Estimated Capital Costs	\$ 1,270,000	\$ 2,300,000
					Average Capital Cost	\$ 1,790,000	
Operation and Maintenance Costs							
Activity	Estimated Annual Cost						
	low	high					
1. Confirmation Monitoring for <i>In Situ</i> Groundwater Treatment Area (assume 1 year)	\$ 50,000	\$ 75,000					
2. Monitoring well abandonment	\$ 40,000	\$ 80,000					
					Subtotal	\$ 90,000	\$ 155,000
					O&M Cost Contingency (20 %)	\$ 18,000	\$ 31,000
					Total Estimated O&M Costs	\$ 108,000	\$ 186,000
					Average O&M Cost	\$ 147,000	
					TOTAL ESTIMATED COST	\$ 1,940,000	

Table 21
Estimated Capital and O&M Costs - Alternative 4
Ex Situ Soil and Groundwater and Groundwater Remediation
Site 6 - Former Machine Shop and Drum Storage Area, and Southeastern Portion of Fabrication Buildings
Napa Pipe Facility, Napa California

Construction Costs							
ITEM	UNIT COST		UNITS	QUANTITY		COST	
	low	high		low	high	low	high
Construction Costs							
1. Mobilization/demobilization	\$ 50,000	\$ 100,000	LS	1	1	\$ 50,000	\$ 100,000
2. Excavate, stockpile, and replace clean overburden	\$ 11	\$ 14	CY	8,000	8,000	\$ 88,000	\$ 112,000
3. Excavate unsaturated and saturated soil >cleanup levels and stockpile for on-site treatment	\$ 4	\$ 7	CY	10,100	10,100	\$ 40,000	\$ 71,000
4. Excavate soil in area where groundwater >cleanup levels	\$ 6	\$ 9	CY	13,800	13,800	\$ 83,000	\$ 124,000
5. Pump groundwater from excavations, treat on-site, and discharge to sewer	\$100,000	\$ 150,000	LS	1	1	\$ 100,000	\$ 150,000
6. Amend excavation bottom prior to backfill	\$ 40,000	\$ 80,000	acre	1.5	2.5	\$ 60,000	\$ 200,000
7. Treatment of contaminated soil on-site (with other soils)							
- Move and replace untreated in commercial area (62% of volume)	\$ 9	\$ 12	CY	14,800	14,800	\$ 133,000	\$ 178,000
- Biopile Treatment (21% of total volume)	\$ 20	\$ 60	CY	5,100	5,100	\$ 102,000	\$ 306,000
- Low Temperature Thermal Desorption (13% of total volume)	\$ 40	\$ 75	CY	3,000	3,000	\$ 120,000	\$ 225,000
- Off-Site Disposal (4% of total volume)	\$ 60	\$ 90	CY	1,000	1,000	\$ 60,000	\$ 90,000
8. Confirmation groundwater sampling (Geoprobe)	\$ 20,000	\$ 40,000	LS	1	1	\$ 20,000	\$ 40,000
9. Confirmation soil/soil gas sampling	\$ 40,000	\$ 75,000	LS	1	1	\$ 40,000	\$ 75,000
				Subtotal		\$ 896,000	\$ 1,671,000
				Engineering and Permitting (15%)		\$ 134,000	\$ 251,000
				Construction Cost Contingency (30%)		\$ 269,000	\$ 501,000
				Total Estimated Capital Costs		\$ 1,300,000	\$ 2,420,000
				Average Capital Cost		\$ 1,860,000	

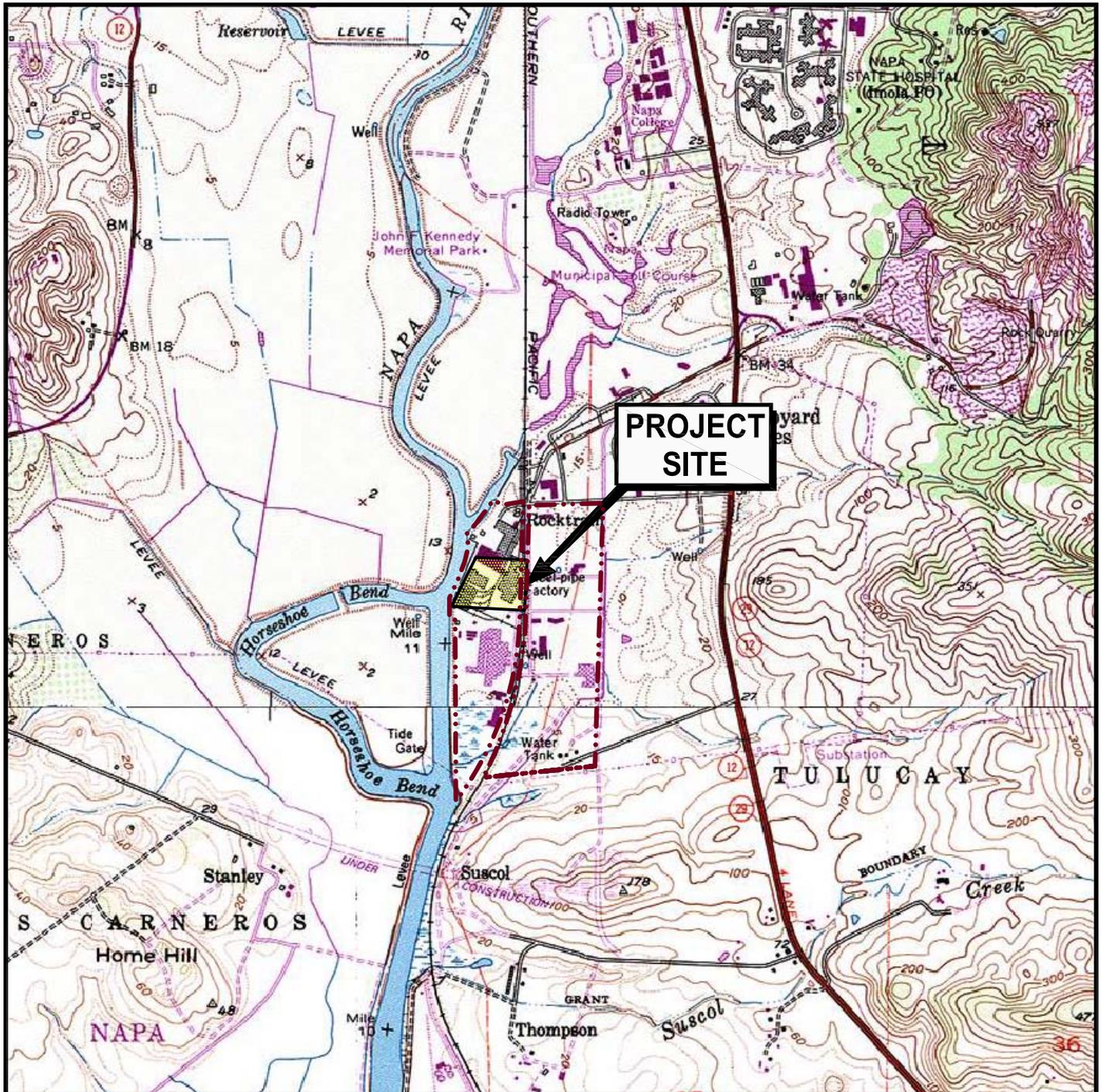
Table 22
Evaluation of Remedial Alternatives
Site 6 - Former Machine Shop and Drum Storage Area, and Southeastern Portion of Fabrication Buildings
Napa Pipe Facility
Napa, California

Evaluation Criteria	Remedial Alternatives				Comparison of Alternatives
	Alternative 1 - No Action	Alternative 2 - Maintain Existing Remedial Actions	Alternative 3 - <i>Ex Situ</i> Source Area Treatment with <i>In Situ</i> Groundwater Remediation	Alternative 4 - <i>Ex Situ</i> Soil and Groundwater Remediation	
NCP Threshold Criteria					
Overall Protection of Human Health and the Environment	Not protective. Would leave COCs in place above cleanup levels in both soil and groundwater.	Not protective for the range of foreseeable land uses. Would require long-term institutional and engineering controls to be protective. Would leave COCs in place above residential-based cleanup levels in both soil and groundwater.	By reducing COCs to below the risk-based cleanup levels, human health and the environment would be protected.	By excavating soil and groundwater with COCs above cleanup levels and treating this soil and groundwater to below the risk-based cleanup levels, Alternative 4 would be protective of human health and the environment.	Alternatives 1 and 2 are not protective of human health and the environment. Both Alternatives 3 and 4 appear to offer similar high levels of protectiveness through aggressive treatment of contaminants.
Compliance With ARARs	Would not comply with ARARs related to protection of human health.	May not fully comply with some ARARs.	Alternative 3 is expected to comply with the applicable ARARs. Treatment technologies would be designed and implemented in compliance with applicable regulations and permit requirements.	Alternative 4 is expected to comply with applicable ARARs. Treatment technologies would be designed and implemented in compliance with applicable regulations and permit requirements.	Alternative 1 would not comply with ARARs. Alternative 2 would comply with the few applicable ARARs, but only through extensive use of institutional and engineering controls. Alternatives 3 and 4 would comply with ARARs to essentially the same degree.
NCP Primary Balancing Criteria					
Long-Term Effectiveness	Ineffective in the long-term as alternative does not achieve, nor maintain, protection of human health and the environment.	Ineffective in the long-term as alternative does not achieve cleanup levels in all but the longest term and requires institutional and engineering controls to maintain protection of human health and the environment.	Through a combination of excavating with <i>ex situ</i> treatment and <i>in situ</i> chemical oxidation, Alternative 3 would permanently reduce contaminant concentrations to below cleanup levels and would therefore be effective in the long-term.	By excavating soil and groundwater exceeding ESLs and treating them <i>ex situ</i> to destroy the contaminants, Alternative 4 would permanently reduce contaminant concentrations to below cleanup levels and therefore would be effective in the long-term.	Alternatives 1 and 2 would not be effective in the long-term. By significantly reducing contaminant concentrations in soil and groundwater, both Alternatives 3 and 4 would be effective in the long-term. By relying solely on excavation to remove contaminants from the subsurface, Alternative 4 would appear to achieve this with a higher degree of certainty as compared to Alternative 3 which uses <i>in situ</i> treatment.
Reduction of Mobility, Toxicity, Volume	Alternative 1 does not achieve reduction in contaminant mobility, toxicity, or volume.	Alternative 2 achieves low to moderate reduction in contaminant mobility, toxicity, or volume via continued groundwater extraction at the Machine Shop area. The extraction system does not address groundwater contamination at the Former Drum Storage/Assembly Bay areas.	The mobility, toxicity, and volume of contaminants would be effectively and significantly reduced through the use of treatment technologies in Alternative 3. The majority of the contaminant mass would be excavated and managed <i>ex situ</i> , thereby effectively eliminating the majority of contaminants from the subsurface. The remaining contaminants present in excess of cleanup levels would be treated <i>in situ</i> to below cleanup levels.	Alternative 4 would significantly reduce the mobility, toxicity, and volume of contaminants through the use of excavation and treatment. This approach would effectively eliminate the majority of contaminants from the subsurface.	Alternative 1 would not reduce contaminant mobility, toxicity, and volume. Over the long-term, Alternative 2 would achieve moderate reduction in contaminant mobility, toxicity, and volume via groundwater extraction at the Machine Shop area, but would not address soil contamination nor groundwater contamination at the Former Drum Storage/Assembly Bay areas. Both Alternative 3 and 4 would provide significant reductions through treatment, although Alternative 4 may achieve this more reliably compared to Alternative 3, as noted above.
Short-Term Effectiveness	Because there are no remedial activities to be implemented or constructed, there are very few short-term risks with this alternative.	There are few short-term risks with this alternative.	There are several potential short-term risks associated with implementing Alternative 3 that would need to be managed to maintain worker health and safety including risks associated with heavy excavation and earthmoving equipment, handling the chemical oxidants, potential vapors present during excavation and treatment operations, and risks related to the <i>ex situ</i> treatment technologies (e.g., LTTD). These risks can be effectively mitigated through careful design, appropriate use of health and safety procedures, personal protective equipment, and engineering controls during implementation.	As with Alternative 3, there are several potential short-term risks associated with implementing Alternative 4. These include risks associated with heavy excavation and earthmoving equipment, potential vapors present during excavation and treatment operations, and risks related to the <i>ex situ</i> treatment technologies (e.g., LTTD). These risks can be effectively mitigated through careful design, appropriate use of health and safety procedures, personal protective equipment, and engineering controls during implementation.	Alternatives 1 and 2 would have few if any short-term risks associated with their implementation. Both Alternatives 3 and 4 would have short-term implementation risks, but in general these are common construction-related concerns encountered at environmental remediation sites and would be easily mitigated through careful design and use of appropriate health and safety procedures. Alternative 3 may have a slightly higher short-term risk due to the use of large quantities of chemical oxidants for the <i>in situ</i> treatment component of this alternative.

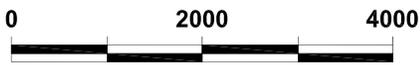
Table 22
Evaluation of Remedial Alternatives
Site 6 - Former Machine Shop and Drum Storage Area, and Southeastern Portion of Fabrication Buildings
Napa Pipe Facility
Napa, California

Evaluation Criteria	Remedial Alternatives				Comparison of Alternatives
	Alternative 1 - No Action	Alternative 2 - Maintain Existing Remedial Actions	Alternative 3 - <i>Ex Situ</i> Source Area Treatment with <i>In Situ</i> Groundwater Remediation	Alternative 4 - <i>Ex Situ</i> Soil and Groundwater Remediation	
Implementability	The no action alternative is technically implementable.	Alternative 2 is technically implementable.	The technologies utilized in Alternative 3 are generally well established and proven technologies. There are, however, implementability issues that need to be addressed to ensure the effectiveness of the remedial activities. Most notable of these are the issues related to <i>in situ</i> chemical oxidation, specifically potential problems with uniformly distributing the oxidant blend throughout the fine-grained soils of the treatment zone. Treatability studies would be performed to develop the appropriate injection approach and spacing and the correct oxidant dosing. Other less significant implementability issues include treatability studies for <i>ex situ</i> biological treatment and conducting significant excavations below the water table; these potential issues can be addressed during the design process. Administratively, the most significant implementability issues would likely be permitting requirements associated with the <i>ex situ</i> treatment technologies, most importantly the air permitting requirements for the low temperature thermal desorption unit.	Alternative 4 utilizes well established construction and treatment technologies with relative few implementability issues including: the need to conduct treatability studies to establish the design parameters for <i>ex situ</i> biological treatment and procedures for conducting significant excavations below the water table. These potential issues can be addressed during the design process and should not pose significant problems for implementation of Alternative 4. Permitting requirements for the soil treatment technologies, especially the air permitting requirements for the low temperature thermal desorption unit present the most significant administrative implementability concerns.	Although Alternatives 1 and 2 are technically implementable; they would not be administratively implementable. The excavation and <i>ex situ</i> components of Alternatives 3 and 4 would utilize the same construction and treatment technologies and therefore this aspect of these alternatives have identical implementability. The <i>in situ</i> component of Alternative 3 would present some potentially more significant implementability issues related to the difficulties in uniformly distributing the oxidant blend throughout the treatment zone, especially given the low permeability soils present at the Site. Bench and pilot scale treatability studies would help address this concern, but even then this aspect of Alternative 3 would make it's implementation somewhat less certain compared to Alternative 4. Administratively, the main issue for Alternatives 3 and 4 would be permitting requirements associated with the soil and groundwater treatment technologies, especially the LTTD unit.
Cost	There is little to no costs associated with the no action alternative.	Groundwater monitoring and extraction system operation for 20 years would cost approximately \$620,000.	Average estimated capital costs for Alternative 3 are \$1.79 million and O&M costs consisting of an estimated one year of groundwater monitoring and well abandonment total \$147,000. The total estimated cost of this alternative is \$1.94 million.	Average estimated capital costs for Alternative 4 are \$1.86 million. There are no O&M costs. The total estimated cost of this alternative is \$1.86 million.	Alternative 1 is by far the least costly, but does not achieve the comparison criteria or remedial objectives. Alternative 2, which only involves maintaining the existing monitoring and limited extraction system, still would cost \$620,000 over 20 years. Within the accuracy of the cost estimates, Alternatives 3 and 4 have essentially the same cost, with Alternative 3 having an estimated cost of approximately \$1.94 million, while Alternative 4 has an estimate cost of \$1.86 million.
NCP Modifying Criteria					
State Acceptance	Would not likely be accepted by State regulatory agencies.	Would not likely be accepted by State regulatory agency given the range of foreseeable land uses.	Given the protectiveness that would be achieved almost exclusively through contaminant treatment, it is expected that State agencies would accept this alternative.	Given the protectiveness that would be achieved almost exclusively through contaminant treatment, it is expected that State agencies would accept this alternative.	Alternatives 1 and 2 would not likely be acceptable to the State; they would not be protective nor comply with one or more of the applicable regulatory requirements. Given the protectiveness that would be achieved almost exclusively through contaminant treatment, both Alternatives 3 and 4 would likely be acceptable to the State.
Community Acceptance	Would not likely be accepted by public.	Would not likely be accepted by public given the range of foreseeable land uses.	Assuming that the short-term risks identified above can be addressed, it is anticipated that the community would accept this alternative due to its high level of protectiveness and permanence.	Potentially more acceptable to the community because all of the contaminants exceeding cleanup levels are removed and treated elsewhere instead of a portion of them being treated <i>in situ</i> .	Alternatives 1 and 2 would not likely be acceptable to the public. Alternatives 3 and 4 are anticipated to both be acceptable to the public given the aggressive approach to treating the contaminants and the cleanup levels achieved.
Summary of Evaluation for Alternatives	The no action alternative does not meet the NCP threshold, primary balancing, or modifying criteria.	Alternative 2 does not meet the NCP threshold, primary balancing, or modifying criteria.	Alternative 3 will meet both the threshold NCP requirements as well as most if not all of the balancing and modifying criteria. The one possible exception is the implementability concerns related to the <i>in situ</i> chemical oxidation. Treatability studies can be conducted to help address these concerns.	Alternative 4 appears to meet all of the NCP criteria with a high degree of certainty.	

ILLUSTRATIONS



— · · — Napa Pipe Facility Boundary



Scale In Feet



U.S.G.S. Topo Map - Napa, California, 7.5-minute quadrangle. Map version 1978; current as of 1980.
 U.S.G.S. Topo Map - Cuttings Wharf, California, 7.5-minute quadrangle. Map version 1978; current as of 1981.



Site Location Map
 Napa Pipe Facility
 1025 Kaiser Road
 Napa, California

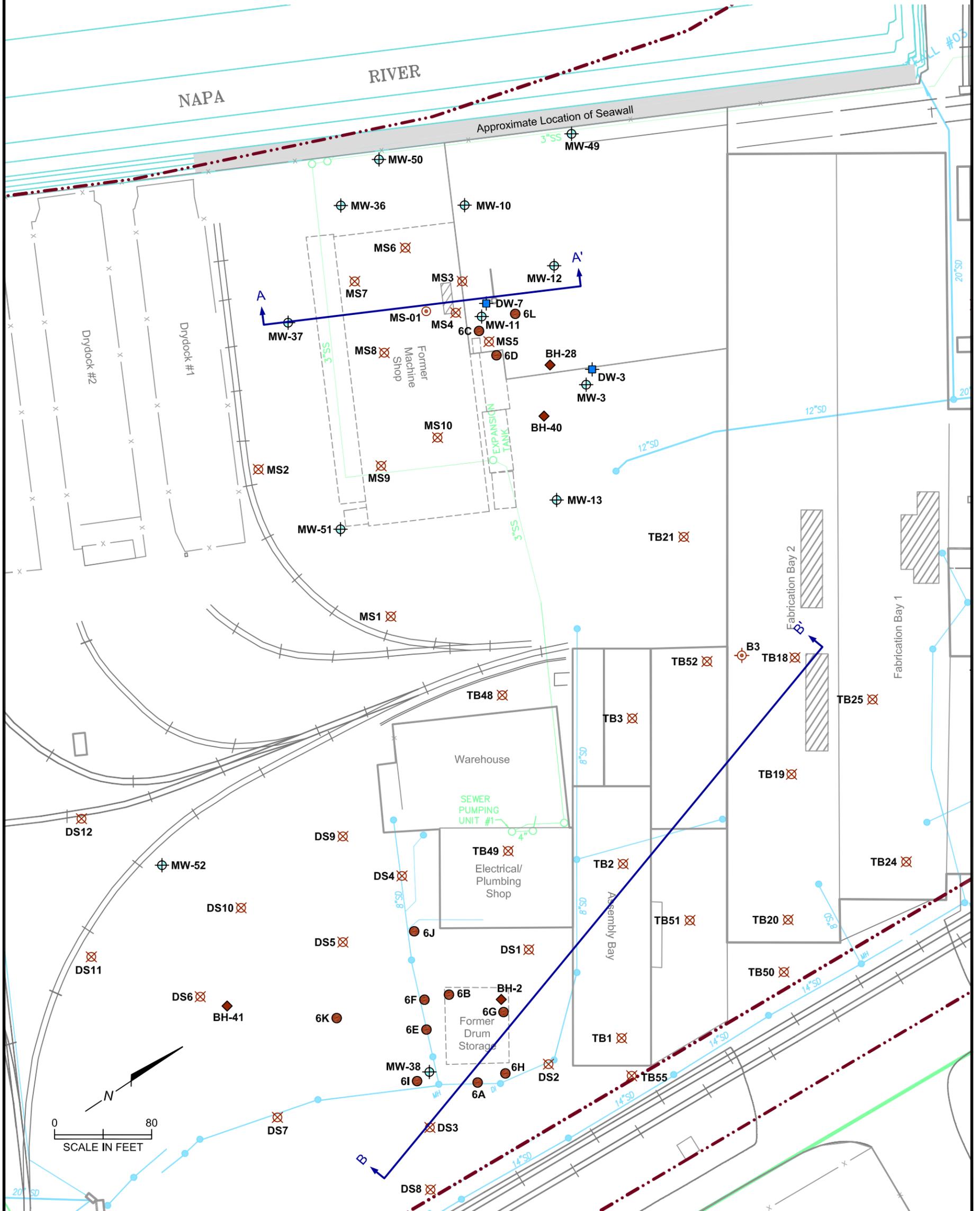
PLATE
1

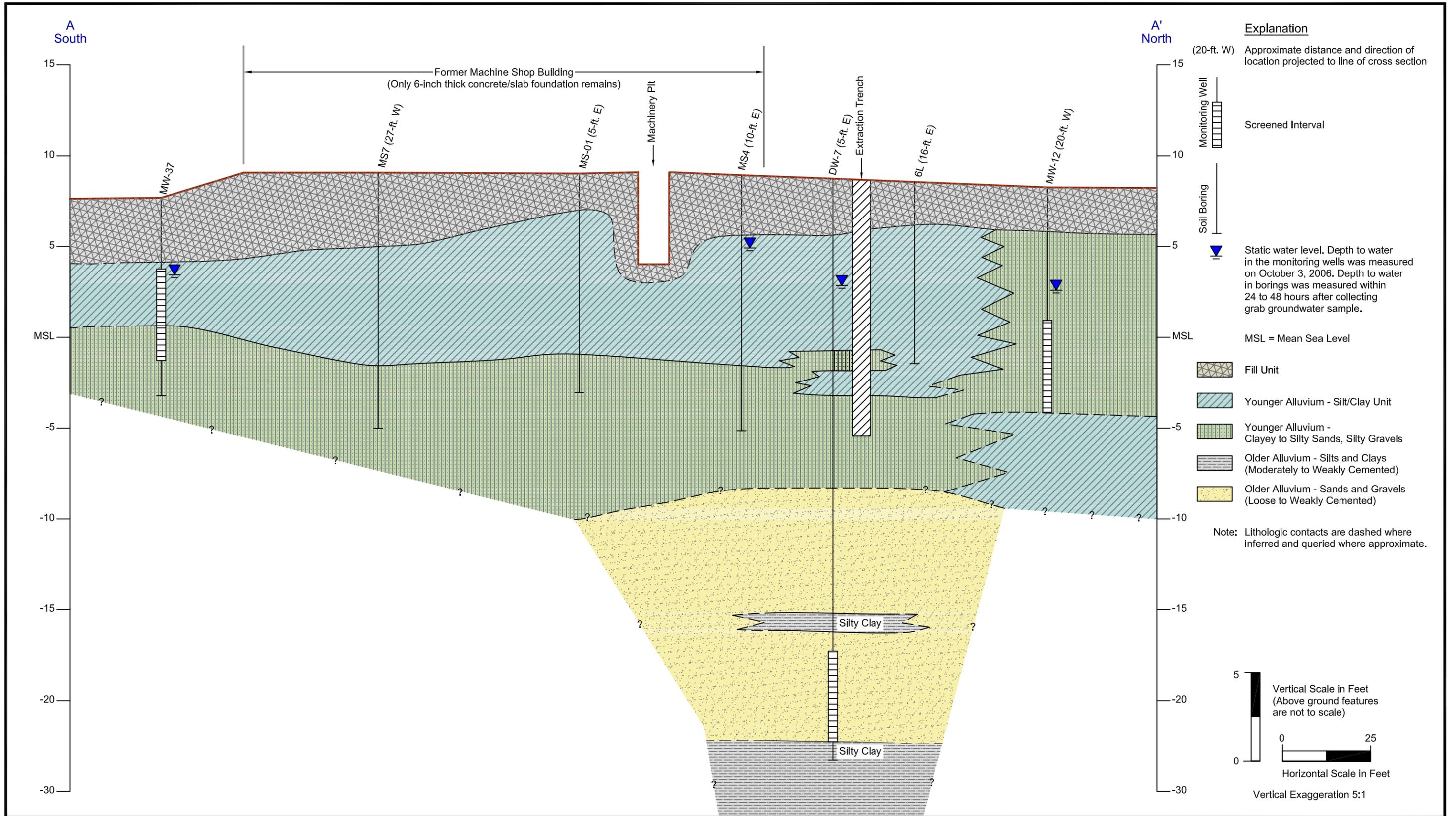
Explanation

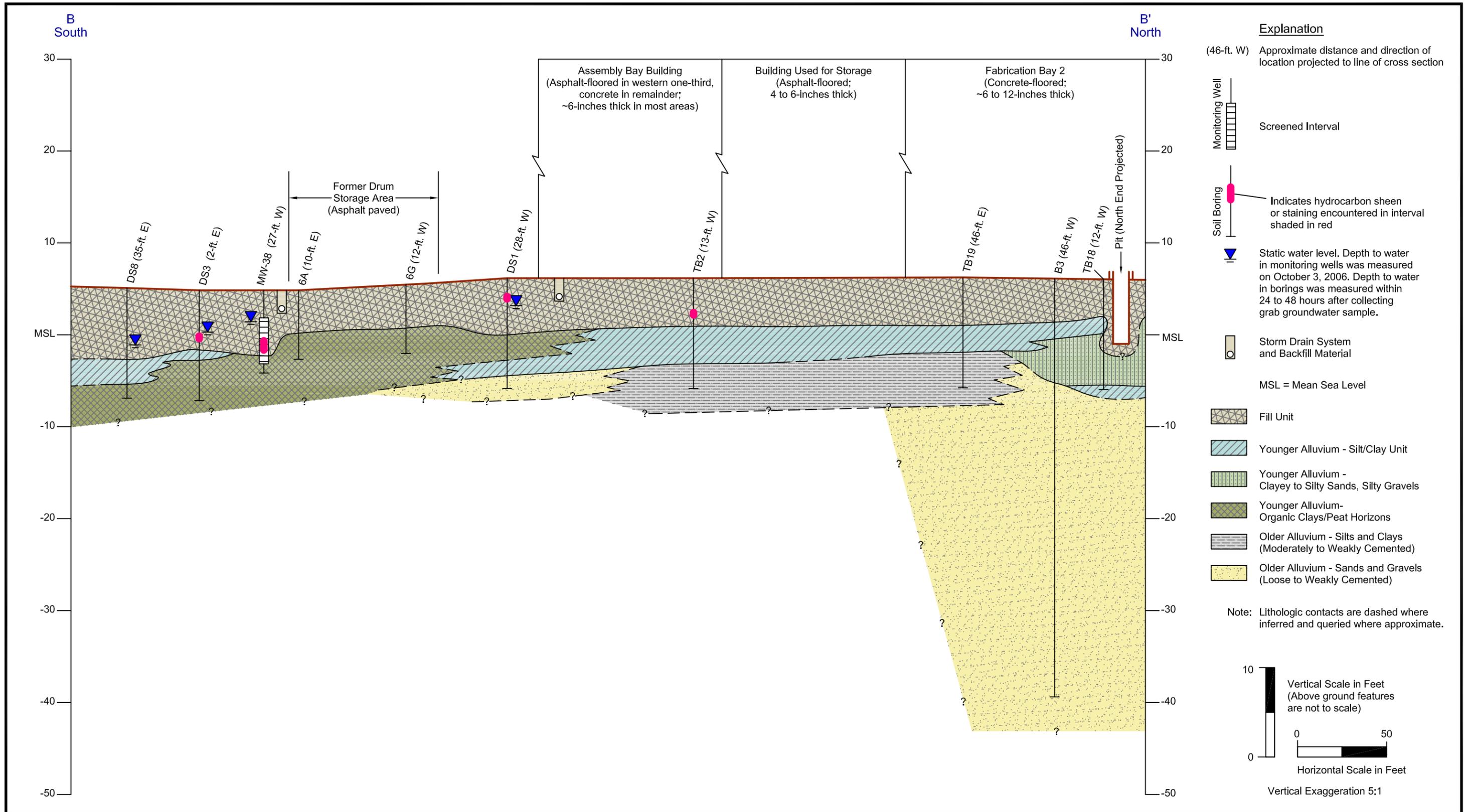
- Approximate Property Boundary
- Fence
- Railroad
- Sanitary Sewer System
- Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump

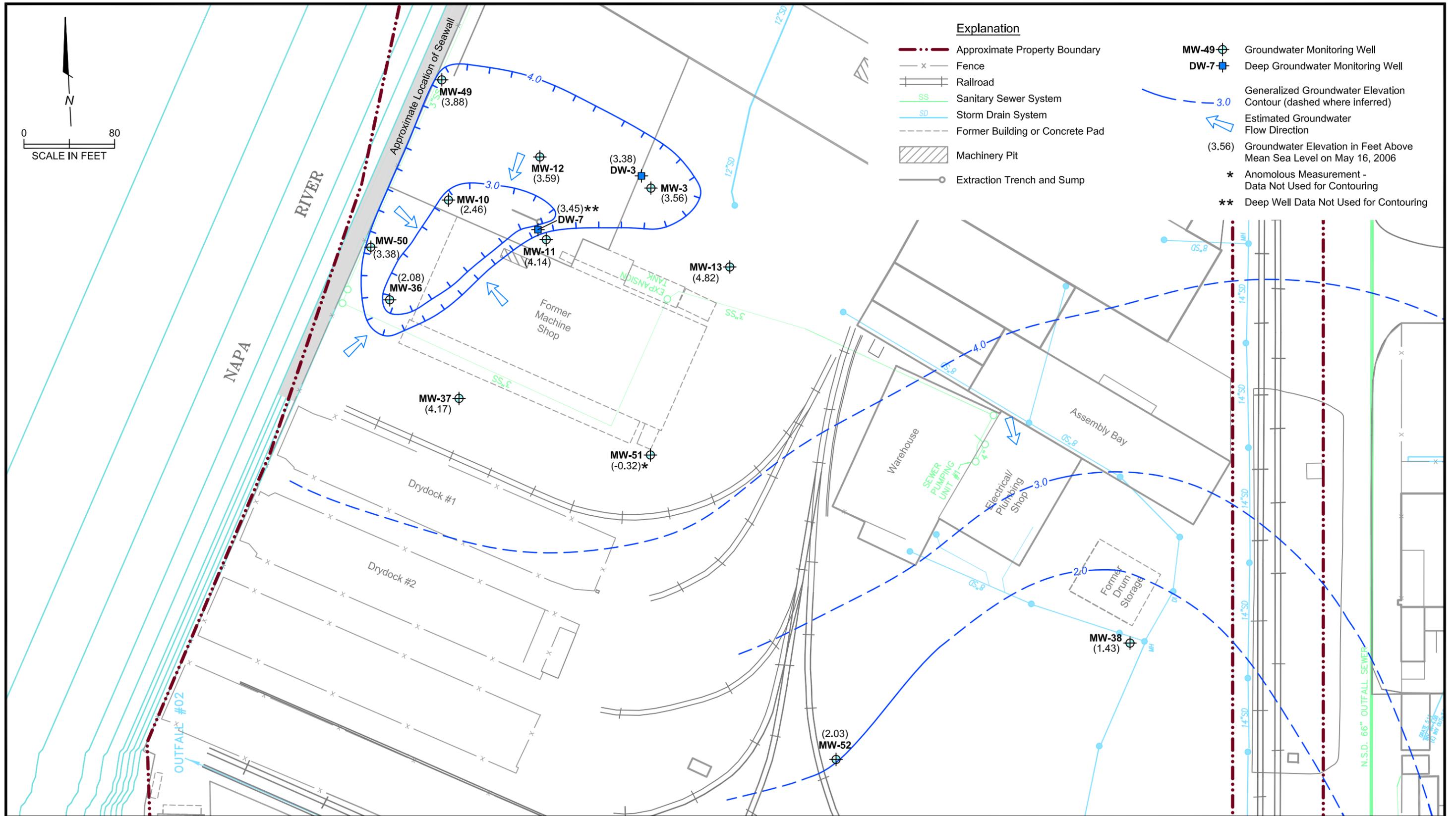
- MW-36 Groundwater Monitoring Well
- DW-7 Deep Groundwater Monitoring Well
- MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- BH-40 Soil Boring Location completed by JMM for KSC
- DS5 PES Supplemental Remedial Investigation Boring Location
- B3 J.H. Kleinfelder & Associates 1981 Geotechnical Boring

Hydrogeologic Cross Section Location (Arrows show direction of view)







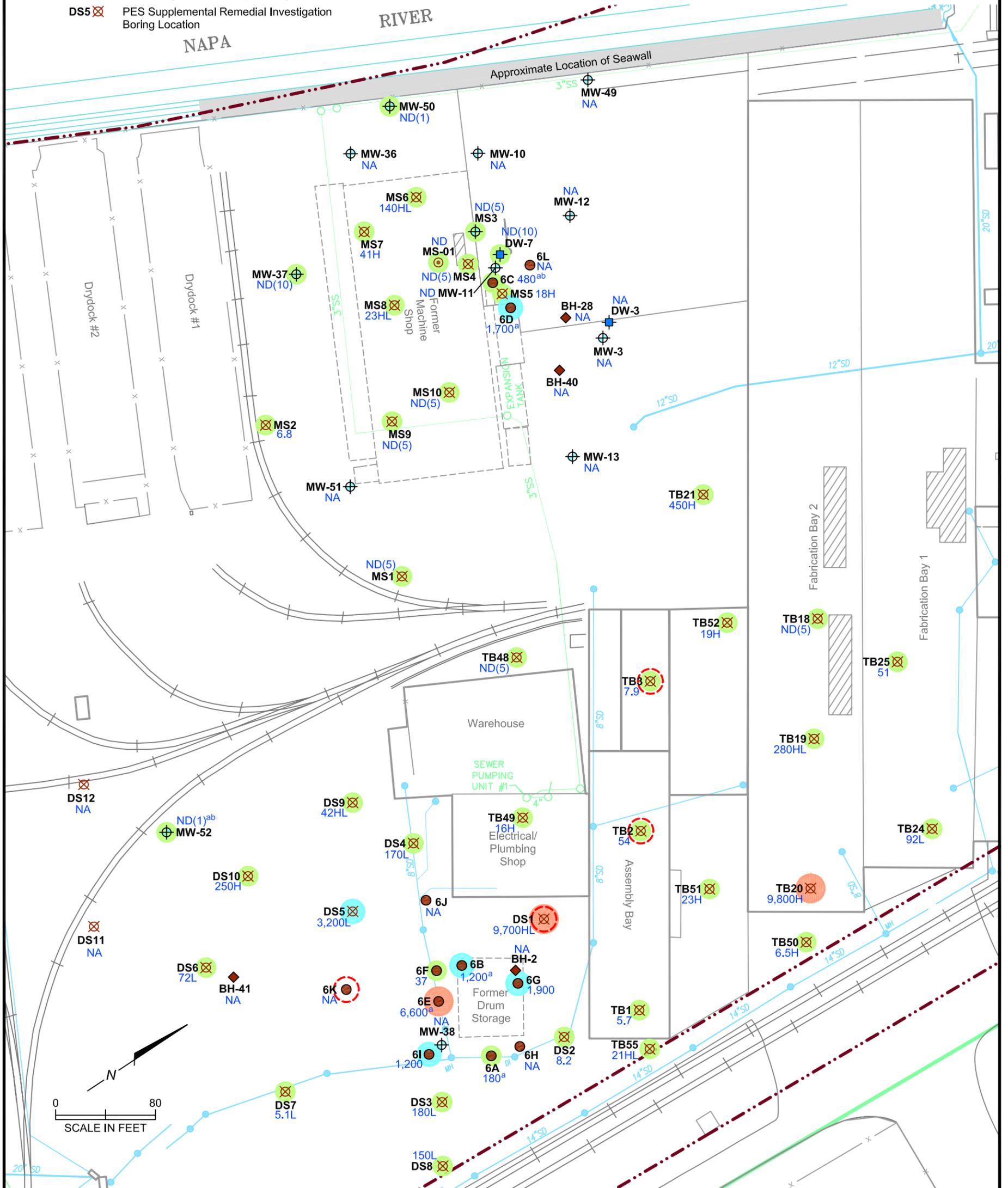


Explanation

- - - - - Approximate Property Boundary
- x - Fence
- =| Railroad
- SS Sanitary Sewer System
- SD Storm Drain System
- - - - - Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump
- MW-36** ⊕ Groundwater Monitoring Well
- DW-7** ⊕ Deep Groundwater Monitoring Well
- MS-01** ⊕ Shaw Phase II Soil Boring Location
- 6L** ● JMM, MW, or MWH Soil Boring Location
- BH-40** ◆ Soil Boring Location completed by JMM for KSC
- DS5** ⊗ PES Supplemental Remedial Investigation Boring Location

- DS6** ● Soil boring where Total Petroleum Hydrocarbons as Motor Oil (TPH-mo) is either not detected or detected at a concentration equal to or below the Environmental Screening Level [ESL] of 500 milligrams/kilogram (mg/kg)
- DS5** ● Soil boring where TPH-mo concentration is between 501 and 5,000 mg/kg
- DS1** ● Soil boring where TPH-mo concentration is between 5,001 and 50,000 mg/kg
- Petroleum hydrocarbon sheen or staining observed in the 0 to 4 ft. below ground surface (bgs) interval
- 72L** Analytical results in mg/kg

- ND** Not Detected (number in parenthesis, if present, is laboratory reporting limit)
 - NA** Not Analyzed
 - a** Reported as Total Petroleum Hydrocarbons (i.e., TPH-d and TPH-mo combined)
 - b** Sample collected at a depth of 3.5 to 4 ft bgs. Therefore, the TPH-mo ESL of 1,000 mg/kg applies to sample. (Note: Green dot represents concentration less than or equal to 1,000 mg/kg and blue dot represents concentration between 1,001 and 5,000 mg/kg.)
- Data Qualifiers**
- L** Lighter hydrocarbons contributed to the quantitation
 - H** Heavier hydrocarbons contributed to the quantitation

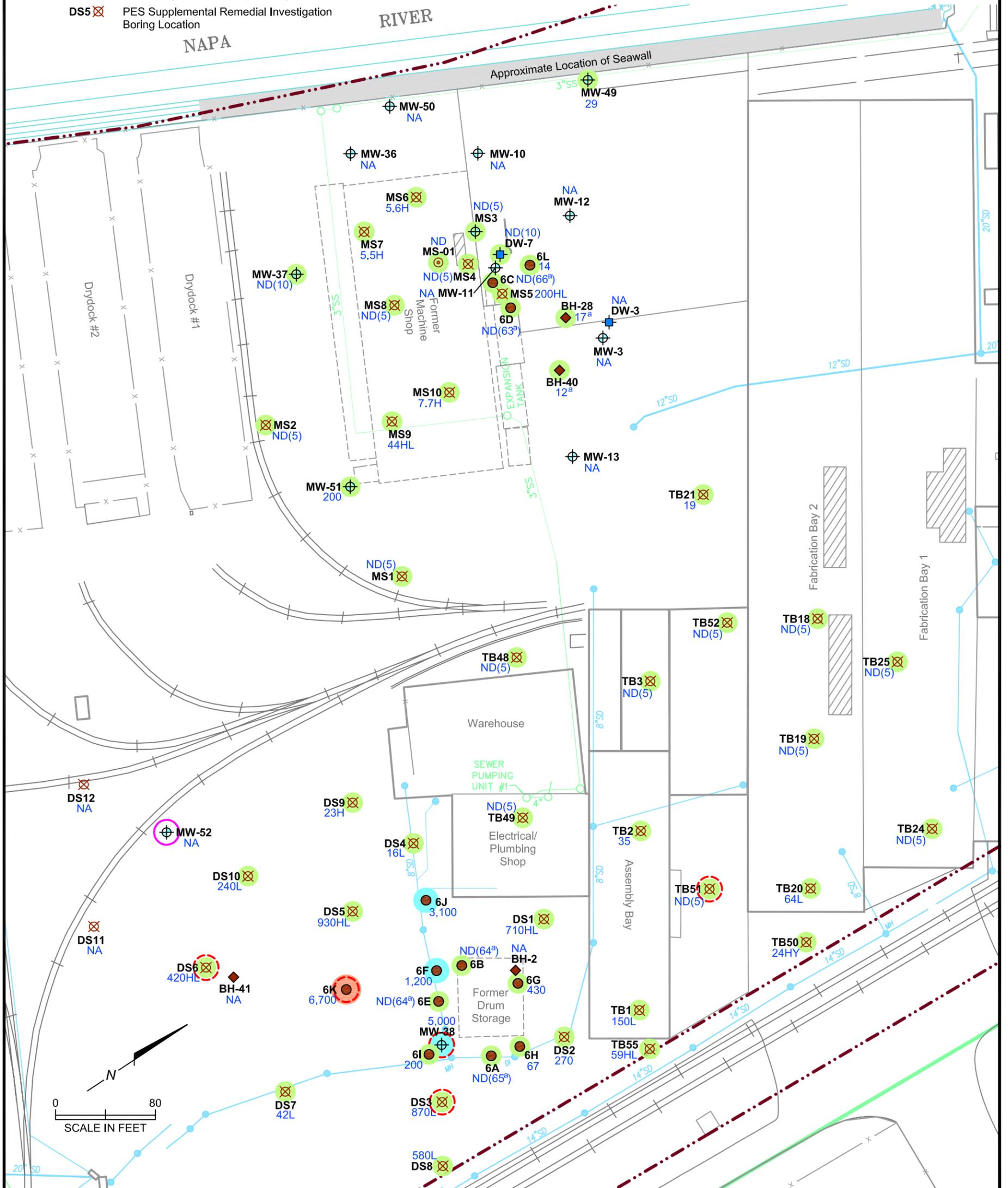


Explanation

- - - Approximate Property Boundary
- x - Fence
- = Railroad
- SS Sanitary Sewer System
- SD Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump
- ⊕ MW-36 Groundwater Monitoring Well
- ⊕ DW-7 Deep Groundwater Monitoring Well
- ⊕ MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- ◆ BH-40 Soil Boring Location completed by JMM for KSC
- ⊗ DS5 PES Supplemental Remedial Investigation Boring Location

- DS6 420HL Soil boring where Total Petroleum Hydrocarbons as Motor Oil (TPH-mo) is either not detected or detected at a concentration equal to or below the Environmental Screening Level [ESL] of 1,000 milligrams/kilogram (mg/kg)
- 6F 1,200 Soil boring where TPH-mo concentration is between 1,001 and 5,000 mg/kg
- DS1 6,700 Soil boring where TPH-mo concentration is between 5,001 and 50,000 mg/kg
- Petroleum hydrocarbon sheen or staining observed in the 4 to 10 ft. below ground surface (bgs) interval
- Separate-phase product observed in the 4 to 10 ft. bgs interval

- 1,200 Analytical results in mg/kg
 - ND Not Detected (number in parenthesis, if present, is laboratory reporting limit)
 - NA Not Analyzed
 - ^a Reported as Total Petroleum Hydrocarbons (i.e., TPH-d and TPH-mo combined)
- Data Qualifiers**
- L Lighter hydrocarbons contributed to the quantitation
 - H Heavier hydrocarbons contributed to the quantitation
 - Y Sample exhibits chromatographic pattern which does not resemble standard



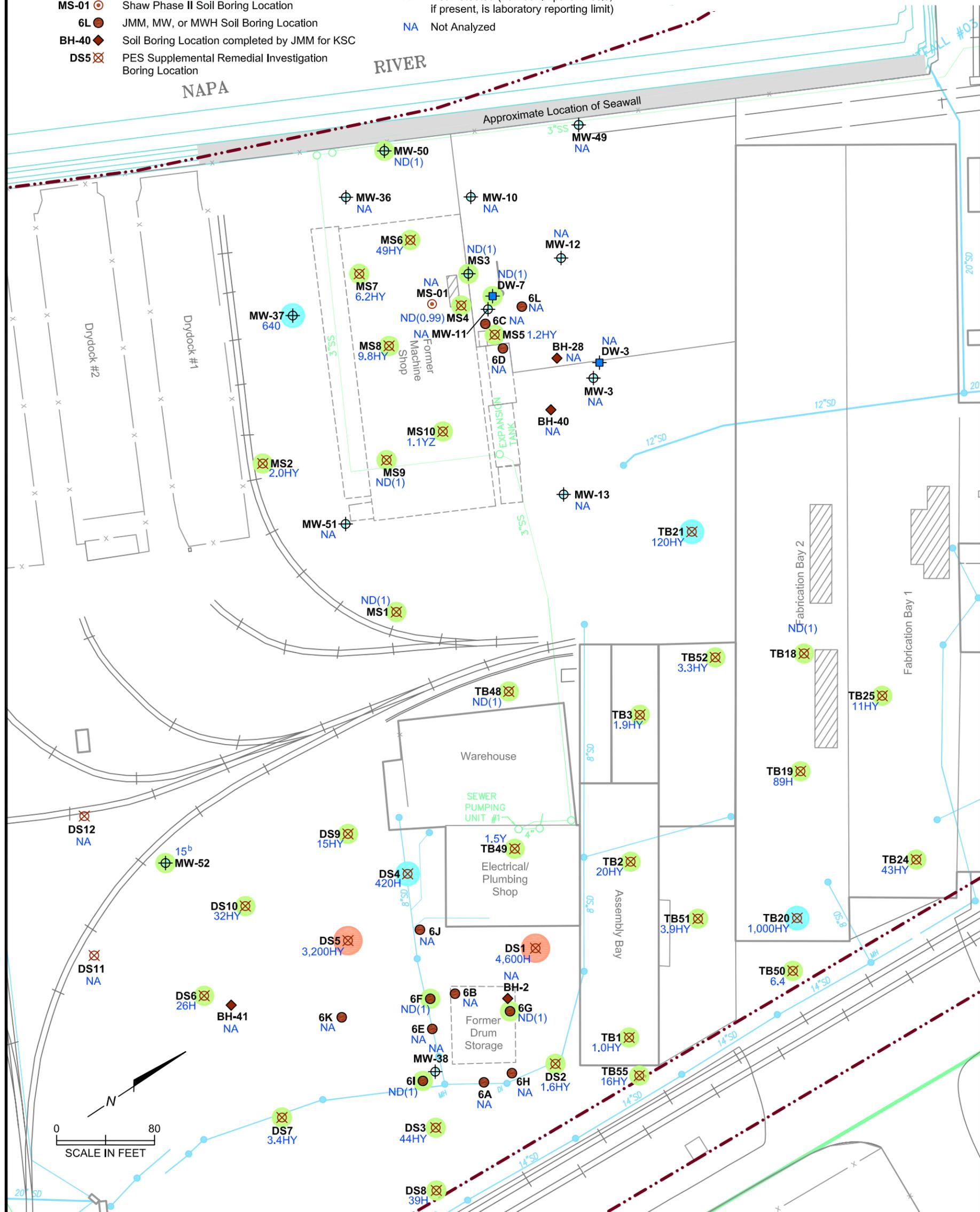
Spatial Distribution of Total Petroleum Hydrocarbons as Motor Oil in Soil (4 to 10 ft. bgs)
Site 6 (Former Machine Shop and Drum Storage Area)
 Napa Pipe Facility, 1025 Kaiser Road
 Napa, California

Explanation

- - - Approximate Property Boundary
- x - Fence
- = Railroad
- SS Sanitary Sewer System
- SD Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump
- ⊕ MW-36 Groundwater Monitoring Well
- ⊕ DW-7 Deep Groundwater Monitoring Well
- ⊕ MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- ◆ BH-40 Soil Boring Location completed by JMM for KSC
- ⊗ DS5 PES Supplemental Remedial Investigation Boring Location

- MS8 9.8HY Soil boring where Total Petroleum Hydrocarbons as Diesel (TPH-d) is either not detected or detected at a concentration equal to or below the Environmental Screening Level [ESL] of 100 milligrams/kilogram (mg/kg)
- MW-37 640 Soil boring where TPH-d concentration is between 101 and 1,000 mg/kg
- DS5 3,200HY Soil boring where TPH-d concentration is between 1,001 and 10,000 mg/kg
- 640 Analytical results in mg/kg
- ND Not Detected (number in parenthesis, if present, is laboratory reporting limit)
- NA Not Analyzed

- Sample collected at a depth of 3.5 to 4 ft bgs. Therefore, the TPH-d ESL of 400 mg/kg applies to sample. (Note: Green dot represents concentration less than or equal to 400 mg/kg and blue dot represents concentration between 401 and 1,000 mg/kg.)
- Data Qualifiers**
- H Heavier hydrocarbons contributed to the quantitation
- Y Sample exhibits chromatographic pattern which does not resemble standard
- Z Sample exhibits unknown peak or peaks



Explanation

- Approximate Property Boundary
- Fence
- Railroad
- Sanitary Sewer System
- Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit

- Extraction Trench and Sump
- MW-36 Groundwater Monitoring Well
- DW-7 Deep Groundwater Monitoring Well
- MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- BH-40 Soil Boring Location completed by JMM for KSC
- DS5 PES Supplemental Remedial Investigation Boring Location

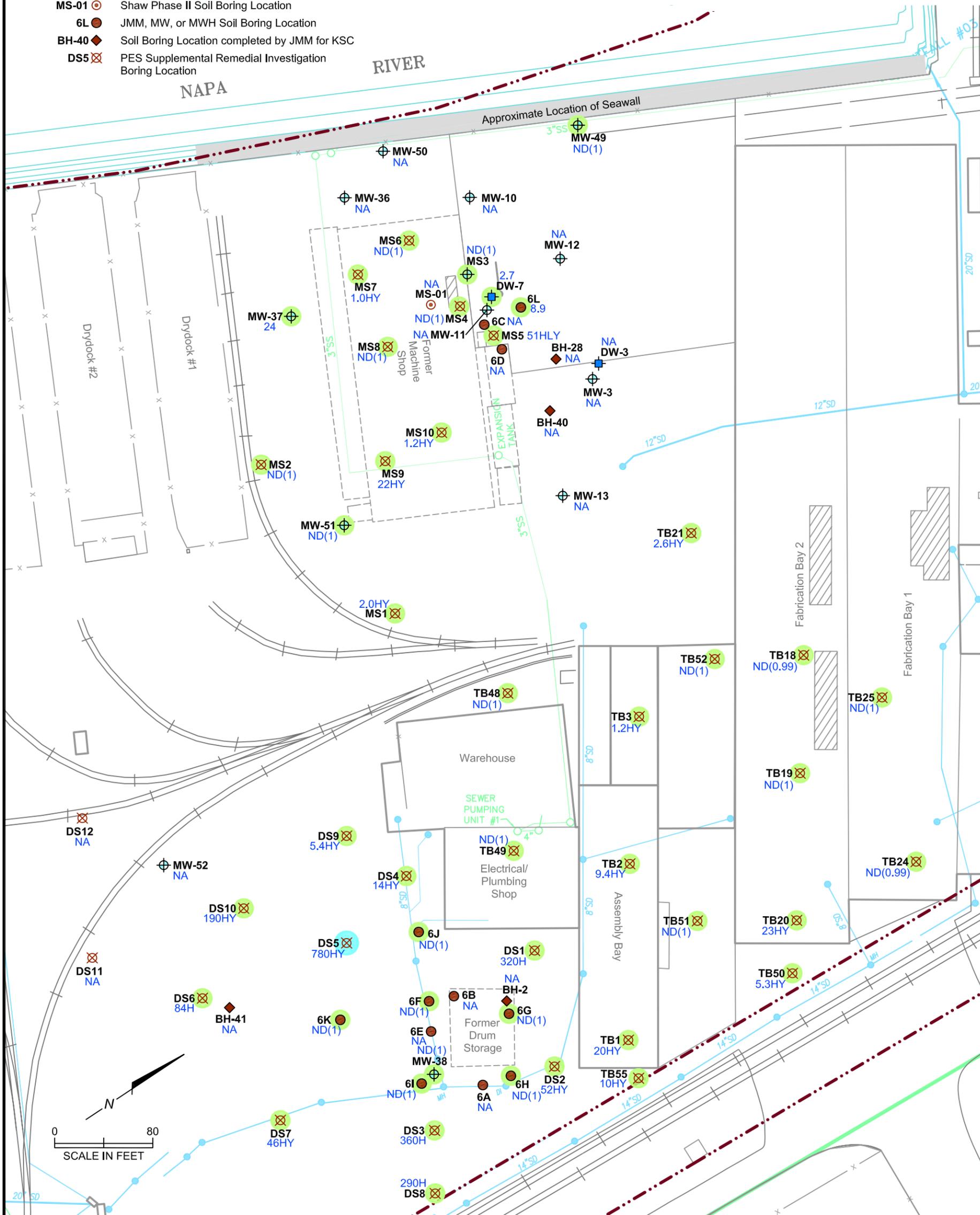
MS1 2.0HY Soil boring where Total Petroleum Hydrocarbons as Diesel (TPH-d) is either not detected or detected at a concentration equal to or below the Environmental Screening Level [ESL] of 400 milligrams/kilogram (mg/kg)

DS5 780HY Soil boring where TPH-d concentration is between 401 and 1,000 mg/kg

2.0HY Analytical results in mg/kg
ND Not Detected (number in parenthesis, if present, is laboratory reporting limit)
NA Not Analyzed

Data Qualifiers

- H** Heavier hydrocarbons contributed to the quantitation
- Y** Sample exhibits chromatographic pattern which does not resemble standard



Explanation

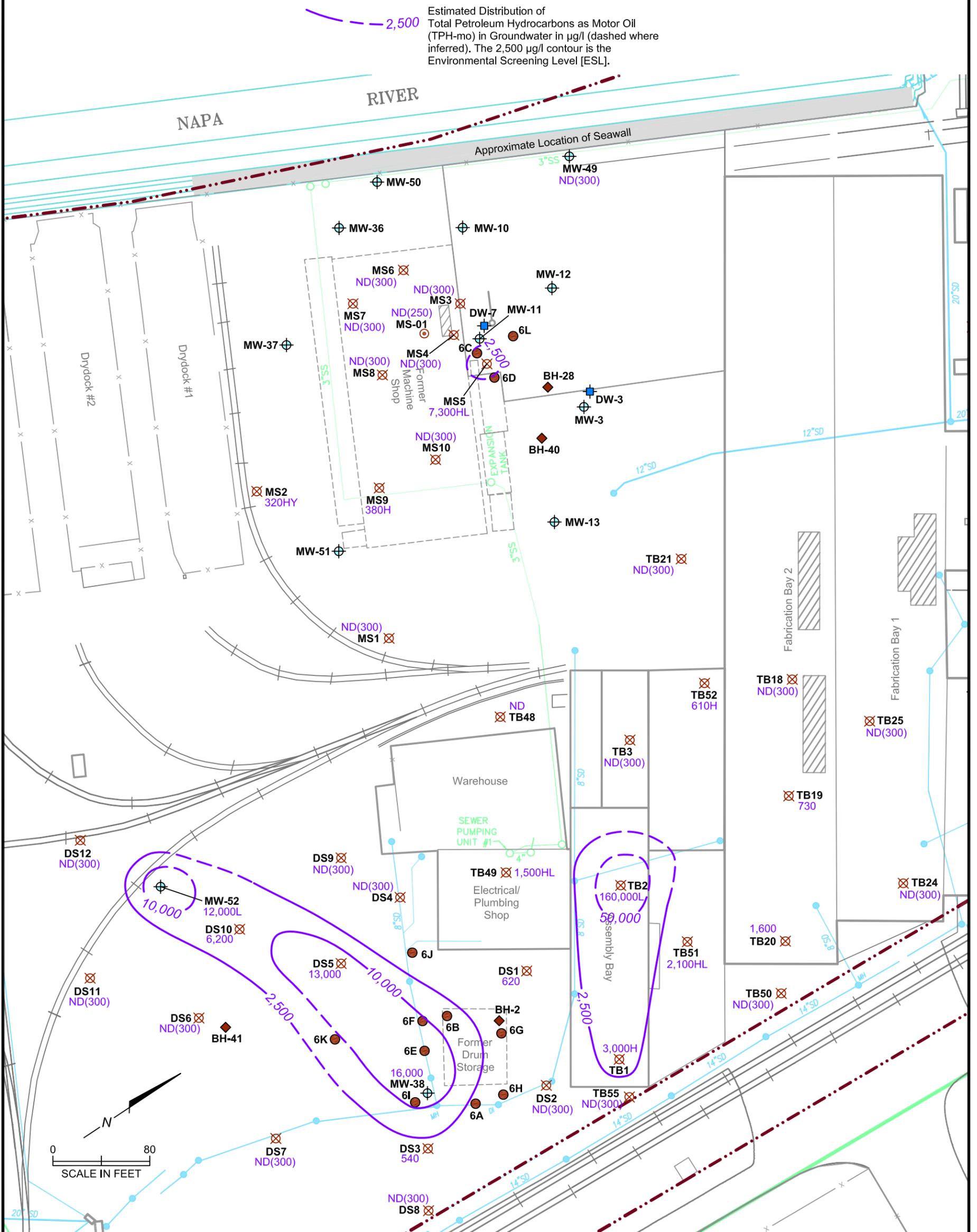
- Approximate Property Boundary
- Fence
- Railroad
- Sanitary Sewer System
- Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump

- MW-36 Groundwater Monitoring Well
- DW-7 Deep Groundwater Monitoring Well
- MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- BH-40 Soil Boring Location completed by JMM for KSC
- DS5 PES Supplemental Remedial Investigation Boring Location
- 7,300HL Concentration in micrograms per liter (µg/l)
- ND(300) Not Detected (number in parenthesis is laboratory reporting limit)

Data Qualifiers

- L Lighter hydrocarbons contributed to the quantitation
- H Heavier hydrocarbons contributed to the quantitation
- Y Sample exhibits chromatographic pattern which does not resemble standard

Note: Posted monitoring well results are from the October 2006 monitoring event.



Distribution of Total Petroleum Hydrocarbons as Motor Oil in Groundwater
Site 6 (Former Machine Shop and Drum Storage Area)
 Napa Pipe Facility, 1025 Kaiser Road
 Napa, California

Explanation

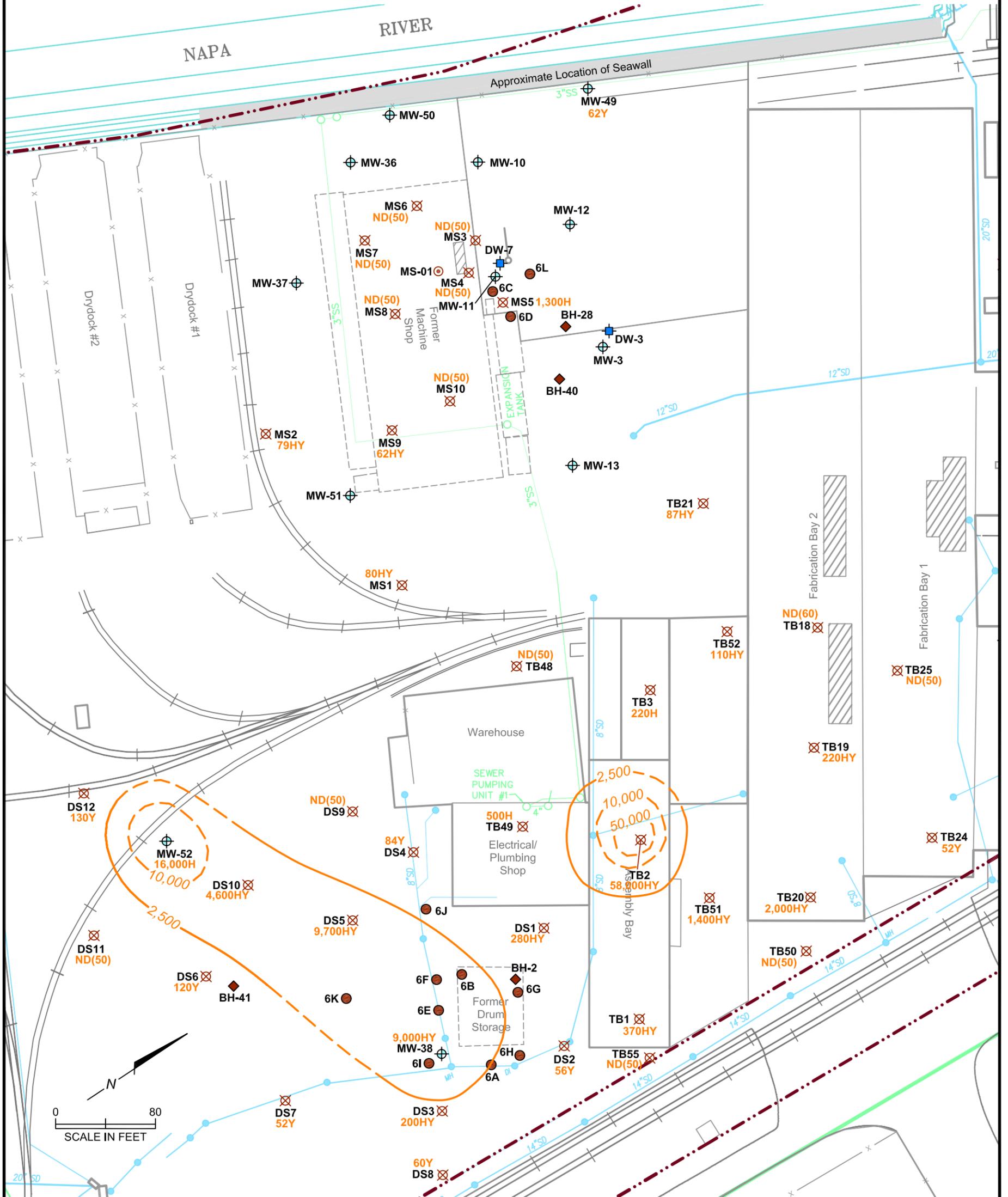
- - - Approximate Property Boundary
- x - Fence
- | | | Railroad
- SS Sanitary Sewer System
- SD Storm Drain System
- - - Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump

- ⊕ MW-36 Groundwater Monitoring Well
- ⊕ DW-7 Deep Groundwater Monitoring Well
- ⊙ MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- ◆ BH-40 Soil Boring Location completed by JMM for KSC
- ⊗ DS5 PES Supplemental Remedial Investigation Boring Location

Data Qualifiers

- H Heavier hydrocarbons contributed to the quantitation
 - Y Sample exhibits chromatographic pattern which does not resemble standard
- Note: Posted monitoring well results are from the October 2006 monitoring event.

- 62Y Concentration in micrograms per liter (µg/l)
- ND(50) Not Detected (number in parenthesis is laboratory reporting limit)
- 2,500 Estimated Distribution of Total Petroleum Hydrocarbons as Diesel (TPH-d) in Groundwater in µg/l (dashed where inferred). The 2,500 µg/l contour is the Environmental Screening Level [ESL].



Explanation

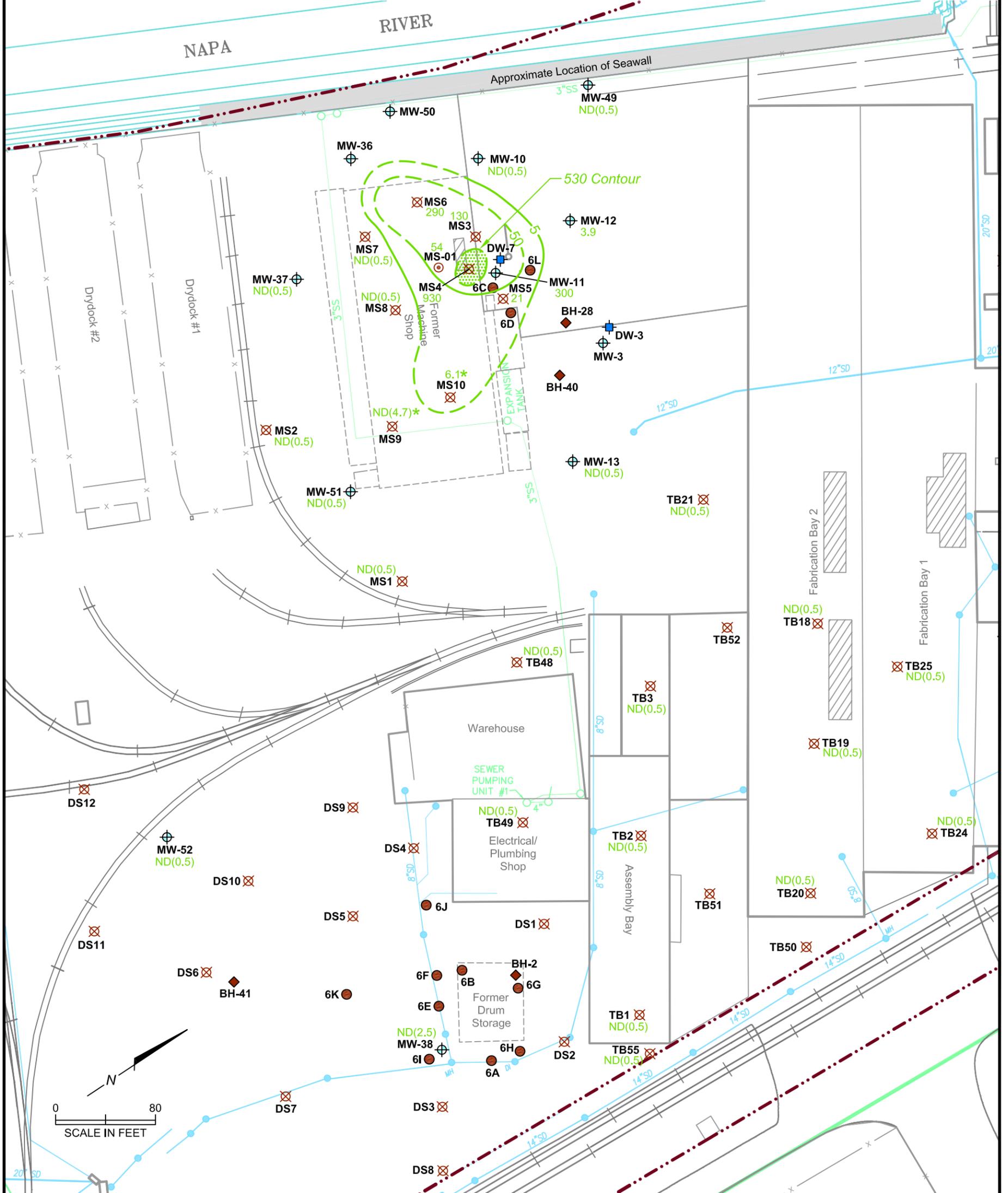
- - - Approximate Property Boundary
- x - Fence
- = Railroad
- SS Sanitary Sewer System
- SD Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump

- ⊕ MW-36 Groundwater Monitoring Well
- ⊕ DW-7 Deep Groundwater Monitoring Well
- ⊕ MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- ◆ BH-40 Soil Boring Location completed by JMM for KSC
- ⊗ DS5 PES Supplemental Remedial Investigation Boring Location

- 130 Concentration in micrograms per liter (µg/l)
- ND(0.5) Not Detected (number in parenthesis is laboratory reporting limit)
- 50 Estimated Distribution of Trichloroethylene in Groundwater in µg/l (dashed where inferred)
- ⊗ Estimated Areal Extent of Shallow Groundwater Concentrations Above the Environmental Screening Level [ESL] of 530 µg/l

* Excessive sediment was in the 40 ml VOA vials for this sample. Consequently, the laboratory was not able to analyze the sample as groundwater, but was able to analyze it as a sediment sample. Therefore, the results are reported in micrograms per kilogram (µg/kg).

Note: Posted monitoring well results are from the October 2006 monitoring event.

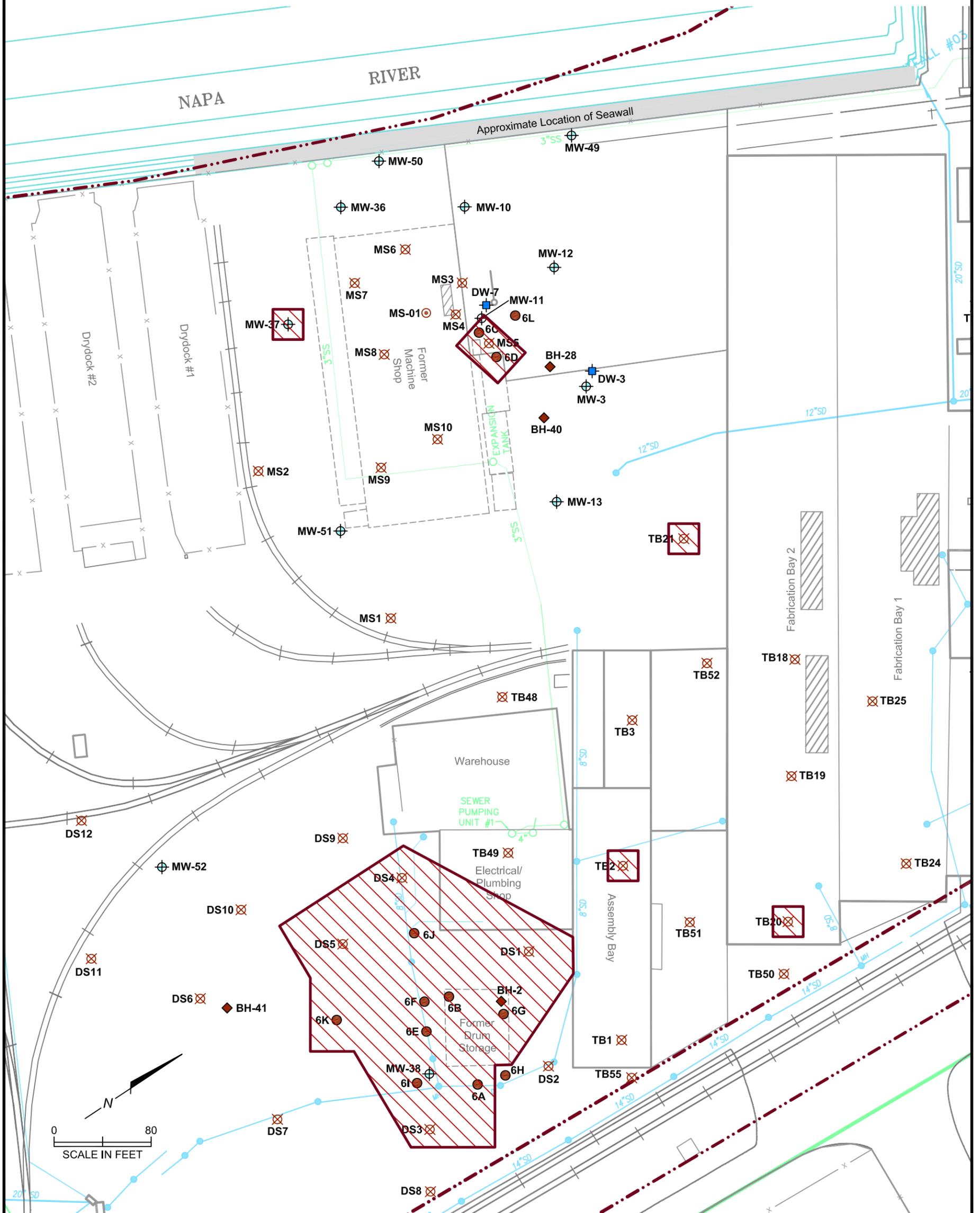


Explanation

- Approximate Property Boundary
- Fence
- Railroad
- Sanitary Sewer System
- Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump

- MW-36 Groundwater Monitoring Well
- MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- BH-40 Soil Boring Location completed by JMM for KSC
- DS5 PES Supplemental Remedial Investigation Boring Location

Area Exceeding Soil Cleanup Levels 0 to 4 ft. below ground surface (bgs)
In-place volume approximately 6,000 cubic yards



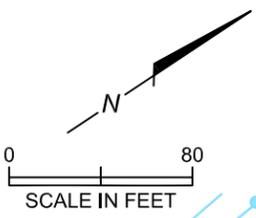
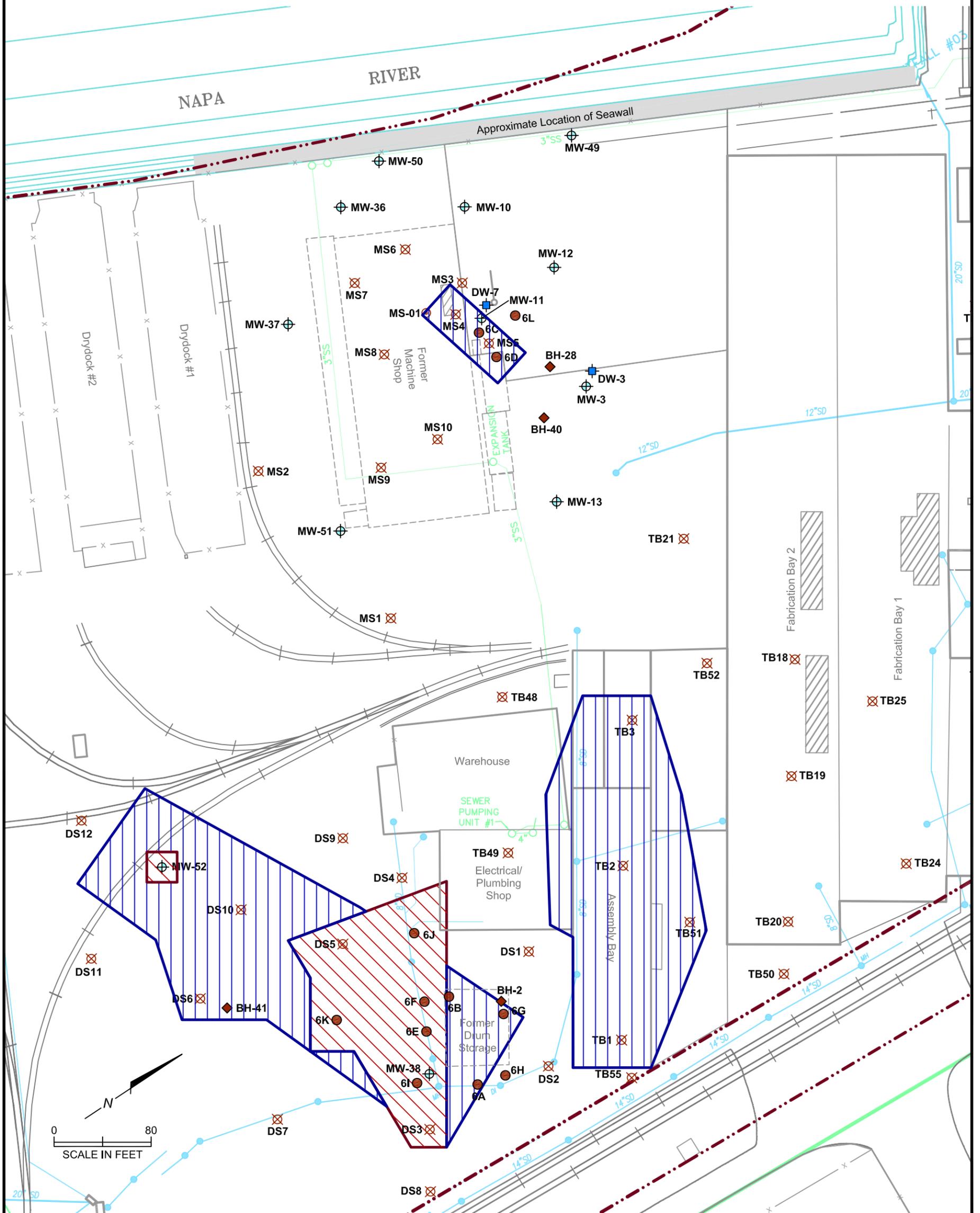
**Approximate Area of Unsaturated Soil (0 to 4 ft. bgs) Exceeding Cleanup Levels
Site 6 (Former Machine Shop and Drum Storage Area)
Napa Pipe Facility, 1025 Kaiser Road
Napa, California**

Explanation

- Approximate Property Boundary
- Fence
- Railroad
- Sanitary Sewer System
- Storm Drain System
- Former Building or Concrete Pad
- Machinery Pit
- Extraction Trench and Sump

- MW-36 Groundwater Monitoring Well
- MS-01 Shaw Phase II Soil Boring Location
- 6L JMM, MW, or MWH Soil Boring Location
- BH-40 Soil Boring Location completed by JMM for KSC
- DS5 PES Supplemental Remedial Investigation Boring Location

- Area Exceeding Only Groundwater Cleanup Levels 4 to 10 ft. below ground surface (bgs)
In-place volume approximately 13,800 cubic yards
- Area Exceeding Soil and Groundwater Cleanup Levels (includes area of estimated extent of separate-phase product/sheen) 4 to 10 ft. bgs
In-place volume approximately 4,100 cubic yards



Approximate Area of Saturated Soil (4 to 10 ft. bgs) and Groundwater Exceeding Cleanup Levels Site 6 (Former Machine Shop and Drum Storage Area)
Napa Pipe Facility, 1025 Kaiser Road
Napa, California

PLATE

16

APPENDIX A

FORMER MACHINE SHOP FLOOR PLAN

APPENDIX B

SUPPLEMENTAL REMEDIAL INVESTIGATION LITHOLOGIC LOGS

APPENDIX C

GEOLOGIC CROSS SECTIONS PREPARED BY MONTGOMERY WATSON

APPENDIX D

**PREVIOUS INVESTIGATION LITHOLOGIC LOGS AND MONITORING WELL
COMPLETION DIAGRAMS**

APPENDIX E

**TABLES AND PLATES FOR 1987 SOIL AND GROUNDWATER TESTING
BY JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.**

APPENDIX F

**TABLES AND PLATES FOR 1989 SOIL AND GROUNDWATER INVESTIGATION
BY JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.**

APPENDIX G

**TABLES AND PLATES FOR 1990 SOIL INVESTIGATION BY
JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.**

APPENDIX H

**TABLES AND PLATES FROM THE 1996 *SITE 6 CHARACTERIZATION AND
REMEDIAL ACTION PLAN* BY MONTGOMERY WATSON**

APPENDIX I

**TABLES AND PLATES FROM THE DECEMBER 2005 *PHASE II SITE*
INVESTIGATION BY SHAW ENVIRONMENTAL INC.**

APPENDIX J

LABORATORY ANALYTICAL REPORTS AND CHAIN OF CUSTODY FORMS

APPENDIX K

**CHEMICAL FATE AND TRANSPORT FROM
MONTGOMERY WATSON'S 1996 *SITE 6*
*CHARACTERIZATION AND REMEDIAL ACTION PLAN***

DISTRIBUTION

**SUMMARY OF REMEDIAL INVESTIGATIONS,
FEASIBILITY STUDY AND REMEDIAL ACTION PLAN
NAPA PIPE FACILITY
1025 KAISER ROAD
NAPA, CALIFORNIA**

**VOLUME 4
SITE 6 – FORMER MACHINE SHOP, FORMER DRUM STORAGE AREA, AND
SOUTHEASTERN PORTION OF FABRICATION BUILDINGS**

JUNE 8, 2007

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